Iowa Toxics Sampling 2017

Results for Acetaldehyde and Formaldehyde

Iowa DNR
Ambient Air Monitoring Group

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Summary

Scope

Section 112 of the Clean Air Act [1] contains the federal strategy for protecting the public from air toxics emissions. The Act specifies a particular list of air toxics called "hazardous air pollutants" (HAPs) for regulatory action [2]. Emitters of large amounts of these HAPs are subject to regulations that require adoption of work practices or installation of control technologies in order to reduce HAP emissions [3]. The Act requires a periodic assessment of the residual health risk posed by the HAPs [4] and adoption of additional control standards where necessary [5].

In order to establish long term trends in HAP concentrations across the nation as a component of its residual risk assessment, the Environmental Protection Agency (EPA) has funded national air toxics trends stations (NATTS) [6]. These sites contain a standard suite of samplers and analytical protocols [7]. Unlike NATTS sites, Iowa's air toxics sites do not have instrumentation to measure toxic metals, polycyclic aromatic hydrocarbons, or black carbon.

A review of the historical air toxics monitoring dataset [8] argues that benzene, formaldehyde, 1,3-butadiene, acrolein, arsenic, hexavalent chromium, and diesel particulate pose the greatest risk to the public health on a national level. Only one of the seven national risk drivers is discussed in this report.

Sampling Schedules

The sampling schedule for formaldehyde and acetaldehyde is based on Iowa's ozone season. As defined by EPA, Iowa's ozone season is March through October. Samples were gathered at a frequency of one sample every sixth day inside ozone season and one sample every twelfth day outside ozone season. In calculations of average pollutant levels and cancer risks, 12-day block averages were constructed. The days in a given block are the days between two days on EPA's one in twelve day sampling schedule, along with the later of the two days that bracket this interval. Averaging over these 12-day blocks instead of averaging over the raw data is performed in order to avoid biasing the average due to accelerated sampling during ozone season.

Data Capture

For the purpose of this report, a valid twelve-day average is an average constructed from one or more samples collected during the scheduled twelve-day sampling period. The data capture rate is defined as the ratio of the number of valid twelve-day averages divided by the number of scheduled twelve-day periods in the year (31). EPA data analysis guidelines typically require 75% data completeness across each sampling quarter. All Iowa sites met this data capture goal for formaldehyde and acetaldehyde.

Data Handling

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.

Precision Data

Precision statistics are calculated from the results of the analysis of duplicate cartridges. Precision statistics shown in this report have been calculated according to 40 CFR Part 58, Appendix A (2006) using the methodology applicable to collocated fine particulate data pairs. The formulas are reproduced in Appendix A.

Results of the Analysis

Formaldehyde and acetaldehyde concentrations were measured at levels above the EPA benchmark of one in a million excess lifetime cancer risk at all Iowa sites. Formaldehyde levels measured during the study period are associated with a much higher cancer risk than acetaldehyde at the Iowa sites in 2017.

IRIS specifies different levels of certainty associated with its cancer risk factors. 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 [9].

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.

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 [10]. In interpreting the results of the 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 approximately three excess cancers per 100,000 people (3×10^{-5}), associated with average formaldehyde levels at sites in Des Moines and Muscatine. For comparison, according to the 2017 edition of Injury Facts published by the National Safety Council, the lifetime risk of dying in a motor vehicle accident is 8.8×10^{-3}, or

approximately 300 times higher. The lifetime risk of being killed by lightning is 6.2 x 10^{-6}, or approximately 5 times lower than developing cancer at this level of formaldehyde exposure [11].

References

1. Federal rules regulating air toxics: http://www.epa.gov/ttn/atw/eparules.html

2. Current list of HAPs and their health effects: http://www.epa.gov/ttn/atw/hlthef/hapindex.html

3. EPA regulations limiting HAPs emissions: https://www.epa.gov/haps/reducing-emissions-hazardous-air-pollutants

4. EAP's latest national assessment of health risks due to HAPs: https://www.epa.gov/national-air-toxics-assessment

5. Residual risk assessments: http://www.epa.gov/ttn/atw/rrisk/rtrpg.html

6. Current list of NATTS sites: http://www.epa.gov/ttnamti1/files/ambient/airtox/nattsite.pdf

7. Sampling protocol used to operate NATTS sites: http://www.epa.gov/ttn/amtic/files/ambient/airtox/NATTS_Model_QAPP.pdf

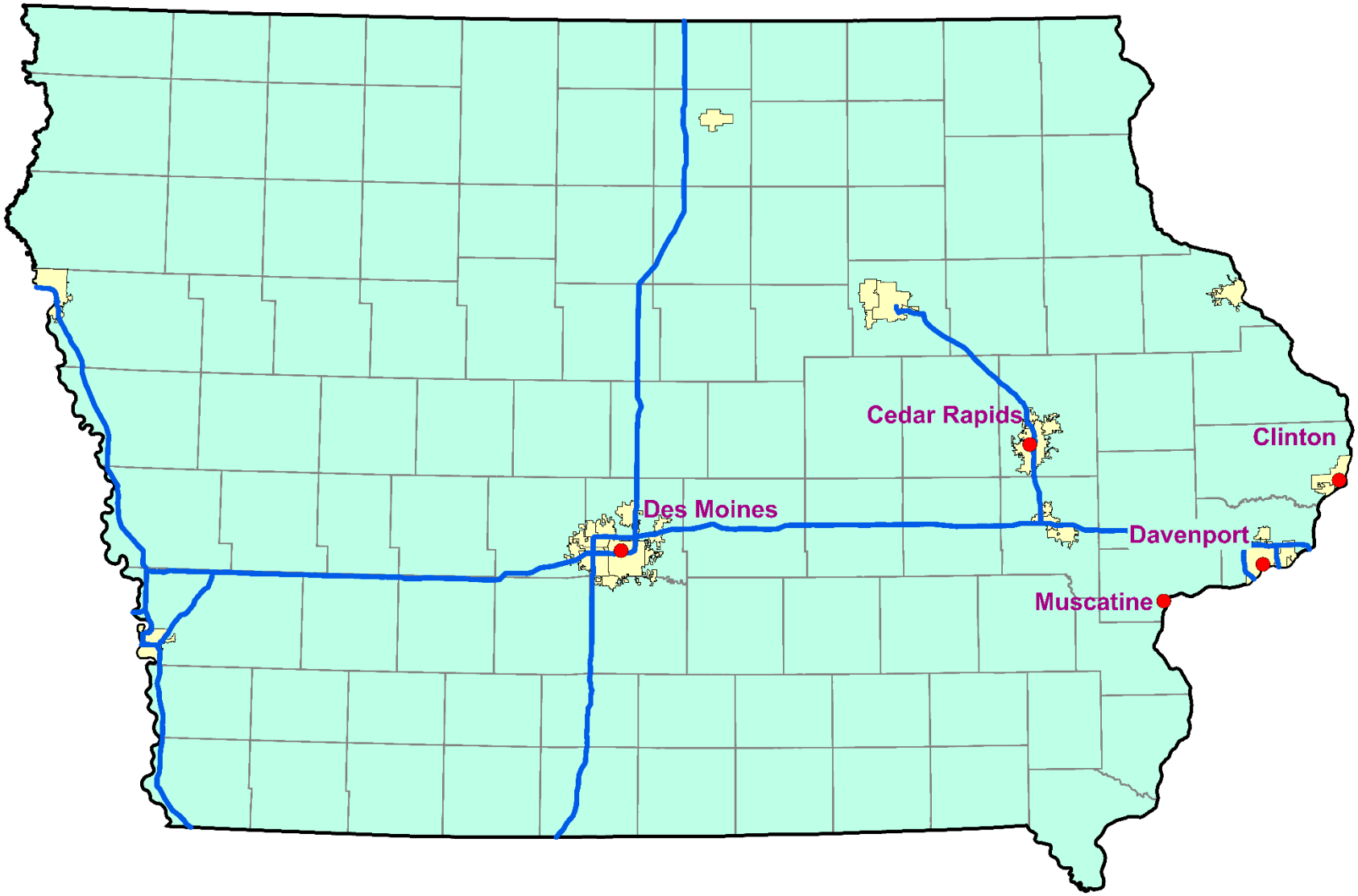
8. Historical review of air toxics monitoring data: http://www.ladco.org/reports/toxics/sti/

9. Integrated Risk Information System: http://www.epa.gov/iris

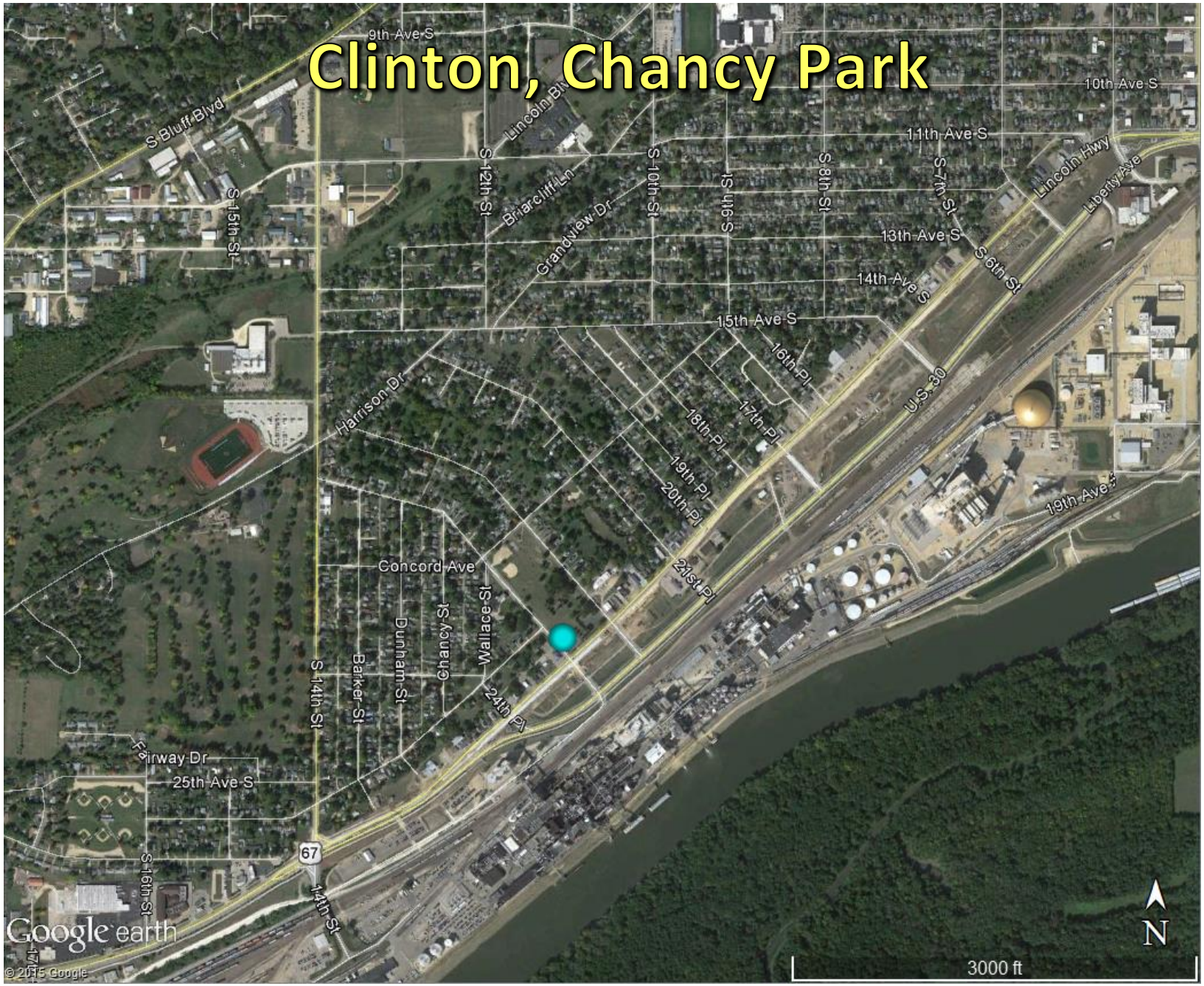
10. Reinhardt TE, Ottmar RD. "Baseline Measurements of Smoke Exposure Among Wildland Firefighters." Journal of Occupational and Environmental Hygiene 2004 Sep; 1 (9):593-606. http://www.ncbi.nlm.nih.gov/pubmed?term=Baseline%20Measurements%20of%20Smoke%20Exposure%20Among%20Wildland

11. Mortality Odds: http://www.nsc.org/learn/safety-knowledge/Pages/injury-facts-chart.aspx

Iowa 2017 Air Toxics Monitoring Network



Air Toxics Monitoring Network 2017				
Site ID	**Site Label**	**City**	**Address**	**County**
190450019	Clinton, Chancy Park	Clinton	23rd & Camanche	Clinton
191130040	Cedar Rapids, Public Health	Cedar Rapids	500 11th St. NW	Linn
191390020	Muscatine, Musser Park	Muscatine	Oregon St. & Earl Ave.	Muscatine
191530030	Des Moines, Health Dept.	Des Moines	1907 Carpenter Ave.	Polk
191630015	Davenport, Jefferson School	Davenport	10th St. & Vine St.	Scott


Clinton, Chancy Park
9th Ave S
10th Ave S
11th Ave S
13th Ave S
14th Ave S
15th Ave S
19th Ave S
25th Ave S
S Bluff Blvd
S 15th St
S 14th St
S 16th St
S 12th St
S 10th St
S 9th St
S 8th St
S 7th St
S 6th St
Lincoln Blvd
Briarcliff Ln
Grandview Dr
Harrison Dr
Concord Ave
Barker St
Dunham St
Chancy St
Wallace St
24th Pl
21st Pl
20th Pl
19th Pl
18th Pl
17th Pl
16th Pl
Fairway Dr
14th St
Lincoln Hwy
Liberty Ave
U.S. 30
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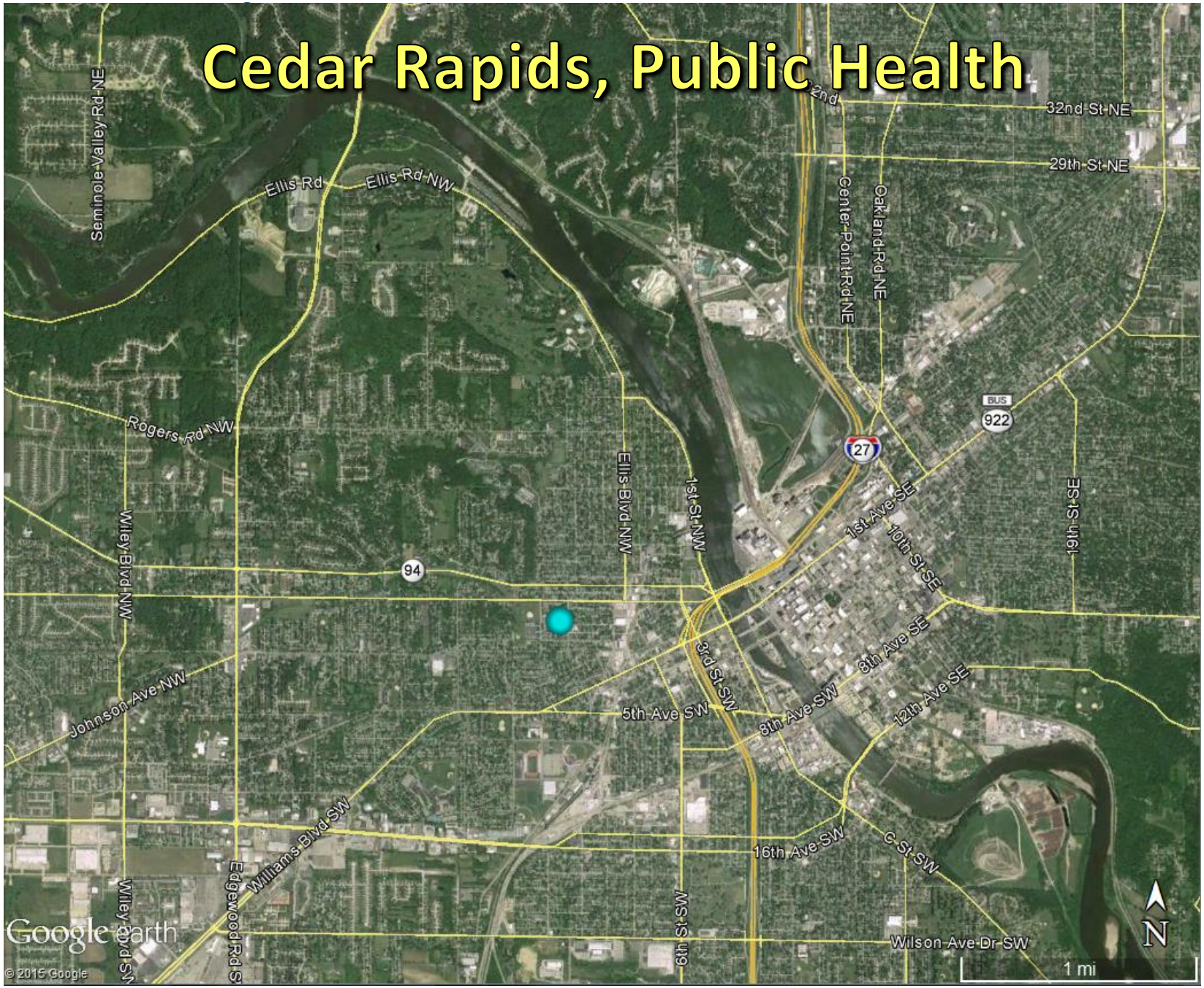
Cedar Rapids, Public Health
Seminole Valley Rd NE
Ellis Rd
Ellis Rd NW
2nd
32nd St NE
29th St NE
Center Point Rd NE
Oakland Rd NE
BUS
922
27
Rogers Rd NW
Ellis Blvd NW
1st St NW
1st Ave SE
10th St SE
19th St SE
Wiley Blvd NW
94
3rd St SW
8th Ave SE
12th Ave SE
Johnson Ave NW
5th Ave SW
8th Ave SW
Williams Blvd SW
16th Ave SW
C St SW
Edgewood Rd S
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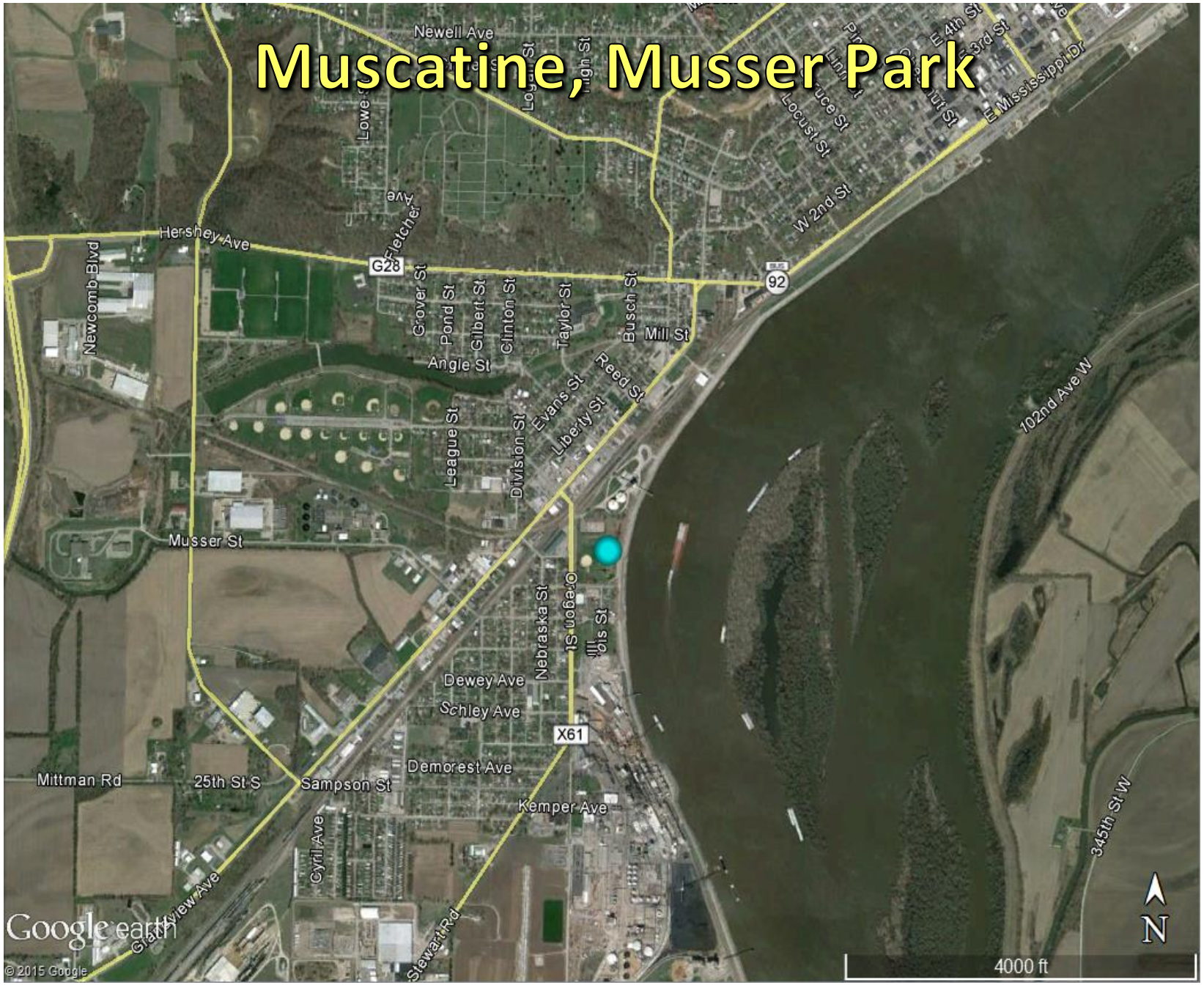
Muscatine, Musser Park
Newell Ave
Hershey Ave
Newcomb Blvd
Fletcher Ave
G28
Grover St
Pond St
Gilbert St
Clinton St
Taylor St
Busch St
Mill St
92
Angle St
Evans St
Reed St
Liberty St
League St
Division St
Musser St
Nebraska St
Oregon St
Dewey Ave
Schley Ave
X61
Demorest Ave
Kemper Ave
Mittman Rd
25th St S
Sampson St
Cyril Ave
Glenview Ave
Stewart Rd
W 2nd St
Locust St
E Mississippi Dr
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345th St W
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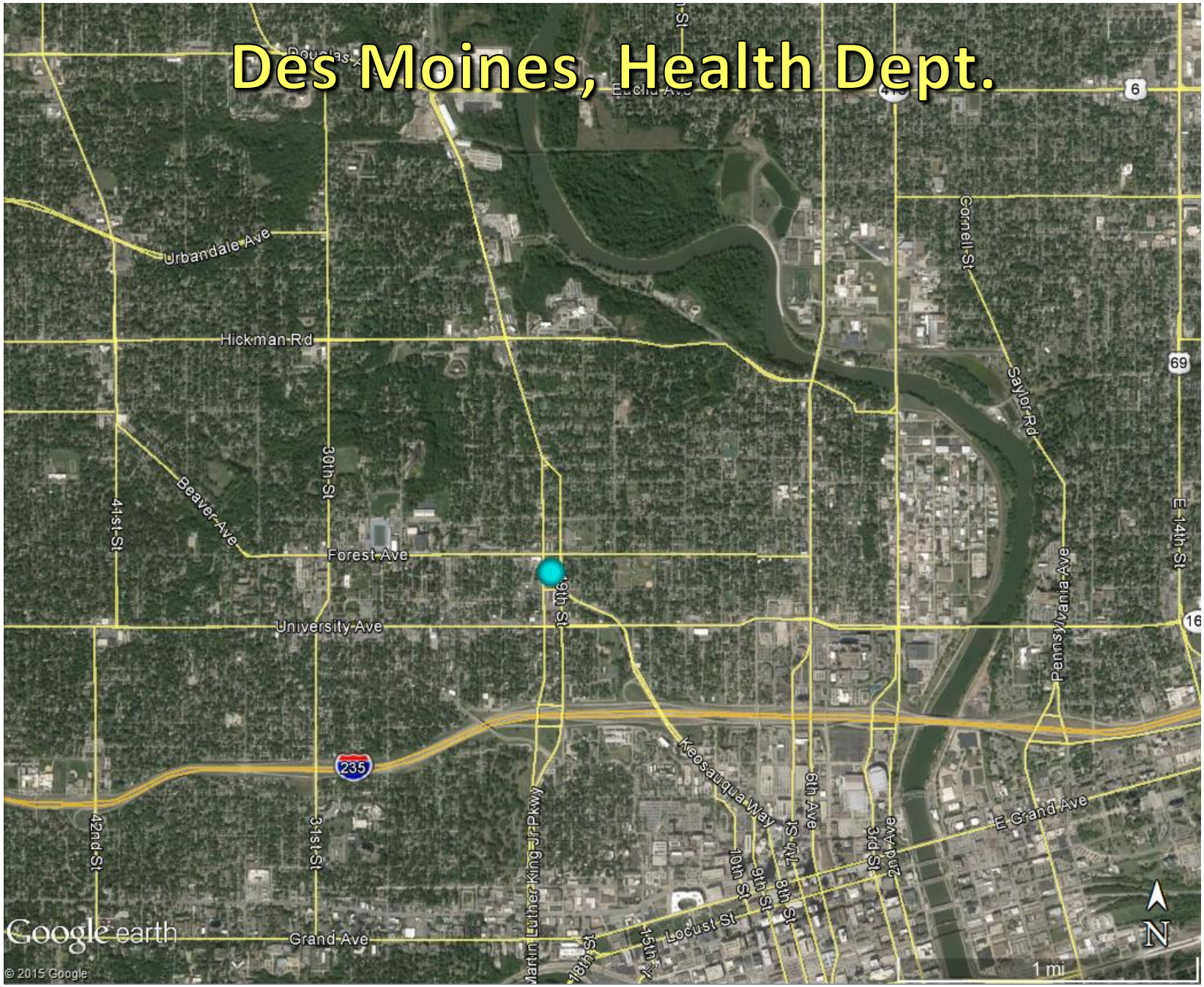
Des Moines, Health Dept.
Urbandale Ave
Hickman Rd
Beaver Ave
41st St
30th St
Forest Ave
University Ave
Grand Ave
42nd St
31st St
Martin Luther King Jr Pkwy
19th St
18th St
15th St
Keosauqua Way
Locust St
10th St
9th St
8th St
7th St
6th Ave
3rd St
2nd Ave
E Grand Ave
Cornell St
Saylor Rd
Pennsylvania Ave
E 14th St
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Davenport, Jefferson School
E 29th St
W Central Park Ave
Hickory Grove Rd
Eastern Ave
N Lincoln Ave
W Locust St
E Locust St
Kirkwood Blvd
Bridge Ave
E 12th St
Waverly Rd
N Division St
N Marquette St
N Gaines St
N Harrison St
E 4th St
E 3rd St
E River Dr
61
67
W River Dr
Arsenal Bridge
Rockingham Rd
Centennial Bridge
Rodman Ave
1st Ave
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24th St
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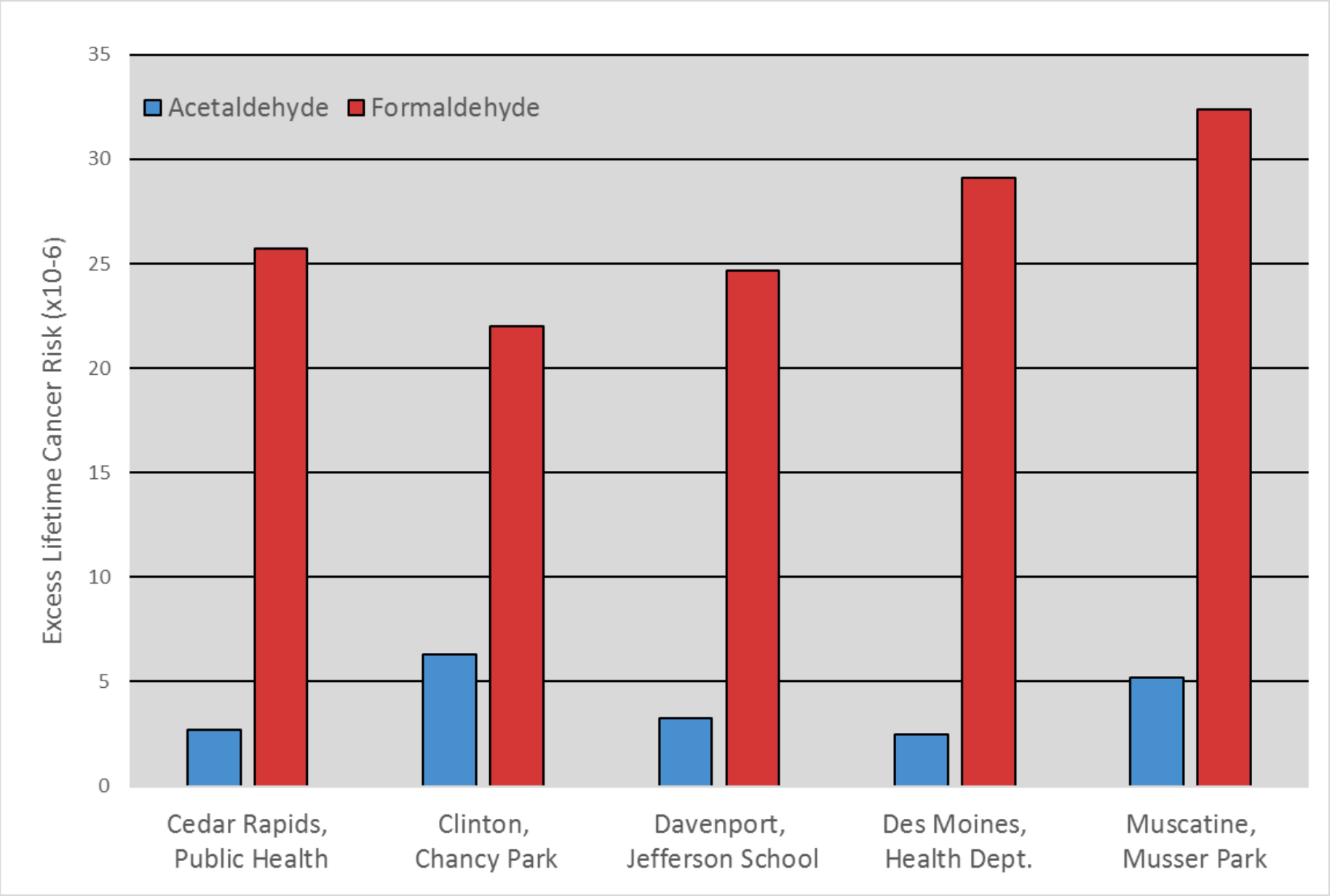
Annual Summary

Graph of Excess Cancer Risk per Million People for Iowa Sites



2017 Annual Concentration[1] (ppb)

Site / Pollutant	Cedar Rapids, Public Health	Clinton, Chancy Park	Davenport, Jefferson School	Des Moines, Health Dept.	Muscatine, Musser Park
Formaldehyde	1.6 (±0.3)	1.4 (±0.3)	1.5 (±0.3)	1.8 (±0.3)	2.0 (±0.5)
Acetaldehyde	0.7 (±0.2)	1.6 (±0.7)	0.8 (±0.1)	0.6 (±0.1)	1.3 (±0.4)

2017 Annual Excess Cancer Risk per Million People

Site / Pollutant	Cedar Rapids, Public Health	Clinton, Chancy Park	Davenport, Jefferson School	Des Moines, Health Dept.	Muscatine, Musser Park
Formaldehyde	26 (±5)	22 (±4)	25 (±5)	29 (±5)	32 (±8)
Acetaldehyde	2.7 (±0.6)	6.3 (±2.8)	3.2 (±0.5)	2.5 (±.3)	5.2 (±1.7)

2017 Annual Percent Data Capture[2]

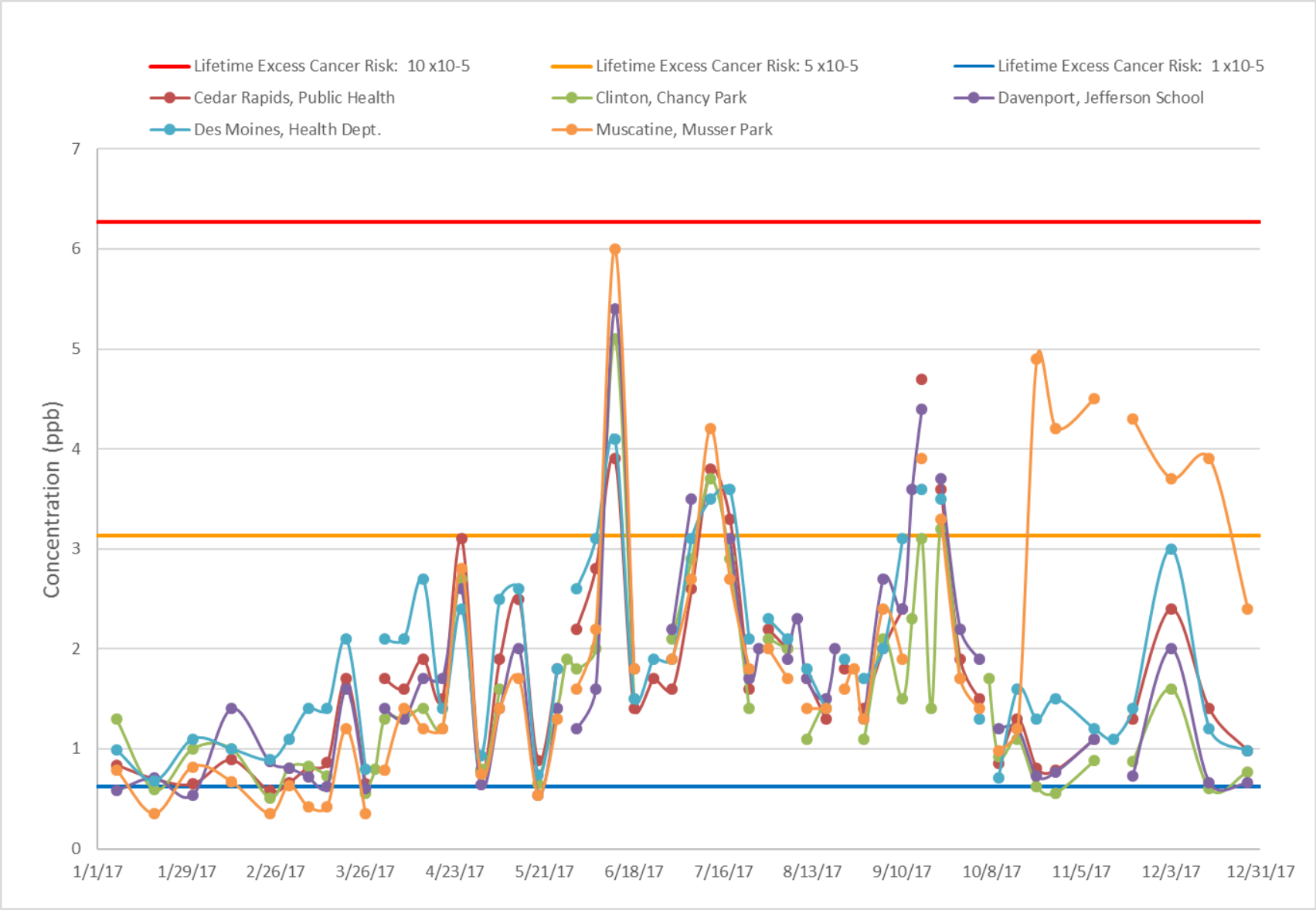
Site / Pollutant	Cedar Rapids, Public Health	Clinton, Chancy Park	Davenport, Jefferson School	Des Moines, Health Dept.	Muscatine, Musser Park
Formaldehyde	100%	100%	100%	100%	100%
Acetaldehyde	100%	100%	100%	100%	100%

[1]Data in the Concentration and Cancer Risk tables were averaged over 12 day blocks to prevent seasonal bias. Values listed in parentheses represent the 95% Confidence Interval for the mean.

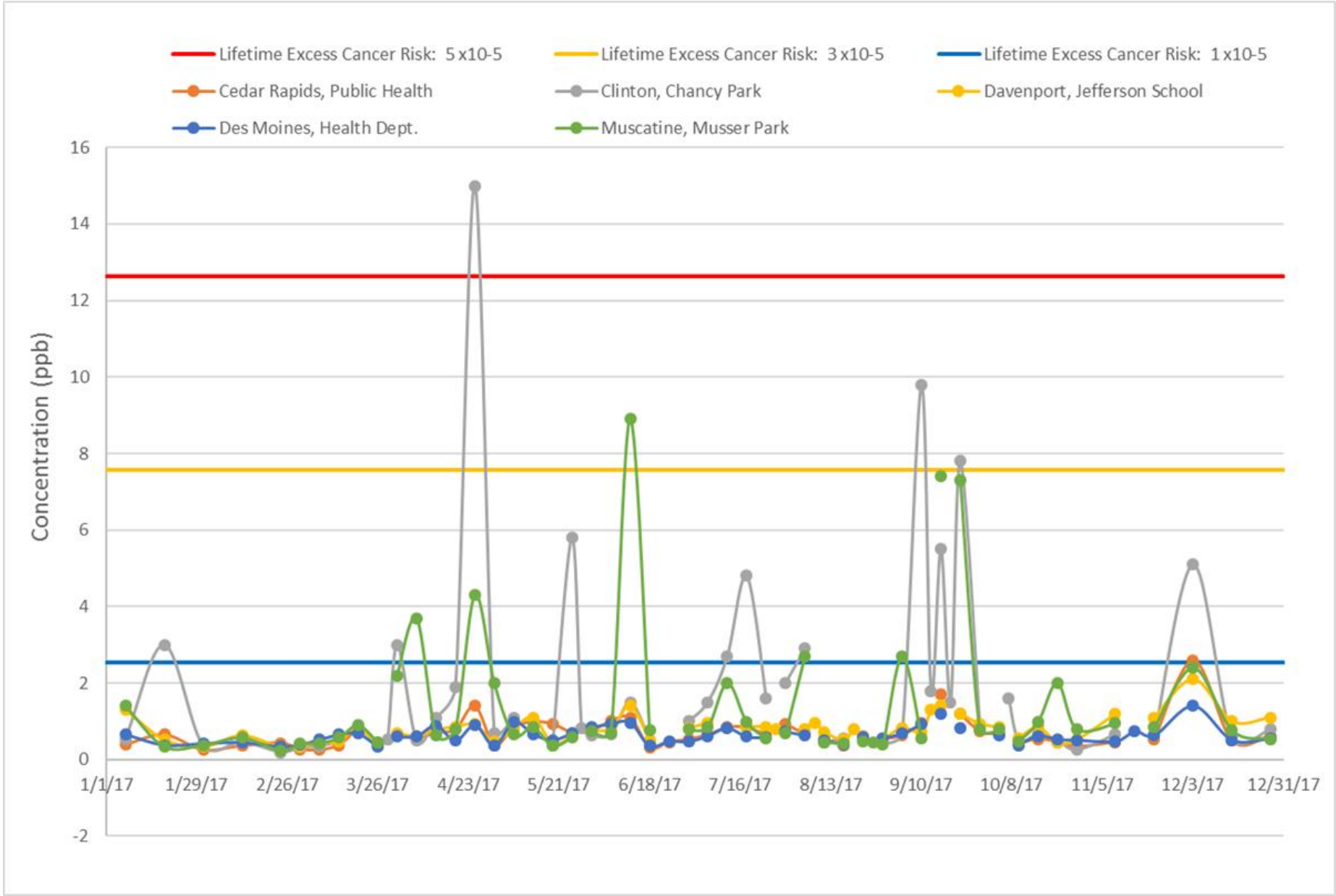
[2] Data capture indicated is the number of 12 day blocks with at least one valid sample, divided by the total number of twelve day blocks in 2017 (31).

Raw Data

Graph of 2017 Formaldehyde Concentrations



Graph of 2017 Acetaldehyde Concentrations



Raw Data– 2017 Formaldehyde Concentrations (ppb)

Date	Cedar Rapids, Public Health	Clinton, Chancy Park	Davenport, Jefferson Sch.,	Des Moines, Health Dept.	Muscatine, Musser Park
1/7/17	0.84	1.30	0.58	0.99	0.79
1/19/17	0.70	0.59	0.71	0.68	0.35
1/31/17	0.65	1.00	0.54	1.10	0.82
2/12/17	0.89	1.00	1.40	1.00	0.67
2/24/17	0.58	0.51	0.87	0.89	0.35
3/2/17	0.66	0.81	0.81	1.10	0.63
3/8/17	0.81	0.83	0.72	1.40	0.42
3/14/17	0.86	0.73	0.62	1.40	0.42
3/20/17	1.70		1.60	2.10	1.20
3/26/17	0.65	0.56	0.60	0.80	0.35
3/29/17		0.80			
4/1/17	1.70	1.30	1.40	2.10	0.79
4/7/17	1.60	1.30	1.30	2.10	1.40
4/13/17	1.90	1.40	1.70	2.70	1.20
4/19/17	1.50	1.20	1.70	1.40	1.20
4/25/17	3.10	2.70	2.60	2.40	2.80
5/1/17	0.79	0.80	0.64	0.93	0.75
5/7/17	1.90	1.60	1.40	2.50	1.40
5/13/17	2.50		2.00	2.60	1.70
5/19/17	0.88	0.65	0.54	0.74	0.54
5/25/17	1.80	1.40	1.40	1.80	1.30
5/28/17		1.90			
5/31/17	2.20	1.80	1.20	2.60	1.60
6/6/17	2.80	2.00	1.60	3.10	2.20
6/12/17	3.90	5.10	5.40	4.10	6.00
6/18/17	1.40	1.50	1.80	1.50	1.80
6/24/17	1.70			1.90	
6/30/17	1.60	2.10	2.20	1.90	1.90
7/6/17	2.60	2.90	3.50	3.10	2.70
7/12/17	3.80	3.70		3.50	4.20
7/18/17	3.30	2.90	3.10	3.60	2.70
7/24/17	1.60	1.40	1.70	2.10	1.80
7/27/17			2.00		
7/30/17	2.20	2.10		2.30	2.00
8/5/17	2.00	2.00	1.90	2.10	1.70
8/8/17			2.30		
8/11/17	1.70	1.10	1.70	1.80	1.40
8/17/17	1.30	1.50	1.50	1.40	1.40
8/20/17			2.00		

8/23/17	1.80			1.90	1.60
8/26/17					1.80
8/29/17	1.40	1.10	1.30	1.70	1.30
9/4/17	2.00	2.10	2.70	2.00	2.40
9/10/17	2.40	1.50	2.40	3.10	1.90
9/13/17		2.30	3.60		
9/16/17	4.70	3.10	4.40	3.60	3.90
9/19/17		1.40			
9/22/17	3.60	3.20	3.70	3.50	3.30
9/28/17	1.90	1.70	2.20		1.70
10/4/17	1.50		1.90	1.30	1.40
10/7/17		1.70			
10/10/17	0.85	0.92	1.20	0.71	0.98
10/16/17	1.30	1.10	1.20	1.60	1.20
10/22/17	0.81	0.62	0.73	1.30	4.90
10/28/17	0.79	0.56	0.77	1.50	4.20
11/9/17	1.10	0.88	1.10	1.20	4.50
11/15/17				1.10	
11/21/17	1.30	0.87	0.73	1.40	4.30
12/3/17	2.40	1.60	2.00	3.00	3.70
12/15/17	1.40	0.60	0.66	1.20	3.90
12/27/17	0.98	0.77	0.66	0.98	2.40

Raw Data– 2017 Acetaldehyde Concentrations (ppb)

Date	Cedar Rapids, Public Health	Clinton, Chancy Park	Davenport, Jefferson Sch.	Des Moines, Health Dept.	Muscatine, Musser Park
1/7/17	0.39	0.54	1.30	0.66	1.40
1/19/17	0.65	3.00	0.52	0.38	0.34
1/31/17	0.25	0.37	0.33	0.42	0.38
2/12/17	0.36	0.46	0.63	0.45	0.57
2/24/17	0.43	0.19	0.32	0.34	0.24
3/2/17	0.27	0.32	0.34	0.39	0.41
3/8/17	0.25	0.35	0.45	0.52	0.43
3/14/17	0.38	0.47	0.47	0.65	0.57
3/20/17	0.75		0.83	0.68	0.90
3/26/17	0.44	0.37	0.33	0.33	0.44
3/29/17		0.53			
4/1/17	0.67	3.00	0.70	0.60	2.20
4/7/17	0.56	0.50	0.61	0.61	3.70
4/13/17	0.70	1.10	0.79	0.89	0.63
4/19/17	0.79	1.90	0.85	0.49	0.81
4/25/17	1.40	15.00	0.92	0.90	4.30
5/1/17	0.38	0.70	0.48	0.36	2.00
5/7/17	0.85	1.10	0.82	0.98	0.65
5/13/17	0.99		1.10	0.67	0.85
5/19/17	0.93	0.36	0.42	0.51	0.36
5/25/17	0.68	5.80	0.61	0.69	0.58
5/28/17		0.82			
5/31/17	0.74	0.64	0.78	0.84	0.74
6/6/17	1.00	0.65	0.80	0.93	0.70
6/12/17	1.10	1.50	1.40	0.97	8.90
6/18/17	0.31	0.48	0.49	0.36	0.76
6/24/17	0.46			0.48	
6/30/17	0.53	1.00	0.82	0.47	0.79
7/6/17	0.65	1.50	0.96	0.62	0.86
7/12/17	0.84	2.70		0.82	2.00
7/18/17	0.84	4.80	0.86	0.60	0.98
7/24/17	0.64	1.60	0.86	0.57	0.56
7/27/17			0.80		
7/30/17	0.93	2.00		0.73	0.68
8/5/17	0.66	2.90	0.81	0.63	2.70
8/8/17			0.97		
8/11/17	0.54	0.44	0.71	0.51	0.46
8/17/17	0.37	0.56	0.52	0.39	0.41
8/20/17			0.80		

8/23/17	0.61			0.57	0.48
8/26/17					0.44
8/29/17	0.54	0.41	0.51	0.56	0.39
9/4/17	0.63	0.69	0.83	0.68	2.70
9/10/17	0.95	9.80	0.72	0.92	0.55
9/13/17		1.80	1.30		
9/16/17	1.70	5.50	1.40	1.20	7.40
9/19/17		1.50			
9/22/17	1.20	7.80	1.20	0.82	7.30
9/28/17	0.74	0.91	0.94		0.79
10/4/17	0.67		0.85	0.63	0.79
10/7/17		1.60			
10/10/17	0.41	0.50	0.55	0.38	0.48
10/16/17	0.54	0.66	0.85	0.62	0.98
10/22/17	0.46	0.51	0.44	0.53	2.00
10/28/17	0.34	0.25	0.52	0.51	0.79
11/9/17	0.46	0.66	1.20	0.48	0.95
11/15/17				0.74	
11/21/17	0.54	0.63	1.10	0.63	0.84
12/3/17	2.60	5.10	2.10	1.40	2.40
12/15/17	0.49	0.57	1.00	0.51	0.76
12/27/17	0.62	0.80	1.10	0.55	0.53

Precision Statistics

Statistic / Pollutant	Number of Pairs	Coefficient of Variation	Lower 90% Confidence Limit	Upper 90% Confidence Limit
Formaldehyde	**85**	**1.9%**	**1.7%**	**2.1%**
Acetaldehyde	**85**	**2.0%**	**1.8%**	**2.3%**

Note: These Statistics generated from duplicate sample pairs collected in 2017. Coefficient of variation and confidence limits are calculated as indicated in Appendix A.

Appendix A. Precision Calculations

Let c_i^1 and c_i^2 represent two concentrations from a particular monitoring location taken on the same day. If both are greater than the MDL, then they may be used to estimate the precision of the data at the sampling location as follows:

First compute the average:

$$\overline{c_i} = \frac{c_i^1 + c_i^2}{2}$$

And the mean difference:

$$\mathrm{d}_i = \frac{\mathrm{c}_i^1 - \mathrm{c}_i^2}{\overline{\mathrm{c}_i}} * 100$$

Define the coefficient of variation for the pair of samples as:

$$\mathrm{CV}_i = \frac{d_i}{\sqrt{2}}$$

Compute the root mean square of the individual coefficients of variation to determine the coefficient of variation of the data at the site for the entire year:

$$CV = \sqrt{\frac{\sum_{i=1}^{n} CV_i^2}{n}}$$

Finally, compute confidence limits in the usual way:

$$\text{Lower Confidence Limit} = CV\sqrt{\frac{n}{X^{-1}(0.05,n)}}$$

$$\text{Upper Confidence Limit} = CV\sqrt{\frac{n}{X^{-1}(0.95,n)}}$$

Where X^{-1} represents the inverse of the chi-squared distribution.