Evaluation of Metals and Carbonyls in Outdoor Air at Woodson Middle School

Woodson Middle School

HOPEWELL, VIRGINIA

Letter Health Consultation

February 4, 2016

Virginia Department of Health
Division of Environmental Epidemiology
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COMMONWEALTH of VIRGINIA

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February 4, 2016

Charles Turner
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Dear Charles Turner,

Thank you for the opportunity to review the air monitoring results from 2009-2013 at Woodson Middle School in Hopewell, VA. As requested, the Virginia Department of Health (VDH) has finished reviewing the metals and carbonyl air monitoring results for public health implications, and concludes that the metals and carbonyl air monitoring results collected at Woodson Middle School from 2009-2013 are not expected to harm people's health. VDH does not have any recommendations at this time and will evaluate any additional air monitoring results for public health implications. This health consultation supplements the letter health consultation dated November 23, 2015 titled, *Evaluation of Volatile Organic Compounds in Outdoor Air at Woodson Middle School. Background, site description, demographics*, and *sampling methods* were discussed in that letter; and per our discussion, will not be presented in this letter.[1]

DISCUSSION

Results

The following section contains results and comparison values (CVs) for metals (Table 1) and carbonyls (Table 2) monitored in 2009-2013 at Woodson Middle School. CVs are discussed in more detail in the public health implications section. The number of samples collected each year and the percent detection for each metal and carbonyl is presented in the attachment (Tables 3 and 4).

1 Personal communication with Charles Turner October 1, 2015.

VDH compared the yearly maximum and average concentrations of each metal with its respective CV. The yearly maximum and yearly average concentrations of arsenic and chromium (total) exceeded their CV. In 2010 and 2011 the maximum cadmium concentration exceeded its CV; however, the yearly average cadmium concentrations were all below its CV.

Table 1. Maximum and yearly average metal concentrations and comparison values (2009-2013)

Metal	2009		2010		2011		2012		2013			
	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	CV	Type
Arsenic	**0.00426**	**0.00093**	**0.00230**	**0.00091**	**0.00192**	**0.00072**	**0.02079**	**0.00112**	**0.00186**	**0.00075**	0.00023	CREG
Berrylium	0.00002	0.00000	0.00003	0.00001	0.00004	0.00000	0.00005	0.00000	0.00004	0.00000	0.00042	CREG
Cadmium	0.00033	0.00009	**0.00067**	0.00012	**0.00063**	0.00012	0.00029	0.00009	0.00031	0.00009	0.00056	CREG
Chromium (total)	**0.00563**	**0.00229**	**0.00570**	**0.00255**	**0.00316**	**0.00215**	**0.00351**	**0.00266**	**0.00397**	**0.00214**	8.30E-05	CREG*
Lead	0.01943	0.00335	0.00650	0.00313	0.00607	0.00275	0.01117	0.00266	0.01321	0.00233	0.15	NAAQS
Manganese	0.03275	0.00858	0.03068	0.01025	0.02300	0.00724	0.02804	0.00803	0.02582	0.00730	0.3	EMEG
Nickel	0.00618	0.00136	0.00446	0.00129	0.00444	0.00111	0.00248	0.00086	0.00268	0.00088	0.09	EMEG

(*Source:* DEQ) All concentrations in micrograms/ cubic meter. **Max** – maximum; **Avg** – average; **CV** – comparison value; **CREG** – cancer risk evaluation guide; **NAAQS** – National ambient air quality standard; **EMEG**– environmental medium evaluation guide; *CREG is for hexavalent chromium; **bold face** – values that exceed the comparison value

VDH compared the yearly maximum and average concentrations of each carbonyl with its respective CV. The yearly maximum and yearly average concentration of formaldehyde and acetaldehyde exceeded their CV.

Table 2. Maximum and yearly average carbonyl concentrations and comparison values (2009-2013)

Carbonyl	2009		2010		2011		2012		2013			
	Max	Avg	Max	Avg	Max	Avg	Max	Avg	Max	Avg	CV	Type
Formaldehyde	**7.4**	**3.170**	**13.131**	**3.960**	**13.023**	**3.319**	**12.8**	**2.874**	**5.88**	**2.818**	0.077	CREG
Acetaldehyde	**2.93**	**1.440**	**4.719**	**1.965**	**3.277**	**1.638**	**3**	**1.425**	**2.49**	**1.260**	0.45	CREG
Propionaldehyde	0.86	0.379	1.038	0.498	0.729	0.424	0.588	0.186	0.674	0.048	8.3	RSL
Acetone	13.17	4.401	12.428	4.844	16.62	4.188	10	3.838	8.82	3.820	31,000	EMEG
Methyl Ethyl ketone	2	0.669	1.827	0.768	1.465	0.708	1.296	0.549	1.46	0.549	5,200	RSL
Methyl isobutyl ketone	0.19	0.018	0.236	0.050	0.16	0.007	0	0.000	0	0.000	3,100	RSL

(*Source:* DEQ) All concentrations in micrograms/ cubic meter. **Max** – maximum; **Avg** – average; **CV** – comparison value; **CREG** – cancer risk evaluation guide; **EMEG**– environmental medium evaluation guide; **RSL** – regional screening level; **bold face** – values that exceed the comparison value

Public Health Implications

Contaminants in the environment can only impact human health if individuals are (1) exposed to contaminants and (2) if contaminants are present at sufficient concentrations. Residents can potentially be exposed to contaminants in ambient air whenever they spend time outdoors. Evaluation of the metals and carbonyl compounds with air concentrations above their respective CV are discussed below.

Contaminants evaluation

Metal and carbonyl concentrations were compared to non-cancer and cancer CVs using the same CVs described in the *Evaluation of Volatile Organic Compounds in Outdoor Air at Woodson Middle School,* November 23, 2015 report:

- environmental media evaluation guides (EMEGs)
- cancer risk evaluation guides (CREGs)
- regional screening levels (RSL)

In addition to these CVs, the national ambient air quality standard (NAAQS) was used to evaluate lead concentrations.[2] Only the maximum air concentration of cadmium in 2010 and 2011 exceeded its CV. CREGs are used for evaluating cancer risk over a lifetime; therefore, the maximum cadmium concentration, which is an acute exposure, was compared to the non-cancer acute EMEG (0.03 µg/m^3). Neither the 2010 or 2011 maximum cadmium concentration exceeded the acute EMEG; and therefore, will not be evaluated further.

Two metals (arsenic and chromium) and two carbonyls (acetaldehyde and formaldehyde) were evaluated further because their yearly average concentrations exceeded their respective CV. General information including reported air concentrations, source, and health effects of acetaldehyde, arsenic, chromium, and formaldehyde can be found in Table 5 in the attachment.

Cancer risk

The average concentrations of the carcinogens, acetaldehyde, arsenic, chromium, and formaldehyde, exceeded their cancer CVs in multiple years. The average of each reported yearly average concentration for each contaminant was multiplied by the inhalation unit risk (IUR) to calculate the cancer risk. (See Box 1). The additional cancer risk for each contaminant is within EPA's generally acceptable target risk range (1 in 10,000 to 1 in 1,000,000) and is considered low.

Chromium is found in the environment in different oxidation states, chromium III and chromium VI. Chromium VI is a known carcinogen. Because total chromium, which contains both chromium III and chromium VI, was reported, VDH calculated the additional cancer risk assuming that the reported chromium only contained chromium VI. This assumption is likely to overestimate cancer risk for the total chromium concentrations reported because it is unlikely that all chromium at Woodson Middle School is chromium VI.

This additional excess cancer risk to individuals living near Woodson Middle School represents a small incremental risk above background cancer levels in the U.S. population which is between one in three to one in four.

2 http://www3.epa.gov/ttn/naaqs/criteria.html last accessed on November 2015

Box 1. Cancer risk calculation for carcinogens discussed

To estimate cancer risk from inhaling carcinogens discussed, the inhalation unit risk (IUR) factor in $(\mu g/m3)^{-1}$ for each carcinogen is multiplied by the air concentration of the contaminant in $\mu g/m^3$. See Equation 1 below.

Equation 1

Cancer Risk = IUR x Concentration

Acetaldehyde (Average 2009-2013 concentration = 1.545 µg/m^3)

$3.4 \times 10^{-6} = 2.2 \times 10^{-6}$ $(\mu g/m^3)^{-1}$ **x** 1.545 $\mu g/m^3$ = less than 4 additional cancers in 1,000,000

Arsenic (Average 2009-2013 concentration = 8.9 x 10^{-4} µg/m^3)

$3.8 \times 10^{-6} = 4.3 \times 10^{-3}$ $(\mu g/m^3)^{-1}$ **x** 8.9×10^{-4} $\mu g/m^3$ = less than 4 additional cancers in 1,000,000

***Chromium (total) (Average 2009-2013 concentration = 2.36 x 10^{-3} µg/m^3)**

$2.8 \times 10^{-5} = 1.2 \times 10^{-2}$ $(\mu g/m^3)^{-1}$ **x** 2.36×10^{-3} $\mu g/m^3$ = less than 3 additional cancers in 100,000

Formaldehyde (Average 2009-2013 concentration = 3.23 µg/m^3)

$4.2 \times 10^{-5} = 1.3 \times 10^{-5}$ $(\mu g/m^3)^{-1}$ **x** 3.23 $\mu g/m^3$ = less than 4 additional cancers in a 100,000

*The IUR for chromium VI was used in this calculation.

CONCLUSIONS

VDH concludes that the metal air concentrations at Woodson Middle School from 2009-2013 are not expected to harm people's health.

VDH concludes that the carbonyl air concentrations at Woodson Middle School from 2009-2013 are not expected to harm people's health.

RECOMMENDATION

VDH does not have any recommendations at this time.

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This report was supported in part by funds provided through a cooperative agreement with the Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services. The findings and conclusions in these reports are those of the author(s) and do not necessarily represent the views of the Agency for Toxic Substances and Disease Registry or the U.S. Department of Health and Human Services. This document has not been revised or edited to conform to agency standards.

ATTACHMENTS

Table 3. Metals and percent detected by year (2009-2013)

Metals	Year & Number of Samples				
	2009 (61 samples)	2010 (61 samples)	2011 (61 samples)	2012 (57 samples)	2013 (58 samples)
Arsenic	100	100	100	100	100
Berrylium	23	41	49	33	45
Cadmium	92	97	98	100	100
Chromium	100	100	100	100	100
Lead	100	100	100	100	100
Manganese	100	100	100	100	100
Nickel	100	100	100	100	100

(*Source:* DEQ)

Table 4. Carbonyls and percent detected by year (2009-2013)

Carbonyls	Year & Number of Samples				
	2009 (61 samples)	2010 (60 samples)	2011 (60 samples)	2012 (59 samples)	2013 (61 samples)
Formaldehyde	100	100	100	100	100
Acetaldehyde	100	100	100	100	100
Propionaldehyde	100	100	100	51	10
Acetone	100	100	100	92	100
Methyl Ethyl ketone	100	100	100	80	92
Methyl isobutyl ketone	21	40	7	0	0

(*Source:* DEQ)

Table 5. Air concentrations, potential sources, and health effects for selected contaminants[3]

Volatile Organic Compound	Reported Air Concentrations (average levels)	Source	Health Effect (s)
Acetaldehyde	outdoor air: 1.6 to 44.1 µg/m^3 (one hour samples) rural air: 1.4 µg/m^3	industrial vehicles	*humans*: irritation of the eyes, nose, throat, and central nervous system; delayed pulmonary edema *animals:* nasal cancer, kidney and reproductive effects
Arsenic	Concentration of arsenic in the air generally range from less than 0.001 to 2 µg/m^3 depending on location, weather conditions, and level of industrial activity urban air: 0.020 to 0.030 µg/m^3	industrial agricultural	*humans:* sore throat, irritated lungs, nausea, vomiting, increased risk of skin, liver, bladder and lung cancer
Chromium	rural air: <0.010 µg/m^3 urban air: 0-0.030 µg/m^3 As a result of smoking, indoor air contaminated with chromium can be 10-400 times greater than outdoor air concentrations	industrial	*humans:* irritation of nose, coughing, shortness of breath, wheezing, increased risk of lung cancer *animals:* cancerous tumors in the stomach, intestinal tract, and lungs
Formaldehyde	Outdoor air concentrations in urban environments vary and depend on local conditions: 1-20 µg/m^3	industrial	*humans:* irritation of the eyes, nose, and throat; continuous exposure can cause nose and throat cancer *animals:* irritation and damage to lining of the nose and throat; high concentrations can irritate lungs and stomach

3 Agency for Toxic Substances and Disease Registry, California Environmental Protection Agency, Hazardous Substances Data Base Last accessed November 2015