



June 22, 2018

To: Waverly Elementary School

From: Christopher Madden, CIH
Indoor Environmental Quality Manager

Re: Indoor Air Quality Testing During Renovations - May

As Waverly Elementary School is currently undergoing renovations, the Howard County Public School System's Office of the Environment is conducting weekly Indoor Air Quality (IAQ) Testing to determine if renovation activities are adversely impacting the IAQ in areas located in close proximity to the renovation. The Office of the Environment visited Waverly Elementary on May 4, 11, 17 and 25, 2018. The Office of the Environment observed if engineering controls were in place to limit construction related constituents from migrating into occupied areas of the school and collected measurements of temperature, relative humidity, carbon dioxide (CO₂), carbon monoxide (CO), volatile organic compounds (VOCs), and particulate matter.

General Observations

May 4, 11, 17, and 25 2018

Construction activities varied during the assessment and included electrical work, duct installation, and finishing work. The construction containments were in place and negative air machines were operational (if work was taking place).

Visible emissions were not observed in the school in the vicinity of the construction containment.

General Indoor Air Quality Measurements

Temperature, Relative Humidity, CO₂, CO, and VOC readings were collected as part of the IAQ assessment.

The American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) recommends a temperature range of 68.5 to 75 degrees Fahrenheit (F) in the winter and 75 to 80.5 degrees F in the summer (assuming 50% relative humidity) (Indoor Environmental Quality 2015). The recommended temperature ranges vary slightly depending on relative humidity. There are no recommendations for the spring and fall due to the variabilities in outdoor temperatures.

To prevent mold growth, The Environmental Protection Agency (EPA) recommends relative humidity should be maintained below 60%, ideally between 30-50%. Humidity readings below 30% are often encountered in buildings where humidity is not introduced through the Heating Ventilation and Air Conditioning (HVAC) system.

Carbon Dioxide measurements can provide a general sense of the adequacy of the ventilation system. It is recommended that CO₂ readings be less than 700 parts per million (ppm) plus the outside concentration of CO₂.

Carbon Monoxide can be introduced through incomplete combustion (car exhaust, improperly ventilated boilers, etc.) and should not exceed 9 ppm.

“Low levels of VOCs are ubiquitous in indoor and outdoor air from both natural and man-made sources (The IAQ 2016). VOCs can be introduced by a variety of indoor (paints, perfumes, art products, building materials, carpet, furnisher, etc.) and outdoor sources (vehicles, manufacturing emissions, etc.). A “spike” is identified when indoor readings are significantly higher than the outdoor readings.

Temperature, Relative Humidity, CO₂, and CO data was collected using a TSI IAQ Calc (Model #7545). VOC data was collected using a Rae ToxiRae Pro Photoionization Detector (PID) (Model #PGM-1800). Below are the results of the temperature, relative humidity, CO₂, and CO measurements collected.

Table I - General IAQ Measurements – May 4, 2018

Location	Temperature (F)	Relative Humidity (%)	CO₂ (ppm)	CO (ppm)	Total VOCs (ppm)
Outside	89.8	43.3	470	0.0	0.1
Construction Containment	82.6	39.0	507	1.0	0.1
Lobby	84.8	39.7	550	0.3	0.1
Music	82.9	43.4	719	0.0	0.1
Hallway Outside of Health Suite	81.9	45.3	572	0.1	0.1
A123	78.0	50.0	570	0.1	0.0
A125	77.2	50.0	503	0.0	0.0
Health	76.5	44.3	724	0.0	0.1
Media	77.3	45.4	887	0.1	0.1
1 st Floor Addition (Near B135)	73.9	48.4	639	0.0	0.0
Cafeteria	76.0	59.5	971	0.0	0.6
Outside	87.7	54.6	607	0.0	0.0

Note: Bolded values were not within recommended limits.

Table II - General IAQ Measurements – May 11, 2018

Location	Temperature (F)	Relative Humidity (%)	CO₂ (ppm)	CO (ppm)	Total VOCs (ppm)
Outside	76.7	51.5	386	0.0	0.0
Construction Containment	75.8	44.4	536	0.4	0.0
Music	74.3	47.5	681	0.2	0.0
Cafeteria	73.6	51.9	639	0.0	0.0
Lobby	73.7	51.7	694	0.0	0.0
Hallway Outside of Health Suite	73.9	51.9	607	0.1	0.0
A123	74.0	51.7	572	0.0	0.0
A125	73.4	51.2	504	0.0	0.0

Table II - General IAQ Measurements (Continued) – May 11, 2018

Location	Temperature (F)	Relative Humidity (%)	CO₂ (ppm)	CO (ppm)	Total VOCs (ppm)
Health	73.2	44.9	704	0.0	0.0
Media	73.2	54.0	849	0.0	0.0
1 st Floor Addition (Near B135)	72.5	51.8	591	0.0	0.0
Outside	74.4	49.1	388	0.0	0.0

Table III - General IAQ Measurements – May 17, 2018

Location	Temperature (F)	Relative Humidity (%)	CO₂ (ppm)	CO (ppm)	Total VOCs (ppm)
Outside	73.9	78.7	443	0.5	0.0
Construction Containment	72.2	66.6	742	0.2	0.0
Lobby	74.6	65.1	637	0.0	0.0
Music	74.4	64.7	707	0.0	0.0
Hallway Outside of Health Suite	73.4	62.2	606	0.0	0.0
A123	73.4	70.7	623	0.0	0.0
A125	73.7	70.3	482	0.0	0.0
Health Suite	73.7	53.5	915	0.1	0.0
Media	73.1	61.9	687	0.0	0.0
1 st Floor Addition	72.6	61.9	565	0.0	0.0
Cafeteria	72.2	69.6	713	0.0	0.0
Outside	71.2	74.2	446	0.0	0.0

Table IV - General IAQ Measurements – May 25, 2018

Location	Temperature (F)	Relative Humidity (%)	CO₂ (ppm)	CO (ppm)	Total VOCs (ppm)
Outside	88.7	40.0	432	0.0	0.1
Construction Containment	84.3	37.8	445	0.5	0.0
Lobby	73.8	50.7	550	0.0	0.0
Music	74.8	48.3	618	0.0	0.0
Hallway Outside of Health	71.8	50.1	540	0.0	0.0
A123	71.1	54.3	705	0.0	0.1
A125	72.2	53.9	646	0.0	0.0
Health Suite	72.8	57.5	848	0.0	0.1
Media	72.6	53.4	693	0.0	0.0
1 st Floor Addition	70.4	54.6	480	0.0	0.0
Outside	83.4	51.5	419	0.0	0.0

Particulate Matter Measurements

Particulate matter “is a complex mixture of extremely small particles and liquid droplets that get into the air (Particulate 2017). The data collected does not distinguish between types of particles in the air which can include pollen, skin cells, soil, human/animal hairs, etc. Particles designated as “respirable” are less than 10 micrometers (μm) in diameter and typically fall into two categories, coarse and fine particles. Coarse particles are those that are less than 10 μm (PM_{10}) and fine particles are those less than 2.5 μm ($\text{PM}_{2.5}$). ANSI/ASHRAE standard 62.1-2016 suggests target indoor concentration for $\text{PM}_{2.5}$ and PM_{10} of 12 and 50 $\mu\text{g}/\text{m}^3$ respectively.

Particulate matter data was collected with a TSI AeroTrak Particle Counter (Model #9306-V2). Note that the particle counter is not capable of collecting $\text{PM}_{2.5}$ data. Due to this limitation, $\text{PM}_{3.0}$ data is used. This would provide a more conservative, overestimate of $\text{PM}_{2.5}$.

Table V - Particulate Matter Measurements – May 4, 2018

Location	$\text{PM}_{0.5}$ (μ/m^3)	$\text{PM}_{1.0}$ (μ/m^3)	$\text{PM}_{3.0}$ (μ/m^3)	$\text{PM}_{5.0}$ (μ/m^3)	$\text{PM}_{10.0}$ (μ/m^3)
Outside	3	5	10	13	31
Construction Containment	6	9	27	88	323
Lobby	2	3	7	20	69
Hallway Outside of Health Suite	3	4	11	43	197
A123	2	3	5	10	24
A125	2	3	4	5	10
Health	3	5	21	51	145
Media	2	3	5	9	29
1 st Floor Addition (Near B135)	2	3	5	8	17
Cafeteria	2	3	10	42	152
Outside	3	4	10	19	47

Table VI - Particulate Matter Measurements – May 11, 2018

Location	$\text{PM}_{0.5}$ (μ/m^3)	$\text{PM}_{1.0}$ (μ/m^3)	$\text{PM}_{3.0}$ (μ/m^3)	$\text{PM}_{5.0}$ (μ/m^3)	$\text{PM}_{10.0}$ (μ/m^3)
Outside	1	2	4	9	14
Construction Containment	2	3	9	21	74
Lobby	1	1	5	21	85
Music	1	1	4	13	55
Cafeteria	1	1	2	5	16
Hallway Outside of Health Suite	1	1	4	15	38
A123	0	0	1	5	13
A125	1	1	1	2	2
Health	1	1	3	6	20
Media	1	1	5	18	72
1 st Floor Addition (Near B135)	1	1	3	8	17
Outside	1	2	4	7	18

Table VII - Particulate Matter Measurements – May 17, 2018

Location	PM_{0.5} (µ/m³)	PM_{1.0} (µ/m³)	PM_{3.0} (µ/m³)	PM_{5.0} (µ/m³)	PM_{10.0} (µ/m³)
Outside	1	2	3	6	19
Construction Containment	0	0	2	7	30
Lobby	0	0	1	7	31
Hallway Outside of Health Suite	0	0	1	5	21
A123	0	0	1	5	12
A125	0	0	0	3	0
Health Suite	0	0	1	4	14
Media	0	0	1	3	10
1sr Floor Addition	0	0	1	2	3
Cafeteria	0	0	1	5	23
Outside	1	1	2	6	13

Table VIII - Particulate Matter Measurements – May 25, 2018

Location	PM_{0.5} (µ/m³)	PM_{1.0} (µ/m³)	PM_{3.0} (µ/m³)	PM_{5.0} (µ/m³)	PM_{10.0} (µ/m³)
Outside	3	5	9	13	29
Construction Containment	4	6	16	52	233
Lobby	3	4	6	9	33
Music	2	3	5	13	49
Hallway Outside of Health Suite	2	3	4	6	14
A123	2	3	4	7	31
A125	2	3	4	7	28
Health Suite	3	4	10	29	71
Media	2	3	4	8	22
1 st Floor Addition	2	3	4	5	9
Outside	3	4	7	12	23

Discussion

With the exception of May 17, 2018, no major concerns were identified during the sampling activities. On May 17, elevated humidity was identified. Conversations with building occupants also indicated the building had “felt” more humid days prior to the sampling. After discussions with the Office of Construction and their Heating Ventilation and Air Conditioning (HVAC) contractor it was determined that the HVAC units discharge set point was improperly configured. This means the outdoor air temperature was not being cooled enough to properly dehumidify the air before being delivered to occupied portions of the building.

Elevated particulate (PM_{10.0}) was detected in various locations. Elevated concentrations are expected and would not necessarily be associated with construction activities. Dust levels are expected to vary overtime based on student and staff activities. Slightly elevated dust levels were identified in the Media on May 11. Conversations with the principal indicated that construction trades were improperly entering/leaving the construction area through the media. A barrier was added to direct contractors to the proper entrance/exit doors.

Conclusion

The sampling activities conducted in May indicate measures are being taken to prevent construction odors/VOCs from entering the occupied areas of the school. A deficiency was identified associated with relative humidity, however the issue has been corrected.

Regarding dust, it should be noted that elevated concentrations are expected and may not necessarily be associated with construction activities. Dust levels are expected to vary overtime based on student and staff activities. Additionally, dust levels are far from the enforceable OSHA Occupational Exposure Limit for respirable nuisance dust of 5,000 $\mu\text{g}/\text{m}^3$.

Housekeeping practices are also pivotal for dust control. Increased frequency of vacuuming and cleaning could also help reduce dust levels in areas around the construction containment such as the lobby, hallway outside of health, and the health suite. Sticky mats could also be added in areas where trades enter/exit the construction areas through the school. This will likely alleviate the tracking of construction dusts into occupied areas of the school.

It should be noted that the sampling is not being conducted for Occupational Safety and Health Administration (OSHA) compliance, in association with the renovation/construction contractors.

References

Indoor Environmental Quality, the National Institute for Occupational Safety and Health/Centers for Disease Control and Prevention, September 1, 2015. Retrieved from: <https://www.cdc.gov/niosh/topics/indoorenv/temperature.html>

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Volatile Organic Compounds (VOC) Criteria for New Construction White Paper, American Industrial Hygiene Association, March 15, 2017.