



September 6, 2016

Mr. Jeff Klenk
Howard County Public School System (HCPSS)
10910 Route 108
Ellicott City, MD 21043

RE: Indoor Air Quality Assessments during Renovations at Swansfield Elementary School
Project #J16-971

Dear Mr. Klenk,

Aria Environmental, Inc. (AE) is pleased to present this report of findings for indoor air quality assessments conducted at Swansfield Elementary School (SWES). Jeff Klenk of HCPSS requested AE start making frequent visits to SWES in order to monitor indoor air quality that may be affected by the current major renovation of the school. The visits discussed in this report were performed on August 26 and September 1, 2016 and included work site observations, and real time measurements for particles and indoor air quality parameters (temperature, humidity, carbon monoxide (CO) and carbon dioxide (CO₂)). These assessments were performed by Julie Barth, CIH, CSP, LEED Green Associate and Tony Schwegmann of AE. Presented below are observations and recommendations made based upon conditions readily observed on the reported date.

Particles

Particulate matter or PM is the term for a mixture of solid particles and liquid droplets found in the air. It does not distinguish between the types of particles in the air (e.g., pollen, skin cells, soil, etc.). Particulate matter includes "inhalable coarse particles," with diameters larger than 2.5 micrometers and smaller than 10 micrometers (PM₁₀) and "fine particles," with diameters that are 2.5 micrometers and smaller (PM_{2.5}). A micrometer is also called a micron and is one millionth of a meter. To put these particle diameters in perspective, the average human hair is about 70 micrometers in diameter – making it 30 times larger than the largest fine particle. Particle loads expected to be a part of the school environment include carpet and clothing fiber, soil tracked from outside, paper dust and dust and fibers from building materials.

ASHRAE Standard 62.1-2010 suggests target indoor concentrations for PM_{2.5} and PM₁₀ of 15 µg/m³ and 50 µg/m³, respectively. These concentrations are taken from the EPA's National Ambient Air Quality Standards (NAAQS) based on annual arithmetic means deemed acceptable for outdoor air quality. Occupational standards and guidelines for particles are nearly an order of magnitude higher than concentrations typically found in non-occupational settings and are not appropriate for comparison. Particle measurements were taken with an Aerocet 531 particulate monitor. The particle monitor takes a two minute averaged sample of particle concentrations in 5 size fractions (PM₁, PM_{2.5}, PM₇, PM₁₀ and total suspended particles (TSP)). Results of particulate monitoring are presented in Tables 1.

Table 1 – Results of Particulate Monitoring Swansfield Elementary School

Date	Location	Time	PM1 ($\mu\text{g}/\text{m}^3$)	PM2.5 ($\mu\text{g}/\text{m}^3$)	PM7 ($\mu\text{g}/\text{m}^3$)	PM10 ($\mu\text{g}/\text{m}^3$)	TSP ($\mu\text{g}/\text{m}^3$)
August 26, 2016	Front Entrance Inside Double Doors	10:15 AM	9	39	798	1,179	1,678
August 26, 2016	Hallway near Construction Door 2	10:18 AM	5	65	538	730	975
August 26, 2016	Hallway near Construction Door 3	10:22 AM	5	89	583	843	1,134
August 26, 2016	Hallway near Construction Door 4	10:25 AM	0	6	53	121	245
August 26, 2016	Hallway near Construction Door 5	10:31 AM	0	21	88	201	390
August 26, 2016	Hallway near Construction Door 6	10:33 AM	0	5	46	75	125
August 26, 2016	Hallway near Construction Door 7	10:35 AM	0	0	203	281	419
August 26, 2016	Hallway near Construction Door 8	10:38 AM	2	31	173	270	410
August 26, 2016	In Classroom Pod near Construction Door 8	10:41 AM	1	12	103	142	188
August 26, 2016	Outside	10:50 AM	0	2	9	14	26
September 1, 2016	Outside	1:13 PM	0	1	6	7	8
September 1, 2016	Front Entrance Inside Double Doors	1:19 PM	22	119	544	784	1,111
September 1, 2016	Hallway near Construction Door 2	1:39 PM	22	120	678	925	1,292
September 1, 2016	Hallway near Construction Door 3	1:42 PM	18	126	703	967	1,276
September 1, 2016	Hallway near Construction Door 4	1:46 PM	6	42	293	444	701
September 1, 2016	Hallway near Construction Door 5	1:48 PM	1	14	128	179	250
September 1, 2016	Hallway near Construction Door 6	1:50 PM	2	21	172	241	335
September 1, 2016	Hallway near Construction Door 7	1:55 PM	1	1	86	186	369
September 1, 2016	Hallway near Construction Door 8	2:02 PM	4	37	254	387	592
September 1, 2016	Non-construction Area Hallway near 3 rd Grade Room	2:05 PM	0	0	103	174	308
September 1, 2016	Non-construction Area Hallway near 1 st Grade Room	2:07 PM	0	6	54	93	154

Bold-faced results indicate results above target concentrations.

The PM_{2.5} particle concentrations ranged from 0 to 89 µg/m³ on August 26, 2016 and from 0 to 126 µg/m³ on September 1, 2016. PM₁₀ particle concentrations ranged from 75 to 1,678 µg/m³ and from 7 to 967 µg/m³ on September 1, 2016. PM 2.5 and PM 10 particle concentrations were above the target concentrations in several locations on both days of monitoring. The monitoring on August 26th took place prior to the start of the school year. The building was occupied with students during the monitoring on September 1, 2016. Welding/soldering odors could be observed in the double door entrance way on September 1st. The construction manager confirmed that copper pipes were being soldered that day. Soldering and welding create small solid airborne particles which explains why the smaller size particles were increased in particle measurements on this day.

Indoor Air Quality Measurements

Industry guidelines or standards for seasonal temperature and humidity ranges for thermal comfort are established by the American Society for Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) standard 55-2013. These ranges are presented in Table 3. The U.S. Environmental Protection Agency (EPA) recommends maintaining indoor relative humidity below 60% and ideally between 30 and 50%. Low humidity is expected in buildings that do not add humidity during the heating season. The comfort ranges are only set for the Summer and Winter seasons when temperatures are usually consistent. There are no Fall or Spring ranges because these seasons can include both heating and cooling modes of HVAC operation. Measurement for temperature, relative humidity, carbon dioxide and carbon monoxide were not collected on August 26 because some doors and windows were open and the building air conditioning was not operating fully. Results of temperature, relative humidity, carbon dioxide and carbon monoxide monitoring on September 1st are presented in Table 4.

Table 3- Acceptable Ranges of Temperature and Relative Humidity in Summer and Winter^a

Relative Humidity	Winter Temperature	Summer Temperature
30%	68.5°F – 76.0°F	74.0°F – 80.0°F
40%	68.5°F - 75.5°F	73.5°F – 79.5°F
50%	68.5°F - 74.5°F	73.0°F – 79.0°F
60%	68.0°F - 74.0°F	72.5°F – 78.0°F

^aadapted from ASHRAE Standard 55-2013

Carbon dioxide and carbon monoxide measurements are used to assess ventilation system performance. The exhaled breath of building occupants is the main indoor source of carbon dioxide; therefore, the build-up of carbon dioxide indicates inadequate ventilation.

Table 4 – Results of Indoor Air Quality (IAQ) Measurements at Swansfield Elementary School on September 1, 2016

Location	Time	Temperature (°F)	Relative Humidity (Rh)(%)	Carbon Monoxide (CO)	Carbon Dioxide (CO₂)
Outside	1:13 PM	78.1	85.8	0.0	300
Front Entrance Inside Double Doors	1:19 PM	78.3	79.5	0.7	312
Hallway near Construction Door 2	1:39 PM	79.2	76.5	0.8	799
Hallway near Construction Door 3	1:42 PM	74.9	75.6	0.9	598

**Table 4 – Results of Indoor Air Quality (IAQ) Measurements
at Swansfield Elementary School on September 1, 2016**

Location	Time	Temperature (°F)	Relative Humidity (Rh)(%)	Carbon Monoxide (CO)	Carbon Dioxide (CO₂)
Hallway near Construction Door 4	1:46 PM	79.5	67.1	0.6	650
Hallway near Construction Door 5	1:48 PM	78.3	58.7	0.4	814
Hallway near Construction Door 6	1:50 PM	76.8	58.5	0.3	817
Hallway near Construction Door 7	1:55 PM	75.8	57.7	0.0	811
Hallway near Construction Door 8	2:02 PM	75.0	63.9	0.5	1,148
Non-construction Area Hallway near 3 rd Grade Room	2:05 PM	74.4	57.9	0.6	648
Non-construction Area Hallway near 1 st Grade Room	2:07 PM	74.1	61.6	0.0	601

Boild-faced indicates results outside of recommended comfort ranges or target concentrations.

The indoor temperatures for September 1, 2016 ranged from 74.1°F to 79.5°F. Measurements in classrooms and occupied areas of the school were mostly acceptable compared to the comfort ranges. Indoor relative humidity measurements on September 1, 2016 were all between 57.7% and 79.5% with six of the ten measurements outside the recommended range of 30 to 60%. Due to construction activities not all HVAC units were operating at normal levels, which contributed to elevated temperature and relative humidity readings. Also, it had rained earlier in the day.

Carbon dioxide concentrations ranged from 312 to 1,148 ppm indoors. The concentration of concern for carbon dioxide is set by ASHRAE standard 62.1 as 700 ppm above outdoor air. On the day of monitoring, the outdoor air concentration of carbon dioxide was 300 ppm; therefore, concentrations were within the comfort parameters in all areas monitored with the exception of the measurement in the hallway near Construction Door 8. Measurements were made during a normal school day when the building was fully occupied, which could have contributed to elevated carbon dioxide readings.

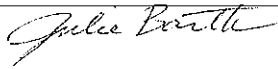
Carbon monoxide is mainly attributed to incomplete combustion. Concentrations of CO ranged from 0.0 ppm to 0.9 ppm for all indoor and outdoor locations monitored and were below the ASHRAE concentration of concern (9 ppm).

Conclusions and Recommendations

Based upon our observations and sampling results on August 26 and September 1, 2016 at Swansfield Elementary School (SWES), current measures are not sufficient to prevent construction dust and odors from entering the occupied areas of the school. We recommend reducing the number of construction doors that enter the occupied areas and closing and sealing these doors with tape or plastic sheeting. We also recommend more frequent floor cleaning in the hallways near the construction doors and barriers. Sticky mats were being used inside the construction doors. We recommend refreshing these mats more often and adding the mats to both sides of the doors. AE will continue to make visits to SWES as requested.

Thank you for choosing Aria Environmental, Inc. for your industrial hygiene consulting needs. Should you have any questions about the information contained herein, please do not hesitate to contact us at 410-549-5774.

Sincerely,
Aria Environmental, Inc.



Julie Barth, CIH, CSP, LEED Green Associate