Aria Environmental, Inc.
INDUSTRIAL HYGIENE & SAFETY CONSULTANTS

June 16, 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 Deep Run Elementary School
Project #J15-867

Dear Mr. Klenk,

Aria Environmental, Inc. (AE) is pleased to present this report of findings for indoor air quality assessments conducted at Deep Run Elementary School (DRES). In response to complaints from Faculty, Jeff Klenk at HCPSS requested that AE start making frequent visits to DRES in order to monitor indoor air quality that may be affected by the current major renovation of the school. The initial visit discussed in this report was conducted on May 16, 2016, and a follow up visit was requested on May 19, 2016. Each visit included work site observations, and real time measurements for particles, volatile organic compounds (VOCs) and indoor air quality measurements (temperature, humidity, carbon monoxide (CO) and carbon dioxide (CO_2)). The assessments were performed by Julie Barth, CIH, CSP, LEED Green Associate on May 16, 2016 accompanied by Chad Porter of HCPSS and Ed Shamus of Riparius. Julie Barth and Julie Fafard of AE performed assessments on May 19, 2016. Measurements were taken inside the construction areas and in occupied areas near construction barriers on May 16th, and in occupied areas near construction barriers only on May 19th. The observations and recommendations made during the visits to DRES are presented below. These observations and recommendations are based upon conditions readily observed on the reported dates.

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 (PM 10) 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 PM 10 of 15 µg/m^3 and 50 µg/m^3, 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 (PM 1, PM 2.5, PM 7, PM 10 and total suspended particles (TSP)). Results of particulate monitoring are presented in Tables 1 and 2. A summary of results is given after the tables.

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Table 1 – Results of Particulate Monitoring Deep Run Elementary School on May 16, 2016

Location	Time	PM1 (µg/m³)	PM2.5 (µg/m³)	PM7 (µg/m³)	PM10 (µg/m³)	TSP (µg/m³)
2nd Grade Common Area	10:57 AM	0	1	19	30	59
At Sealed Double Door to Construction Area	11:00 AM	0	1	23	38	112
2nd Grade Classroom near wall to Construction	11:05 AM	0	0	7	11	24
Inside the Construction Area near 2nd Grade	11:10 AM	0	3	42	**94**	271
Inside the Construction Area near New Partition to Classroom	11:16 AM	0	0	147	**237**	476
Inside the Construction Area near New Classroom B112	11:20 AM	0	3	67	**116**	229
Inside the Construction Area on Back Side of Double Doors	11:27 AM	0	5	54	**124**	320
In School Near Construction and 2 Story Addition	11:35 AM	0	6	19	38	93
Media Center (Near Construction Partition)	11:43 AM	0	1	20	26	71
Outdoors at front entrance	11:54 AM	0	0	1	1	8

Bold text indicates measurements above target concentrations.

The PM 2.5 particle concentrations ranged from 0 to 6 µg/m³ and PM10 particle concentrations ranged from 1 to 237 µg/m³ On May 16, 2016. Particle concentrations were below the target concentrations in all areas monitored that were inside the school near construction barriers but were above the target concentrations inside the construction areas. The construction director was present for these measurements.

Table 2 – Results of Particulate Monitoring Deep Run Elementary School on May 19, 2016

Location	Time	PM1 (µg/m³)	PM2.5 (µg/m³)	PM7 (µg/m³)	PM10 (µg/m³)	TSP (µg/m³)
At Sealed Double Door to Construction Area	12:55 PM	0	1	17	25	52
2nd Grade Common Area	12:59 PM	0	1	27	38	67
2nd Grade Classroom near wall to Construction	1:01 PM	0	2	30	43	84
Media Center (Near Construction Partition)	1:06 PM	0	0	3	3	29
Media Center Away from Partition Wall	1:11 PM	0	0	3	5	12
Hallway Near Cafeteria w/ Student Traffic (Walking)	1:17 PM	0	0	5	12	91
Hallway Near Cafeteria After Student Traffic Subsides	1:23 PM	0	1	28	43	92
Outdoors at Front Entrance	1:25 PM	0	1	3	5	7

The PM 2.5 particle concentrations ranged from 0 to 2 µg/m³ and PM10 particle concentrations ranged from 3 to 43 µg/m³. Particle concentrations were below the target concentrations in all areas monitored that were outside the construction areas.

Volatile Organic Compounds Monitoring

Instantaneous measurements for volatile organic compounds (VOCs) were collected using a ppbRae 3000 monitor. This instrument is used as a screening tool for VOCs in general; for short or long periods of time. The limit of detection for VOCs is 1 ppb. VOCs include a variety of chemicals, some of which may cause adverse health effects. Concentrations of many VOCs are generally higher indoors than outdoors. VOCs are emitted by many common products including paints and lacquers, paint strippers, cleaning supplies, pesticides, building materials and furnishings, fuels, office equipment and supplies, glues and adhesives, and permanent markers, as well as cosmetics, perfumes, hand sanitizers and other personal hygiene products. All of these products can release organic compounds while being used or stored. It is important to note that the measurements taken with the ppbRAE monitor are instantaneous and are intended only as a quick reference in this particular case. VOC measurements are presented in Table 2.

Table 3 – Results of Volatile Organic Compound (VOC) at Deep Run Elementary School on May 16, 2016

Location	Time	VOCs (ppb)
2nd Grade Common Area	10:57 AM	0
At Sealed Double Door to Construction Area	11:00 AM	0-4
2nd Grade Classroom near wall to Construction	11:05 AM	0
Inside the Construction Area near 2nd Grade	11:10 AM	0
Inside the Construction Area near the New Partition to Classroom	11:16 AM	0
Inside the Construction Area near New Classroom B112	11:20 AM	0
Inside the Construction Area on Back Side of Double Doors	11:27 AM	60-2,080
In School Near Construction and 2 Story Addition	11:35 AM	300-400
Media Center (Near Construction Partition)	11:43 AM	45
Outdoors at Front Entrance	11:54 AM	0

Indoor concentrations of VOCs measured on May 16, 2016 ranged from 0 to 2,080 ppb at DRES. The outdoor measurement was 0 ppb. The higher measurements along the back side of the double doors and near the 2 story addition were a result of the use of PVC glue. The glue was being applied at the time of the measurement and was not dried resulting in the release of VOCs as identified on the product warning label. The construction director was present for these measurements.

Table 4 – Results of Volatile Organic Compound (VOC) at Deep Run Elementary School on May 19, 2016

Location	Time	VOCs (ppb)
At Door to Construction Area	12:55 PM	0.0
2nd Grade Common Area	12:59 PM	0.0
2nd Grade Classroom near wall to Construction	1:01 PM	0.0
Media Center (Near Construction Partition)	1:06 PM	0.0

Location	Time	VOCs (ppb)
Media Center Away from Partition Wall	1:11 PM	0.0
Hallway Near Cafeteria w/ Student Traffic (Walking)	1:17 PM	0.0
Hallway Near Cafeteria After Student Traffic Subsides	1:23 PM	0.0
Outdoors at Front Entrance	1:25 PM	0.0

Indoor concentrations of VOCs measured on May 19, 2016 were 0.0 ppb at DRES. The outdoor measurement was 0.0 ppb. No VOCs were detected in the general location of where the PVC glue was used at the previous visit.

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 5. 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. Results of temperature, relative humidity, carbon dioxide and carbon monoxide monitoring are presented in Tables 6 and 7.

Table 5- 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

[a]adapted 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 6 – Results of Indoor Air Quality (IAQ) Measurements at Deep Run Elementary School on May 16, 2016

Location	Time	Temperature (°F)	Relative Humidity (Rh) (%)	Carbon Monoxide (CO)	Carbon Dioxide (CO_2)
2nd Grade Common Area	10:57 AM	71.6	**27.7**	0.0	696
At Sealed Double Door to Construction Area	11:00 AM	72.4	**26.8**	0.0	676
2nd Grade Classroom near wall to Construction	11:05 AM	72.3	**25.6**	0.0	577
Inside the Construction Area near 2nd Grade	11:10 AM	**66.4**	**22.5**	0.0	422

Location	Time	Temperature (°F)	Relative Humidity (Rh) (%)	Carbon Monoxide (CO)	Carbon Dioxide (CO_2)
Inside the Construction Area New Partition to Classroom	11:16 AM	**63.7**	**26.4**	0.0	377
Inside the Construction Area near New Classroom B112	11:20 AM	**63.7**	**28.0**	0.0	381
Inside the Construction Area on Back Side of Double Doors	11:27 AM	**66.1**	**29.4**	0.0	454
In School Near Construction and 2 Story Addition	11:35 AM	69.6	**27.3**	0.0	688
Media Center (Near Construction Partition)	11:43 AM	72.1	**24.9**	0.0	658
Outdoors at Front Entrance	11:54 AM	55.5	30.6	0.0	313

The indoor temperatures for May 16, 2016 ranged from 63.7°F to 72.4°F. Temperature measurements in classrooms and occupied areas of the school were within ASHRAE acceptable comfort ranges. Temperatures within the construction area were slightly below the acceptable range. Relative humidity measurements on May 16, 2016 were all below the recommended minimum of 30%. Low humidity is expected when outdoor relative humidity is low or during the heating season in buildings that do not add humidity.

Carbon dioxide concentrations ranged from 377 to 696 ppm indoors. The concentration of concern for carbon dioxide is set by ASHRAE standard 62.1–2013 as 700 ppm above outdoor air. On the day of monitoring, the outdoor air concentration of carbon dioxide 313 ppm. Carbon dioxide concentrations were within the comfort parameters established by ASHRAE in all areas monitored.

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

Table 7 – Results of Indoor Air Quality (IAQ) Measurements at Deep Run Elementary School on May 19, 2016

Location	Time	Temperature (°F)	Relative Humidity (Rh)	Carbon Monoxide (CO)	Carbon Dioxide (CO_2)
At Door to Construction Area	10:57 AM	74.8	42.2	0.0	685
2nd Grade Common Area	11:00 AM	75.3	40.8	0.0	653
2nd Grade Classroom near wall to Construction	11:05 AM	76.3	39.6	0.0	647
Media Center (Near Construction Partition)	11:10 AM	75.8	37.1	0.0	443
Media Center Away from Partition Wall	11:16 AM	75.6	36.8	0.0	398
Hallway Near Cafeteria w/ Student Traffic (Walking)	11:20 AM	74.0	41.2	0.0	500
Hallway Near Cafeteria After Student Traffic Subsides	11:27 AM	73.7	40.7	0.0	487

Location	Time	Temperature (°F)	Relative Humidity (Rh)	Carbon Monoxide (CO)	Carbon Dioxide (CO_2)
Outdoors at Front Entrance	11:35 AM	70.4	38.8	0.0	318

The indoor temperatures measured on May 19, 2016 ranged from 73.7°F to 76.3°F. Classrooms and occupied areas of the school were within ASHRAE acceptable comfort ranges. No measurements were taken within the construction area. Relative humidity measurements on May 19, 2016 were all between 36.8% and 42.2% which is within the recommended range of 30 to 60%.

Carbon dioxide concentrations ranged from 398 to 685 ppm indoors. On the day of monitoring, the outdoor air concentration of carbon dioxide was 313 ppm; therefore, carbon dioxide concentrations were within the comfort parameters established by ASHRAE in all areas monitored.

Concentrations of CO were consistently 0.0 ppm for all indoor and outdoor locations measured and below the ASHRAE concentration of concern (9 ppm).

Observations

No odors related to the PVC glue being used inside the construction area could be observed near the construction barriers. On May 16, 2016 a light loading of light-colored dust was observed near the construction partition in the Media Center. The same dust was observed on May 19th. This dust may have been related to the installation of the partition wall.

Conclusions and Recommendations

Based upon our observations and sampling results on May 16 and 19, 2016 at Deep Run Elementary School (DRES), measures are being taken to control dust and odors during construction activities; however, some improvement can be made in sealing construction barriers with tape and plastic sheeting and in cleaning up any dust related to barrier wall installation. AE will continue to visit DRES as needed.

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