INDOOR AIR QUALITY ASSESSMENT

Bridgewater Raynham Regional High School
415 Center Street
Bridgewater, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health
Indoor Air Quality Program

April 2017

Background

Building:	Bridgewater Raynham Regional High School (BRRHS)
Address:	415 Center Street, Bridgewater, MA
Assessment Requested by:	Paul Fox, Director of Facilities
Date of Assessment:	March 21, 2017
Bureau of Environmental Health (BEH) Indoor Air Quality (IAQ) Program Staff Conducting Assessment:	Cory Holmes and Sharon Lee, Environmental Analysts
Date of Building Construction:	2007
Reason for Request:	General IAQ assessment
Building Type:	3-story, red brick school building
Building Population:	Approximately 1,740 students and 150 employees
Windows:	Openable

IAQ Testing Results

Please refer to the IAQ Manual for methods, sampling procedures, and interpretation of results (MDPH, 2015). The following is a summary of indoor air testing results (Table 1).

- ***Carbon dioxide*** levels were above 800 parts per million (ppm) in 36 of 137 areas surveyed, indicating a lack of air exchange in a number of areas.
- ***Temperature*** was within or very close to the recommended range of 70°F to 78°F in all areas tested. However, many excessive heat control complaints were expressed on the third floor and some areas of the second floor. Heat related concerns are likely due to solar gain.
- ***Relative humidity*** was below the recommended range of 40 to 60% in all areas tested, which is typical in New England during winter months.
- ***Carbon monoxide*** levels were non-detectable (ND) in all areas tested.
- ***Fine particulate matter (PM2.5)*** concentrations measured were below the NAAQS limit of 35 $\mu g/m^3$ in all areas tested.

It is important to note that relative humidity levels in the building would be expected to be low during the winter months due to atmospheric conditions and heating. Low relative humidity can lead to common symptoms such as: dry skin, lips, and scalp; dry/scratchy throats and noses (nose bleeds); exacerbation of asthma, eczema, or allergies; dry/irritated eyes; and irritation of the respiratory tract.

Ventilation

A heating, ventilating, and air-conditioning (HVAC) system has several functions. First it provides heating and, if equipped, cooling. Second, it is a source of fresh air. Finally, an HVAC system will dilute and remove normally-occurring indoor environmental pollutants by not only introducing fresh air, but by filtering the airstream and ejecting stale air to the outdoors via exhaust ventilation. Even if an HVAC system is operating as designed, point sources of respiratory irritation may exist and cause symptoms in sensitive individuals.

Mechanical ventilation is provided by rooftop air-handling units (AHUs; Pictures 1 and 2). Outside air is drawn through a bank of pleated filters (Picture 3), heated or cooled, and delivered to occupied areas via ducted supply diffusers (Picture 4). The filters in use at the BRRHS appear to have a Minimum Efficiency Reporting Value (MERV) rating of 8, which are reportedly changed quarterly and are adequate in filtering out pollen and mold spores (ASHRAE, 2012). Return air is drawn through ceiling grates (Picture 5) and returned back to the AHUs.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. It was reported that the system is automated by software/computer controlled. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

Microbial/Moisture Concerns

In order for building materials to support mold growth, a source of water is necessary. A number of areas had water-damaged ceiling tiles (Picture 6, Table 1), which can indicate current or historic roof/plumbing leaks. After the source of the leak above the ceiling tiles is repaired, water-damaged ceiling tiles should be removed and replaced. Other conditions that may result in water damage or infiltration, or conditions that can lead odors or microbial growth include:

- Broken window in room F304 (Picture 7);

- Failing window gasket in room D208 and failing window caulking around the exterior of the building (Picture 8);
- Plant growth against the foundation along the exterior (Picture 9);
- Missing/damaged caulking between the sink countertop and backsplash in Room D208 (Picture 10);
- Aquariums and terrariums in several rooms. These items should be properly maintained to prevent bacteria/microbial growth; and
- Water cooler on the carpet in Room A150 (Picture 11).

Plants, which can be a source of pollen and mold and be respiratory irritants to some individuals, were observed in a number of areas. Plants should be properly maintained and equipped with drip pans to prevent water leaks and damage. They should also be located away from air diffusers to prevent the aerosolization of dirt, pollen, and mold.

Other IAQ Evaluations

Volatile Organic Compounds (VOCs)

Exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat, and/or respiratory irritation in some sensitive individuals. In addition to testing, IAQ staff examined rooms for products containing VOCs. IAQ staff noted air fresheners, scented hand sanitizers, cleaners, and dry erase materials within the building (Table 1). All of these products have the potential to be irritants to the eyes, nose, throat, and respiratory system of sensitive individuals and their use should be minimized. Hand sanitizer products may contain ethyl alcohol and/or isopropyl alcohol, which are highly volatile and may be irritating to the eyes and nose. These products may also contain fragrances to which some people may be sensitive.

Strong photocopier odors were noted in room H208. Excess heat, odors, VOCs, and ozone can be produced by laminators and photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, 1992). The photocopier should be relocated to the exhaust vent near the window (Picture 12).

Of particular note were conditions found in the chemical prep rooms/science areas (Picture 13 to 15). It was determined that a calibration program does not exist for the chemical lab hoods. Proper function of this equipment is essential for health and safety. Some chemical containers were found labeled with chemical formula rather than chemical name, and some materials were old/outdated/crystalized. Additionally, items were being stored in chemical lab hoods. Unused items should be properly discarded or returned to their proper storage cabinets.

Other Conditions

Some personal fans, supply, and exhaust vents were observed to have accumulated dust/debris (Table 1, Pictures 4, 5, and 16). Particulates can be reaerosolized from these items and they should be cleaned regularly. Dust accumulation was also observed on flat surfaces in some areas (Picture 10).

In several areas, items were observed on the floor, windowsills, tabletops, counters, bookcases, and desks. The large number stored items provide a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Once aerosolized, they can act as irritants to eyes and the respiratory system. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up.

Room F114 is used as an industrial shop class (Picture 17). However, the room was not designed for these activities. As a result, no dedicated exhausts for woodworking and soldering are available. These activities produce airborne dust, fume, and particulates and require dedicated exhaust equipment to prevent respiratory irritation.

Finally, the kiln room, D207 contains two kilns that share a single dedicated exhaust hood (Picture 18). At the time, one kiln was not working. Each kiln should have its own dedicated exhaust to ensure vapors and dusts are adequately removed during the firing process. Any dust/debris that escapes the kiln should be cleaned.

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. Work with HVAC engineering firm to ensure system software is up to date and working properly. Adjust outside air intake to provide increased fresh air circulation and comfort. Ensure supply and exhaust ventilation operate continuously and remain unobstructed in all areas during occupied periods.

2. Consider adopting a balancing schedule of every 5 years for all mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).
3. Install blinds, reflective shades, or solar tint to windows in areas of the building with chronic solar gain/heat complaints, particularly on the second and third floors.
4. Ensure any building envelope or plumbing leaks are repaired, and replace water-damaged ceiling tiles.
5. Repair broken window in room F304.
6. Make repairs to window gaskets (D206) and ensure window caulking is intact along exterior.
7. Remove plant growth from directly against foundation to prevent damage.
8. Seal sink countertop/backsplash with caulking in Room 208.
9. Consider placing water dispensers on non-carpeted areas or place a waterproof mat underneath them.
10. Ensure plants are properly maintained and equipped with drip pans. Plants should be located away from the airstream of air diffusers and ventilation equipment to prevent the aerosolization of dirt, pollen, and mold.
11. Ensure aquariums and terrariums are properly maintained to prevent odors and microbial growth.
12. Relocate photocopier in room H208 to the exhaust vent near window.
13. Consult with teacher and an HVAC specialist on obtaining proper exhaust equipment for woodworking and soldering in room F114.
14. Remove non-working kiln in room D207 and relocate the working kiln directly below the exhaust.
15. Conduct a building-wide chemical audit to ensure proper storage, and initiate removal of old/outdated materials. Refer to the following resources on storage and cleanout:
    a. Reducing Risks to Students and Educators from Hazardous Chemicals in a Secondary School Chemical Inventory (ACS, 2015)
    b. Toolkit for Safe Chemical Management in K-12 Schools (EPA, 2017)
    c. Proper Use and Storage of Chemicals in Schools to Protect Public Health (MDPH, 2016).
    d. Chemical Storage in Schools and Impact on Indoor Air Quality (MDPH, 2006).

16. Institute an annual calibration program for all chemical lab hoods to ensure proper function.
17. Do not store materials in lab hoods. Return materials to stock/proper storage cabinets upon completion of experiments.
18. Clean personal fans, supply, and return vents periodically of accumulated dust, perhaps quarterly after filter changes.
19. Relocate or consider reducing the amount of stored materials to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
20. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
21. Consider reducing the use of hand sanitizers, fragrances, and dry erase materials in use within the office since all of these products have the potential to be irritants to the eyes, nose, throat, and respiratory system of sensitive individuals.
22. Refer to resource manual and other related indoor air quality documents located on the MDPH's website for further building-wide evaluations and advice on maintaining public buildings. These documents are available at http://mass.gov/dph/iaq.

References

American Chemical Society. (ACS). 2015. Reducing Risks to Students and Educators from Hazardous Chemicals in a Secondary School Chemical Inventory. American Chemical Society, Washington, DC. http://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/publications/reducing-risks-to-students-and-educators-from-hazardous-chemicals.pdf

American Society of Heating, Refrigeration and Air Conditioning Engineers. (ASHRAE). 2012. Standard 52.2-2012 -- Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size (ANSI Approved).

Massachusetts Department of Public Health. (MDPH). 2015. "Indoor Air Quality Manual: Chapters I-III". Available at: http://www.mass.gov/eohhs/gov/departments/dph/programs/environmental-health/exposure-topics/iaq/iaq-manual/

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Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA). 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

United States Environmental Protection Agency (US EPA). 2017. Toolkit for Safe Chemical Management in K-12 Schools. Available at: https://www.epa.gov/schools-chemicals/toolkit-safe-chemical-management-k-12-schools

Picture 1

Rooftop air handling unit (AHU)

Picture 2

Rooftop AHU

Picture 3

Bank of pleated air filters in AHU

Picture 4

Supply air diffuser, note dust/debris accumulation on louvers

Picture 5

Return grill, note dust/debris accumulation on louvers

Picture 6

Water-damaged ceiling tiles

Picture 7

Broken classroom window

Picture 8

Failing caulking around exterior window

Picture 9

Plant growth against the building foundation

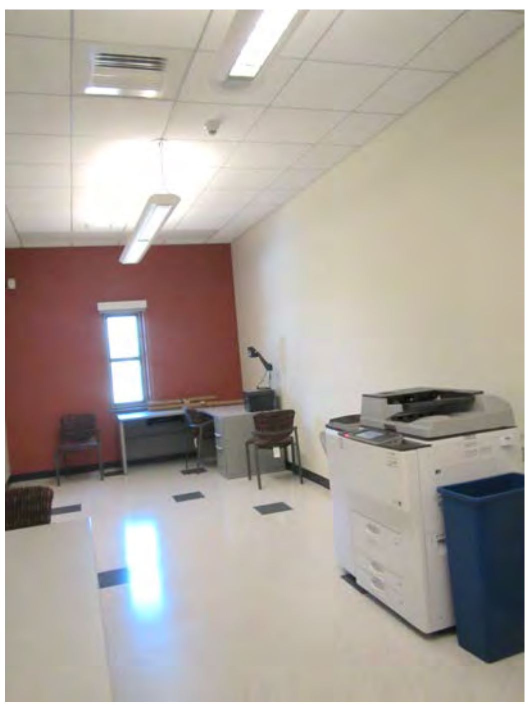
Picture 10

Breach between sink countertop and backsplash

Picture 11

Water cooler on carpet

Picture 12



Photocopier in front of room, note exhaust vent near window

Picture 13

Bottles labeled with chemical formula only, note some labels are peeling

Picture 14

Chemical crystallization due to evaporation

Picture 15

Items stored in chemical hood

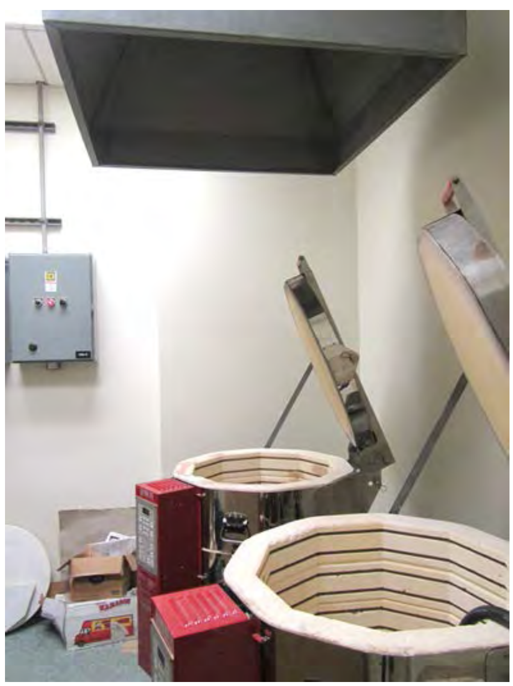
Picture 16

Accumulated dust/debris on fan blades in classroom

Picture 17

Woodworking equipment lacking dedicated wood dust collection system

Picture 18



Kiln vent shared between two kilns

Location: Bridgewater Raynham High School **Indoor Air Results**

Address: 415 Center Street, Bridgewater, MA **Table 1** **Date: 3/21/2017**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (ug/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
Background	301	ND	50	20	16					Cool, scattered clouds
Third Floor										
E312	737	ND	74	14	11	0	N	Y	Y	2 PC, DO
E320 computer lab	914	ND	74	15	4	23	N	Y	Y	29 computers, DO, 4 WD CTs, MT
F301	1017	ND	70	20	9	21	Y	Y	Y	DO, DEM, CPs, PF
F302	757	ND	72	14	6	1	Y	Y	Y	Ripped window screen, PF
F303	815	ND	71	17	8	15	Y 2/8 open	Y	Y	DEM, DO, PF, DEM, CPs, HS
F304	653	ND	72	13	7	8	Y	Y	Y	DO, broken window, DEM, HS, CPs
F305	1171	ND	72	20	8	26	Y	Y Dusty	Y	DEM, PF
F306	850	ND	74	14	7	21	Y 4/8	Y	Y	DEM, DO, PF
F307	983	ND	74	16	8	25	Y 4/8	Y	Y	PF, DEM, HS, excessive heat concerns

ppm = parts per million
$\mu g/m^3$ = micrograms per cubic meter
ND = non detect
CP = cleaning products
DEM = dry erase materials
PF = personal fan
CT = ceiling tile
HS = hand sanitizer
DO = door open
AC = air conditioner
MT = missing tile
AT = ajar tile
WD = water-damaged

Comfort Guidelines

Carbon Dioxide: < 800 ppm = preferred
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Table 1 (continued)

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (ug/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
F308	1290	ND	74	20	8	27	Y 2/8	Y	Y	DEM, HS
F309	1295	ND	75	8	10	22	Y	Y	Y	PF, HS, DEM, AT
F310	1172	ND	74	17	8	27	Y 2/8	Y	Y	DEM, HS, CP
F312	663	ND	74	13	7	6	Y	Y	Y	PF, DEM
G301	376	ND	74	11	6	1	Y	Y	Y	DEM, HS, CPs, PF, DO
G303	628	ND	73	13	4	21	Y	Y Dusty	Y	DEM, HS, CPs
G304	708	ND	73	15	6	23	Y	Y	Y	Dust/debris on vents, DO
G305	719	ND	73	13	6	24	Y	Y Dusty	Y	CPs, DEM, PF
G306	684	ND	73	14	7	13	Y	Y	Y	DO, DEM, HS
G307	592	ND	74	13	4	21	Y	Y Dusty	Y	CPs, DEM, PF
G308	437	ND	73	13	3	20	Y	Y Dusty	Y	PF

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Table 1 (continued)

Indoor Air Results

Date: 3/21/2017

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (ug/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
G309	285	ND	74	10	4	1	Y	Y Dusty	Y	PF, portable AC, refrigerator, DEM, HS
G310	405	ND	72	11	5	1	N	Y	Y	DO
G311	259	ND	72	11	4	0	Y	Y	Y	DO, DEM
H301	612	ND	74	15	8	1	Y	Y	Y	Dust/debris on vents
H302	875	ND	75	17	5	31	Y	Y	Y	2 WD CT
H303	759	ND	74	16	6	26	Y	Y	Y	DO, PF, 2 WD CT
H304	778	ND	74	17	7	22	Y	Y	Y	PF, DO
H305	849	ND	69	21	6	18	Y	Y	Y	Dust/debris on vents
Middle School Office	753	ND	74	14	6	2	N	Y	Y	
Teacher's Breakroom	636	ND	72	14	3	3	Y	Y	Y	4 WD CT
Second Floor										

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Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (ug/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
A204	425	ND	73	11	5	6	Y	Y	Y	
A205	446	ND	74	12	5	2	Y	Y	Y	2 PC, DO
A211	417	ND	72	11	4	0	Y	Y	Y	DO, dust/debris on vents
A212	935	ND	72	16	6	24	Y Open	Y	Y	
A216	472	ND	72	12	5	2	N	Y	Y	
A218	433	ND	74	11	4	1	N	Y	Y	
Media Center	417	ND	73	12	5	3	Y	Y	Y	
B204	763	ND	75	16	4	0	Y	Y	Y	Portable AC
B206	1797	ND	74	24	4	25	Y	Y	Y	DO, portable AC, AT
D204	602	ND	75	14	7	0	Y	Y	Y	DO, items
D206	634	ND	78	13	4	18	Y 1/1 open	Y	Y	29 computers, plants, failing window gasket, DO

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Table 1 (continued)

Indoor Air Results

Date: 3/21/2017

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (ug/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
D207 kiln room									Y	DO, one dedicated exhaust for two kilns
D208	667	ND	75	14	8	14	Y 1/8 open	Y	Y	Potting, dusty flat surfaces, PF, breach between sink backsplash and counter
E205	482	ND	74	12	3	0	N	Y	Y	DO
E207	481	ND	73	12	9	0	N	Y	Y	Microwave
E210	487	ND	74	13	4	1	N	Y	Y	DO, copier
E212	672	ND	74	14	18	15	Y	Y	Y	Strong food odor, microwave, refrigerator
E218	793	ND	75	15	4	0	N	Y	Y	Occupants at lunch, dust/debris on vents
F201	749	ND	75	15	6	1	Y	Y	Y	26 occupants gone ~15 mins
F204	834	ND	73	15	5	0	Y	Y	Y	PF, occupants at lunch
F206	730	ND	73	15	7	4	Y	Y	Y	DO
F207	702	ND	74	16	6	1	Y	Y	Y	23 occupants gone ~ 10 mins

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Table 1 (continued)

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F208	730	ND	73	15	5	1	Y	Y	Y	DO
G201	496	ND	74	12	5	0	Y	Y	Y	PF
G202	750	ND	74	14	5	1	Y	Y	Y	Items/papers on floor/windowsill, DO, DEM, PF
G203	831	ND	74	16	5	0	Y	Y	Y	Class just left for lunch
G204	660	ND	74	14	5	16	Y	Y	Y	PF, DEM
G205	723	ND	74	15	7	0	Y	Y	Y	PF
G206	629	ND	74	14	5	20	Y	Y Dusty	Y	DO, PF, DEM
G207	926	ND	74	17	5	18	Y	Y	Y	PF(2)
G208	621	ND	74	14	5	15	Y	Y	Y	DEM, HS, PF
G209	776	ND	73	17	7	16	Y	Y	Y	DO, dust/debris on vents
G210	763	ND	74	14	4	30	7	7	7	DEM, PF, HS

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G211	501	ND	72	13	5	1	Y	Y	Y	PF
H201	876	ND	74	15	4	2	Y	Y	Y	DO, aquarium
H202	546	ND	73	15	5	1	Y	Y	Y	Terrarium
H203	463	ND	75	13	3	1	Y	Y	Y	DEM, CPs, HS, PF, AD
H204	514	ND	73	14	3	14	Y	Y	Y	DO, DEM, HS
H205	638	ND	73	14	4	20	Y	Y	Y	DO
H208	440	ND	73	13	4	0	Y	Y	Y	Strong copier odors
First Floor										
Auditorium	399	ND	71	11	4	0	N	Y	Y	
A104	481	ND	74	13	5	0	Y	Y	Y	
A105	490	ND	73	13	5	0	N	Y	Y	DO

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A107	471	ND	73	13	5	0	Y	Y	Y	
A112	436	ND	72	13	4	0	Y	Y	Y	DO
A122	458	ND	72	13	4	0	Y	Y	Y	DO
A135	503	ND	70	15	4	6	Y	Y	Y	DO
A136	296	ND	71	13	4	1	Y	Y	N	Plants, DO
A137	751	ND	71	18	2	2	N	Y	Y	AD, HS
A140	381	ND	71	13	4	1	N	Y	Y	HS
A150	297	ND	72	13	4	0	N	Y	N	Water cooler on carpet, DO
A152	318	ND	71	13	4	1	Y	Y	N	DO
B101 cafeteria	313	ND	74	12	4	250	Y	Y	Y	
B114	205	ND	72	11	3	0	Y	Y	Y	Copier, 4 WD CT, AT

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B120	2672	ND	74	29	4	26	Y	Y	Y	DEM, HS
B122	734	ND	75	15	4	10	Y	Y	Y	DEM, 29 computers, AD
B124	929	ND	75	17	4	3	Y	Y	Y	27 computers, DO, DEM
C103	640	ND	72	17	11	0	N	Y	Y	
Boys Locker Room	942	ND	72	23	4	0	N	Y	Y	Dust/debris on vents, class just left
C116	899	ND	73	23	6	4	N	Y	Y	Dust/debris on vents
C119	928	ND	73	21	4	1	N	Y	Y	Dust/debris on vents, DO
C201	339	ND	72	15	4	1	Y 2/2 open	Y	Y	Copier, PF, DO
C212 girls' locker room			72	17	4			Y	Y	
D112	761	ND	71	17	5	1	N	Y	Y	Burned coffee odor
D121	692	ND	73	15	2	1	N	Y	Y	DO

ppm = parts per million	CP = cleaning products	CT = ceiling tile	AC = air conditioner	WD = water-damaged
$\mu g/m^3$ = micrograms per cubic meter	DEM = dry erase materials	HS = hand sanitizer	MT = missing tile	
ND = non detect	PF = personal fan	DO = door open	AT = ajar tile	

Comfort Guidelines

Carbon Dioxide:	< 800 ppm = preferred	Temperature:	70 - 78 °F
	> 800 ppm = indicative of ventilation problems	Relative Humidity:	40 - 60%

Table 1 (continued)

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (ug/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
D128A	645	ND	73	15	3	0	N	Y	Y	DO
D129	655	ND	73	15	3	1	N	Y	Y	DO
D138	985	ND	73	20	6	16	Y	Y	Y	DO
D140	822	ND	74	15	4	1	Y	Y	Y	DEM, DO, HS
E104	772	ND	71	16	5	0	N	Y	Y	
E105	730	ND	70	15	4	0	N	Y	Y	DO, 1 WD CT
E107	731	ND	71	16	4	0	N	Y	N	DO
E111	707	ND	72	16	5	1	N	Y	Y	
E112	561	ND	72	15	4	0	Y	Y	Y	Microwave, refrigerator, temperature concern (too cold in corner)
E116	719	ND	72	15	5	1	N	Y	Y	
E120	551	ND	71	14	4	1	Y	Y	Y	

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ND = non detect
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PF = personal fan
CT = ceiling tile
HS = hand sanitizer
DO = door open
AC = air conditioner
MT = missing tile
AT = ajar tile
WD = water-damaged

Comfort Guidelines

Carbon Dioxide:	< 800 ppm = preferred	Temperature:	70 - 78 °F
	> 800 ppm = indicative of ventilation problems	Relative Humidity:	40 - 60%

Location: Bridgewater Raynham High School **Indoor Air Results**

Address: 415 Center Street, Bridgewater, MA **Table 1 (continued)** **Date: 3/21/2017**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (ug/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
E121	505	ND	71	15	4	0	N	Y	Y	
E124	927	ND	75	17	12	21	Y	Y	Y	DO
Gym	782	ND	72	21	4	~50	N	Y	Y	
Main Office	520	ND	71	14	5	3	N	Y	Y	DO
Main Office Reception	503	ND	74	13	5	1	Y	Y	Y	
F101	1047	ND	74	19	6	22	Y	Y	Y	DO, PF
F102	973	ND	73	18	6	28	Y	Y	Y	Dust/debris on vents
F103	824	ND	74	18	7	1	Y	Y	Y	20 occupants gone ~15 mins, dust/debris on vents
F106	717	ND	73	16	8	24	Y	Y	Y	PF, 2 AT
F107	730	ND	74	16	7	26	Y	Y	Y	DO, PF, AT
F108	937	ND	73	19	5	22	Y	Y Dusty	Y	DEM, HS, PF

ppm = parts per million
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PF = personal fan
CT = ceiling tile
HS = hand sanitizer
DO = door open
AC = air conditioner
MT = missing tile
AT = ajar tile
WD = water-damaged

Comfort Guidelines

Carbon Dioxide: < 800 ppm = preferred
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Table 1 (continued)

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (ug/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
F109	792	ND	73	20	6	24	Y	Y	Y	DO
F110	623	ND	72	16	6	0	Y 1/10 open	Y	Y	DEM, HS
F112	284	ND	71	13	3	0	Y	Y	Y	CPs, DO, microwave
F114	330	ND	69	15	8	19	Y ¼ open	Y	Y	Exterior DO, no dedicated exhaust for woodworking and soldering equipment
G101	908	ND	74	19	12	30	Y	Y	Y	DO
G102	904	ND	72	18	6	21	Y	Y	Y	DEM, DO
G103	764	ND	73	17	5	26	Y	Y	Y	DO, PF, dust/debris on vents
G104	497	ND	72	16	6	10	Y	Y	Y Dusty	DEM
G105	844	ND	73	17	7	25	Y	Y	Y	
G106	451	ND	72	15	4		Y	Y	Y	PF, DEM, DO
G107	686	ND	73	16	7	24	Y	Y	Y	

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HS = hand sanitizer
DO = door open
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Comfort Guidelines

Carbon Dioxide: < 800 ppm = preferred
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Location: Bridgewater Raynham High School

Address: 415 Center Street, Bridgewater, MA

Indoor Air Results

Date: 3/21/2017

Table 1 (continued)

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (ug/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
G108	657	ND	72	7	4	19	Y 1/10	Y	Y	DEM, HS
G109	641	ND	72	15	6	17	Y	Y	Y	Dust/debris on vents, DO
G110	869	ND	71	18	4	31	Y 1/10 open	Y	Y	DEM, HS, PF
G111	653	ND	73	16	6	4	Y	Y	Y	
H101	681	ND	73	17	4	20	Y	Y	Y	3 WD CT, item storage
H102	941	ND	71	19	6	23	Y	Y	Y	Dust/debris on vents, 1 WD CT, DO, PF
H103	633	ND	72	17	4	1	Y	Y	Y Dusty	Items
H104	994	ND	71	20	6	30	Y	Y	Y	Dust/debris on vents
H105	824	ND	71	20	5	21	Y	Y	Y Dusty	PF, 5 WD CT, 1 AT
H106	612	ND	71	16	6	1	Y	Y	Y	DO
H107 chemical storage								Y	Y	Chemical containers and other items stored in chemical hood, chemicals labelled with formula only, crystallization observed in bottles

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ND = non detect
CP = cleaning products
DEM = dry erase materials
PF = personal fan
CT = ceiling tile
HS = hand sanitizer
DO = door open
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Comfort Guidelines

Carbon Dioxide:	< 800 ppm = preferred > 800 ppm = indicative of ventilation problems	Temperature: Relative Humidity:	70 - 78 °F 40 - 60%

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (ug/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
H110 science prep								Y	Y	
Guidance Office	328	ND	71	13	4	0	Y	Y	Y	

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$\mu g/m^3$ = micrograms per cubic meter
ND = non detect
CP = cleaning products
DEM = dry erase materials
PF = personal fan
CT = ceiling tile
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DO = door open
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Carbon Dioxide:	< 800 ppm = preferred	Temperature:	70 - 78 °F
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