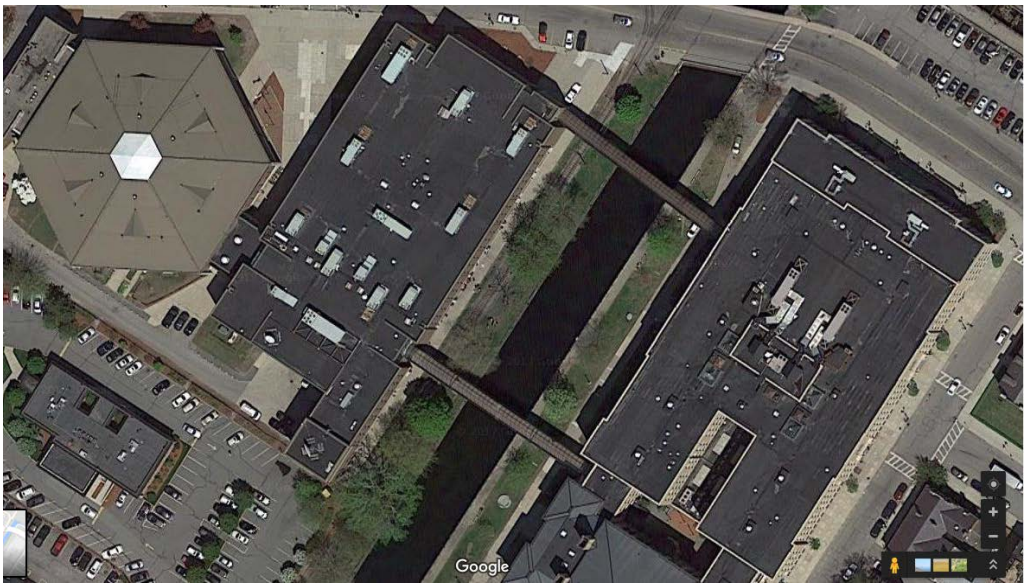
INDOOR AIR QUALITY ASSESSMENT

Lowell High School
1922 Building
14 French Street
Lowell, MA



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health
Indoor Air Quality Program
December 2017

Background

Building:	Lowell High School
Address:	14 French Street, Lowell, MA
Assessment Coordinated Through:	Lowell Public Schools
Reason for Request:	General Indoor Air Quality (IAQ) concerns. Note that a preliminary walkthrough of the building was conducted over the summer while this visit was conducted during the school year while the building was under normal occupancy.
Date of Assessment:	December 12, 2017
Massachusetts Department of Public Health/Bureau of Environmental Health (MDPH/BEH) Staff Conducting Assessment:	Cory Holmes, Environmental Analyst, Jason Dustin, Environmental Analyst, Sharon Lee, Environmental Analyst Ruth Alfasso, Environmental Engineer, and Mike Feeney Director, IAQ
Building Description:	The Building at 14 French Street was built in 1922 with brick and concrete construction and a complex shape. This building is connected to the building at 50 Father Morissette Boulevard by several enclosed walkways.
Windows:	Openable

Methods

Please refer to the IAQ Manual for methods, sampling procedures, and interpretation of results (MDPH, 2015).

IAQ Testing Results

Table 1 shows the information collected during the preliminary walkthrough in July of 2017. Table 2 includes indoor air testing results, which are summarized below.

- ***Carbon dioxide levels*** were above 800 parts per million (ppm) in more than two-thirds of all areas assessed including all occupied classrooms, indicating a lack of adequate air exchange in those areas of the building.

- ***Temperature*** was within or close to the lower end of the recommended range of 70°F to 78°F in all areas on the day of assessment.
- ***Relative humidity*** was below the recommended range of 40 to 60% in the areas tested which is typical during the heating season.
- ***Carbon monoxide*** levels were non-detectable in most areas tested. Low levels of carbon monoxide were detected in a few rooms on the first floor.
- ***Fine particulate matter (PM2.5)*** concentrations measured were below the National Ambient Air Quality (NAAQS) limit of 35 $\mu g/m^3$ in the majority of areas tested.

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. (For a description of the HVAC system, please refer to the August 2017 IAQ assessment).

Based on air sampling, it appears that most classrooms with normal occupancy appeared to have a lack of air exchange provided by the HVAC system in its current operating mode as demonstrated by carbon dioxide levels above 800 ppm. Given the age and operation of the existing HVAC system, it may be necessary to use opening windows to supplement fresh air supply for classrooms.

The HVAC systems should be regularly maintained and operate continuously during occupied hours. It may be possible to adjust AHUs to allow more fresh air into the system, e.g. by opening supply louvers or adjusting the proportion of air exhausted rather than recirculated. Exhaust ventilation should also be checked periodically to ensure a draw of air from classrooms. It was noted that the cooking area (Room 17) lacked exhaust ventilation, which is particularly important in areas where pollutants would be generated. In some other classroom, exhaust ventilation is only activated on a switch, which should be turned on whenever the classroom is occupied (Table 2).

In order to have proper ventilation with a mechanical supply and exhaust system, these systems must be balanced to provide an adequate amount of fresh air while removing stale air from a room. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). It is unknown the last time these systems were balanced.

Microbial/Moisture Concerns

The 1800's and 1920's building sections were constructed with materials that, for the most part, are not susceptible to mold growth. The majority of these building sections consist of brick, concrete, tile, plaster, and glass; none of which contain carbon and are resistant to mold growth even with chronic moistening. Hardwood is also highly resistant to microbial growth. Hardwood was observed throughout these sections in flooring, support beams, and trim.

Building renovations that occurred in later years added "porous" building materials such as carpeting, ceiling tiles, and gypsum wallboard. All of these materials contain carbon, which can support mold/microbial growth.

As reported by City of Lowell officials, original floors that were water-damaged were replaced with plywood and carpeted. An interior hallway adjacent to Room 105A has a water-damaged original floor that is likely the condition that required replacement with plywood (Picture 1). Room 105A has water-damaged wall plaster located behind a free-standing shelf (Picture 2), which may be the source of water that would be wetting the floor during/after wet weather.

Musty/stale odors were noted in a number of classrooms with wall-to-wall carpeting. Classrooms with either wood or tiled floors did not have the stale, musty odor. Wall-to-wall carpeting was also noted in offices as well as below grade spaces. Wall-to-wall carpeting is not recommended in school classrooms in general, due to the difficulty in maintaining in good condition, including wear, dirt and spills. Carpeting is also not recommended in below-grade areas due to the likelihood of moisture exposure from condensation forming on floors in contact with the ground during humid weather and/or ground or storm water infiltration. Roof leaks leading to stained ceiling tiles and water-damaged plaster can also be a source of water to moisten carpeting. Carpeting moistened periodically will be subject to microbial growth. The odors detected in these carpeted areas are likely from water damage that subsequently led to

microbial colonization of carpeting, as well as a buildup of dirt and debris in older carpeting that could no longer be adequately cleaned. Some carpeting was visibly stained, wrinkled, or threadbare (Tables 1 and 2; Picture 3), indicating it was past its service life. The service life of carpeting in schools is approximately 10-11 years (IICRC, 2002). Aging carpet can produce fibers that can be irritating to the respiratory system. In addition, tears or lifting carpet can create tripping hazards. Carpeting should be cleaned annually or semi-annually in soiled high traffic areas as per the recommendations of the Institute of Inspection, Cleaning, and Restoration Certification (IICRC, 2012).

Water-damaged ceiling tiles and gypsum wallboard were observed in classrooms, offices, and hallways (Table 2). Damage to these materials indicates leaks from the building envelope or plumbing system. Ceiling tiles and gypsum wallboard should be replaced after the leak is found and repaired. In general, ceiling tiles have an open space above them (the ceiling plenum) and tend to dry out quickly, reducing the chance that they will be colonized with mold.

Measures should be taken to ensure water-damaged materials are cleaned, replaced, and/or repaired in a manner consistent with the U.S. Environmental Protection Agency's guidelines (US EPA, 2008). The US EPA and the American Conference of Governmental Industrial Hygienists (ACGIH) recommend that porous materials (e.g., ceiling tiles, gypsum wallboard) be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2008; ACGIH, 1989). If not dried within this time frame they should be removed/discarded.

Water-damaged ceiling tiles need to be removed and replaced. In many areas, some ceiling tiles were also missing (Table 2). These need to be replaced to maintain a continuous ceiling plenum and prevent dust and debris from above the ceiling tiles entering occupied areas.

Water was observed leaking from a radiator into a bucket in Room 113; it was reported to be on a repair list. Until the piping can be repaired, this bucket, and any other water catch receptacle used in the building, needs to be emptied regularly and kept clean to prevent odors.

Windows open in most exterior classrooms. Open windows can be an additional source of fresh air. However, windows need to be tightly closed at the end of each day to prevent water infiltration and pest intrusion. Note that a few windows were found to be misaligned so that they would be difficult to close completely (Tables 1 and 2); these should be repaired/replaced.

Some areas in the buildings are equipped with air conditioning from the AHUs. Doors between these areas and non-air-conditioned areas should be kept closed to prevent condensation

of humid air on chilled surfaces. A few other areas were equipped with portable or window air conditioners. It is important that these units have the ability to properly drain any condensation they generate so that it does not leak and moisten building materials.

Other Conditions

Exposure to low levels of volatile organic compounds (VOCs) may produce eye, nose, throat, and/or respiratory irritation in some sensitive individuals. BEH/IAQ staff examined spaces for products containing VOCs, noting cleaning products, air fresheners, hand sanitizers and dry erase materials in a number of areas throughout the office space (Table 2). All of these products have the potential to be irritants to the eyes, nose, throat, and respiratory system of sensitive individuals. Other sources of total volatile organic compounds (TVOCs) include copy machines and laminators (Table 2). Excess heat, odors, VOCs and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, 1992). Laminators produce TVOCs and plastic odors. This equipment should be used in well-ventilated areas away from occupants.

In many areas, items, including books, papers, and decorative items were observed on floors, windowsills, tabletops, counters, bookcases, and desks, which can make it more difficult for custodial staff to clean (Table 2). Many classrooms had personal fans and some of these had dusty blades. Many supply and exhaust vents were also observed to be dusty (Table 2). Dust on ventilation and fan equipment can be aerosolized when the units are activated.

Conclusions/Recommendations

The following recommendations are made to assist in improving IAQ:

1. For information regarding the roof and recommendations, please refer to the August 2017 IAQ assessment.
2. Remove any water-damaged, musty, or worn carpeting and replace with non-porous flooring in classrooms and below-grade areas.
3. Use openable windows to supplement fresh air during temperate weather. Ensure all windows are tightly closed at the end of the day. Inform occupants that windows should not be opened while the HVAC system is in cooling mode to avoid condensation.

4. Consult with an HVAC contractor to thoroughly examine all HVAC system components to ensure proper function. Make any necessary repairs to ensure the system is working as designed. Assess whether adjustments can be made to allow more fresh air into the system.
5. Operate all supply and exhaust ventilation equipment continuously during occupied periods. Do not block supply or exhaust vents with furniture or items. Check exhaust/return vents periodically for proper function. Where exhaust vents are switch-operated, ensure they are turned on when the room is occupied.
6. Ensure areas which generate pollutants, such as cooking class areas, have operable exhaust functioning.
7. Ensure that a system of regular "Operations and Maintenance" remains in place to keep HVAC systems in proper working order.
8. Consider adopting a balancing schedule of every 5 years for all mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).
9. Repair water leaks in Room 105A. Repair plaster once water leak once repaired.
10. Replace any water-damaged/mold-colonized porous building materials (e.g., ceiling tiles, gypsum wallboard) in classrooms, hallways and stairwell areas. Ensure water-damaged materials are cleaned, replaced, and/or repaired in a manner consistent with the U.S. Environmental Protection Agency's guidelines (US EPA, 2008).
11. Replace any missing or ajar ceiling tiles to avoid pathways to unconditioned areas.
12. Ensure that a system of regular "Operations and Maintenance" remains in place to keep HVAC systems in proper working order.
13. Ensure pipe leak in room 113 is repaired.
14. Regularly inspect window and portable air conditioning units to ensure proper drainage of condensate and regular cleaning of filters.
15. Ensure that doors are closed between areas with air conditioning and areas without air conditioning, to avoid condensation of humid air on chilled surfaces.
16. Refrain from storing porous items (e.g., boxes, books, paper, clothing) directly on flooring, in below grade spaces, or under sink cabinets to avoid microbial colonization.
17. Trim back trees/vegetation within 5′ of the building. Remove any vegetation (e.g., ivy) that is growing on the building to avoid damage to exterior from associated moisture.

18. Reduce the use of products containing VOCs.
19. Locate photocopiers and laminators in well ventilated areas away from occupants.
20. Ensure Material Safety Sheets are available for all laboratory, maintenance and janitorial chemicals used in the building.
21. Regularly clean supply/return vents and fans to avoid aerosolizing accumulated particulate matter.
22. Consider reducing the amount of items stored in classrooms to make cleaning easier. Periodically move items to clean flat surfaces.
23. Clean any remaining carpeting and area rugs annually or more often in high-traffic locations in accordance with IICRC recommendations (IICRC, 2012) and discard those that are worn out or too soiled to be cleaned.
24. Encourage faculty to report classroom/building related issues via a tracking program.
25. Continue to adopt the US EPA (2000) document, "Tools for Schools", as an instrument for maintaining a good IAQ environment in the building available at: http://www.epa.gov/iaq/schools/index.html.
26. Refer to resource manual and other related IAQ 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

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Picture 1

Water-damaged floor of hall adjacent to room 105A

Picture 2

Water-damaged plaster in room 105A behind freestanding shelf

Picture 3

Worn, stained carpeting

Location: Lowell High School **Indoor Air Results**

Address: 14 French Street, Lowell, MA

Table 1

Date: July 26, 2017

Location	Windows Openable	Ventilation		Remarks
		Intake	Exhaust	
301 A (Main Area)				6 WD CT
301 A (Slattery Office)				Hole in wall-exposed fiberglass insulation
304		Y	Y	12+ WD CT, tile floor, dry drain, PC
305 A		Y	Y	Carpeted, dust/debris on vents, WD CP along windows/corner
305 B		Y	Y	Carpeted, dust/debris on vents
306	Y	Y	Y	Musty carpet odor
308		Y	Y	5 WD CT, carpeted, WD plaster
310	Y	Y	Y	
311				WD CP, peeling paint, open pipe ceiling
312	Y	Y	Y	Storage/desk, 1 WD CT, carpeted, WD plaster
313	Y	Y	Y	Wood floor, dirty lights
314 Chemistry	Y	Y	Y	Stored chemicals, chemical odors, HS, sinks, floor tiles damaged, WD ceiling

AC = air-conditioner
AI – accumulated items
CP= ceiling plaster
CT = ceiling tile
DEM = dry erase materials
DO = door open
FCU = fan-coil unit
GW = gypsum wallboard
MT = missing tile
NC = not carpeted
PF = personal fan
UF = upholstered furniture
WAC = window air-conditioner
WD = water-damaged

Table 1 (continued)

Location	Windows Openable	Ventilation		Remarks
		Intake	Exhaust	
314 Storage		N	N	9 WD CT, tile floor
315				WD CP, peeling paint, PF
318		Y	Y	2 WD CT and plaster, carpeted
319				PF
320		Y	N	Carpeted
321	Y	Y	Y	Tile floor, damaged, PF, DEM, science sinks and eyewash
323 R				Carpeted, WAC
324 Physics	Y	Y	Y	Carpeted, DEM
325		Y	Y	Exhaust vent obstructed w/file cabinet, WD CP and peeling paint
326		Y	Y	WD plaster, carpeted
329				WD CP and peeling paint, PF, ajar CT-wiring
330		Y	Y	10+ WD CT, carpeted

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Table 1 (continued)

Location	Windows Openable	Ventilation		Remarks
		Intake	Exhaust	
331				WD CP and peeling paint, WD CT
332		Y	Y	4 WD CT, carpeted
333	Y	Y	Y	Wood floor, PF
334		Y	Y	4 WD CT, carpeted
338		Y	Y	wood floor
346	Y open	Y	Y	Carpet
349 Computer Lab	Y open	Y	Y	Worn carpeting, numerous computers
351				Carpeted, WD CP and peeling paint, stained CP, 3 WD CTs
389	Y	Y	Y	WD CT, PC, worn carpeting
Boys Restroom	N	N	Y	WD plaster, broken urinal
Crowell Office				3 WD CTs, WD CP along windows
Custodial Closet	N	N	Y	Slop sink, WD CP, open pipe, odors

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Table 1 (continued)

Location	Windows Openable	Ventilation		Remarks
		Intake	Exhaust	
Faculty Men's Restroom	N	N	Y	WD ceiling plaster
Girls Restroom	N	N	Y	WD CP
Hallway (323)				Abandoned water fountain-covered w/trash bag
Stairwell B	N	N	N	WD CT, MT, dirty lights,
Teacher's Center -Upstairs	N	Y	Y	Carpet, PC, plants, AI, DEM, mechanical room access
Teacher's Center -Tile Side	N	Y	Y	NC, PF, CPs, WD CTs x 10, dusty vents, boxes stored on floor
Teachers Center Conference Area	Y	Y	Y	PC, carpeted
Teachers Center Food Area	Y	Y	Y	NC, 2 fridges, microwave
201 B				Carpeted
203				Carpeted
206 B	Y	Y	Y	Carpet, PF

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Table 1 (continued)

Location	Windows Openable	Ventilation		Remarks
		Intake	Exhaust	
206 D		Y	Y	Carpet, PF, HS, AF
207 A		Y	Y	Dust/debris on vents, portable AC unit
207 B		Y	Y	Carpeted, window in disrepair-sign “do not touch window”, dust/debris on vents
208 B	N	Y	Y	Carpet
209 R	N	Y	Y	WD and MT, carpeted, DEM
209 A	N	Y	Y	Carpet in waiting room area
209 B	Y open	Y	Y	Hallways in this area are new Pergo flooring, this office is carpeted (new), window poorly sealed/off track
209 E	N	Y	Y	New carpet
210	Y open	Y	Y	Carpet, DEM
212 A		Y	Y	Carpeted
213				Carpeted, PF, WD CP and peeling paint/corner
214 A	Y	Y	Y	Wood floor, WD CT

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Table 1 (continued)

Location	Windows Openable	Ventilation		Remarks
		Intake	Exhaust	
214 B	Y open	Y	Y	Asphalt odor detected (roof below?), WD plaster ceiling
215	Y open	Y	Y	Wood floor
216		Y	Y	Wood floor
217				Carpeted, PF
218		Y	Y	Wood floor
219	Y open	Y	Y	WD CT, wood floor, PF
220		Y	Y	Carpeted
223	Y open	Y	Y	Wood floor
226		Y	Y	Wood floor
227				PF
229		Y	Y	Carpeted, PF, ajar CT, dust/debris on vents, WD CP and peeling paint
230		Y	Y	Wood floor

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Table 1 (continued)

Location	Windows Openable	Ventilation		Remarks
		Intake	Exhaust	
231				
232		Y	Y	Carpeted
235				PFs
236				Custodial closet, odor of cleaners/mop
237 Computer Lab		Y	Y	Dust/debris on vents
239				Peeling paint
240		y	y	carpeted no odor, 1 WD CT
249	Y open	Y	Y	1 WD CT, carpet
254		Y	Y	1 WD CT, carpeted floor
255		Y	Y	1 WD CT, carpeted
259 Hall		Y	Y	WD CT
Auditorium Upper Level	N	Y	Y	AC, carpet, upholstered chairs

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Table 1 (continued)

Location	Windows Openable	Ventilation		Remarks
		Intake	Exhaust	
Boys Restroom	N	N	Y	Many WD CT, CP, wall tiles
Español	Y open	Y	Y	Carpeted, DEM, cleaning products
Girls Restroom	N	N	Y	A few WD CT, CP
Girls Restroom		Y	Y	5 WD CT, carpeted floor, WD GW ceiling
Men's Faculty Restroom	N	N	Y	WD plaster
Mural room	N	N	N	Missing light cover
Second Floor Stairwell B	Y open	N	N	
Womens restroom	Y open	Y	Y	Dusty vents
101		Y	Y	Carpeted
101 Storage		Y	Y	2 WD CT, WD GW, mold
102	Y	Y	Y	DEM, carpet
105				Carpeted, PF, severely damaged wall and ceiling plaster/corner

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Table 1 (continued)

Location	Windows Openable	Ventilation		Remarks
		Intake	Exhaust	
106	Y	Y	Y	DEM, newer carpet, , WAC, microwave/fridge, PC, reports of previous flood from 3rd floor, slight foul odor
106 A	N	Y	Y	Carpet
107	Y open	Y	Y	Carpet, PFs, WD GW ceiling, carpeted
109	Y open	Y	Y	DEM, carpet w/stains
110		Y	Y	Wood floor
112	Y	Y	Y	Carpet, mini fridge, computer lab
114		Y	Y	Wood floor
115		Y	Y	1 WD CT, wood floor
116	Y	Y	Y	AI, carpet
117	Y	Y	Y	Portable AC - on, new carpet, fridge and microwave
118		Y	Y	Tile floor, WD plaster and peeling paint
119		Y	Y	Wood floor

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Table 1 (continued)

Location	Windows Openable	Ventilation		Remarks
		Intake	Exhaust	
120 B	Y	Y	N	CPs, carpet, UF
120 E	N	Y	N	MT, DEM
122	Y	Y	Y	Carpet (musty odor), DEM, debris on carpet
123		Y	Y	Wood floor
126 A	Y	Y	Y	Storage, old carpet, ajar CT, wood floor
126 B	Y	Y	Y	SPED sensory room, upholstery and cloth items, tile floor
128				Cobwebs near windowsill
131				Carpeted, PF
132				
133				Carpeted, PF
134		Y	Y	Carpeted, PF, dust/debris on vents
137				Utility hole in wall

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Table 1 (continued)

Location	Windows Openable	Ventilation		Remarks
		Intake	Exhaust	
139				Carpeted, ajar CT
144		Y	Y	Carpeted, 4 WD CTs, dust/debris on vents, filter in ceiling vent, PC
145 Computer Lab		Y	Y	Carpeted, dust/debris on vents, 3 WD CTs, filter in ceiling vent
147		Y	Y	Carpeted, dust/debris on vents, WD CT
199	Y open	Y	Y	Carpet
Auditorium Lower Level	N	Y	Y	
B House	Y	Y	N	PC, Carpet, gap around utilities in CT
Boys Restroom			Y	Dust/debris on vents, WD CP and peeling paint
Girls Restroom	N	Y	Y	
Staff/SPED Restroom			Y	Air filter, WD ceiling, toileting materials
Stage				Wood floor
Womens Restroom	N	N	Y	WD plaster, cleaning products

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Table 1 (continued)

Location	Windows Openable	Ventilation		Remarks
		Intake	Exhaust	
004		Y	Y	1 WD CT, carpeted, WD plaster
009 Courtyard Restaurant		Y	Y	Dust/debris on vents
010		Y	Y	3 WD CT, carpeted
012	Y	Y	Y	Musty odor, tile floor, WD CTs x 4, PF, CPs, sinks
012		Y	Y	1 WD CT, tile floor
012 Kitchen Area	Y	Y	Y	Dirty supply vents/ghosting, DEM
013				WD CTs, missing light cover
016		Y	Y	Tile floor
017	Y	Y	Y	NC, sinks, fridge, stoves
019	Y	Y	Y	NC, FCU in ceiling, sinks
020	N	Y	Y	Tile floor, DEM
021	Y	Y	Y	WD CT, stained carpeting

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WD = water-damaged

Table 1 (continued)

Location	Windows Openable	Ventilation		Remarks
		Intake	Exhaust	
021 Laundry	N	Y	Y	MT, WD ceiling, ceiling-mounted AC/FCUs
024		Y	Y	Carpeted, WD/moldy CTs
025		Y	Y	Carpeted, dust/debris on vents
026 Music		Y	Y	Stained CT and dust
028	N	Y	Y	Carpet, cleaner odors, WD CT, microwave
028 Waiting Room	N	Y	Y	NC
038		Y	Y	
039		Y	Y	Carpeted, dust/debris on vents, PF
Band Storage Room				
Basement Girls Restroom	N	Y	Y	Sink, WD ceiling plaster, broken toilet
Boys Restroom			Y	WD ceiling
Mailroom		Y	Y	Tile floor

AC = air-conditioner
AI – accumulated items
CP= ceiling plaster
CT = ceiling tile
DEM = dry erase materials
DO = door open
FCU = fan-coil unit
GW = gypsum wallboard
MT = missing tile
NC = not carpeted
PF = personal fan
UF = upholstered furniture
WAC = window air-conditioner
WD = water-damaged

Table 1 (continued)

Location	Windows Openable	Ventilation		Remarks
		Intake	Exhaust	
Music	N	Y	Y	Carpet, musty odor, MTs x 5, WD plaster ceiling above
Music-Office	N	Y	Y	WD CT, costumes, musty odor

AC = air-conditioner
AI – accumulated items
CP= ceiling plaster
CT = ceiling tile
DEM = dry erase materials
DO = door open
FCU = fan-coil unit
GW = gypsum wallboard
MT = missing tile
NC = not carpeted
PF = personal fan
UF = upholstered furniture
WAC = window air-conditioner
WD = water-damaged

Location: Lowell High School, 1920s building **Indoor Air Results**

Address: 14 French Street, Lowell, MA **Table 2** **Date: 12/12/17**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Background	331	ND	51	67	23					Rain, sleet, wind
Third Floor										
Teacher's center										
Workroom	878	ND	68	28	47	1	Y	Y	Y	PC, carpet, one window ajar
Workroom classroom	971	ND	69	29	9	0	Y	Y	Y	Carpet, vending machine
Women's restroom						0	N	Y	Y	
Book storage	1003	ND	70	27	7	0	N	Y	Y	Books, some on floor
Upper level area										
P161	896	1.8	72	32	11	1	N	Y	Y	
East	846	1.8	69	30	9	0	N	Y	Y	

µg/m^3 = micrograms per cubic meter
ppm = parts per million
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CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials
DO = door open
FCU = fan coil unit
HS = hand sanitizer
MT = missing tile
PC = photocopier
PF = personal fan
PS = pencil shavings
WD = water-damaged
WAC = window air conditioner

Comfort Guidelines

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

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

Location: Lowell High School, 1920s building **Indoor Air Results**

Address: 14 French Street, Lowell, MA **Table 2 (continued)** **Date: 12/12/17**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
West	826	2	66	28	7	0	N	Y	Y	11 WD CT
Third floor main area										
304A	1128	ND	72	28	7	19	Y	Y	Y	Tile, DEM, CPs
305 A	982	ND	70	29	7	11	Y	Y	Y	Carpet, dust/debris on vents
306	1118	ND	70	27	5	0	Y	Y	Y	Carpet
308	853	ND	70	27	17	1	Y	Y	Y	2 WD-CTs, WD wall plaster, DEM
309	911	ND	71	28	6	9	Y	Y	Y	Carpet, PF, 7 WD CTs, 2 PCs
309 Office	909	ND	70	29	6	0	N	Y	N	Carpet
310	1300	ND	72	34	18	25	Y 3/5 open	Y	Y	DEM, clutter, plants, DO
311	1309	ND	71	33	9	20	Y	Y	Y	DO, WD CP, PFs

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CT = ceiling tile
DEM = dry erase materials
DO = door open
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Location: Lowell High School, 1920s building **Indoor Air Results**

Address: 14 French Street, Lowell, MA **Table 2 (continued)** **Date: 12/12/17**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
312	831	ND	71	23	19	0	Y	Y	Y	29 computers, WD ceiling plaster
313	1167	ND	71	33	8	19	Y	Y	Y	DEM, wood floor
314	830	ND	71	26	16	0	Y	Y	Y	WD ceiling plaster, DEM, cleaning products
315	1492	ND	72	35	7	23	Y	Y	Y	PFs, WD CP
316	1983	ND	72	34	9	16	Y	Y	Y	Carpet, DEM
317 storage/prep								Y	Y	Wood floor and cabinets, science items, dusty fan
318	2208	ND	72	37	8	22	Y	Y	Y	Hardwood floor
319	1375	ND	71	32	8	25	Y	Y	Y	DO, PF, WD CT
320	1383	ND	72	28	5	3	Y	Y	Y	DEM, old carpet
321	1086	ND	72	38	7	24	Y	Y	Y	Tile floor, portable AC, DEM

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HS = hand sanitizer
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Location: Lowell High School, 1920s building **Indoor Air Results**

Address: 14 French Street, Lowell, MA **Table 2 (continued)** **Date: 12/12/17**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
323	712	ND	70	25	9	0	N	Y	Y	Carpet, DO
323 R	578	ND	70	24	8	0	Y	Y	Y	Carpet, AC
324	954	ND	72	35	8	0				Carpet, DEM, PF
324	946	ND	72	27	18	16	Y	Y	Y	DEM, PF, DO, WD wall plaster
325	722	ND	70	29	7	15	Y	Y	Y	DO, cracked window, WD CT, WD CP/peeling paint, area rug
326	1044	ND	71	23	3	0	Y	Y	Y	Old carpet, blocked gravity exhaust
329	765	ND	70	28	7	22	Y	Y	Y	Cracked window, PF
330	1640	ND	72	30	10	7	Y	Y	Y	DEM, old carpet
331	1470	ND	70	33	11	21	Y	Y	Y	Wood floor, DEM, chalk
331	1499	1.2	69	37	8	5	Y	y	Y	

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CT = ceiling tile
DEM = dry erase materials
DO = door open
FCU = fan coil unit
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Location: Lowell High School, 1920s building **Indoor Air Results**

Address: 14 French Street, Lowell, MA **Table 2 (continued)** **Date: 12/12/17**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
332	1248	1.3	73	30	7	29	Y	Y	Y	Carpet
333	973	ND	69	25	8	0	Y	Y	Y	Wood floor, DEM, PF - dusty
333	928	0.8	69	29	7	30	Y	Y	Y	
334	1660	ND	72	34	7	29	Y	Y	Y	Carpet
338	1246	ND	72	31	5	18	Y	Y	Y	Carpet
346	1112	1.8	71	30	3	26	Y	Y	Y	Carpet
348	1295	ND	72	30	14	0 some just left	Y	Y	Y	DEM, carpet, plant
348	1458	ND	72	32	9	28	Y	Y	Y	Carpet
351	1112	ND	72	25	8	0	Y	Y	Y	Carpet, damaged wall, 6 WD CT, DEM
351	1089	1.6	71	27	5	0	Y	Y	Y	Carpet, 5 WD CT

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FCU = fan coil unit
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Location: Lowell High School, 1920s building **Indoor Air Results**

Address: 14 French Street, Lowell, MA **Table 2 (continued)** **Date: 12/12/17**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
352	1252	1.4	72	29	11	0	Y	Y	Y	Carpet
Clark Office	970	ND	71	26	7	11	N	Y	Y	Carpet, 3 WD CT, PF
Coburn break area	1104	ND	70	28	7	1	Y	Y	Y	Soiled carpet
Coburn computer area	830	ND	70	26	7	1	Y	Y	Y	Soiled carpet
Coburn Teachers Area	1211	ND	68	31	8	0	Y	Y	Y	carpet
Cromwell Guidance	1182	ND	69	28	9	0	Y	Y	Y	DEM, 1 WD CT, WAC, carpet, WD ceiling plaster next to windows
custodial, electric near 324										
custodian closet near 321		ND					N	N	N	Moldy smell, wet mop bucket, water damaged wall plaster and ceiling
Director of curriculum	823	ND	69	27	17	0	Y	Y Dusty	Y	DO, High efficiency particulate arrestance air purifier, plants, DEM, 4 WD-CTs
E house Dean	1074	ND	68	27	7	2	Y	Y	Y	Carpet

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Location: Lowell High School, 1920s building **Indoor Air Results**

Address: 14 French Street, Lowell, MA **Table 2 (continued)** **Date: 12/12/17**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
E house office left office	1083	ND	69	28	7	0	Y	Y	Y	Carpet, water cooler on carpet
E house reception	1080	ND	69	28	6	2	N	Y	Y	Carpet
Entry foyer	579	ND	70	42	12	11	N	Y	Y	
Staff bathroom			70	29	18	0	Y	N	Y Dusty	
Teachers Area office	1130	ND	68	31	6	1	N	Y	Y	PF
Women's' room			70	28	17			N	Y	
Second Floor										
Auditorium Balcony	573	ND	71	26	5	0	N	Y	Y	
201B	770	ND	69	331	7	11	Y	Y	Y	Carpet
202	718	ND	70	31	6	0	Y	Y	Y	Carpet

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Location: Lowell High School, 1920s building **Indoor Air Results**

Address: 14 French Street, Lowell, MA **Table 2 (continued)** **Date: 12/12/17**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
204 U	1678	ND	70	34	6	28	Y	Y	Y	Carpet
207B	898	ND	68	32	6	5	Y	Y	Y	Carpet
208B	831	ND	68	34	6	28	Y	Y	Y	Carpet
209A	789	ND	67	31	8	0	Y	Y	Y	
210	1256	ND	70	33	4	11	Y	Y	Y	DEM, carpeting, active leak in overhead pipe
212A	1409	ND	70	33	7	23	Y	Y	Y	Carpet, DEM
213	1183	ND	71	27	7	1	Y	Y	Y	Carpet, PF, plants
214	1539	ND	68	35	5	15	Y	Y	Y	Carpeting, DEM
214A	1060	ND	68	30	2	22 gone 25 min	Y	Y	Y gravity	Wood floor, HS, PF
215	1290	ND	73	31	9	25	Y	Y	Y	DO

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DO = door open
FCU = fan coil unit
HS = hand sanitizer
MT = missing tile
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Location: Lowell High School, 1920s building **Indoor Air Results**

Address: 14 French Street, Lowell, MA **Table 2 (continued)** **Date: 12/12/17**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
216	1056	ND	71	28	17	1		Y	Y	PF, cleaning products, WD CP, DEM
217	1247	ND	72	32	9	27	Y	Y	Y	Carpet, DEM, plants, HS
218	1541	ND	70	37	15	25	Y	Y	Y	
219	1300	ND	73	31	10	22	Y	Y	Y	DO
220C	1546	ND	70	34	14	8	Y	Y	N	Carpet
220B	1307	ND	69	30	15	0	N	N	Y	
220	1206	ND	69	37	13	0	N	Y	Y	DO
223	1171	ND	72	30	7	10	Y	Y	Y	
224	1208	ND	71	30	10	21	Y	Y	Y	Carpet, PF
224	1355	ND	70	32	5	19	Y	Y	Y	HS, DEM, carpeting, PF

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FCU = fan coil unit
HS = hand sanitizer
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Location: Lowell High School, 1920s building **Indoor Air Results**

Address: 14 French Street, Lowell, MA **Table 2 (continued)** **Date: 12/12/17**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
226	1179	ND	66	32	2	22 gone 10min	Y	Y	Y	DEM, HS
227	1385	ND	70	30	6	22	Y	Y	Y	Wood floor, chalk, DEM
229	1079	ND	70	26	25	5	Y	Y	Y	DEM, carpet, chalk
230	1401	ND	68	35	13	22	Y	Y	Y	DEM, HS
231	836	ND	70	36	7	2	Y	Y	Y	Wood floor, DEM, fridge, chalk
232	1344	ND	70	34	15	26	Y	Y	Y	WD ceiling plaster, DO, DEM, carpet
234	986	ND	69	29	19=4	0	Y	Y	Y	PF, DEM, refrigerator, DO
235	1021	ND	69	17	6	6	Y	Y	Y	DEM, PF, wood floor, fridge, chalk
235	887	ND	68	30	7	7	Y	Y	Y	Carpet
237	965	ND	69	26	7	15	Y	Y	Y	Wood floor, books on floor, DEM, chalk

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Location: Lowell High School, 1920s building **Indoor Air Results**

Address: 14 French Street, Lowell, MA **Table 2 (continued)** **Date: 12/12/17**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
239	1237	ND	69	31	8	2	Y	Y	Y	Wood floor, DEM
248	674	ND	70	24	7	11	Y open	Y	Y	DEM, Carpet, DO
249	1360	ND	770	30	8	21	Y	Y	Y	Computers, carpet, DEM
251	1641	ND	70	31	5	24	Y*	Y	Y	Old carpet, DEM, *windows don't open (inoperable)
254	1074	ND	71	28	15	0	Y	Y	Y	DEM
First Floor										
Auditorium	550	ND	69	25	5	0	Y	Y	Y	Some carpet
Auditorium lobby	715	ND	66	28	7	1	Y	Y	Y	Doors to street
101	865	ND	71	32	6	32	Y	Y	Y	WD plaster and floor
105A	805	ND	69	31	7	1	Y	Y	Y	

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Location: Lowell High School, 1920s building **Indoor Air Results**

Address: 14 French Street, Lowell, MA **Table 2 (continued)** **Date: 12/12/17**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
106	854	ND	66	36	8	28	Y	Y	Y	Carpet
106A	609	1.2	69	30	6	2	Y	Y	Y	Carpet
106A	656		71	28	6	2	Y	N	N	Carpet
107	733	1	69	30	6	0	Y	Y	Y	2 WD CT
108A	568	ND	66	30	6	1	Y	Y	Y	Carpet
109	798	1.8	69	32	7	19	Y 1 open	Y	Y	
113	837	ND	66	30	8	1	Y	Y	Y	Carpet, DO, radiator leaks-buckets (on repair list)
115	1121	ND	71	31	8	23	Y	Y	Y	wood floor, DEM, small fridge, food
117	1301	ND	68	33	10	2	Y	Y	Y	Carpet
119	1269	ND	71	32	7	23	Y	Y	Y	Chalk, DEM, wood floor, built in cabinets

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CT = ceiling tile
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Location: Lowell High School, 1920s building **Indoor Air Results**

Address: 14 French Street, Lowell, MA **Table 2 (continued)** **Date: 12/12/17**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
121	931	ND	70	31	10	17	Y	Y	Y	Carpet, plants
123	1074	ND	70	29	8	23	Y	Y	Y	Wood floor, DEM, HS
125	679	ND	69	27	10	6	Y	Y	Y	Carpet, duct tape window
126B	990	ND	68	29	7	0				"snooze" room, bedding and soft furniture
131	907	ND	70	31	9	14	Y	Y	Y	Carpet
133	794	ND	67	28	8	0	Y	Y	Y	DEM, carpet, chalk
135 stage	895	ND	68	28	7	10	N			
137	633	ND	69	28	8	10	Y	Y	Y	Carpet
139	703	ND	67	27	7	0	Y	Y	Y	Carpet, AT, DEM, PS
145	767	ND	65	30	9	0	Y	Y	Y	

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CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials
DO = door open
FCU = fan coil unit
HS = hand sanitizer
MT = missing tile
PC = photocopier
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Location: Lowell High School, 1920s building **Indoor Air Results**

Address: 14 French Street, Lowell, MA **Table 2 (continued)** **Date: 12/12/17**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
147	796	ND	67	30	9	18	Y	Y	Y	
Basement										
Band	628	ND	70	28	3	22	N	Y	Y	DEM, carpet
Restaurant	768	ND	70	28	5	4	N	Y	Y	Carpeting
Weight room	908	ND	67	34	13	12	N	N	Y	WD ceiling
Gym office/storage	862	ND	67	34	11	0	N	N	Y	
12	834	ND	67	32	3	10	N	Y	Y	Tile
13	873	ND	69	32	4	22	N	Y	Y	FCUs, tile, art supplies
14	1122	ND	65	36	3	19	N	Y	Y	Rubber mats
16	930	ND	68	34	4	9	N	Y	Y	DEM, tile

µg/m^3 = micrograms per cubic meter
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ND = non detect
AC = air conditioner
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FCU = fan coil unit
HS = hand sanitizer
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PF = personal fan
PS = pencil shavings
WD = water-damaged
WAC = window air conditioner

Comfort Guidelines

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

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

Location: Lowell High School, 1920s building **Indoor Air Results**

Address: 14 French Street, Lowell, MA **Table 2 (continued)** **Date: 12/12/17**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
17 cooking class	618	ND	70	26	3	3	N	Y	N*	*Need exhaust ventilation, DEM, HS, food odors
18	768	ND	67	30	3	1	N	Y	Y	DEM, odor
19	645	ND	69	27	5	5	N	Y	Y	HS, DEM, plants, laminate floor, FCU off, cleaning products
20	717	ND	68	30	3	6	N	Y	Y	DEM, tile
21	1243	ND	68	32	3	6	N	Y	Y	HS, carpet soiled
22 office coordinator	619	ND	68	26	13	2	N	N	Y Switch activate	DO, transom
22 social workers	560	ND	67	25	14	0	Y	Y	Y	Passive door
22 main	618	ND	67	26	14	1	Y	Y	N	
22 quiet room	709	ND	67	25	12	0	N	N	Y Switch activate	
22 nurse main office	589	ND	67	25	12	0	Y	Y	Y	

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Location: Lowell High School, 1920s building **Indoor Air Results**

Address: 14 French Street, Lowell, MA **Table 2 (continued)** **Date: 12/12/17**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
22 exam room 1	659	ND	68	26	11	0	Y	N	Y Switch activate	
24	578	ND	68	25	2	0	N	Y	Y	Carpet
22 exam room 2	749	ND	67	26	12	0	N	N	Y Switch activate	
28	1048	ND	70	29	12	14	Y	Y	Y	Food storage, DEM, refrigerator, 2 WD-CT
28 language director	1065	ND	70	29	10	1	N	N	N	2 MT, 1 WD-CT, CPs
29 Band	478	ND	69	27	3	0	N	Y	Y	FCUs, carpet, MTs
30	696	ND	69	25	5	17	N	Y	Y	Carpet, WD CT
37	736	ND	69	26	16	17	Y	Y	Y Dusty	4 MT, 7 WD-CT
39	645	ND	70	27	14	0	Y	Y	Y	
Old building										

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Location: Lowell High School, 1920s building **Indoor Air Results**

Address: 14 French Street, Lowell, MA **Table 2 (continued)** **Date: 12/12/17**

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	PM2.5 (µg/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
001 back storage	648	ND	63	32	14	0	N	N	N	WD ceiling, WD CT, MT, predominately storage
ROTC uniform room	433	ND	71	29	17	0	Y	Y	Y	Musty odors, 3 MT, dehumidifiers

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