INDOOR AIR QUALITY ASSESSMENT

Casimir Pulaski Elementary School
1097 Braley Road
New Bedford, MA 02745

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

February 2009

Background/Introduction

At the request of New Bedford Mayor Scott Lang, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) provided assistance and consultation regarding indoor air quality (IAQ) at the Casimir Pulaski Elementary School (PES) located at 1097 Braley Road, New Bedford, Massachusetts. The assessment was coordinated with the Mayor's Office, the New Bedford Health Department (NBHD), and the New Bedford Public School Department (NBSD) as part of an on-going effort to monitor and improve IAQ conditions in New Bedford's public schools.

On October 21, 2008, a visit was made to this building by Cory Holmes and Sharon Lee, Environmental Analysts/Inspectors for BEH's Indoor Air Quality (IAQ) Program. During the assessment, BEH staff were accompanied by Don Andrews, Senior Custodian. BEH staff had previously visited the building in August 2008 to investigate mold concerns related to flooding in the library/lower level of the building. A report detailing conditions observed at the time of the assessment with recommendations for the remediation of mold was issued (MDPH, 2008). At the time of the current assessment, water-damaged carpeting in the library and surrounding areas had been removed and replaced with tiles (Pictures 1 through 3). This report focuses on general IAQ conditions throughout the building.

The PES is a two-story red brick building that was constructed circa 1975. The school contains general classrooms, rooms for specialized instruction, library, computer room, music/band rooms, art room, gymnasium, auditorium, kitchen, cafeteria and office space. Classrooms are grouped in pods, which are separated by dividers from floor to ceiling. The majority of building components (roof, HVAC, carpeting) are reportedly original; however, the school department has instituted a program to remove carpeting throughout the school and replace with non-porous floor tiles as funds become available. As previously discussed, carpeting in the library and adjacent areas has been removed. Windows are openable throughout the building.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were conducted with the TSI, Q-Trak, IAQ Monitor, Models 8554 and 7565. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. MDPH staff also performed visual inspection of building materials for water damage and/or microbial growth.

Results

The school houses approximately 625 elementary students in kindergarten to grade 5 with approximately 75 staff members. Tests were taken during normal operations at the school and results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million (ppm) in 11 of 70 areas at the time of the assessment, indicating adequate air exchange in the majority of areas surveyed. It is important to note that at the time of the assessment, several areas had open windows and/or were empty/sparsely populated; both conditions can greatly reduce carbon dioxide levels. Carbon dioxide levels would be expected to be higher with increased occupancy and windows closed.

Mechanical ventilation for classrooms is supplied by rooftop air-handling units (AHUs) (Picture 4). Fresh air supplied by the AHUs is ducted to classrooms via ceiling mounted fresh air diffusers (Picture 5). Exhaust air is drawn through wall or ceiling-mounted vents and ducted back to the AHUs (Picture 6). Ventilation for common areas (auditorium, cafeteria, gymnasium) is provided by ceiling-mounted AHUs. These systems were functioning at the time of the assessment. It is important to note however, that rooftop AHUs appear to be original 1970s era equipment, making them approximately 30+ years old. Efficient function of such equipment can be difficult to maintain since compatible replacement parts are often unavailable.

A number of classroom exhaust vents were obstructed by furniture and other items, limiting airflow (Picture 7). Some exhaust vents are located behind classroom doors (Table 1). Due to their location, these vents are prone to blockage when the doors are left open (Picture 8). In addition, with the classroom doors open the exhaust vent tends to draw air from the hallway *into* the classroom instead of stale air *out* of the classroom.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. 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).

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or openable windows

(SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, consult Appendix A.

During the assessment, temperature measurements ranged from 71^{o} F to 76^{o} F, which were within the MDPH recommended comfort range. The MDPH recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in the building on the day of the assessment ranged from 31 to 37 percent, which was below the MDPH recommended comfort range. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Several areas had water-damaged ceiling tiles, which can indicate leaks from the roof or plumbing system (Pictures 9 and 10/Table 1). Water-damaged ceiling tiles can indicate sources of water penetration and provide a source of mold growth. In classroom H-4, dark staining that appeared to be mold was visible on a ceiling tile (Picture 10). However, there was no evidence of further mold growth above the ceiling tiles. Ceiling tiles should be replaced after a water leak is discovered and repaired. At the time of assessment, BEH staff recommended that this ceiling tile be removed.

Open seams between sink countertops and walls were observed in several rooms (Picture 11/Table 1). Improper drainage or sink overflow can lead to water penetration into the countertop, cabinet interior and areas behind cabinets. If not watertight, moisture can penetrate through the seam, causing water damage and potential mold growth.

Several classrooms had a number of plants. Moistened plant soil and drip pans can be a source of mold growth. Plants in one area were observed on paper (Picture 12), which is a porous material that is susceptible to mold growth if moistened repeatedly. Plants should be equipped with drip pans; the lack of drip pans can lead to water pooling and mold growth on windowsills. Plants are also a source of pollen. Plants should be located away from the air stream of ventilation sources to prevent the aerosolization of mold, pollen or particulate matter throughout the classroom.

Shrubs/trees were observed growing in close proximity to exterior walls (Picture 13 and 14). Accumulated leaves, moss and plant debris was observed on the roof (Pictures 15 and 16). These conditions can hold moisture against exterior brick or on the roof, preventing drying and serving as sources for potential water penetration. Over time, these conditions can undermine the integrity of the building envelope and provide a means of water entry into the building via roof leaks or capillary action through concrete and masonry (Lstiburek & Brennan, 2001).

Other IAQ Evaluations

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion emissions include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the school environment, BEH staff obtained measurements for carbon monoxide and PM2.5.

Carbon Monoxide

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

The American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2006). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS levels (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2006).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. On the day of assessment, outdoor carbon monoxide concentrations were non-detect (ND) (Table 1). Carbon monoxide levels measured in the school were also ND.

Particulate Matter (PM2.5)

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The

NAAQS originally established exposure limits to particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 microgram per cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 2006). These standards were adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA established a more protective standard for fine airborne particles. This more stringent PM2.5 standard requires outdoor air particle levels be maintained below 35 $\mu g/m^3$ over a 24-hour average (US EPA, 2006). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, MDPH uses the more protective PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM2.5 concentrations were measured at 17 $\mu g/m^3$ (Table 1). PM2.5 levels measured in the school were between 3 to 12 $\mu g/m^3$ (Table 1), which were below the NAAQS PM2.5 level of 35 $\mu g/m^3$. Frequently, indoor air levels of particulates (including PM2.5) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in schools can generate particulate during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

Volatile Organic Compounds

Indoor air concentrations can be greatly impacted by the use of products containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to identify materials that can potentially increase indoor VOC concentrations, BEH staff examined classrooms for products containing these respiratory irritants.

Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat. Cleaning products were also found on countertops and in unlocked cabinets beneath sinks in some classrooms. Like dry erase materials, cleaning products contain VOCs and other chemicals that can be irritating to the eyes, nose and throat of sensitive individuals.

Plug-in air fresheners were in use in a few areas (Picture 17). Air fresheners contain chemicals that can be irritating to the eyes, nose and throat of sensitive individuals. Further, air fresheners do not remove materials causing odors, but rather mask odors which may be present in the area.

In an effort to reduce noise from sliding chairs, tennis balls had been sliced open and placed on chair legs (Picture 18). Tennis balls are made of a number of materials that are a source of respiratory irritants. Constant wearing of tennis balls can produce fibers and cause TVOCs to off-gas. Tennis balls are made with a natural rubber latex bladder, which becomes abraded when used as a chair leg pad. Use of tennis balls in this manner may introduce latex dust into the school environment. Some individuals are highly allergic to latex (e.g., spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997). A question and answer sheet concerning latex allergy is attached as Appendix B (NIOSH, 1998).

Other Conditions

Other conditions that can affect indoor air quality were observed during the assessment. In several classrooms, items were observed on windowsills, tabletops, counters, bookcases and desks (Picture 19). The large number of items stored in classrooms provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up. In addition, these materials can accumulate on flat surfaces (e.g., desktops, shelving and carpets) in occupied areas and subsequently be re-aerosolized causing further irritation. A number of personal fans in classrooms were observed to have accumulated dust/debris. Re-activated supply fans can aerosolize dust accumulated on fan blades/housing.

Occupants in classroom K-1 had complaints of restroom odors. BEH staff examined the local exhaust vent in the student restroom and found that it was not drawing air. Exhaust ventilation is necessary in restrooms to remove excess moisture and to prevent restroom odors from penetrating into adjacent areas.

Finally, the floor of the nurse's suite has wall to wall carpet. This is problematic due to the likelihood of biological fluids and other biological materials soiling the carpet.

Conclusions/Recommendations

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

1. Continue to operate all ventilation systems throughout the building (e.g., gym, cafeteria, classrooms) *continuously* during periods of school occupancy
2. Restore restroom exhaust ventilation.
3. Inspect all exhaust motors and belts periodically for proper function. Repair and replace as necessary.
4. Close classroom doors to maximize air exchange.
5. Remove all blockages from exhaust vents to ensure adequate airflow.
6. Use openable windows in conjunction with mechanical ventilation to increase air exchange. Care should be taken to ensure windows are properly closed at night and weekends to avoid the freezing of pipes and potential flooding.
7. Consider adopting a balancing schedule of every 5 years for all mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).
8. 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).
9. Ensure roof leaks are repaired. Remove/replace any water-damaged ceiling tiles.

10. Encourage staff to monitor their classrooms for active leaks/water damage and report to school maintenance staff for prompt remediation.
11. Seal areas around sinks to prevent water damage to the interior of cabinets and adjacent wallboard.
12. Avoid over-watering plants and examine drip pans periodically for mold growth. Disinfect with an appropriate antimicrobial where necessary.
13. Trim shrubbery/trees back approximately 5-feet to prevent water impingement on exterior brick.
14. Remove accumulated plant debris from roof to prevent water pooling.
15. Store cleaning products properly and out of reach of students. Ensure spray bottles are properly labeled.
16. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning of classrooms. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
17. Clean personal fans periodically of accumulated dust.
18. Refrain from using strongly scented materials (e.g., plug-in air fresheners).
19. Remove carpeting from nurse's suite. Continue with carpet replacement throughout the building as funds become available.
20. Clean carpeting annually (or semi-annually in soiled high traffic areas) as per recommendations of The Institute of Inspection, Cleaning and Restoration Certification (IICRC). Copies of the IICRC fact sheet can be downloaded at: http://www.cleancareseminars.com/carpet_cleaning_faq4.htm (IICRC, 2005)

21. Consider adopting the US EPA (2000) document, "Tools for Schools", as an instrument for maintaining a good indoor air quality environment in the building. This document is available at: http://www.epa.gov/iaq/schools/index.html.

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.

The following **long-term measure** should be considered:

1. Contact an HVAC engineering firm for an assessment of the ventilation system's control system (e.g., controls, air intake louvers, thermostats). Based on the age, physical deterioration and availability of parts for ventilation components, such an evaluation is recommended to determine the operability and feasibility of repairing/replacing the equipment.

References

ASHRAE. 1989. Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigeration and Air Conditioning Engineers. ANSI/ASHRAE 62-1989.

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL.

IICRC. 2005. Carpet Cleaning FAQ 4 Institute of Inspection, Cleaning and Restoration Certification. Institute of Inspection Cleaning and Restoration, Vancouver, WA.

Lstiburek, J. & Brennan, T. 2001. Read This Before You Design, Build or Renovate. Building Science Corporation, Westford, MA. U.S. Department of Housing and Urban Development, Region I, Boston, MA

MDPH. 1997. Requirements to Maintain Air Quality in Indoor Skating Rinks (State Sanitary Code, Chapter XI). 105 CMR 675.000. Massachusetts Department of Public Health, Boston, MA.

MDPH. 2008. Indoor Air Quality Assessment, Mold Investigation, Casimir Pulaski Elementary School, New Bedford, MA. Massachusetts Department of Public Health, Bureau of Environmental Health, Boston, MA. August 2008.

NIOSH. 1997. NIOSH Alert Preventing Allergic Reactions to Natural Rubber latex in the Workplace. National Institute for Occupational Safety and Health, Atlanta, GA.

NIOSH. 1998. Latex Allergy A Prevention. National Institute for Occupational Safety and Health, Atlanta, GA.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

Sanford. 1999. Material Safety Data Sheet (MSDS No: 198-17). Expo® Dry Erase Markers Bullet, Chisel, and Ultra Fine Tip. Sanford Corporation. Bellwood, IL.

SBAA. 2001. Latex In the Home And Community Updated Spring 2001. Spina Bifida Association of America, Washington, DC.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

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

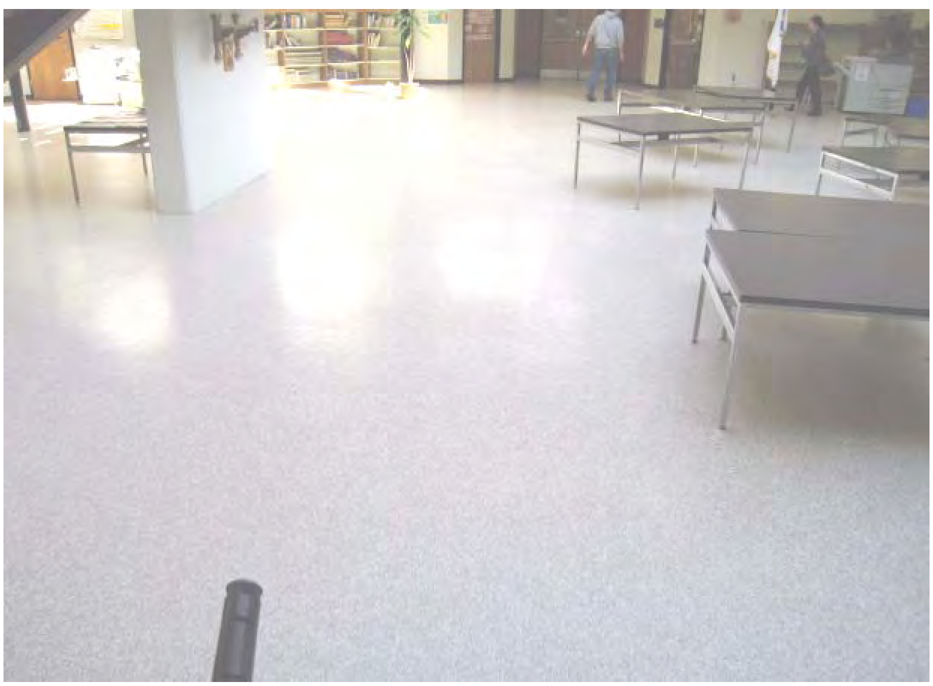
US EPA. 2000. Tools for Schools. Office of Air and Radiation, Office of Radiation and Indoor Air, Indoor Environments Division (6609J). EPA 402-K-95-001, Second Edition. http://www.epa.gov/iaq/schools/tools4s2.html

US EPA. 2006. National Ambient Air Quality Standards (NAAQS). US Environmental Protection Agency, Office of Air Quality Planning and Standards, Washington, DC. http://www.epa.gov/air/criteria.html.

Picture 1

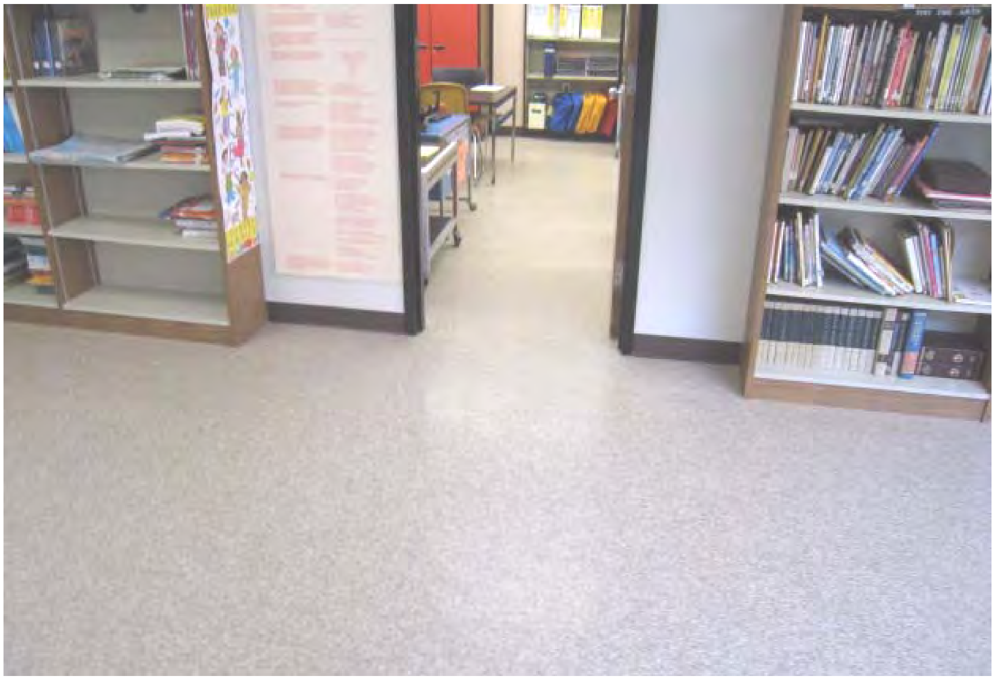
Carpeting Removed in Lower Level Media Center and Replaced with Tile

Picture 2



Carpeting Removed in Lower Level Media Center Replaced with Tile

Picture 3



Carpeting Removed in Lower Level Media Center/Perimeter Rooms and Replaced with Tile

Picture 4

Rooftop Air Handling Unit

Picture 5

Ceiling-Mounted Supply Diffuser

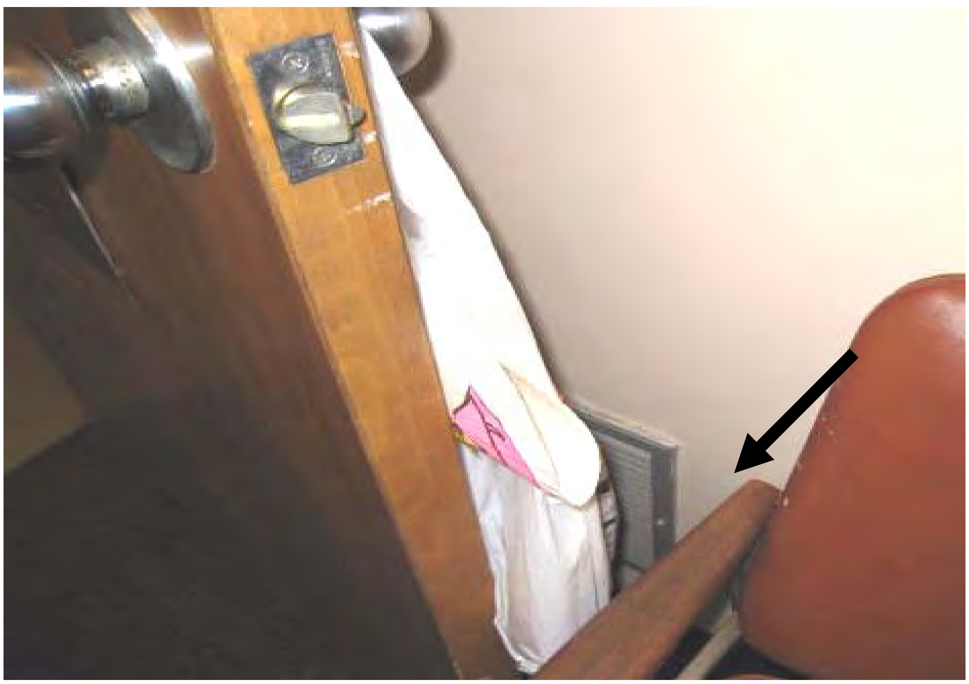
Picture 6

Wall-Mounted Exhaust Vent in Classroom

Picture 7

Wall-Mounted Exhaust Vent in Classroom Obstructed by Bookcase

Picture 8



Wall-Mounted Exhaust Vent in Classroom Obstructed by Open Classroom Door

Picture 9

Water Damaged Ceiling Tile in Classroom/Restroom

Picture 10

Water Damaged Ceiling Tile in Classroom, Noted Area Indicates Possible Mold Growth

Picture 11

Breach between Sink Countertop and Backsplash

Picture 12

Plants on Paper in Classroom

Picture 13

Plant Growth against Exterior Brick

Picture 14

Trees in Close Proximity to Exterior Brick

Picture 15

Accumulated Leaves, Moss and Plant Debris on Roof

Picture 16

Overhanging Branches and Accumulated Plant Debris on Roof

Picture 17

Plug-In Air Freshener

Picture 18

Tennis Balls on Chair Legs

Picture 19

Accumulated Items on Flat Surfaces in Classroom

Location: Pulaski Elementary School **Indoor Air Results**

Address: 1097 Braley Road, New Bedford, MA **Date: 10-21-2008**

Table 1

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
A-1	0	76	33	690	ND	7	Y	Y	Y	Window open, TB, PF, occupants at lunch, hamster
A-2	1	76	34	808	ND	7	N	Y	Y	PF-dusty, DO
A-3	0	76	33	730	ND	6	N	Y	Y	PF, TB
A-4	0	75	34	639	ND	4	Y	Y	Y	TB, occupants at lunch
Art	0	71	31	444	ND	9	Y	Y	Y	3 MT-leak, scheduled for replacement
Assistant Principal	1	73	34	439	ND	8	N	Y	Y	DO, PC, cooler on carpet, refrigerator
Auditorium	9	72	31	542	ND	7	N	Y	Y	
B-1	12	72	34	548	ND	10	Y	Y	Y	
B-2	6	71	35	488	ND	9	N	Y	Y	Exhaust partially obstructed
B-3	0	71	35	456	ND	7	N	Y	Y	DO

ppm = parts per million
$\mu g/m^3$ = micrograms per cubic meter
ND = non detect

AC = air conditioner
aqua. = aquarium
CD = chalk dust
CT = ceiling tile

DEM = dry erase materials
DO = door open
PC = photocopier
PF = personal fan

TB = tennis balls
terra. = terrarium
WD = water-damaged

Comfort Guidelines

Carbon Dioxide:	< 600 ppm = preferred	Temperature:	70 - 78 °F
	600 - 800 ppm = acceptable	Relative Humidity:	40 - 60%
	> 800 ppm = indicative of ventilation problems	Particle matter 2.5	< 35 ug/m^3

Location: Pulaski Elementary School

Address: 1097 Braley Road, New Bedford, MA

Indoor Air Results

Date: 10-21-2008

Table 1 (continued)

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 (μg/m^3)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
B-4	12	73	35	620	ND	9	Y	Y	Y	Exhaust obstructed by bookcase
background		54	53	407	ND	17				Partly cloudy, cool
C-1	0	75	34	735	ND	10	N	Y	Y	Occupants at lunch ~10 mins
C-2	0	75	33	554	ND	10	N	Y	Y	Exhaust obstructed, PF-dusty, items hanging from CTs
C-3	0	75	32	442	ND	9	N	Y	Y	Spaces between sink backsplash and countertop
C-4	0	76	33	690	ND	12	Y	Y	Y	Window open
Cafeteria	~150	73	35	609	ND	11	Y	Y	Y	CTs- above freezer
Conference Room 1	1	73	31	445	ND	6	N	Y	Y	
Conference Room 2	5	72	37	827	ND	8	N	Y	Y	Exhaust obstructed, DO

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Address: 1097 Braley Road, New Bedford, MA **Date: 10-21-2008**

Table 1 (continued)

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								Supply	Exhaust	
Conference Room 3	0	72	34	423	ND	8	N	Y	Y	Exhaust behind door, DO, plant, PC, Items hanging from CTs
D-1	22	74	35	817	ND	4	Y	Y	Y	
D-2	21	75	34	838	ND	6	N	Y	Y	DO, AT, spaces between sink backsplash and countertop
D-3	8	75	34	830	ND	5	N	Y	Y	DO
D-4	28	75	34	953	ND	6	N	Y	Y	DO, items hanging from CT, AT
E-1	0	73	32	422	ND	9	N	Y	Y	
E-2	4	73	35	538	ND	9	N	Y	Y	DO, PF
E-3	0	76	32	431	ND	8	N	Y	Y	25 computers, DO
F-1	5	73	35	568	ND	12	Y	Y	Y	

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								Supply	Exhaust	
F-3	4	71	34	500	ND	7	N	Y	Y	DO, PF
F-4	5	74	34	531	ND	7	N	Y	Y	Exhaust obstructed by furniture, accumulated items
Faculty Work Room A	1	73	34	535	ND	3	Y	Y	Y	
G-1	0	74	32	669	ND	7	Y	Y	Y	Occupants gone ~30 mins
G-2	8	75	33	931	ND	6	N	Y	Y	Exhaust obstructed by furniture, PF, toaster, fridge, microwave, items hanging from CTs, DO
G-3	1	75	32	745	ND	5	N	Y	Y	Dripping sink
G-4	0	74	31	605	ND	7	Y	Y	Y	Occupants gone ~25 mins, window open, PF
Gym	0	71	33	457	ND	9	N	Y	Y	
H-1	0	72	32	468	ND	8	Y	Y	Y	

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Comfort Guidelines

Carbon Dioxide:	< 600 ppm = preferred	Temperature:	70 - 78 °F
	600 - 800 ppm = acceptable	Relative Humidity:	40 - 60%
	> 800 ppm = indicative of ventilation problems	Particle matter 2.5	< 35 ug/m^3

Location: Pulaski Elementary School **Indoor Air Results**

Address: 1097 Braley Road, New Bedford, MA **Date: 10-21-2008**

Table 1 (continued)

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
H-2	0	73	32	504	ND	7	N	Y	Y	Exhaust obstructed by furniture, PF
H-3	0	74	32	504	ND	8	N	Y	Y	Exhaust obstructed by furniture, accumulated items, DO
H-4	13	72	33	543	ND	9	Y	Y	Y	DO, 4 CT
I-1	0	73	32	420	ND	9	N	Y	Y	4 CT
I-2	2	74	31	497	ND	8	N	Y	Y	
I-3	21	73	33	893	ND	10	N	Y	Y	DO
I-4	7	75	33	552	ND	9	Y	Y	Y	TB, DO, PF, CP, exhaust obstructed by furniture
J-1	21	75	32	862	ND	4	Y	Y	Y	
J-2	0	75	31	765	ND	6	N	Y	Y	

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Table 1 (continued)

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
J-3	25	75	32	869	ND	7	N	Y	Y	CP, TB, MTs
J-4	26	75	33	1051	ND	7	N	Y	Y	Exhaust obstructed by furniture, PF-dusty, DO
K-1	22	71	37	546	ND	10	Y	Y	Y	1 CT bathroom, CP, bathroom exhaust – off, carpet dry/low moisture measurement
K-2	0	73	31	481	ND	10	Y	Y	Y	Low moisture measurements carpet near rear door, space between sink backsplash and countertop
Literacy Coaches	2	72	34	442	ND	7	N	Y	Y	Broken CT, DO
M-1	10	74	34	643	ND	9	N	Y	Y	Food, accumulated items, DO, spaces between sink backsplash and countertop
M-2	5	73	31	493	ND	8	N	Y	Y	DO, 1 CT near sink
M-3	15	76	32	631	ND	10	N	Y	Y	Exhaust obstructed by furniture, PF, DO

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Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
M-4	22	75	33	630	ND	9	Y	Y	Y	DO, plants on paper
Main Office	4	71	35	483	ND	7	N	Y	Y	Water cooler on carpet
Media Office Workroom	0	72	35	448	ND	8	N	Y	Y	Exhaust behind door, DO, AT
Media/Library	0	71	34	409	ND	8	N	Y	Y	PC, plant
Mrs. Wood Office	0	72	34	438	ND	7	N	Y	Y	Exhaust behind door, DO
Music	2	72	32	560	ND	11	N	Y	Y	20 + occupants gone ~ 2 mins, damaged/frayed carpet
Music 2/L-3	0	72	32	447	ND	8	N	Y	N	DO
Nurse	1	71	33	487	ND	7	N	Y	Y	Carpeted, plug-in air freshener
Pre-K	17	72	34	718	ND	10	Y	Y	Y	Items hanging from CT system, DO, dehumidifier, CP

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Location: Pulaski Elementary School **Indoor Air Results**

Address: 1097 Braley Road, New Bedford, MA **Table 1 (continued)** **Date: 10-21-2008**

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	PM2.5 ($\mu g/m^3$)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Principal's Office	1	72	35	416	ND	7	N	Y	Y	
Project Area 1	1	72	35	485	ND	8	N	Y	Y	DO, refrigerator
Project Area 2	2	71	36	565	ND	9	N	Y	Y	Exhaust obstructed by desk, WD CT, MT
Reading Room	0	71	34	457	ND	6	N	Y	Y	
Teacher's Lounge	3	71	34	460	ND	7	N	Y	Y	
Teacher's Resource	0	72	35	431	ND	8	N	Y	Y	Broken CT, AP
Workroom	0	72	34	429	ND	7	N	Y	Y	DO
Workroom B	2	72	34	706	ND	7	Y	Y	Y	

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