INDOOR AIR QUALITY REASSESSMENT

Waterford Street School
62 Waterford Street
Gardner, Massachusetts

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

At the request of F. Daniel Hill, Principal of the Waterford Street School (WSS), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) conducted an indoor air quality (IAQ) reassessment at the WSS, located at 62 Waterford Street, Gardner, Massachusetts. On January 12, 2010, Lisa Hébert, Environmental Analyst/Regional Inspector within BEH's IAQ Program visited the school to conduct the reassessment. Ms. Hébert was accompanied by Bob O'Brien, Facilities Director, Gardner Public Schools (GPS).

The building was previously visited by BEH staff in September of 2002 to provide technical assistance regarding IAQ issues stemming from a fire in the art room and in January 2004 for reports of odors in a classroom. A third visit was conducted in September 2006 to investigate reported mold odors. For each visit, a report was issued detailing conditions observed in the building with recommendations to correct observed conditions (MDPH, 2002; MDPH, 2004). Results of the September 2006 visit were released in a report dated February 2007 (MDPH, 2007). This most recent request was prompted by employee complaints concerning the general indoor air quality in the building.

Actions on MDPH Recommendations

As mentioned, MDPH staff had previously visited the building and issued reports with recommendations to improve indoor air quality. Prior to this reassessment, BEH staff requested information as to the implementation of recommendations listed in the most recent 2007 report (MDPH, 2007). A summary of actions taken on previous recommendations based on observations made by BEH staff during this assessment is included as Appendix A.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were conducted with the TSI, Q-Trak, IAQ Monitor, Model 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. BEH staff also performed a visual inspection of building materials for water damage and/or microbial growth.

Results

The school houses approximately 500 students in grades pre-K through two and has a staff of 65. Tests were taken during normal operations at the school and results appear in Table 1. Due to repairs being made to the heating/mechanical ventilation system, several classrooms were without heat/ventilation for a period of time during the assessment.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were above 800 parts per million (ppm) in thirty of fifty four areas indicating poor air exchange in over half of the rooms surveyed. It is important to note that several areas were unoccupied or sparsely occupied at the time carbon dioxide measurements were taken, which can greatly reduce carbon dioxide levels. Carbon dioxide levels would be expected to be higher with full occupancy.

Fresh air in classrooms is supplied by a unit ventilator (univent) system. Univents are designed to draw air from outdoors through a fresh air intake located on the exterior walls of the building and return air through an air intake located at the base of each unit (Figure 1). Fresh and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the unit. As discussed, univents were off in several areas due to repair work (Table 1), therefore no means of mechanical ventilation were being provided to these areas at the time of the assessment. In addition, obstructions to airflow, such as furniture in front of univents were noted (Picture 1). In order to provide fresh air as designed, univents must remain free of obstructions and importantly, these units must remain activated and allowed to operate during periods of occupancy.

Please note that the ventilation equipment in this building was likely installed when the building was constructed (i.e., over 50 years ago). Efficient function of such aged equipment is difficult to maintain, since compatible replacement parts are often unavailable. According to the American Society of Heating, Refrigeration and Air-Conditioning Engineering (ASHRAE), the service life[1] for a unit heater, hot water or steam is 20 years, assuming routine maintenance of the equipment (ASHRAE, 1991). Despite attempts to maintain the univents, the operational lifespan of this equipment has been exceeded.

The mechanical exhaust system in classrooms consists of grated wall vents ducted to rooftop motors. A number of the exhaust vents were blocked by furniture and classroom supplies (Picture 2). As with the univents, in order to function properly, exhaust vents must remain free of obstructions.

It was reported by WSS staff that the exhaust vents in the kindergarten wing were non-functional at the time of the assessment. In subsequent correspondence, Mr. O'Brien indicated

[1] The service life is the median time during which a particular system or component of …[an HVAC]… system remains in its original service application and then is replaced. Replacement may occur for any reason, including, but not limited to, failure, general obsolescence, reduced reliability, excessive maintenance cost, and changed system requirements due to such influences as building characteristics or energy prices (ASHRAE, 1991).

that the exhaust vents are systematically being examined and repaired. He also reported that only four exhaust vents remain to be repaired out of the initial ten which required repair.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of 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 date of the last balancing of these systems was unknown at the time of the assessment. Given the age of the HVAC system, balancing may not be possible.

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 B.

Indoor temperature measurements ranged from 63º F to 76º F, which were below the MDPH recommended comfort range in a number of areas surveyed the day of the assessment (Table 1). The MDPH recommends that indoor air temperatures be maintained in a range of 70º F to 78º 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. In addition, it is difficult to control temperature and maintain comfort without operating the ventilation equipment as designed (e.g., univents/exhaust vents deactivated/obstructed).

The relative humidity measured in the building ranged from 17 to 30 percent, which was below the MDPH recommended comfort range in all areas surveyed during the assessment (Table 1). 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

The crawlspace contained a substantial amount of standing water (Picture 3). It was reported by WSS staff that the school was built on a swamp; four sump pumps operate year round to pump water from the crawlspace. The high water mark observed on pillars within the crawlspace indicates the water rises substantially during high groundwater conditions. Mr. O'Brien reported that the crawlspace is passively vented by a series of pits located along the exterior wall/foundation of the building (MDPH, 2007). Most of these vents were obstructed by heavy snow cover during the assessment; however, preventing air flow (Picture 4). Another vent was covered by pea stone (Picture 5). If vents are not kept clear of snow, melting snow will likely enter the crawlspace in warmer weather. In addition to the passive ventilation, Mr. O'Brien reported that a mechanical ventilation system exists to exhaust air from the crawlspace through a rooftop vent.

- BEH staff examined the exterior of the building to identify breaches in the building envelope and other conditions that could provide a source of water penetration. Several potential sources were identified:
- Deteriorated mortar was observed (Picture 6).
- Cracked, deteriorated areas of concrete were visible on the exterior of the building, exposing rebar in some cases (Pictures 7 and 8).
- Expansion joint sealant was cracked and deteriorating (Picture 9).
- Window sealant was in disrepair in several areas. Window and expansion joint sealant may be composed of regulated materials [e.g., asbestos, polychlorinated biphenyls or (PCBs)]. For further information regarding PCBs in schools, please consult MDPH guidance in Appendix C.

The aforementioned conditions represent potential water penetration sources. Over time, these conditions can undermine the integrity of the building envelope and provide a means of water entry into the building via capillary action through foundation concrete and masonry (Lstiburek & Brennan, 2001). In addition, these breaches may provide a means for pests/rodents to enter the building.

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 indoor 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 effects. 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. Outdoor carbon monoxide concentrations ranged from 1.2 to 1.4 ppm the day of the assessment, likely due to traffic and/or idling vehicles in the school parking lot (Table 1). No measureable levels of carbon monoxide were detected in the building during the assessment (Table 1).

Particulate Matter

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 (μg/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 μg/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 concentration was measured at 18 μg/m^3 (Table 1). PM2.5 levels measured indoors ranged from 6 to 16 μg/m^3 (Table 1), which were below the NAAQS PM2.5 level of 35 μg/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 indoors 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 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 permanent markers, 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 observed in a number of classrooms. Like dry erase materials, cleaning products contain VOCs and other chemicals. These chemicals can be irritating to the eyes, nose and throat and should be kept out of reach of students. Additionally, a Material Safety Data Sheet (MSDS) should be available at a central location for each product in the event of an emergency. Consideration should be given to providing teaching staff with school issued cleaning products to ensure that MSDS information is available for all products used at the school.

Air fresheners and deodorizing materials were observed in the teachers' restrooms. Air deodorizers contain chemicals that can be irritating to the eyes, nose and throat of sensitive individuals. Many air fresheners contain 1,4-dichlorobenzene, a VOC which may cause reductions in lung function (NIH, 2006). Furthermore, deodorizing agents do not remove materials causing odors, but rather mask odors that may be present in the area.

Photocopiers and laminators were in use in several areas. Lamination machines melt plastic and give off odors and VOCs. Similarly, photocopiers also produce VOCs and ozone, particularly if the equipment is older and in frequent use. Ozone is also a respiratory irritant (Schmidt Etkin, 1992). No dedicated exhaust system was in place to remove heat and odors produced by this equipment.

Other Conditions

Other conditions that can affect indoor air quality were observed during the assessment. In at least two classrooms, sinks had dry drains. The purpose of a drain trap is to prevent sewer gases and odors from entering the occupied space. When water is poured into a trap, an air tight seal is created by the water in the U-bend section of the pipe. These drains must have water poured into the traps at least twice a week to maintain the integrity of the seal. Without water, the drain opens the room to the drainage system. In one classroom, sinks were used as storage compartments with unsealed drains (Pictures 10 and 11). If a mechanical device (e.g., exhaust fan) depressurizes the room, air, gas and odors can be drawn from the drainage system into the room. The effect of this phenomenon can be increased if heavy rains cause an air backup in the drainage system.

Stuffed toys and upholstered furniture were noted in some classrooms (Picture 10). Stuffed toys used by an individual child should be washed on a weekly basis to prevent disease transmission (Hale and Polder, 1996). Furthermore, stuffed toys can be a point source for dust collection. Close contact with such items can leave oils, perspiration, hair and skin cells. Dust mites feed upon human skin cells and excrete waste products that contain allergens. Dust can be irritating to the eyes, nose and respiratory system.

A number of personal fans were observed to have accumulated dust/debris. These fans should be cleaned in order to prevent dust/debris from being aerosolized and redistributed throughout the room. Heavy chalk dust accumulation was observed in some classrooms (Picture 12). Chalk dust is a fine particulate, which can be easily aerosolized and serve as an eye and respiratory irritant. Open utility holes were also observed in several areas (Picture 13/Table 1).

Open utility holes can provide a means of egress for odors, fumes, dusts and vapors between rooms and floors.

Food storage was identified in some classrooms. Rodent infestation can result from easy access to food and water in a building. Rodent infestation can result in indoor air quality related symptoms due to materials in their wastes. Mouse urine contains a protein that is a known sensitizer (US EPA, 1992).

Boxes of fluorescent light bulbs were stored above lockers in the hallway (Picture 14). Since fluorescent light fixtures contain mercury, it would be prudent to store them in an area where they would not be subject to damage. For further information concerning proper storage and handling of fluorescent light fixtures, consult the Massachusetts Department of Environmental Protection's (DEP) website; http://www.mass.gov/dep/toxics/stypes/hglamps.htm.

Damaged floor tiles were observed in some areas (Picture 15). Floor tiles of this type and age often contain asbestos. Intact asbestos-containing materials (ACM) do not pose a health hazard. If damaged, ACM can be rendered friable and become aerosolized. Friable asbestos is a chronic (long-term) health hazard that can lead to serious lung disease (i.e. mesothelioma). These types of health impacts are very different than those more typically associated with indoor air quality comfort problems (e.g. headaches, fatigue). Where ACM are found damaged, these materials should be removed or remediated in a manner consistent with Massachusetts asbestos remediation laws (MDLI, 1993). Some unit ventilators are covered with a deteriorated material of unknown composition (Picture 16). The composition of the material should be determined prior to taking any corrective action in the event it also contains ACM.

In regards to ACM, schools should be in compliance with the Asbestos Hazard Emergency Response Act (AHERA), which requires inspection of asbestos containing materials every three years. In addition, a semi-annual walkthrough is conducted to determine current conditions of ACM. AHERA requires public and private non-profit primary and secondary schools to inspect their buildings for asbestos-containing building materials and to develop, maintain and update an asbestos management plan to be kept at the school.

Conclusions/Recommendations

GPS officials, working in conjunction with private contractors, WSS administration, faculty members and school maintenance staff, have made progress to improve indoor environmental conditions in the building by implementing some of MDPH's previous recommendations; however, as indicated in Appendix A, several of these recommendations need further action. In view of the findings at the time of this visit, a series of short-term and long-term recommendations are made to further improve indoor air quality. Short-term recommendations can be made as soon as practicable. Long-term measures will require planning and resources to adequately address overall indoor air quality concerns.

The following **short-term** recommendations are provided:

1. Continue to implement recommendations in Appendix A which have not yet been addressed.
2. Improve air exchange in classrooms. An increase in the percentage of fresh air supply and/or increased exhaust capabilities is recommended. Contact an HVAC engineering firm to determine if univents/exhaust motors can be modified to increase the introduction of fresh air and/or removal of stale classroom air. Continue to repair non-functioning exhausts, including restroom exhaust vents.

3. Once repairs are made, operate all ventilation systems throughout the building (e.g., gym, cafeteria, classrooms) continuously during periods of occupancy independent of thermostat control to maximize air exchange.
4. Use openable windows in conjunction with mechanical ventilation to facilitate 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.
5. Consider adopting a balancing schedule of every 5 years for all mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).
6. Remove obstructions from in front of ventilation equipment.
7. 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 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).
8. Clear all obstructions from the grates on top of exterior passive vents.
9. Ensure mechanical ventilation for crawlspace is functioning at all times.
10. Routinely monitor and maintain sump pumps in good working order.
11. Repair deteriorated mortar on exterior masonry.
12. Repair areas of broken, missing concrete.
13. Address deteriorated window and expansion joint sealants in accordance with EPA regulations and the MDPH guidance document related to PCBs in building materials.

14. Routinely clean dry erase boards and trays.
15. Cleaning products should be properly labeled and stored in an area inaccessible to children.
16. Consider providing school issued cleaning products to staff.
17. Pour water into drains twice a week (or as needed) to maintain an airtight seal.
18. Disconnect service to unused sinks, then seal drains.
19. Eliminate use of air fresheners.
20. Stuffed toys used by students should be washed on a weekly basis; if not feasible consider removal.
21. Professionally clean upholstered furniture on an annual basis; if not feasible consider removal.
22. Routinely clean dust accumulation from personal fans.
23. Periodically clean chalkboards and trays of accumulated dust.
24. Seal spaces around utility holes and breaches in walls/floors and ceilings with an appropriate fire-rated sealant, paying particular attention to breaches between the first floor and the crawlspace.
25. Store food in airtight, rodent-proof containers.
26. Store fluorescent light bulbs in a secure area and in accordance with Massachusetts Department of Environmental Protection's guidelines.
27. Determine composition of damaged floor tiles and damaged material on top of univents. If found to contain ACM, remediate in accordance with applicable State and Federal regulations.

28. Ensure school is in compliance with the Asbestos Hazard Emergency Response Act (AHERA), which requires inspection of asbestos containing materials every three years. In addition, a semi-annual walkthrough is conducted to determine current conditions of ACM. AHERA requires public and private non-profit primary and secondary schools to inspect their buildings for asbestos-containing building materials and to develop, maintain and update an asbestos management plan to be kept at the school. Remediate noncompliant ACM in accordance with applicable federal and state regulations.
29. 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.
30. 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.

In view of the findings at the time of the visit, the following **long-term** recommendations are provided:

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 necessary to determine the operability and feasibility of repairing/replacing the equipment.

2. Consider consulting a professional HVAC engineering firm to evaluate the efficiency of the mechanical ventilation system for the crawlspace to ensure the exhaust is adequate for the volume of air in the crawlspace.
3. Consider eventual removal of carpets in classrooms directly above crawlspace areas. Replace carpet with a nonporous material (e.g., tile).
4. Consider having exterior walls re-pointed and waterproofed to prevent water intrusion. This measure should include a full building envelope evaluation.
5. Consider providing local, dedicated exhaust for copiers and laminating machines.

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Picture 1

Univent Return Vent (along Front) Blocked by Furniture

Picture 2

Exhaust Blocked by Metal Cabinet

Picture 3

Standing Water in Crawlspace

Picture 4

Passive Vent Covered With Snow

Picture 5

Passive Vent Obstructed by Pea Stone and Snow

Picture 6

Cracked, Deteriorated Mortar

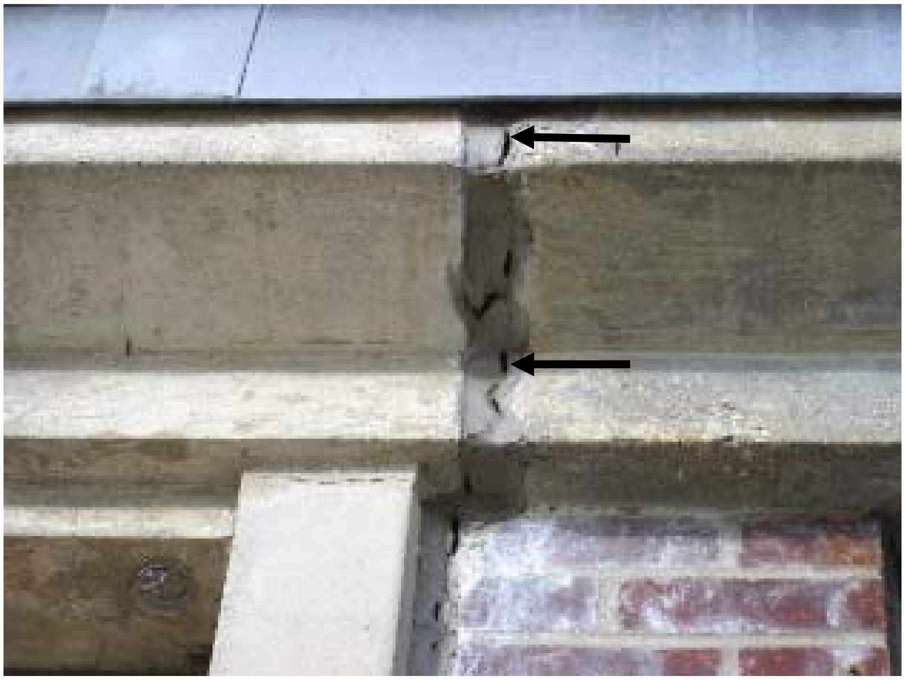
Picture 7

Crevices and Deteriorated Concrete

Picture 8

Failing Concrete and Exposed Rebar

Picture 9



Expansion Joint Sealant in Disrepair

Picture 10

Double Bay Sink Utilized for Storage

Picture 11

Sink With Dry Drain

Picture 12

Chalk Dust Accumulation

Picture 13

Open Utility Hole

Picture 14

Fluorescent Light Bulb Storage

Picture 15

Damaged Floor Tiles

Picture 16

Damaged Material Covering Univent

Location: Waterford Street School **Indoor Air Results**

Address: 62 Waterford Street, Gardner, MA **Table 1** **Date: 1/12/10**

Location	Occupants in Room	Carbon Dioxide (ppm)	Temp (°F)	Relative Humidity (%)	Carbon Monoxide (ppm)	PM2.5 (μg/m3)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
Outside (Background)	-	393	43	17	1.2-1.4	18	Y or N	-	-	Overcast, Wind Dir NW, wind speed 8 mph
Cafetorium	2	633	70	23	ND	14	N	Y	Y	DO
Cafetorium, class on stage	1	670	71	22	ND	11	N	N	N	DEM, clutter
Room 9	2	1008	73	25	ND	12	Y	N	N	DC
Room 10	21	822	71	22	ND	16	Y	Y blocked	Y	DC
Room 11B	13	1026	72	25	ND	10	Y	Y	Y blocked	DC, DEM, CD, dry sink drain, floor tiles in disrepair
Room 11A	0	958	70	23	ND	9	Y	N	N	DC, DEM, stove, sink
Room 12	17	1046	71	20	ND	15	Y	Y blocked	Y	DC, DEM, dry sink
Room 13	10	714	70	19	ND	12	Y 1 open	Y	Y	DO, CD
Room 14	19	791	71	19	ND	15	Y	Y	Y	DO, DEM

ppm = parts per million
FC = food containers
CD = chalk dust
DO = door open
DC = door closed
DEM = dry erase materials
UF = upholstered furniture
MT = missing ceiling tile
ND = non detect
PC = photocopier
PF = personal fan
TB = tennis balls
VL = vent location
WD = water-damaged

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

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

Location: Waterford Street School

Address: 62 Waterford Street, Gardner, MA

Table 1 (continued)

Indoor Air Results

Date: 1/12/10

Location	Occupants in Room	Carbon Dioxide (ppm)	Temp (°F)	Relative Humidity (%)	Carbon Monoxide (ppm)	PM2.5 (μg/m3)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Room 14 (interior)	2	935	71	20	ND	13	Y	N	N	DC
Room 18	0	768	69	22	ND	11	Y	N	N	DO, AP
Room 15	18	1069	70	23	ND	11	Y	Y	Y Blocked	DO, DEM
Room 16	23	1077	70	20	ND	14	Y	Y	Y	DC, PF, CD, DEM, FC
Room 17	23	1046	72	23	ND	13	Y	Y	Y	DO, PF
Girls' Room	0	643	71	22	ND	12	Y	N	Y	DO, peeling paint
Teachers' Lounge	0	590	71	29	ND	11	Y	N	N	DC
Room 18	3	847	68	24	ND	15	Y	N	N	DO
Room 15A	5	858	70	24	ND	11	Y	N	N	DO

ppm = parts per million
FC = food containers
CD = chalk dust
DO = door open
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ND = non detect
PC = photocopier
PF = personal fan
TB = tennis balls
VL = vent location
WD = water-damaged

Comfort Guidelines

Carbon Dioxide:	< 600 ppm = preferred 600 - 800 ppm = acceptable > 800 ppm = indicative of ventilation problems	Temperature: Relative Humidity:	70 - 78 °F 40 - 60%

Location: Waterford Street School **Indoor Air Results**

Address: 62 Waterford Street, Gardner, MA **Date: 1/12/10**

Table 1 (continued)

Location	Occupants in Room	Carbon Dioxide (ppm)	Temp (°F)	Relative Humidity (%)	Carbon Monoxide (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
Room 25	18	944	72	22	ND	12	Y	Y	Y	DC, 26 comp.
Room 24	20	924	71	19	ND	15	Y	Y	Y	DC, DEM, UF, plants
Room 23	24	1040	71	21	ND	13	Y	Y	Y	DC, UF, DEM
Room 22	19	980	69	20	ND	12	Y	Y blocked	Y	DO, DEM, PF
Room 21	18	1088	70	24	ND	14	Y	Y off	Y blocked	DC
Room 20	0	686	69	22	ND	12	Y	Y off	Y blocked	DO
Room 29	21	1033	69	27	ND	12	Y	Y off	Y	DC, DEM, PF
Room 28	0	932	69	24	ND	12	Y	Y off	Y	DO, CD, PF
Room 27	15	1002	69	20	ND	14	Y	Y off	Y	DO,CD, DEM, PF

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Relative Humidity: 40 - 60%

Location: Waterford Street School **Indoor Air Results**

Address: 62 Waterford Street, Gardner, MA **Date: 1/12/10**

Table 1 (continued)

Location	Occupants in Room	Carbon Dioxide (ppm)	Temp (°F)	Relative Humidity (%)	Carbon Monoxide (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Room 26	21	978	69	21	ND	13	Y	Y	Y Blocked	DC, DEM
Occupational therapy	3	710	67	22	ND	10	Y	N	N	DO, open penetration
S-1	0	635	67	24	ND	11	N	N	N	DO
Nurse's Office	3	693	67	22	ND	10	N	Y	Y blocked	DO
Nurse Leader Office	1	708	69	21	ND	12	N	Y blocked	N	DO
Gymnasium	72	764	67	21	ND	12	N	Y	Y	DO
Art	0	668	66	30	ND	10	N	Y	Y	DC, DEM
Room 8	6	668	67	19	ND	8	Y	Y	N	DC
Room 7	0	547	64	19	ND	8	Y	Y	Y off	DC, DEM

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Location: Waterford Street School **Indoor Air Results**

Address: 62 Waterford Street, Gardner, MA **Date: 1/12/10**

Table 1 (continued)

Location	Occupants in Room	Carbon Dioxide (ppm)	Temp (°F)	Relative Humidity (%)	Carbon Monoxide (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
Room 6	15	822	66	24	ND	9	Y	Y	Y off	Exhaust blocked
Room 5	4	643	66	19	ND	10	Y	Y	Y off	DC
Room 4	8	598	69	20	ND	7	Y	Y	Y off	DC
Room 3	1	671	66	18	ND	7	Y	Y	Y off	Exhaust blocked, backdraft
Room 2	21	1014	65	25	ND	8	Y	Y	Y off	DC, CD, PF, exhaust backdraft
Room 1	20	700	63	19	ND	8	Y	Y	Y off	DC, DEM, CD, FC, exhaust backdraft
Speech A	3	653	73	17	ND	8	Y	N	N	DC
Speech B	2	1041	75	21	ND	8	Y	N	N	DC
Vice Principal	2	701	76	18	ND	9	Y	N	N	DC

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Carbon Dioxide: < 600 ppm = preferred
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Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Location: Waterford Street School **Indoor Air Results**

Address: 62 Waterford Street, Gardner, MA **Table 1 (continued)** **Date: 1/12/10**

Location	Occupants in Room	Carbon Dioxide (ppm)	Temp (°F)	Relative Humidity (%)	Carbon Monoxide (ppm)	PM2.5 (μg/m3)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Speech and Language	3	851	74	18	ND	8	Y	N	N	DC, bathroom exhaust nonfunctioning
S 2	2	919	76	17	ND	8	Y	N	N	DC
Guidance Office	1	886	74	20	ND	7	Y	N	N	DC
Principal's Office	2	867	71	24	ND	10	Y	N	N	DC, UF
Guidance 2	1	995	72	22	ND	13	Y	N	N	DC
Library	24	939	73	19	ND	8	Y	Y	Y	DC, DEM, exhaust could not be identified
Office (front)	5	880	73	23	ND	8	Y	N	N	DC
Office/copy room	0	742	74	24	ND	7	Y	N	N	DO, DEM
Kitchen	0	572	68	26	ND	6	Y	N	Y	DO

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Relative Humidity: 40 - 60%

Appendix A

Actions on MDPH Recommendations, Waterford Street School, Gardner, MA

The following is a status report of action(s) taken on MDPH recommendations (**in bold**) based on reports from school officials, maintenance staff, documents, photographs and MDPH staff observations. It should be noted that since the last report was issued, personnel in the Principal's office as well as in the Maintenance Department have changed; therefore, the status of all actions taken in response to MDPH recommendations were not known by current officials and staff.

Remove engineered wood backings from student hallway shelves in the Classroom 1-8 wing.

Action: This action was reportedly completed.

- **Continue to operate mechanical ventilation systems continuously during periods of school occupancy to maximize air exchange.**
  - **Action:** This action is reportedly done, however many univents and exhaust vents were not operating during the reassessment.
- **Remove all blockages from univents and exhaust vents to ensure adequate airflow.**
  - **Action:** Although this has been addressed in the past, many univents and exhaust vents were obstructed on the day of the reassessment.
- **Examine the pipe drain seals for integrity beneath the floor plugs in room 13 and 14 and repair as needed.**
  - **Action**: This action was reportedly done.

Appendix A

- **Seal spaces around all univent heat pipes and other penetrations connected to the crawlspace with an appropriate fire-rated sealing compound.**
  - **Action:** This action was reportedly done.
- **Remove gravel from the passive foundation vent shown in Picture 6.**
  - **Action:** At least one vent was filled with gravel on the day of the reassessment.
- **Examine the feasibility of installing an appropriate downspout and drain system for the roof of the wing containing classrooms 1-8. Re-establish the slope of the tarmac outside this area.**
  - **Action:** This action was not done at the time of the reassessment.
- **Move plants away from univents in classrooms. Avoid over-watering and examine drip pans periodically for mold growth. Disinfect with an appropriate antimicrobial where necessary.**
  - **Action:** Many reminders were reportedly given to school staff and routine checks are conducted. More work is needed in this area.
- **Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.**
  - **Action:** Some reminders were reportedly given to teachers and routine checks are conducted. More work is needed in this area.
- **Ensure that local exhaust ventilation in the teacher's workroom is operating while equipment is in use to help reduce excess heat and odors.**
  - **Action:** No mechanical exhaust ventilation was provided at the time of the reassessment.