INDOOR AIR QUALITY ASSESSMENT

Memorial Middle School
615 Rollstone Street
Fitchburg, 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 William Barletta, Facilities Director for Fitchburg Public Schools (FPS), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) provided assistance and consultation regarding indoor air quality (IAQ) at the Memorial Middle School (MMS), 615 Rollstone Street, Fitchburg, Massachusetts. The assessment was conducted as part of an on-going effort to monitor and improve IAQ conditions in Fitchburg's public schools.

On January 9, 2009, a visit to conduct an assessment was made to the MMS by Mike Feeney, Director, and Lisa Hébert, Environmental Analyst/Inspector in BEH's Indoor Air Quality (IAQ) Program. On February 6, 2009, Ms. Hébert returned to the MMS to complete the assessment. BEH staff was accompanied by Mr. Barletta during portions of the assessment.

The MMS is a two level brick building that was constructed in 1967. In addition to classrooms, the building contains a library, gymnasium, auditorium, cafeteria and kitchen as well as administrative offices. A portion of the gravel roof was replaced in 1993 with a membrane roof. The majority of the rooms in the school have openable windows. MMS also utilizes two portable classrooms. The building is provided with heat by means of a boiler system. When the building was constructed, two boilers were installed. At the present time, only one boiler is operational.

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were conducted with the TSI, Q-Trak, IAQ Monitor, Model 8551. 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 MMS has an employee population of approximately 79 and serves 650 children in grades five through eight. Tests were taken under normal operating conditions and results for January 9, 2009 appear in Table 1. The results for measurements taken on February 6, 2009 appear in Table 2. Air sampling results are listed in the table by location that the air sample was taken.

Discussion

Ventilation

It can be seen from Tables 1 and 2 that carbon dioxide levels were above 800 parts per million (ppm) in 23 out of 51 areas surveyed on January 9, 2009. Carbon dioxide levels were above 800 parts per million (ppm) in 24 out of 27 areas surveyed on February 6, 2009. These results indicate poor air exchange in the majority of areas surveyed. Elevated levels of carbon dioxide may be the result of deactivated/obstructed mechanical ventilation equipment. It is also important to note that several classrooms were empty/sparsely populated, which can greatly reduce carbon dioxide levels. Carbon dioxide levels would be expected to increase with full occupancy.

Fresh air is supplied to classrooms by unit ventilator (univent) systems (Picture 1). A univent draws air from the outdoors through a fresh air intake located on the exterior wall of the building and returns air through an air intake located at the base of the unit (Figure 1). In order for univents to provide fresh air as designed, air diffusers, intakes and return vents must remain free of obstructions. Importantly, these units must remain "on" and be allowed to operate while rooms are occupied.

Classroom exhaust ventilation is provided by unit exhaust ventilators (Picture 2). A unit exhaust ventilator appears similar to a univent, but removes air from the classroom and moves it out of the building. Exhaust equipment in many classrooms was not functioning. Without exhaust ventilation, environmental pollutants can build up in the indoor environment and lead to indoor air quality complaints. Both univents and univent exhaust systems appear to have been installed at the time the building was constructed in 1967, which places them over thirty years old. Mechanical ventilation units of this age can be difficult to maintain because replacement parts are often unavailable.

Portable classrooms are provided with fresh air by rooftop air handling units (AHUs). The remaining rooms and offices in the building are served by AHUs as well as fan coil units (FCUs). MMS staff were unable to confirm the type of ventilation system used for the administrative offices. Wall mounted air conditioners are used in some areas of the building to provide comfort.

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 date of the last balancing of these systems was not available at the time of the assessment.

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

Temperature measurements in the school ranged from 62° F to 78° F on January 9, 2009, which were within the MDPH recommended range in the majority of areas surveyed (Table 1).

Similarly, temperature measurements in the school ranged from 64° F to 83° F on February 6, 2009 (Table 2). The MDPH recommends that indoor air temperatures be maintained in a range of 70° F to 78° 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 11 to 29 percent on January 9, 2009 and from 9 to 22 percent on February 6, 2009, which was below the MDPH recommended comfort range on both days of the assessment (Tables 1 & 2). 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.

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. Drinking water during the day can help ease some symptoms associated with a dry environment (e.g., throat and sinus irritations).

Microbial/Moisture Concerns

Several potential sources of water damage and/or mold growth were observed during the assessment. Active roof leaks were observed in the form of water damaged building materials. Water damaged, broken, stained and (in some cases) mold colonized ceiling tiles were observed throughout the school (Picture 3). Of note is a white powdery material (i.e., efflorescence) noted on the ceiling in a storage area, which indicates water penetration (Picture 4). Efflorescence is a characteristic sign of water intrusion but it is not mold growth. As moisture works its way through the building envelope, water-soluble compounds dissolve, creating a solution. As this solution moves to the surface of the ceiling, the water evaporates, leaving behind white, powdery mineral deposits. Evidence of water exposure was also observed on walls of classrooms and in the auditorium (Pictures 5 through 7).

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommend that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If not dried within this time frame, mold growth may occur. Once mold has colonized porous materials (such as ceiling tiles), they are difficult to clean and should be removed/discarded.

Water distribution lines for the boiler's heating system exhibited some valve joints that were wrapped with cloth, indicating potentially active leaks in the office over carpeted areas (Picture 8). The seals on the sink in room 120 are in disrepair, which may allow water to escape from the sink basin. Additionally, the left portion of the sink has been repaired with a piece of wood. Wood is not impervious to water and could support mold growth and eventually deteriorate (Pictures 9 & 10).

Plants were observed in some classrooms, many which were not properly maintained. Plant soil and drip pans can serve as a source of mold growth. Plants should be properly maintained and be equipped with drip pans. In addition, plants should also be located away from the air stream of mechanical ventilation to prevent aerosolization of dirt, pollen or mold.

BEH staff examined the exterior of the main building as well as the portable classrooms in order to identify breaches in the building envelope that could provide a source of water penetration. Several potential sources were identified:

Main Building

- Exterior doors exhibit gaps (Picture 11).
- The sealant around the perimeter façade of the building was failing (Picture 12), which can allow moisture, drafts as well as pests into the building. In fact, the soffit already exhibits evidence of water penetration (Picture 13).
- The configuration of the exterior auditorium wall provides numerous corners in which snow and ice can accumulate during the winter months. It may also inhibit access to sun and wind, preventing these areas from drying as quickly as the exterior walls on the rest of the building. In addition, the sealant surrounding the decorative pebble-board in this area is deteriorated and missing in some areas, and is therefore allowing water to penetrate the building envelope (Pictures 14 & 15).
- Some weep holes exhibit wicks that were not functioning as intended (Picture 16). Wicks were originally installed to enhance water movement from the drainage plane. Over time, sediment accumulation turns the wick into a stopper, which prevents water drainage from the exterior wall system. "[Use of] ropes or tubes for weep [hole]s" is not recommended (Nelson, 1999). Without appropriate drainage, moisture can build up

inside the wall's drainage plane, resulting in increased water/moisture problems in the exterior wall.

Portable Classrooms

- Window casings exhibit water damaged/rotted components (Picture 17).
- Downspouts are missing in several areas, allowing water and ice to accumulate against the building (Picture 18).
- Snow was piled up against the portable classroom walls, causing moisture to have prolonged contact with the exterior building envelope.

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 January 9, 2009, outdoor carbon monoxide concentrations were non-detect (ND) (Table 1). On February 6, 2009, outdoor carbon monoxide concentrations were measured at 2 parts per million (ppm) (Table 2). No measurable levels of carbon monoxide were detected in the building on both days of the assessment.

A parking area is located outside of lower level classrooms. Although no vehicles were observed to be idling at the time of the assessment, idling vehicles can result in the entrainment of vehicle exhaust into the building, which may, in turn, provide opportunities for exposure to compounds such as carbon monoxide. M.G.L. chapter 90 section 16A prohibits the unnecessary operation of the engine of a motor vehicle for a foreseeable time in excess of five minutes (MGL, 1996).

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 taken on January 9, 2009 were measured at 2 $\mu g/m^3$. PM2.5 levels measured inside the school ranged from 1 to 33 $\mu g/m^3$ (Table 1), which were below the NAAQS PM2.5 level of 35 $\mu g/m^3$. The highest level of 33 $\mu g/m^3$ was measured in the ESL room, which was a small room that had a lot of student activity and no mechanical ventilation. Outdoor PM2.5 concentrations taken on February 6, 2009 were measured at 10 $\mu g/m^3$. PM2.5

levels measured inside the school ranged from 6 to 24 μg/m^3 (Table 2), which were also 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 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.

TVOCs

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.

Some classrooms contained dry erase boards and dry erase markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs) (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve), which can be irritating to the eyes, nose and throat (Sanford, 1999). Cleaning products were found in a number of classrooms. Cleaning products and dry erase board markers and cleaners contain chemicals that can be irritating to the eyes, nose and throat of sensitive individuals. Cans of flammable paints were observed in the art room. These products should be stored in an area inaccessible to children. Additionally, Material Safety Data Sheets (MSDS) should be available at a central location for these products in the event of an emergency.

Other Conditions

Other conditions that can affect indoor air quality were observed during the assessment. Numerous unit ventilators and exhausts were blocked by furniture, bookcases, posters and accumulated paper (Picture 19). Interior of the unit ventilators examined revealed accumulated dust and debris. In addition, the utility holes for univent plumbing were not sealed, which can draw unconditioned air, particulates and odors into the univent to subsequently be dispersed throughout the classroom.

In several classrooms, cracked, broken and missing sections of what appeared to be concrete were observed adjacent to window frames exposing a large breach into the wall cavity (Picture 20). This condition allows unconditioned air to enter the classroom. The temperature of the air in one of these crevices was measured at 45ºF on the day of the assessment. In addition to allowing unconditioned air to enter the space, these conditions may also allow odors, dusts and particulates to enter the room from the interior wall space and become distributed by the unit ventilator throughout the classroom.

In some areas, snow was plowed and deposited in such a manner as to obstruct univent fresh air intakes and exhaust vents. For proper function, fresh air intakes and exhausts must remain free from obstructions.

Several bathroom fans were found to be nonfunctioning. This condition prevents the continuous removal of moisture and restroom odors. On windy days, air can be forced down the exhaust ducts “pressurizing” the rooms. If exhaust vents are not functioning, back-drafting can occur, which can re-aerosolize accumulated dirt and dust particles and force restroom odors into adjacent areas.

Carpeting was damaged in some areas of the school. BEH was unable to determine the age of the carpeting; however, carpet in schools has a normal life span of approximately eleven years (IICRC, 2002). The useful life span carpeting and/or other flooring materials should be considered replacement is planned.

Some sinks in the MMS exhibited dry drain traps. The purpose of a drain trap is to prevent gases and odors from the drainage system 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 (or as needed) to maintain the integrity of the seal. Without water, the drain opens the room to the drainage system. 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.

Open utility holes were observed throughout MMS. Open utility holes can provide a means of egress for odors, fumes, dusts and vapors between rooms and floors. In addition, these materials can migrate into the air handling chambers of unit ventilators and be distributed to occupied areas. Holes in drywall and areas of missing coving were also observed, which can provide for migration of odors, fumes, dusts and vapors in occupied areas as well.

A moderate to heavy amount of peeling paint was observed on the bathroom walls (Picture 21). If the surface was painted with lead based paint, care must be taken to prepare and repaint the wall surface in compliance with state lead paint laws (105 CMR 460.000).

Numerous ceiling tiles were either missing or ill-fitting throughout MMS. Missing ceiling tiles can provide a means of egress for odors, fumes, dusts and vapors between rooms and floors. The movement of ceiling tiles can introduce dirt, dust and particulate matter into occupied areas. These materials can be irritating to certain individuals.

Accumulated chalk dust was noted in several classrooms (Picture 22). Chalk dust is a fine particulate, which can become easily aerosolized and serve as a source of eye and respiratory irritation.

A number of areas throughout the school exhibited worn, cracked or broken floor tiles (Picture 23). These floor tiles may contain asbestos. Intact asbestos-containing materials do not pose a health hazard. If damaged, asbestos-containing materials can be rendered friable and become aerosolized. Friable asbestos is a chronic (long-term) health hazard, but will not produce acute (short-term) health effects (e.g., headaches) typically associated with buildings believed to have indoor air quality problems. Where asbestos-containing materials are found damaged, these materials should be removed or remediated in a manner consistent with Massachusetts asbestos remediation laws (MDLI, 1993).

A number of rooms contained upholstered furniture. Upholstered furniture is covered with fabric that comes in contact with human skin. This type of contact can leave oils, perspiration, hair and skin cells. Dust mites feed upon human skin cells and excrete waste products that contain allergens. In addition, if relative humidity levels increase above 60 percent, dust mites tend to proliferate (US EPA, 1992). In order to remove dust mites and other pollutants, frequent vacuuming of upholstered furniture is recommended (Berry, M.A., 1994). It is also recommended that upholstered furniture (if present in schools), be professionally cleaned on an annual basis. If an excessive dusty environment exists due outdoor conditions or indoor activities (e.g., renovations), cleaning frequency should be increased (every six months) (IICRC, 2000).

In several classrooms, items were observed on the floor, windowsills, tabletops, counters, bookcases and desks. The large number of items stored in classrooms provides a source for dusts to accumulate. These items (e.g., papers, folders) 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.

The break room located in a portable classroom exhibited a fair amount of food spillage. Classrooms and break areas should remain free from food debris which may attract rodents. 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). Care should also be taken to ensure all kitchen appliances are routinely cleaned as well.

Numerous MMS staff reported odors in the building, particularly in the morning when the boiler is turned on and often when the building is re-opened after a weekend or vacation. BEH was unable to confirm the fact that odors were emanating from the boiler room on the day of the assessment. As mentioned, two boilers were installed in 1967, only one of which is currently operable. BEH was informed by MMS staff that funding was currently being sought for replacement of the inoperable boiler.

Nesting materials were observed in crevices on the exterior of the building where the sealant was missing from the perimeter façade. Birds can be a source of disease, and bird wastes and feathers can contain mold and bacteria, which can be irritating to the respiratory system. No obvious signs of bird roosting inside the building or in ventilation components were noted by BEH staff or reported by occupants.

A wooden beam in the hallway appears to have shifted over time (Picture 24). This condition should be examined by a structural engineer to determine its integrity.

Finally, a former exhaust hood located in a classroom is currently being utilized for storage of a microwave oven. Unless the hood is equipped with a baffle or backflow prevention device, unconditioned air may be entering the classroom by means of the hood (Picture 25). This condition may cause dusts and particulates to aerosolize as the air enters the classroom.

Conclusions/Recommendations

The conditions noted at the MMS raise a number of indoor air quality issues. The general building conditions, work practices and the age/condition of HVAC equipment, if considered individually, present conditions that could degrade indoor air quality. When combined, these conditions can serve to further degrade indoor air quality. Some of these conditions can be remedied by actions of building occupants. Other remediation efforts will require alteration to the building structure and equipment. For these reasons, a two-phase approach is required for remediation. The first consists of **short-term** measures to improve air quality and the second consists of **long-term** measures that will require planning and resources to adequately address the overall indoor air quality concerns.

Short-Term Recommendations:

1. Operate both supply and exhaust continuously during periods of school occupancy.

2. Set thermostat controls in modular classrooms to the "on" position to provide constant supply and exhaust ventilation during periods of occupancy.
3. Remove obstructions (furniture, bookcases, posters and accumulated paper) from in front of unit ventilators and unit exhaust ventilators.
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. Contract with a ventilation engineer to inspect AHUs, UVs as well as unit exhaust ventilators for proper function. Repair or replace components as necessary to ensure adequate air supply and exhaust capability throughout the school's classrooms and offices.
6. Consider adopting a balancing schedule of every 5 years for all mechanical ventilation systems, as recommended by ventilation industrial standards (SMACNA, 1994).
7. Change filters for air-handling equipment (e.g., univents, AHUs and ACs) as per the manufacturer's instructions or more frequently if needed. Vacuum interior of units prior to activation to prevent the aerosolization of dirt, dust and particulates. Ensure filters fit flush in their racks with no spaces in between.
8. Contract with a professional to inspect and repair current boiler to ensure proper operation and to identify and remedy any odors associated with it.
9. Ensure roof leaks are repaired and replace water damaged, missing and ill-fitting ceiling tiles. Examine the area above and around these areas for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial.
10. Repair holes in wall surfaces.

11. Investigate valve joints wrapped in cloth and if plumbing leaks are found, repair in accordance with Massachusetts Plumbing Code.
12. Repair any defective seals on sinks. If wood must be utilized as the edge of a sink, ensure a waterproof seal is maintained on the wood to reduce exposure to moisture.
13. Store cleaning products and flammable spray paints properly and out of reach of students. Ensure spray bottles are properly labeled. All products used at the facility should be approved by the school department with MSDS' available at a central location.
14. Consider providing plants with drip pans and avoid over-watering. Examine drip pans periodically for mold growth. Disinfect with an appropriate antimicrobial where necessary.
15. Determine whether floor tiles in question contain asbestos. If so, remediate damaged floor tiles in conformance with Massachusetts asbestos remediation and hazardous waste disposal laws.
16. Repair broken surfaces adjacent to windows as seen in Picture 20 in classrooms and library.
17. Remediate peeling paint in girls' bathroom and if applicable in accordance with state lead laws.
18. Restore exhaust ventilation in bathroom areas; make repairs as necessary.
19. Eliminate food storage in classrooms and food spillage in break room. Clean all appliances on a routine basis to eliminate sources of food and potential rodent infestation. Dispose of old food containers promptly.

20. 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.

21. Seal spaces around pipe penetrations in the floors of univent cabinets, utility holes and breaches in walls/floors and ceilings with an appropriate fire-rated sealant.

22. Pour water into sink drain traps twice weekly (or as needed) to prevent gases and odors from entering occupied space. If sinks are no longer in use, they should be removed and capped in accordance with the State Plumbing Code.

23. Clean chalk and dry erase boards and trays to prevent accumulation of materials.

24. Clean upholstered furniture annually or more frequently if needed.

25. Eliminate gaps on all exterior doors by installing weather-stripping or door sweeps.

26. Repair failing/missing sealant on the perimeter façade of the building. Where visible, remove nesting materials.

27. Repair missing sealant on pebble-board on the exterior of building.

28. Remove remaining wicks from weep holes in masonry.

29. Repair/Replace portable classroom window frames.

30. Install downspouts on portable classroom gutter system.

31. Eliminate the practice of plowing snow against portable classroom walls as well as univent fresh air intakes and exhaust vents.

32. Consider eliminating parking and/or idling vehicles in front of fresh air intakes. If not feasible consider posting signage instructing vehicles not to back in and to obey state anti-idling laws. M.G.L. chapter 90 section 16A prohibits the unnecessary operation of

the engine of a motor vehicle for a foreseeable time in excess of five minutes (MGL, 1996).

33. Examine the former exhaust hood to determine whether a baffle exists to prevent unconditioned air from back-drafting into the classroom. If none is found, consider sealing both ends of the hood.

34. 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).

35. Consider cleaning carpeting annually (or semi-annually in soiled high traffic areas) as per the 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).

36. 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.

37. 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.

Long-term Recommendations:

1. Consider establishing a schedule for replacement of carpets based on IICRC recommendations.
2. Considering the age, physical deterioration and availability of parts of the HVAC system, an evaluation by an HVAC engineering firm is strongly recommended for proper operation and/or repair/replacement of the ventilation systems.
3. Consider consulting a structural engineer regarding the integrity of the beam in Picture 23.

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Picture 1

Unit Ventilator

Picture 2

Unit Exhaust Ventilator

Picture 3

Water Damaged and Mold Colonized Ceiling Tile

Picture 4

Efflorescence on Storage Room Ceiling

Picture 5

Water Damaged Ceiling Tiles and Water Stains on Wall

Picture 6

Evidence of Water Infiltration in Auditorium

Picture 7

Efflorescence and Water Stains

Picture 8

Cloth Wrapped Around Valve Joint

Picture 9

Portion of Sink Top Made of Wood
Note Edges of Sink are not Secure

Picture 10

Sealant is Lacking on Portions of Sink

Picture 11

Exterior Door Exhibits Gap

Picture 12

Sealant on Exterior Façade in Disrepair

Picture 13

Missing Sealant, Note Water Damaged Soffit

Picture 14

Snow Accumulation on Exterior of Auditorium

Picture 15

Missing Sealant Adjacent To Masonry

Picture 16

Wick Protruding From Weep Hole in Masonry

Picture 17

Deteriorated Window Casing Portable Classrooms

Picture 18

Missing Downspouts on Exterior of Portable Classrooms

Picture 19

Univent Exhaust Blocked by Bookcase

Picture 20

Deteriorated Surface Adjacent to Window and Interior Sill

Picture 21

Peeling Paint in Bathroom

Picture 22

Accumulated Chalk Dust

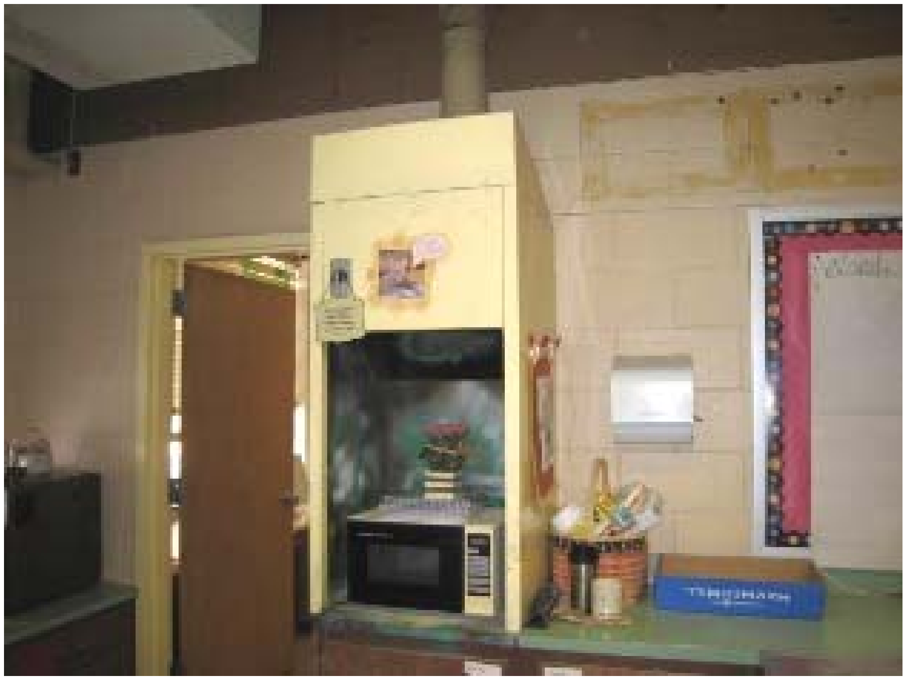
Picture 23

Cracked, Broken Floor Tiles

Picture 24

Wooden Beam Appears to Have Shifted

Picture 25



Old Ventilation Hood Housing Microwave Oven

Location: Memorial Middle School

Address: 615 Rollstone Street - Fitchburg

Table 1

Indoor Air Results

Date: 01/09/09

Location	Occupants in Room	Carbon Dioxide (ppm)	Temp (°F)	Relative Humidity (%)	Carbon Monoxide (ppm)	PM2.5 (μg/m3)	Windows Openable	Ventilation		Remarks
								Supply	Exhaust	
Outside (Background)	-	390	41	12	ND	2	-	-	-	
Office Conf. Room	2	782	72	21	ND	4	N	Y	N	DC, subsequently opened
Office Break Area	3	826	72	16	ND	4	N	Y	N	FC, sink, WD CT
Copy Room	2	908	72	18	ND	4	N	Y	Y	DO, WD CT, laminator, strong odor in room
Front Reception Area	1	762	72	15	ND	4	N	Y	N	DO, WD CTs, PF, comp.
Main Office (Mrs. Auger)	1	743	72	14	ND	5	N	Y	N	WD CTs, AC
Guidance (Rodriguez)	1	596	73	13	ND	3	Y	N	N	DO
Guidance 2	0	505	72	12	ND	2	Y	N	N	DO
Principal	0	615	71	13	ND	3	Y	N	N	DO, UF
File Area	0	744	71	13	ND	3	N	N	N	DO, broken CT

ppm = parts per million
AT = ajar ceiling tile
DEM = dry erase materials
ND = non detect
TB = tennis balls
design = proximity to door
GW = gypsum wallboard
PC = photocopier
VL = vent location
DC = door closed
DO = door open
MT = missing ceiling tile
PF = personal fan
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: Memorial Middle School

Address: 615 Rollstone Street - Fitchburg

Indoor Air Results

Date: 1/09/09

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	
Vault	0	581	67	14	ND	3	N	N	N	Roof leaks, efflorescence on ceiling
Supply Room	0	628	62	15	ND	4	Y	N	N	WD CTs wall and ceiling, damaged floor tiles
Conference Room 2	0	696	62	16	ND	3	Y	N	N	DO, missing CT
Vice Principal	0	563	64	15	ND	3	Y	N	N	DO, PF, plants
Social Worker	1	681	67	17	ND	3	Y	N	N	DC
Office 1	0	736	68	15	ND	4	Y	N	N	DC
Speech	0	647	68	14	ND	4	Y	N	N	DO,WD wall and light
In House Suspension	4	711	68	14	ND	5	N	Y	N	DO
Ms. Heinemann	3	670	68	14	ND	4	Y	N	N	DO, WD CTs, plant
Storage	0	589	68	14	ND	4	N	N	Y Broken	WD CTs, mold colonization, dry sink
Mrs. Sulin	0	658	70	15	ND	5	N	N	Y Broken	DC

ppm = parts per million
ND = non-detectable

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		

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	
Nurse's Room	3	855	72	17	ND	4	Y	N	N	DO, WD CT, sink
Nurse's bathroom	0	770	74	16	ND	4	Y	N	N	DO, WD CTs
Room 53	2	727	70	14	ND	5	Y	Y	Y Off	DO, PF, DEM, debris in univent
Room 43	17	1350	73	22	ND	8	Y	Y	N	DEM, WD CTs
Room 51	10	1424	74	20	ND	10	Y	Y	Y Off	DO
Room 49	0	1007	74	15	ND	4	N	Y	Y Off	DC, WD CTs, paper accumulation, CD
Room 29	22	2105	75	29	ND	6	Y	Y	Y Off	DC
Room 31	2	1104	75	20	ND	4	N	N	N	DC
Room 31A	6	1160	75	20	ND	4	N	Y	N	DO, DEM
Sean Walker	0	1234	77	18	ND	4	Y	Y	Y	DO, DEM
Room 233	0	824	76	15	ND	3	Y	Y	Y Off	DC, hood in room, former auto body shop

ppm = parts per million
ND = non-detectable

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		

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	
Mr. Cannon (Portable)	0	596	75	14	ND	2	Y	Y	Y	DO, WD CT CD
Break Rm (Portable)	2	775	74	16	ND	1	N	Y	N	DO
Mr. Serafini (Port)	0	586	73	14	ND	1	Y	Y	Y	DO, WD CTs
Room 35	0	785	74	16	ND	5	Y	Y	Y	Open utility holes,
Room 37	0	607	75	11	ND	2	Y	Y	Y Off	DO,DEM, CD, dry trap
Mrs. Brideau	0	1252	74	17	ND	7	Y	Y	Y Off	DO, DEM, CD, paper accum.
Room 241	0	1294	74	20	ND	7	Y	Y	Y Off	DO,DEM, CD, plants
Room 47 (former locker space)	0	1116	74	17	ND	7	N	Y	N	DC, WD CTs
Room 55	0	1199	75	18	ND	12	Y	N	N	DO, WD CTs, missing CTs
Gymnasium	45	845	74	18	ND	7	N	Y	Y	Gap at door to exterior

ppm = parts per million
ND = non-detectable

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		

Location: Memorial Middle School **Indoor Air Results**

Address: 615 Rollstone Street - Fitchburg **Table 1 (continued)** **Date: 1/09/09**

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
Boys' Locker Rm	1	764	71	16	ND	4	Y	Y	N	DO
ESL	9	1741	72	24	ND	33	Y	N	N	DC, DEM, paper accum.
257	5	1345	74	22	ND	8	N	Y	Y	DO, CD, WD CTs
Women's Room (teachers)	0	1355	70	23	ND	8	Y	N	Y Weak	DC, AD
Room 27A	26	1726	78	23	ND	6	Y	Y	Y Off	DEM, CD
Room 25	1	1201	77	17	ND	9	Y	Y	Y	DO, DEM, PF
Room 23	0	1166	76	17	ND	8	Y	Y	Y Off	DO, CD
Room 21	4	1077	74	16	ND	9	Y	Y	Y Off	DEM, CD, PF
Auditorium	0	594	73	15	ND	2	N	Y	Y	DC, large gap at door
Boiler Room	0	676	75	15	ND	7	N	Y	-	

ppm = parts per million
ND = non-detectable

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		

Location: Memorial Middle School | **Indoor Air Results**

Address: 615 Rollstone Street - Fitchburg | **Date: 2/6/09**

Table 2

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)	-	54	8	390	2	10	-	-	-	
Room 219	13	64	21	1245	ND	14	Y	Y Off	Y Off	DC, DEM, CD
Room 217	20	68	21	1533	ND	18	Y	Y	Y Off	DC, DEM, blinds
Girls' Bathroom	3 (2 mins. Earlier)	67	18	1074	ND	-	Y	N	Y Off	DO, hole in window, peeling paint
Handicapped Bathroom	0	66	20	1129	ND	13	N	N	Y Off	DO,WD ceiling, AD hall outside has WD CTS
Room 215	19	71	22	1625	ND	16	Y	Y	Y Off	DC, CD, toaster, coffee pot
Room 213	21	71	21	1612	ND	15	Y	Y Off	T Off	DC, PF, CD, comp
Room 211	18	74	21	1611	ND	14	Y	Y	Y Off	CD, plants, micro
Room 209	16	79	15	1255	ND	19	Y	Y	Y Off	DO, CD
Room 207	9	77	14	1361	ND	15	Y	Y	Y Blocked	DO, CD, DEM

ppm = parts per million
AD = air deodorizer
AT = ajar ceiling tile
design = proximity to door
DO = door open
DEM = dry erase materials
GW = gypsum wallboard
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: Memorial Middle School **Indoor Air Results**

Address: 615 Rollstone Street - Fitchburg **Table 2 (continued)** **Date: 2/6/09**

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 205	10	76	17	1450	ND	13	Y	Y	Y Off	DO, CD, DEM
Room 254	3	74	13	1018	ND	14	N	Y	Y Off	DO, AD, WD CTs, paper accum.
Lower Level Room 2	23	70	17	995	ND	12	Y	Y	Y Off	DO, DEM, micro
Room 4	22	71	15	1121	ND	11	Y	Y	Y Off	DC, DEM, dust on shelves
Room 6	24	72	11	947	ND	11	Y	Y	Y Blocked	DO, DEM, FC, micro AD, paper accum.
Room 8	19	75	16	1381	ND	9	Y	Y	Y Blocked	DC, plants, paper on UV
Room 10	3	75	13	857	ND	8	Y	Y	Y	DO, open utility holes
Room 12	21	75	14	1048	ND	11	Y	Y	Y Off	DC, CD, DEM, open utility holes
Room 14 Art	15	70	14	1026	ND	11	Y	Y	Y Off	DO, spray paints, paper accum.
Room 16	22	83	11	718	ND	9	Y 1/8	Y	Y Off	DO, CD, DEM CD
Room 18	19	74	9	953	ND	8	Y	Y	Y Blocked	DO, DEM, peeling paint on ceiling

ppm = parts per million
ND = non-detectable

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		

Location: Memorial Middle School **Indoor Air Results**

Address: 615 Rollstone Street - Fitchburg **Table 2 (continued)** **Date: 2/6/09**

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 20	1	75	10	706	ND	6	Y	Y	Y Off	DC, CD, AD, open utility holes
Ms. Allen	0	72	12	912	ND	8	Y	N	N	DO, former closet
Cafeteria	60	72	16	1071	ND	24	Y	Y	Y	WD CTs
Former Teachers' Lounge	14	70	16	1322	ND	14	Y	N	Y	WD CTs, DEM,
Kitchen	3	70	18	1126	ND	21	N	Y	Y	DO, WD CTs
Class off Cafeteria	4	71	15	1269	ND	17	Y	N	N	DEM
Music	17	70	13	645	ND	11	Y	Y	Y	DEM, CD, PF, hallway outside room has broken floor tiles

ppm = parts per million
ND = non-detectable

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%