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Health Impact Assessment (HIA) of Building Renovations at Gerena Community School, Springfield, Massachusetts

Office of Research and Development and Region 1 (New England)
U.S. Environmental Protection Agency

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Authors of this Report

(in alphabetical order of last name)

Adkins, Lauren[1]; Frantz, George[2]; Fulk, Florence[3]; Rhodus, Justicia[1]; Thompson, Bob[4]; Vesper, Steve[3]; Williams, Ron[4]; Zartarian, Valerie[5]; Zimmerman, Emily[2]

[1] CSS-Dynamac, c/o U.S. Environmental Protection Agency Cincinnati, OH 45268

[2] U.S. Environmental Protection Agency, Region 1 (New England), Boston, MA 02109

[3] U.S. Environmental Protection Agency, Office of Research and Development, National Exposure Research Laboratory, Cincinnati, OH 45268

[4] U.S. Environmental Protection Agency, Office of Research and Development, National Risk Management Research Laboratory, Research Triangle Park, NC 27709

[5] U.S. Environmental Protection Agency, Office of Research and Development, National Exposure Research Laboratory, Boston, MA 02109

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Notice

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Contact Information

For more information about this HIA, please contact:

Florence Fulk, U.S. EPA
26 W. Martin Luther King Dr.
Cincinnati, Ohio 45268
Phone: 513-569-7379
Email: fulk.florence@epa.gov

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About This Report

The final HIA Report represents the full documentation of the work completed for the HIA, including (but not limited to) the HIA's purpose, findings, and recommendations, documentation of the processes and methods involved or reference to an external source of documentation for those processes, and must be made publically accessible. This report documents all of the work performed for the HIA of Building Renovations at Gerena Community School, Springfield, Massachusetts. The HIA evaluated a list of proposed renovations the Department of Parks, Buildings and Recreation Management (PBRM) was considering for their potential impacts to health and wellness and included several processes, such as stakeholder engagement, onsite observation, forensic investigation, and material development.

The authors developed the HIA Report in accordance with the HIA Minimum Elements and Practice Standards and other guidance documents developed by the HIA community of practice. Following the Introduction, each chapter reflects a step in the HIA process. The authors provide a timeline of activities at the beginning of each chapter to add a temporal context to the activities performed during that step. Because the HIA spanned over a period of three years, the final HIA Report is expansive and may include information not applicable to all readers. To address this issue, the authors prepared factsheets, presentations, and summary reports (such as the Executive Summary of Preliminary Findings) for the variety of users. Those materials are provided in the appendices at the end of this document.

HIA Report Notations

The following abbreviations are used throughout the document:
"e.g." = *exempli gratia*, which means "for example"
"i.e." = *id est*, which means "that is"
"etc." = *et cetera,* which means "and so on"

Cautions or caveats are noted with:

Meetings with stakeholders are noted with:

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Executive Summary of Preliminary Findings and Recommendations (7/25/14)

GERENA COMMUNITY SCHOOL

German Gerena Community School (Gerena) is a public elementary school built over forty years ago in the North End Community of Springfield, Massachusetts. The main building sits between an interstate and an industrial railroad line. The school is connected to two underground tunnels that provide a covered walkway for residents and students. Gerena also serves as a community center providing residents with space for afterschool programs, a swimming pool, a gymnasium, and health clinics.

Over the years, Gerena has endured natural ageing, structural damage, flooding, and fire. Many offices and community spaces in the tunnels are closed due to flooding and air quality concerns. The building's systems and equipment that treat incoming water and air are expensive to maintain and many are due to be replaced.

Parents and educators are concerned that the conditions in the school may be affecting the health and performance of the students. Respiratory health is a particular concern, since over one-fifth (20%) of the student body suffer from asthma [1]. The City of Springfield's Department of Parks, Buildings, and Recreation Management (PBRM) is managing the renovations at Gerena and has made health and safety top priorities.

THE PROPOSED DECISION

The 2010 Needs Survey from the State of Massachusetts School Building Authority gave Gerena low scores for both building condition and general environment [2]. PBRM led several investigations to identify and prioritize how Gerena could be improved. There are many options to renovate the building, but time and funding are limiting factors. PBRM was in the process of selecting and implementing renovation options when this HIA began.

Overview of options being considered:

- Continue to inspect and reduce sources of water coming into underground areas (Tunnels A and C).
- Redesign and upgrade HVAC systems, which may include relocating fresh air intakes and associated equipment.
- Repair/replace/upgrade building systems, equipment, and materials (as needed) and install security equipment to deter vandalism.
- In Tunnel C, seal the outer tunnel from the inner tunnel and install a new exhaust system to exhaust moisture and air from the maintenance corridor to outside the building.

For a more detailed list of the renovation options considered, see page 5.

EPA AND HIA

The U.S. Environmental Protection Agency (EPA) is assessing the value of using health impact assessment (HIA) as a tool to build more sustainable and healthy communities and promote the consideration of impacts to vulnerable populations in decision-making. Staff in EPA's Sustainable and Healthy Communities research program and Region I Office (Boston, MA) collaborated with PBRM to decide whether an HIA would bring value to the selection of renovations at Gerena. It was decided that the HIA would provide:

- ✓ Valuable health-focused information in time for PBRM to consider its conclusions and recommendations while making repair decisions;
- ✓ Another platform for the community to become engaged in the decision-making process; and
- ✓ A unique perspective on implementation and best practices for future HIAs.

A core team made of researchers, staff, and contractors from the EPA was established to lead and perform the HIA. PBRM contributed to this HIA by providing access to and knowledge of Gerena. From this point, the core team will be referred to as the EPA.

In early October 2012, the EPA announced its intent to conduct this HIA at a community meeting in the school.

What is a Health Impact Assessment?

Health Impact Assessments:

- ✓ Evaluate a proposed decision (policy, plan, program, or project) and provides recommendations to promote health that combine science-based research with input from stakeholders;
- ✓ Follow a **6-step systematic process** – deciding whether to conduct an HIA (screening), defining the scope and design of the assessment (scoping), gathering and analyzing information to predict potential impacts to health (assessment), making recommendations based on the findings (recommendations), reporting the findings (reporting), and providing a post-study monitoring plan and evaluation of the process (monitoring and evaluation); and
- ✓ Maintain core values – **democracy** in decision-making, **equity** in the opportunity for healthy living, transparency and **ethical use** of the evidence found, a **comprehensive approach** to addressing public health issues, and **sustainability**.

HIA GOALS

At the start of this HIA, the HIA Core Group identified the following goals:

- The HIA will present a set of recommendations to be considered in the decision-making that would maximize potential benefits to health and well-being and avoid and/or mitigate potential harmful impacts of implementing the proposed renovations.
- The EPA will deliver a fully developed HIA that examines health and environmental impacts of the proposed school renovation options being considered.
- The HIA will provide educational materials that are context-specific and science-based to the community and other stakeholders regarding air pollution and ways to mitigate asthma triggers.
- The EPA will use tools and approaches to conduct the HIA that will generate lessons learned and best practices for implementing HIA by a federal agency.

STAKEHOLDER ENGAGEMENT

Stakeholder engagement is a key part of the HIA process. Stakeholders are any persons or entities that may be impacted by the decision being made. In this HIA, the EPA engaged community residents, parents, school staff, PBRM, and representatives from community-based organizations to gain an understanding of their concerns about Gerena. Identified concerns included the perceived poor air quality and amount of particulate matter in the air, the poor conditions of the carpet, the negative perceptions of Gerena among the community, the presence of mold, asthma symptoms occurring at the school, the potential harmful impacts to vulnerable populations using Gerena, differing priorities between school and city administrators, absenteeism, and classroom noise.

HIA SCOPE

This HIA focused on environmental conditions in Gerena and how renovations could influence health and wellness of facility users, especially among vulnerable populations.

STUDY DESIGN

This HIA was designed to address all of the concerns raised by stakeholders. From October 2012 to June 2013, EPA collected new information, including anecdotal and direct observations about the school's history and uses. For a summary of the onsite observations, continue to page 3. Comprehensive literature reviews of peer-reviewed scientific journals and published reports were performed to establish the connections (or lack thereof) between environmental conditions and health. A summary of the literature findings are on page 4. Literature evidence, observations made, and professional expertise were used as a foundation to characterize the predicted impacts to health for each of the proposed renovation options (see page 5).

On-site diagnostics performed at Gerena included:

- Settled dust sampling to test mold contamination;
- Air pressure mapping throughout the facility;
- Building enclosure air tightness testing and infrared imaging;
- A visual survey of heating, ventilation, and air conditioning (HVAC) equipment and maintenance plan;
- 3-day continuous recording of indoor carbon dioxide, temperature, relative humidity, and laser particle counting in selected areas; and
- 6-day recording of indoor temperature, relative humidity, and select combustion source pollutants (particles and gases).

OBSERVATIONS IN THE SCHOOL AND COMMUNITY

The Population using Gerena

According to the 2013 school year report card, Gerena enrolled 667 students with an attendance rate of 93%. The student body was largely a minority population (81.3% Hispanic or Latino ethnicity) with 37% speaking English as a second language [3]. It is estimated that students spend an average of 7 hours per day in the school, more for those who participate in after school programs.

The Massachusetts Department of Education considers most students at Gerena as "high needs." In 2013, 93% of students at Gerena were either students with disabilities (13.5%), English language learners (28%), former English language learners (37.2%), or from low-income families [3]. In addition, 20% of the 667 students attending Gerena in 2013 had asthma, a respiratory condition which renders a person more sensitive to air pollutants, and 211 were young children (pre-kindergarten and kindergarten grades).

Facility users, other than students, include school administrators, staff, security guards and community residents and visitors. Census data showed Gerena serves a community of about 8,718 people with a median age of 24-31 years. The resident population is majority female and of Hispanic or Latino descent (81- 90%). A large proportion of the population (up to 61%) lives below the federal poverty level. The two most common health concerns in the community, based on mortality rates, were respiratory and cardiovascular diseases. [4,5,6]

Community Perceptions

There are three overarching perceptions about Gerena in the community: 1) conditions at Gerena are unhealthy and not safe for vulnerable populations, especially asthmatics; 2) accessibility is a key determinant of facility use among residents; and 3) Gerena is an invaluable asset to the community. [See full report for citations]

Temperature and Relative Humidity

Temperature and relative humidity appeared to be well-controlled. The Commonwealth of Massachusetts follows the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Standard 55-1992 which recommends relative humidity should not go above 60%. The rooms where humidity was found above 60% included the mechanical room, gym, special education room, library, and principal's office.

Air Movement

Investigators mapped the air flow throughout the building and found that air was being pulled from the lower floor (tunnels) and Birnie Avenue up to the second floor of the main building. Infrared imaging identified several sites where air was leaking out of the building's enclosure (e.g., through gaps in the walls and wall joints). The building enclosure air tightness testing showed an abnormally high rate of air was leaking from the building, which can cause HVAC systems to run longer and less efficient.

HVAC Operation and Equipment

Investigators found major malfunctions with the air handlers and air conditioning units surveyed. There are zones where ventilation equipment are not working as intended and do not meet the minimum code requirements for supplying outside air. Other issues identified included microbial growth in the air conditioning drain pans, and parts of the air conditioning units were inaccessible for regular maintenance.

Mold Contamination

Researchers found that mold contamination was high throughout the school compared to other offices and schools. The average mold contamination value for each floor went up with the building floor number. For example, the highest mold contamination value was found in pod 7 (Level 3), and the lowest value was found in Tunnel C (Level 1).

Indoor Combustion Source Air Pollutants

As expected, there were outdoor air pollutants found coming into the building. Roadway traffic and wind direction appeared to influence the levels of combustion source pollutants (e.g., from motor vehicles) in the building. Although there are no regulated standards for indoor air and pollutant concentrations, other standards such as ASHRAE and EPA's National Ambient Air Quality Standards were sometimes used for informational purposes only relative to the observed indoor levels at Gerena [7]. Based on these guidelines, the average pollutant levels were relatively low and not above a level of concern.

LITERATURE FINDINGS

What contributes to indoor air quality?

The quality of the indoor air is largely influenced by the presence of particles, biological organisms, harmful gases, moisture, and temperature. Generally, there is a heating, ventilation, and air conditioning (HVAC) system that controls the moisture and temperature levels in the building. The HVAC system can also filter harmful pollutants out of the air coming into the building.

How can indoor air quality impact health?

After a review of selected studies on children and environmental exposure, EPA found that indoor air quality (presence of pollutants, moisture, etc) can greatly impact respiratory health and trigger asthma symptoms. Typical asthma symptoms include wheezing, difficulty breathing, and irritated respiratory passages. Findings from the review showed that exposure to dampness (moisture), mold and particulate matter (PM_{10}) were major risk factors for childhood asthma [8, 9, 10]. Slightly lower risk factors included exposure to cockroaches and combustion source air pollutants [10, 11, 12]. The lowest ranking risk factors included exposure to dog and cat allergens, ozone, and formaldehyde [12, 13]. Populations more sensitive to the quality of the indoor air include infants and young children, older adults (over 65 years), and persons with pre-disposing conditions (e.g., asthma, allergies, and lowered lung function).

What contributes to "noise" in a classroom?

"Noise" is a subjective term used to describe unwanted sound. Noise can be generated from inside or outside the classroom, and/or intrude from adjacent rooms or hallways through walls/ceilings/floors, windows, and air vents [14]. Classroom acoustics, which is characterized by the level and movement of sound in a learning space, is influenced by the level of background "noise" compared to a speaker's voice, the placement of materials that absorb or reflect sound, space design, and "noisy" mechanical equipment [15].

How can "noise" impact health and performance?

Noise can impact health directly by causing shifts in hearing levels and physiological functions (at 75 decibels), and indirectly by impeding thought processes, concentration, and communication (at 70 decibels) [16, 17]. Noise levels in a classroom typically range from 46 to 77 decibels, depending on the activities taking place [17]. The acoustic environment impacts student and teacher performance through changes in behaviors and attitudes [18, 19]. The ability and desire to learn and perform well in school are strong indicators of future health and wellness [20, 21]. Populations more sensitive to classroom acoustics include young children and adolescents, persons with pre-disposing physical/mental/behavioral conditions (e.g., ear infections, anxiety, ADHD, etc.), and persons learning a second language.

What contributes to community perceptions?

There is increasing evidence that conditions of buildings and structures can influence peoples' perceptions. Although there are several interacting factors that play a role in developing perceptions, one of the biggest contributors is the presence of social or physical decline (e.g., unfriendliness and vandalism) [22, 23]. On the contrary, community spaces that provide the opportunity for social interaction and physical activity have been found to promote positive health behaviors, improve perceptions, and build stronger social ties among residents [24, 25].

How can perceptions impact health?

Perceptions can influence how a person feels and their behaviors and attitudes. For example, a place perceived as lively, friendly, and safe can encourage a person to feel secure and participate in the activities, which can lead to healthy behaviors (e.g., physical activity) and attitudes (e.g., social inclusion) [24, 25]. Physical activity is important to overall health because of its protective effects against disease and disability [26]. A space perceived as dangerous or harmful can lead to avoidance of that space and higher stress [24]. Prolonged stress can lead to chronic illness, disability, and a lower overall quality of life [22, 23, 27]. Persons more sensitive to their perceived environment include youths, girls, older adults (elderly), and those with previous unpleasant experiences.

PREDICTED IMPACTS TO HEALTH

Before the HIA began, PBRM had already started renovating at the school. The list of potential renovation options changed as work progressed and issues at the school were investigated further. At the start of this HIA (October, 2012), PBRM was considering a list of proposed renovation options generated from three main investigative reports prepared by PBRM's contractors: the Industrial Hygiene Assessment [IHA], the HVAC Study [HVAC], and the Tunnel Leakage and Air Quality Study (Phase 1) [TLAQ]. EPA looked at each of these reports in detail and judged each of the renovation options for potential impacts to respiratory health, classroom acoustics, and community perception. Judgments were based on on-site observations, reviewed evidence, and professional expertise. The predicted impacts were characterized by direction, likelihood, magnitude, and distribution among building users. After reviewing the predicted impacts, EPA assigned each renovation option a relative value based on the potential to influence health.

It is expected that not all of the renovations may be selected and/or those selected may require phased implementation due to available funding, planning requirements, and other factors. In addition to health value, other factors that could be considered in the selection of renovation actions include first cost[1], operating cost (or savings)[2], ease of operation or maintenance[3], durability[4], and occupancy[5]. Renovation options considered to have a **high health value** were further prioritized into an order of implementation. The table below summarizes the predicted health impacts and the relative priority assigned to each of the proposed renovation options. High valued items are further grouped (in alphabetical order) to show recommended staging. *Please Note: relative values ranked 'high' correspond with the letter in our final HIA recommended recommendations framework on page 7.*

Source	Proposed Renovation Options	Respiratory Health	Classroom Acoustics	Community Perception	Relative Value
IHA	Eliminate water and accumulation of moisture from entering the building. Continue investigations into the source(s) of water infiltration, and implement necessary repairs and upgrades as needed.	▲▲▲▲ +	No Effect	▲▲▲▲ +	High (C)
IHA	Remove and discard porous building materials that have been wet for greater than 48-hours and not professionally dried and cleaned or show visible evidence of mold growth. Consider replacing removed materials with those not affected by water or moisture (i.e., ceramic tile flooring) in areas where water infiltration occurs.	▲▲▲▲ +	▼▼ -	▲▲▲▲ +	High (D)
IHA	Continue with efforts to evaluate the HVAC system to ensure proper design and distribution (i.e., flow, balancing, fresh air introduction, etc.) is in place.	▲▲▲▲ +	No Effect	No Effect	High (E)
HVAC	Re-evaluate optimal location for fresh air intakes of Building A, if appropriate, and swap intakes for Building B with exhausts.	▲▲▲▲ +	▲▲▲ +	▲▲▲	High (E)
HVAC	Repair/upgrade all air handling units and exhaust systems in Building B, including fresh air intake dampers, controls, and associated equipment for air handling units. Rebalance system after replacements/upgrades are implemented.	▲▲▲▲ +	▲▲▲ +	No Effect	High (B)

[1] *First cost* is the initial cost or funding required to complete the item.
[2] *Operating costs* is the costs (or savings earned) that will occur after implementation.
[3] *Ease of operation and maintenance* refers to the time and actions for operations or maintenance after implementation.
[4] *Durability* refers to how long the item is expected to last before it will need to be replaced or performed again.
[5] *Occupancy* refers to whether the action can be completed when the building is open (occupied) or closed (unoccupied).

Source	Proposed Renovation Options	Respiratory Health	Classroom Acoustics	Community Perception	Relative Value
HVAC	Install a new exhaust fan and duct system for Tunnel C to exhaust air from outer tunnel space to exterior of building.	▲▲▲▲ +	No Effect	▲▲▲	High (A)
HVAC	Seal outer Tunnel C completely off from the inner tunnel space, in order to prevent air from traveling between spaces.	▲▲▲▲ +	No Effect	▲▲▲	High (A)
HVAC	Contract a qualified, certified professional to test the indoor air quality.	No Effect	No Effect	No Effect	Low
HVAC	Contract a qualified, certified professional to test for Hazardous Materials (HAZMATs) prior to any demolition.	No Effect	No Effect	No Effect	Low
HVAC	Conduct an outdoor air quality test and wind study at different locations on school campus, including the current locations, to investigate optimal locations for air intake louvers, and relocate louvers to optimal location, if appropriate.	No Effect	No Effect	No Effect	Low
HVAC	Complete comprehensive HVAC replacement program, including replacement of all of the existing air handling units and their controls, expanding the Building Management System (BMS), exhaust and return fans, boilers, pipes, associated appurtenances (i.e., valves, dampers, controls, louvers, air separator, expansion tank, etc.), and modifications to some of the mechanical piping and ductwork.	▲▲▲▲ +	▲▲▲ +	▲▲▲▲ +	High (E)
HVAC	For Building B, replace and upgrade boilers, including associated appurtenances (e.g., flue, pumps, piping, ductwork, etc.) with higher efficiency, sealed combustion condensing type boilers.	No Effect	No Effect	No Effect	Low
TLAQ	For Buildings A and C, further investigate into the walls' interior construction and assess conditions and need for repairs, including seasonal monitoring of groundwater level, and replace stormwater pump stations, as needed.	▲▲▲▲+	No Effect	▲▲▲▲+	High (C)
TLAQ	For Building A, replace roofing membrane; install a waterproof membrane; install new drains, a sill pan and new door weather stripping for exposed east end of tunnel; isolate the new roof from the roof beneath the overpass; and repair concrete masonry unity (CMU) walls.	▲▲▲▲+	No Effect	▲▲▲▲+	High (C)

Table Legend

▲▲▲▲ = strong impact on many that would promote health, ▲▲▲ = moderate impact on some that would promote health, ▼▼ = small impact on some that would detract from health, **(+)** = sensitive or vulnerable groups would benefit more, **(-)** = disproportionate harm to groups more sensitive or vulnerable

FINAL RECOMMENDATIONS OF THE HIA

EPA developed recommendations, based on the predicted impacts to health, for the purposes of avoiding/mitigating potentially harmful impacts and maximizing potentially beneficial impacts. Recommendations ranged from simple additions to an already proposed action item, to a completely new and separate action item. For example, the building assessment yielded the finding of sites in the building enclosure where air leaked out of the building. This finding led to EPA adding a recommended action to seal the identified sites of air leaking from the building. Recommended actions were organized into a guidance framework so the recommendations could be easily interpreted and added to existing frameworks. The following table represents the recommended action items (i.e., those with high health values) for implementing renovations at Gerena. Items are to be completed in their entirety and in numerical order, within the assigned immediate-, near-, and long-term phase. The recommendations added by EPA are provided in *italics*. It should be noted that because the building was built before 1980, testing for hazardous materials must be performed by a certified professional prior to any demolition or disturbance of building materials.

HIA RECOMMENDED RENOVATIONS FRAMEWORK

Immediate Term Action Items (To be completed within 1 year)	***Added by EPA***	1. *Seal building enclosure air-tight at identified air leak sites in building enclosure, which includes:* - *Using approved weatherization materials and techniques to seal the identified cracks and openings. For examples, see the areas noted in the Turner Building Science & Design (TBS) report.*
	A	2. *Change the air flow between outer mechanical space and inner community space of Tunnel C so that the mechanical space becomes negative pressure relative to the community space, which includes:* - Installation of new exhaust fan and duct system for Tunnel C to exhaust air from outer tunnel space to exterior of building; and - Air sealing outer tunnel space completely off from inner tunnel space in order to prevent air from traveling between spaces.
	B	3. Inspect and repair every air handling unit (AHU) in Building B, to ensure that at least minimum delivery of outdoor air supply is reached, which includes: - *Repairing and adjusting the ventilation systems as identified in the EPA Indoor Air Quality Tools for Schools HVAC checklist. For example, repairing broken belts and air dampers that do not open, etc.; and* - Adjusting outdoor air supply ventilation component systems as needed.
	Added by EPA	4. *Provide increased cleaning of air conditioning drain pans, which includes:* - *Following EPA and industry guidance on cleaning and treating drain pans (EPA IAQ Tools for Schools Kit);* - *Ensuring drain pans drain properly; and* - *Enhance ease of access to air conditioning drain pans, filters, etc. for routine maintenance. For example, upgrading to latch system for doors.*
	Added by EPA	5. *Ensure consistent use of all checklists in EPA IAQ Tools for Schools kit, within one month of completing #3 and #4. Then, follow the recommended schedule to ensure proper continued operation (Gerena has been following EPA's IAQ Tools for Schools Kit checklists, but some improvements can be made).*
Near Term Action Items (To be completed within 2-3 years)	**C**	6. Implement *on-going program of waterproofing below-ground areas (tunnels), which includes*: - Replace roofing membrane and install new drains for exposed east end of Tunnel A (Building A). Isolate the new roof from the roof beneath the overpass; - Repair concrete masonry unit (CMU) walls, install a waterproof membrane, and install a sill pan in the opening and weather stripping around the door of Tunnel A; - Further investigate into the walls' interior construction and assess conditions and need for repairs of Tunnels A and C, including seasonal monitoring of groundwater levels; - *Sealing water leaks throughout the facility; and* - Replacing water pump stations in tunnels, as needed.
	D	7. Remove and discard porous building materials (e.g., carpet, furniture coverings, etc.) that have been damaged by water intrusion for longer than 48 hours and not professionally dried or cleaned (AFTER water intrusion is stopped), which includes: - *Following guidance from EPA IAQ Tools for Schools Kit checklists;* - *Extensive cleaning of building, including shelves, counters, floors, ceilings, walls, etc.; and* - *Replacement of discarded building materials with nonporous moisture resistant materials, only AFTER water intrusion is stopped.*
Long Term Action Items (To be completed after 3 years)	**E**	8. Complete redesign and replacement of HVAC systems, which includes: - *If changes in HVAC system, pollutant levels and/or pollutant sources are expected,* re-evaluate optimal locations of air intake louvers *and filters used through long-term air sampling (i.e., multi-seasonal).* Air sampling should include a wind study and monitoring of outdoor air pollutant levels, sources, and impacts on indoor air quality. If findings from longer air monitoring support the recommendation, relocate fresh air intakes from Building A to a more optimal location; - *Planning for future air movement throughout the facility;* - *Incorporate easy access doors for equipment in new HVAC design;* - Swapping the fresh air intakes for the five mechanical rooms in Building B with exhausts. - Replacing and upgrading all air handling units, exhaust systems (especially Chiller Room exhaust), and existing controls with high efficiency electronic-controlled models. This includes relocating thermostats to a location that provides more accurate temperature readings; - Replacing any damaged/missing equipment (e.g., diffusers, grilles, insulation, etc.) and install new security measures for building equipment external to building; - Extensive cleaning of any ductwork or materials *not being replaced within the next five years*; - Installation of a new energy management system (EMS) with local computer, communications network, equipment controllers, valve controllers, sensors, air flow and temperature monitors, etc.; - Installation of new security measures to prevent vandalism or damage of equipment outside facility; and - Rebalancing HVAC system after new installation.
	Added by EPA	9. *Rebuild and reopen community spaces once they are deemed safe for occupancy, which includes replacing corroded building systems components.*

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Chapter 1. Introduction

1.1. About Health Impact Assessment

The pursuit of more sustainable and healthy communities has steered public health professionals to encourage the use of more integrated approaches to address community challenges. Health impact assessment (HIA) is one of the many tools used to consider health in traditionally non-health focused decision-making. HIAs bring together an assortment of information from science-based research, community input, and professional expertise so that decision-makers have the best available evidence. The overarching purpose of all HIAs are to advocate for health and wellness regardless of the final decision.

HIA was developed based on the awareness that a variety of factors (internal and external to self) that can influence health and well-being and a more comprehensive approach was needed for decision-making (Centers for Disease Control and Prevention (CDC), 2009). In 1999, the World Health Organization (WHO) issued a paper that outlined the core concepts of HIA and specifically defined the process and elements included. A working group of HIA practitioners at the first North American Conference on HIA in 2008 developed a set of practice guidelines that defined the HIA Minimum Elements and Practice Standards for HIAs performed in North America. Those guidelines were later updated in 2010 and 2014 to capture the evolution of HIA practice. In 2011, the National Research Council (NRC) Committee on Health Impact Assessment released a report that further refined the definition of HIA as:

"A *systematic process that uses an array of data sources and analytic methods and considers input from stakeholders to determine the potential effects of a proposed policy, plan, program, or project on the health of a population and the distribution of the effects within the population; and provides recommendations on monitoring and managing those effects." (NRC, 2011)*

The HIA process consists of six steps─ screening, scoping, assessment, recommendations, reporting, and monitoring and evaluation (North American HIA Practice Standards Working Group, 2010; NRC, 2011; Human Impact Partners, 2011; 2012; Bhatia, 2011). A brief description of each step is provided in Table 1.

Table 1. HIA Step and Description

HIA Step	Description
Screening	Screening determines whether HIA is an appropriate approach to evaluate the pending decision, and whether the HIA will provide information useful to the stakeholders and decision-makers.

HIA Step	Description
Scoping	Scoping establishes the goals of the HIA, the scope of health impacts that will be included in the HIA, the population to be impacted, the group of people that will perform the HIA, and the sources of data and methods to be used.
Assessment	Assessment involves a two-step process that first describes the baseline health status of the population, and then assesses potential impacts that may result from the decision.
Recommendations	In the Recommendations step, actions or strategies are identified based on the assessment findings that will improve the decision or otherwise manage the health impacts, if any, to achieve protection or promotion of health and wellness.
Reporting	In the Reporting step, the results of the HIA process, including the findings and recommendations, are documented and presented to stakeholders, decision-makers, and the public. The Reporting step is completed when the HIA Final Report is made publically available.
Monitoring and Evaluation	The Monitoring and Evaluation step includes following up after the findings and recommendations of the HIA are reported and the decision has been made.

The Core Values (Guiding Principles) of HIA:

- ***A comprehensive approach to individual and community health issues***
- ***Equity in the opportunity for healthy living***
- ***Democracy in the decision-making process***
- ***Sustainable development for short-term and long term goals***
- ***Ethical use of evidence that includes transparent and rigorous methods***

1.2. About Gerena Community School

1.2.1. Historical Background

Before 1973, the North End Community of Springfield, Massachusetts (MA) was physically divided by the construction of Interstate 91 (I-91) and a railroad. Both the interstate and railroad tracks caused a physical barrier, making it difficult and dangerous for residents to travel from one side of the community to the other (Warwick & Sarno, 2013). At that time, the community was comprised of low-income, Latino residents. To help address some of the physical and social concerns facing the community, the City of Springfield (i.e., the City) built Gerena Community School (i.e., Gerena) to reconnect the community and provide needed services, including an elementary school and community center with language, adult education, and other programs and services. The school was named after Germán Gerena, a prominent community leader and the first Latino principal in Springfield, Massachusetts (Cameron, 2013).

1.2.2. Campus Layout

Because the school serves multiple purposes, the design of the facility is very complex. Figure 1 provides an aerial view of the campus layout, which consists of four buildings.

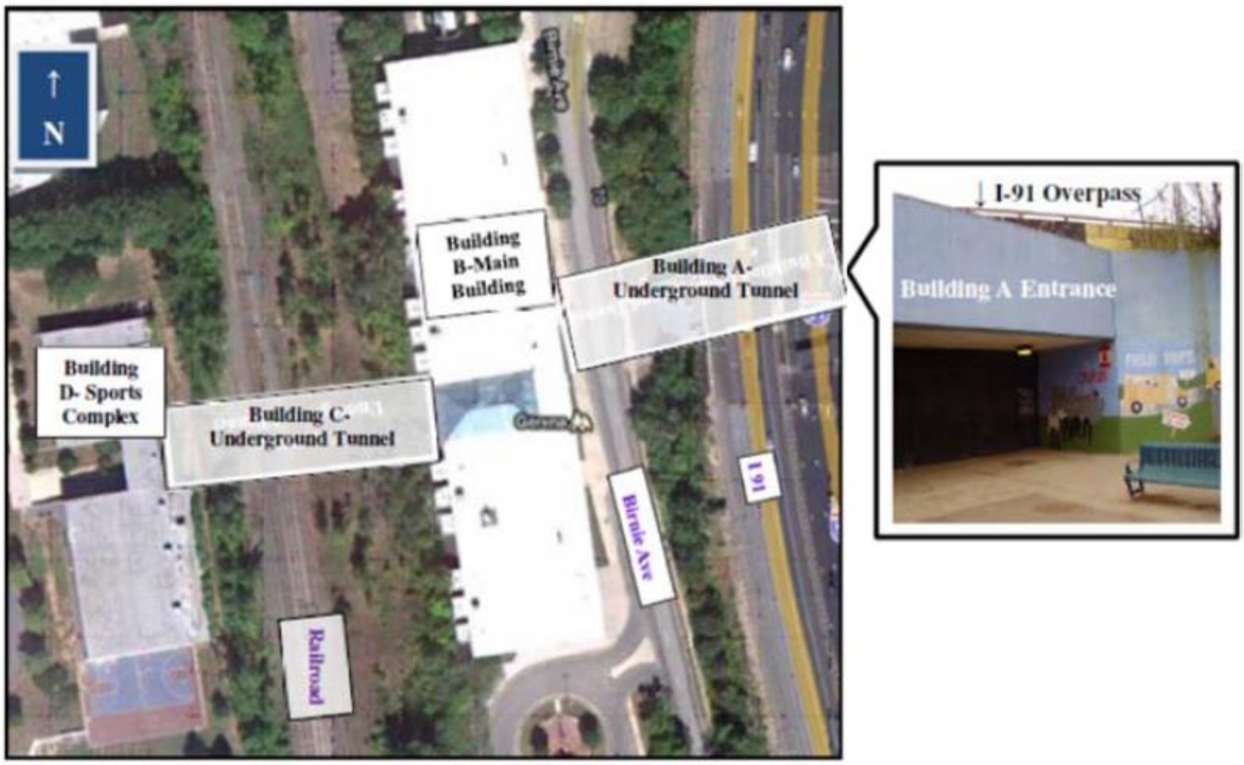

Figure 1. Aerial view of Gerena Community School (Source: image provided by the City of Springfield, 2013) and entrance to Building A (Source: picture taken by EPA staff, 2013).

The first building (i.e., Building A) is also an underground tunnel that sits below the I-91 overpass and Birnie Avenue. The entrance to Building A opens to Linda Park on Main Street, which connects to downtown. The west end of the tunnel connects to the east wall of Building B (i.e., Main Building). Building A houses empty community offices and spaces, that were closed in 2009 due to flooding and related issues, and the occupied WGBY office (a local public television station).

The Main Building is located between Birnie Avenue and the railroad tracks and has three levels. The lower (underground) level is open to the second level, and includes a community mall, with dental offices, a playground, and other community spaces, the school's cafeteria, and the first level of the auditorium. The second level houses the special education classroom, chiller and boiler rooms, upper part of the auditorium, nurse and administrator offices, music and math labs, language room, counselor's suite, and the media center/library. The third level houses most of the classrooms. The west wall of the Main Building is also attached to an underground tunnel (i.e., Building C), which runs underneath the railroad tracks to connect to the sports complex.

Building C (which lies entirely underground) houses community offices, which were closed due to flooding and related issues, and the Department of Recreation. Building C connects to the sports complex (i.e., Building D), which is located aboveground, across from Chestnut Accelerated Middle School. Inside Building D are the gym and pool, which are available for both student and public use. The underground tunnels are continuous and provide a walkway for the public and students to travel between the aboveground buildings and out to the surrounding neighborhoods.

Gerena's tunnels were built underneath a major expressway, railroad tracks, and interrupts an underground stream that supplies a constant source of groundwater (Massachusetts School Building Authority (MSBA), 2012). For these reasons, the facility was originally constructed with eight groundwater-pumping stations, each a pit and two large (30-40 horsepower) pumps that convey groundwater away from the facility. Figure 2 is of the two pumps, each of which were designed to handle the water intrusion load at that point, should the other pump fail.

Figure 2. The stormwater pump stations at Gerena Community School (photo by Mark Murray from a February 9, 2012 article in the Republican).

1.2.3. (Historical) Environmental Issues and Renovations

Over the years, Gerena has endured natural ageing and damage from storms, seismic activity, flooding (from internal and external causes), and vandalism. One of the most significant events that affected the building occurred in 1994, when a water main under Birnie Avenue broke and flooded the entire lower level of the Main Building and connected tunnels. There have also been smaller flood events due to stormwater coming into the building from adjacent streets and broken pipes. During events of heavy rainfall, water was seen coming into the tunnels through unplanned routes in the walls and ceiling (e.g., gaps in the wall joints, breakdown of the brick mortar, etc.), and up through the tunnel floors causing some intermittent and some continual damage to building materials and permitting mold growth. Figure 3 is an example of the damage to the tunnel areas caused by unplanned, incoming water in 2012.

Figure 3. Peeling wall paint and water-stained walls in the tunnel walkway (photo by Mark Murray from a February 9, 2012 article in the Republican).

In Springfield, MA, all public buildings and recreational facilities are managed and operated by the Department of Parks, Buildings and Recreation Management (PBRM). PBRM has performed ongoing renovations, repairs, and general maintenance to keep the facility operational for the community.[6] In 2010, MSBA performed a survey of schools across the state. This

[6] PBRM performed major repairs to the heating, ventilation, and air conditioning (HVAC) system in 1997 (following a major flood); installed new boilers in 2007; replaced rusted and pitted piping wherever found; installed a new roof and atrium skylight for the Main Building in 2011 (following major leaks); repaired and replaced the mortaring of the brick walls on the north and south side of Building B; and repaired and replaced parts for the sewage and groundwater pumps.

survey found that the conditions in Gerena's buildings were generally in good condition, but still had a few systems that may need alteration, replacement, and/or repair (MSBA, 2011).

The maintenance requirements for the facility have exceeded typical maintenance and repair costs performed at most of the other City buildings, costing several millions of dollars in recent years. The systems and equipment designed to manage incoming water are very expensive to maintain. The heating, ventilation and air conditioning (HVAC) systems have reached their expected lifespan and PBRM recommended having an on-site HVAC technician for Gerena. In addition, PBRM hired a team to monitor the district's HVAC systems and perform quarterly maintenance. The HVAC system is obsolete, meaning broken parts have to be special ordered or made by hand, which increases the repair costs. PBRM has had to seek both federal and state funds in addition to the annual maintenance budget to address issues at Gerena.

1.2.4. Future Plans for the Facility

Based on a limited review of social media and news articles, the opinion of community residents appears mixed regarding plans for the school. Some of the options expressed in interviews by WGBY (a local public television station) included closing Gerena, replacing the facility, or continue renovating the buildings. Closing the school would require students to be bussed elsewhere and eliminate the many public amenities provided by the facility that would otherwise be absent from this neighborhood. Many residents are resistant to closing the school, but do not want the current conditions to persist any longer (Warwick & Sarno, 2013; Kraft, 2012; Roman, 2012). Replacing the school would require many years and millions of dollars for planning and construction. Representative Cheryl Coakley-Rivera estimated, based on current costs in 2013, that replacing the school would require $30 million and ten years for planning and construction (Coakley-Rivera, Rolden, & Owens, 2013). Rebuilding would also require relocating the school to a different site, once again leaving the community physically divided. In the event that the City decides to construct a new school, Gerena would still need to continue operating until the new school is completed. Continuing to maintain and renovate the school would still be costly. Regardless, PBRM's primary objective for Gerena is to ensure a healthy and safe building for the community, staff, and students, and plans to continue renovating the facility.

Chapter 2. The Screening Step

Screening is the initial step of the HIA process in which the decision to perform an HIA is made. Stakeholders decide whether performing an HIA would add value to the decision and/or decision-making process, if there are enough resources available (e.g., personnel, funding, scientific tools, etc.) to perform the HIA, and if there is enough time for the recommendations to be considered before the decision is made. Not all screening steps result in completed HIAs (i.e., practitioners may decide to not perform an HIA). This chapter documents the activities and results of the screening step.

2.1. Overview of the Screening Step

The U.S. Environmental Protection Agency (EPA) is assessing the value of using the HIA process as a decision-support tool. Staff in EPA's Region 1 (New England) office and Office of Research and Development (ORD) performed the Screening step, with input from PBRM. The Screening step progressed over six months, from April 2012 to October 2012. Figure 4

Figure 4. Timeline of activities performed in the Screening step.

outlines the screening activities performed and the timeline in which they took place. The last two activities (with red flags) are also considered Reporting activities.

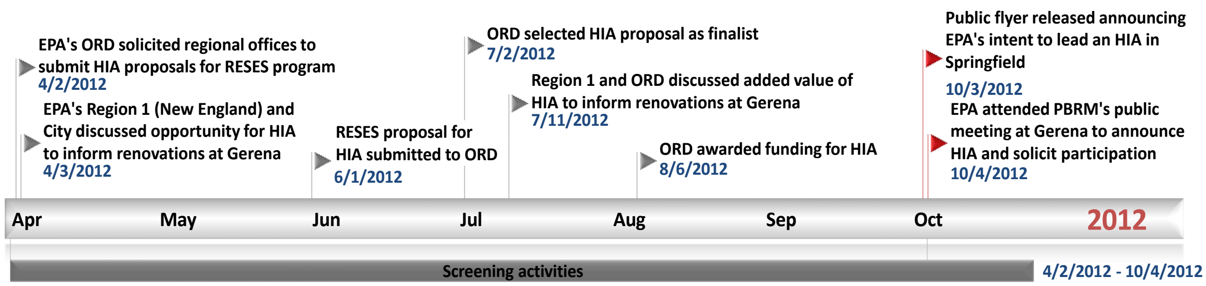

Figure 4. Timeline of activities performed in the Screening step.

On October 4, 2012, PBRM hosted a meeting at the school to discuss the on-going efforts to improve Gerena and the next steps forward. Representatives from EPA's regional office attended the meeting and announced the intention to lead an HIA at Gerena. Refer to Appendix A for notes from this meeting.

2.2. Considerations for Performing an HIA

2.2.1. Opportunity for Collaboration

Prior to this HIA, EPA has provided funding and technical assistance for several projects in the Springfield, MA area for addressing indoor air quality and other environmental concerns, strengthening communities, and performing environmental research. These efforts helped develop a close partnership between the regional office and the City.

Before April 2012, staff in ORD's Sustainable and Healthy Communities (SHC) research program met with staff in EPA's Region 1 (New England) office in Boston, MA to discuss collaborative opportunities between the two offices for developing EPA's science, tools, and expertise to support communities' environmental health-related decisions. One topic of discussion between these groups was the environmental issues and renovation plans at Gerena.

In April 2012, ORD sent a memo to each of the Agency's ten regional offices inviting them to submit project proposals for funding through the Regional Sustainable Environmental Science (RESES) program. The focus of EPA's RESES program is on forming "regional research partnerships to enable effective, efficient, and socially responsible solutions to commonly-faced resource sustainability problems" and demonstrate the application of a collaborative, community-based approach to a regional environmental issue (EPA, 2013). ORD is assessing the value of using HIA as a decision-support tool to promote sustainable and healthy communities, was looking for an opportunity to demonstrate its use, and announced, in the invitation, that proposals to perform an HIA would be given higher priority status as a nation-wide group of HIA case studies led by EPA.

Staff in Region 1 (New England) met with PBRM to discuss the opportunity to conduct an HIA at Gerena— to which PBRM welcomed and agreed to participate. Those individuals then met with others in SHC and the National Exposure Research Laboratory (NERL) to discuss whether an HIA would be appropriate. The HIA process was the only approach considered for this project and staff quickly made the decision to move forward with the HIA. Together, those individuals developed the RESES proposal for the HIA and submitted it in April 2012, as the HIA Project Leads. Appendix B contains the RESES proposal submitted to ORD.

2.2.2. Decision Timeline

In April 2012, PBRM requested assistance from EPA to help determine which renovations would provide the greatest benefits to health, considering total costs and benefits. Considering renovation activities were ongoing, this HIA would progress in concert with the renovation planning process. EPA identified several possible points in PBRM's planning process that an HIA could provide valuable information. For example, PBRM could use the interests and/or concerns identified by stakeholders during the Scoping step to decide which renovations should be made a priority in the upcoming budget year or show the community how those items were addressed. Table 2 identifies those points in which the HIA was intended to influence the decision.

Table 2. Points of Influence for the HIA in the Decision Timeline

Decision Timeline	HIA's Potential Influence
(Summer/Fall) PBRM contractors investigate building issues and recommend proposed renovations.	The Screening step of the HIA would provide a platform for PBRM and EPA to discuss interests and/or concerns about the environmental conditions inside Gerena and identify opportunities to align research goals.
(Fall/Winter 2012) PBRM begins planning phase for funding short-term renovation options and submits the proposed budget to the City's Office of Management and Budget.	PBRM could use the identified community stakeholder interests and/or concerns gained from the scoping process to focus remediation planning and inform stakeholders which items that have already been addressed.
(Winter/Spring 2013) PBRM meets with the Mayor and Office of Management and Budget to discuss and finalize the proposed budget that will be presented to City Council.	PBRM could leverage the evidence gained from the assessment to promote the beneficial renovations and include mitigation strategies for those renovations with potential harmful effects. PBRM could also use the evidence gained to help inform the community on the issues addressed to improve building conditions and plans to address unresolved issues.
(Spring/Summer 2013) City Council reviews the budget and if approved, disperses funds to the departments.	PBRM could leverage the HIA recommendations to inform the City Council's and Mayor's decision on approving funding for renovations.
(Summer 2013) PBRM performs short-term renovations and continues planning for long-term renovations.	PBRM could use the HIA recommendations as a checklist when implementing short-term renovations and planning for long-term renovations.
(post-Fall 2013) PBRM provides updates to stakeholders on the progress of renovations at Gerena.	Stakeholders could refer to the HIA final report to track how their input was used in the HIA. Stakeholders can follow-up on how the information gained from the HIA was used and whether the HIA recommendations were adopted.

Unforeseen circumstances caused the HIA to exceed the original intended decision timeframe. The first two points of influence were able to influence the decision as intended. The authors provide further discussion related to this challenge in section 7.2.1.

2.2.3. Potential for Decision to Affect Health

EPA leads several environmental and public health initiatives in Springfield, MA related to environmental justice (EJ)[7] or the "degree of protection from environmental and health hazards and access to the decision-making process." For example, EPA is providing support to the City of Springfield and Pioneer Valley Asthma Coalition, through the Community Action for a Renewed Environment (CARE) grant program, to help reduce asthma severity in the area. Springfield is one of Massachusetts top five hotspots for high pediatric asthma rates. EPA is also providing technical assistance to help evaluate indoor air quality and energy efficiency in the City's schools and developing improvement strategies. PBRM is especially interested in determining the quality of the indoor air and opportunities for improvement at Gerena.

Asthma is a particular concern at Gerena. In 2009, school nurses reported that 24.7% of the 710 students had physician-diagnosed asthma at Gerena, which was significantly higher than the state average of 10.9% (Massachusetts Department of Public Health (MA DPH), 2012). Thus, a significant portion of the student body are more sensitive (i.e., vulnerable) to the quality of the indoor air. An HIA would bring value to the decision-making process by providing information on the distribution of potential health impacts, specifically the extent to which each of the planned renovations would affect students with asthma. Considering the distribution of health effects among the population using Gerena and taking measures to avoid an undue burden of adverse health effects among vulnerable populations also promotes health equity or the equal opportunity for health and wellness.

Considering the many amenities Gerena provides to students and the surrounding population, the potential for renovations to affect the health of all users is very likely. Gerena's tunnels provide a safe and covered walking corridor for the public traveling through the neighborhood. The sports complex, which is accessible to both students and the public, is a valuable source for physical activity. The community spaces and offices in the tunnels provide space for residents to

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[7] An area with a disproportionate burden of environmental hazards and high presence of low income and/or minority populations are focus areas for environmental justice.

build social bonds, skills, and seek other services. Changes to the indoor environment at Gerena is likely to affect persons that rely heavily on Gerena's many amenities or use the building frequently. An HIA would bring value to the decision-making process by evaluating the potential health impacts of each of the planned renovations from a comprehensive public health perspective.

2.2.4. HIA Goals

The HIA Project leads drew from the needs of PBRM, EPA, and community residents to identify goals the HIA should achieve. The HIA goals included:

- Present a set of recommendations to be considered in the decision-making that would maximize potential benefits to health and avoid and/or mitigate potential harmful impacts of implementing the proposed renovations.
- Deliver a fully developed HIA that examines health and environmental impacts of the proposed school renovation options being considered.
- Provide educational materials that are context-specific and science-based to the community and other stakeholders regarding air pollution and ways to mitigate asthma triggers.
- Use tools and approaches to conduct the HIA that will generate lessons learned and best practices for implementing HIA by a federal agency.

2.2.5. Resources Available

In July 2012, ORD selected the HIA as one of six finalists across the nation. One of the requirements for the funding vehicle included outlining plans for any anticipated new data collection and resources needed to complete the project. Considering the impetus for the HIA and the majority of proposed renovations related to indoor air quality, the HIA Project leads identified two approaches that could be used to inform the assessment of health impacts: collecting site-specific data on indoor air pollutants, mold, moisture, and health data (if accessible); and performing broader outdoor air monitoring. The HIA Project Leads agreed that the community stakeholders would ultimately determine the specific study questions and health impacts appraised in the assessment. The funding, methods, and personnel available to perform each analysis would determine the final selection of methods.

EPA would provide the staff, expertise, scientific tools, to accomplish the HIA activities. Stakeholder participation would be obtained through the partnerships formed from previous work in the area. Staff in the regional office and a full-time Fellow from the Association of Schools of Public Health (ASPH) would provide the support for convening stakeholders and serve as the primary vehicle for communicating with stakeholders outside EPA. In addition, EPA would contract technical support to assist in convening stakeholders, collecting and analyzing data, and documenting HIA activities. The CDC, through a cooperative agreement with EPA, would provide funding for an HIA advisor from the National Network of Public Health Institutes. ORD awarded funding for the HIA in August 2012.

2.3. The Proposed Renovations

PBRM led several technical investigations to identify the sources for water intrusion and air quality issues in the facility and to develop short-term and long-term solutions. In Spring 2012, PBRM contracted Timothy Murphy Architects to investigate water leakage and air quality in Buildings A and C. Simpson, Gumpertz and Heger performed the water leakage investigation in concert with RDK Engineers' investigation of the HVAC and other mechanical systems (e.g., electric, plumbing, energy conservation, etc.) at Gerena. In June 2012, O'Reilly, Talbot and Okun Engineering Associates also performed an industrial hygiene assessment at Gerena at the request of the City of Springfield as part of a city-wide indoor air quality program.

While the HIA progressed, PBRM continued to further investigate issues and implement some of the immediate actions (e.g., resurfacing the floor in Building C and installing security doors). Refer to Appendix C for the full list of investigation reports reviewed and renovations considered at the start of this HIA. The following is a list of the proposed renovations used as the HIA decision alternatives taken from PBRM's technical investigations at Gerena.

1. **Eliminate water and accumulation of moisture from entering the building. Continue investigations in the source(s) of water infiltration, and implement necessary repairs and upgrades as needed. This option includes corrective actions to both Buildings A and C.**
2. **Remove and discard porous building materials that have been wet for greater than 48-hours and not professionally dried and cleaned or show visible evidence of mold growth. Consider replacing removed materials with those not affected by water or moisture (i.e., ceramic tile flooring) in areas where water infiltration occurs.**
3. **Continue with efforts to evaluate the HVAC system to ensure proper design and distribution (i.e., flow, balancing, fresh air introduction, etc.) is in place.**
4. **Re-evaluate optimal location for fresh air intakes of Building A, if appropriate, and swap intakes for Building B with exhausts.**
5. **Repair/upgrade all air handling units (AHUs) and exhaust systems in Building B, including fresh air intake dampers, controls, and associated equipment for air handling units. Rebalance system after replacements/upgrades are implemented.**
6. **Install a new exhaust fan and duct system for Building C to exhaust air from outer tunnel space to exterior of building.**

7. **Seal the outer tunnel in Building C completely off from the inner tunnel space, in order to prevent air from traveling between spaces.**
8. **Contract a qualified, certified professional to test the indoor air quality.**
9. **Contract a qualified, certified professional to test for hazardous materials (HAZMATs) prior to any demolition.**
10. **Conduct an outdoor air quality test and wind study at different locations on school campus, including the current locations, to investigate optimal locations for air intake louvers, and relocate louvers to optimal location, if appropriate.**
11. **Complete comprehensive HVAC replacement program, including replacement of all of the existing air handling units and their controls, expanding the Building Management Systems, exhaust and return fans, boilers, pipes, associated appurtenances (i.e., valves, dampers, controls, louvers, air separator, expansion tank, etc.), and modifications to some of the mechanical piping and ductwork.**
12. **For Building B, replace and upgrade boilers, including associated appurtenances (e.g., flue, pumps, piping, ductwork, etc.) with higher efficiency, sealed combustion condensing type boilers.**
13. **For Buildings A and C, further investigate into the walls' interior construction and assess conditions and need for repairs, including seasonal monitoring of groundwater level, and replace stormwater pump stations, as needed.**
14. **For Building A, replace roofing membrane; install a waterproof membrane; install new drains, a sill pan and new door weather stripping for exposed east end of tunnel; isolate the new roof from the roof beneath the overpass; and repair concrete masonry unit walls.**

This list represents a "snap-shot" in time, specifically at the start of the HIA in fall 2012. It is important to note that PBRM completed #12 (upgrading boilers) during the course of the HIA; items #3 and #8 (regarding evaluation of the indoor air and HVAC performance) were completed in part as a component of the HIA analyses; item #9 is required due to the building's age and is already incorporated into all demolition/renovation activities at Gerena; and items #1, #2, and #13 (related to investigating incoming water) were performed and/or were in progress during the HIA process.

Chapter 3. Setting the Scope

The purpose of the scoping step is to plan the assessment. Activities involved in scoping include: establishing the goals of the HIA; determining the individuals/team that will perform the HIA and their roles; developing a plan for engaging and communicating with stakeholders; defining the breadth of health impacts included in the assessment; identifying the population and vulnerable sub-groups that might be effected; and determining the HIA research questions, data sources and analytical methods used to answer the research questions.

3.1. Overview of the Scoping Step

The Scoping activities progressed over five months from October 2012 to March 2013. The Scoping activities grew from the Screening activities to establish the HIA Core Group, the stakeholder engagement and communications plan, and the assessment plan. There were numerous team meetings to discuss and finalize the assessment plan (i.e., specific tasks related to data collection and analysis). Figure 5 outlines the scoping activities and the timeline when they took place. Items with red flags are also considered Reporting activities.

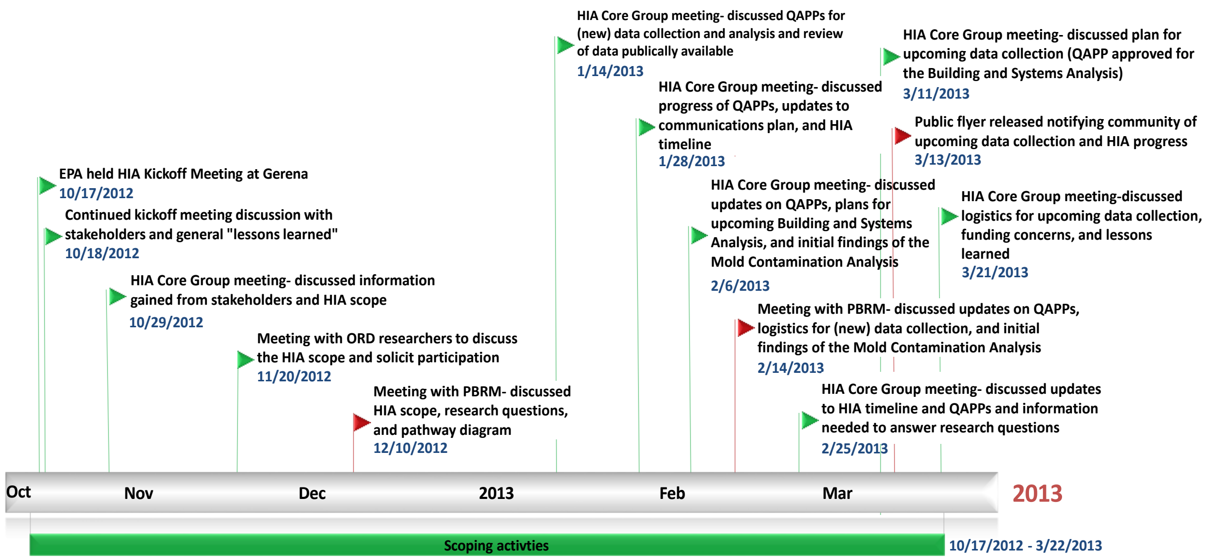

Figure 5. Timeline of activities performed in the Scoping step.

3.2. Establishing the HIA Team and Roles

3.2.1. HIA Project Leads and Technical Leads

The funding vehicle (i.e., RESES research program) requires members of ORD and the regional office partner to lead the project. The authors of the RESES proposal fulfilled the role of HIA

Project Leads. HIA Project Leads were tasked with performing numerous duties that included (but were not limited to) acquiring funding for this HIA, directing HIA activities, leading group discussions, and making final decisions regarding the direction of the process. Marybeth Smuts from the Office of Ecosystem Protection (OEP) and George Frantz from the Office of Environmental Stewardship (OES) served as the regional partners for the HIA. Valerie Zartarian and Florence Fulk from NERL served as the ORD partners for the HIA.

In addition to the HIA Project Leads, there were also EPA Technical Leads that managed the procedural aspects of the HIA. Responsibilities of the Technical Leads included (but were not limited to) supervising and/or performing tasks related to data collection and analysis, developing the Quality Assurance Project Plan (QAPP) (if needed), securing and managing contracts with entities outside EPA, providing the final synopsis of the data analyzed, and managing work products and their translation into the HIA Report. EPA's Technical Leads had expertise in HIA, exposures contributing to pediatric asthma, indoor environments related to indoor air quality, mold, moisture, building design and mechanical systems, and outdoor air quality.

In addition to EPA Technical Leads, the CDC (through a collaborative agreement with the National Network of Public Health Institutes) provided a funding vehicle for an HIA Advisor from the Oregon Public Health Institute (OPHI). OPHI conducts HIAs and provides expertise and training sessions to those wanting to conduct HIAs through its HIA Initiative Program.

3.2.2. HIA Core Group

The team established to perform the HIA included a core group of EPA staff and contractors. The HIA Core Group included the HIA Project Leads, EPA Technical Leads, a full-time ASPH Fellow, and a NERL contractor from CSS-Dynamac. EPA secured additional technical support for data collection and analysis through contracts with ARCADIS and Turner Group.

Some of the individuals involved at the start of this HIA were unable to participate through project completion, because the timing of this HIA far exceeded the original planned timeline. In addition, the HIA Project Leads were unable to secure a graduate student vehicle to perform the outdoor air monitoring and source analysis.

Members of the HIA Core Group were selected based on their professional expertise, ability to fulfill the duties needed, and ability to commit time to the HIA. Each member served in one or more roles as described in Table 3.

Table 3. HIA Roles and Responsibilities

HIA Role	Responsibilities
Investigator/ Researcher	Participated in developing and leading investigations that supported the HIA, including collecting, analyzing, synthesizing, and interpreting data.
EPA Contractor/ Technical Support	Performed specific tasks that supported the development and progress of the HIA, including data collection and management, scheduling and documenting meetings, and conducting research.
HIA Project Lead	Acquired funding for HIA activities, directed HIA activities, led group discussions, and made final decisions regarding the direction of the process.
Communications Specialist/ Coordinator	Communicated with stakeholders and prepared and distributed communications materials, including factsheets, public meeting notifications, and reports.
Technical Writer/ Editor	Reviewed and edited communications materials and final products of the HIA.
EPA Technical Lead	Advised on technical aspects of investigations, evaluated the information obtained, developed recommendations for the HIA, supervised tasks performed, prepared QAPPs, and ensured tasks performed met quality assurance and standard operating procedures.
HIA Advisor	Advised on HIA best practices, steps in the HIA process, and strategies to achieve the minimum elements and practice standards for HIA.

3.2.3. HIA Partners (Stakeholder Engagement)

A stakeholder is any group or individual that may be affected by the decision and/or has an invested interest in the decision's outcome. Stakeholder engagement is essential to the success of an HIA and a core part of the process. There are different levels of stakeholder participation in the HIA process, ranging from appraisal of the HIA's progress (i.e., no direct participation) to being directly involved in the HIA decision-making and/or leading the HIA itself. There is no single, best approach for engaging stakeholders, because each HIA can have unique conditions regarding populations impacted and/or the decision-making process. The different stakeholder groups, such as community residents, decision-makers, and representatives that advocate for special interests and/or populations affected, may serve in different HIA roles, but operate as the HIA Partners.

EPA, the lead organization for the HIA, partnered with CDC to acquire an HIA Advisor. PBRM served as a vital partner to EPA, providing technical expertise, access to the school and data, and input for HIA activities and products. The Massachusetts Department of Environmental

Protection (MA DEP), MA DPH, and Springfield Public Schools also were valuable partners, providing access to data and input that informed decision-making within the HIA. The Pioneer Valley Asthma Coalition was a valuable partner in soliciting and obtaining community participation.

Communications Plan

At the beginning of the Scoping step, the HIA Core Group established a communications plan to manage the flow of information between the various entities. A communications plan is a list of activities, resources, and contacts that provides a roadmap for transferring information. The HIA Core Group chose to use factsheets, PowerPoint presentations, and public notice flyers as the primary method of communicating information about the HIA's progress and findings. For each communications piece, the team identified a target audience, date of distribution, and responsible entities. Appendix D documents the original communications plan for this HIA.

The Communications Specialist/Coordinator would coordinate all information released to the public, including factsheets, flyers, and presentations. For example, the HIA Core Group released a public flyer in March 2013, announcing upcoming data collection and the HIA's progress. Appendix E provides the documentation of the communications materials- except for the Executive Summary of Findings, which is at the beginning of this report.

3.2.4. External Stakeholder Group

The HIA Core Group established the External Stakeholder Group (i.e., stakeholders outside the EPA), which served as the primary route for stakeholder engagement in the HIA. The Communications Specialist/Coordinator identified a list of stakeholders and contacted them to participate in the HIA, via email, phone, and mail. Table 4 lists the twenty-eight stakeholder organizations and/or entities invited to participate in the HIA.

It is important to note that stakeholder participation in this HIA was voluntary. The input provided in this report represents the view/opinions of those who attended the HIA meetings, which may or may not be representative of all stakeholders. The organizations and/or entities that participated in the HIA stakeholder meetings are those that were documented in the sign-in sheets or roll call. Some individuals may have belonged to more than one group. Groups not indicated by the participant were not documented.

Table 4. List of Invited Stakeholders that Participated in the HIA

Stakeholders Invited to Participate in HIA	HIA Participant
Arise for Social Justice	Yes
Baystate High St. Health Center, Pediatrics	No
Brightwood Community Residents	Yes
Children's House (Daycare Center)	No
Gerena Community School, Principal Dianne Gagnon	Yes
Gerena Parent Teacher Organization	Yes
Gerena School Nurse	Yes
Healthy School's Network, Inc.	No
MA DEP, Western Regional Office	Yes
MA DPH, Western Regional Office	Yes
Massachusetts State Representative- 10th District	No
Neighbor to Neighbor	No
New North Citizen's Council	No
New North Child Care (Daycare Center)	No
New North Community Center	No
North End Organizing Network	No
Partners for a Healthier Community	No
Pioneer Valley Asthma Coalition	Yes
Playful Minds (Afterschool Program)	No
Springfield City Council (Ward 1 Representative)	No
Springfield Department of Health and Human Services	No
Springfield PBRM	Yes
Springfield Education Association	Yes
Springfield Public Schools	Yes
Springfield Public School Committee	No
Local United Food and Commercial Workers Union	No
Voices of the Community (Voices De La Communidad)	Yes
WGBY (local public television station)	No

Plan for Stakeholder Engagement

Several meetings were planned between the HIA stakeholders at various milestones in the HIA. Staff in EPA's regional office took the lead on convening and communicating with individual stakeholders. The purpose of engaging stakeholders was to discuss progress of the HIA, solicit feedback, and ensure the HIA was responsive to stakeholder needs. Input from the External

Stakeholder Group was used to directly shape the HIA scope and reporting processes. This approach allowed stakeholders to influence the direction of the HIA, but the HIA Core Group retained the authority to make specific decisions regarding the assessment and recommendations. Table 5 outlines the plan for engaging stakeholders, developed by the HIA Core Group.

Table 5. Stakeholder Engagement Plan

HIA Step	Stakeholder Engagement Activities (Planned)
Screening	• Consult with stakeholders and determine added value of HIA • Site visit= attend PBRM's public meeting to announce future HIA
Scoping	• Site visit= hold public HIA Kickoff Meeting with stakeholders to develop HIA scope and assessment plan • Communicate assessment plan to PBRM and then External Stakeholder Group
Assessment	• Touch base with partners regarding data collection and analysis • Site visit= perform mold contamination sampling • Site visit= perform building and systems evaluation • Site visit= perform indoor air sampling • Communicate preliminary HIA findings to PBRM and then External Stakeholder Group
Recommendations	• Site visit= meet with PBRM and then External Stakeholder Group (public meeting) to discuss preliminary HIA recommendations
Reporting	• Report final results of the HIA to PBRM and then External Stakeholder Group • Site visit= meet with PBRM and then External Stakeholder Group (public meeting) to discuss Draft HIA report and Executive Summary
Monitoring and Evaluation	• Follow-up on conditions in Gerena and evaluate HIA after some of the renovations are implemented

It is important to note that the public meetings after the initial HIA Kickoff meeting were not achieved. The HIA Core Group were able to meet periodically with PBRM to ensure the HIA stayed relevant and responsive to the needs of the decision-makers.

3.2.5. Ensuring Equity in Stakeholder Engagement

A key component of the HIA process is to ensure that all stakeholders have equal opportunity to be involved in the HIA. In order to ensure stakeholders had equal opportunity, the HIA Core Group used different strategies to solicit participation, including:

- Hosting community meetings at the school at different times during the day for stakeholder convenience;
- Inviting stakeholders to HIA meetings via printed flyers in the community, personal phone calls, and email;
- Notifying stakeholders of opportunities for participation in HIA at other project and organization meetings; and
- Written invitations in both English and Spanish and hiring a Spanish translator for community meetings to avoid potential language barriers.

3.3. HIA Quality Assurance and Evaluation Plan

Prior to conducting this HIA, EPA conducted a review of over 80 existing HIAs to determine the current state-of-science and to identify best practices and areas for improving HIA implementation (Rhodus, Fulk, Autrey, O'Shea, & Roth, 2013). The HIA Core Group used EPA's review and other HIA practice guidance documents to guide the development of this HIA. The *Minimum Elements and Practice Standards for Health Impact Assessment* (North American HIA Practice Standards Working Group, 2010) served as the benchmarks for HIA tasks.

Once completed, the HIA would be evaluated through an external review among peers in HIA and internal environments. The evaluation of the HIA process determines whether the methods used in the HIA were appropriate, how well the HIA was implemented as planned, and whether the HIA provided the anticipated benefit. EPA's review coordinator was responsible for identifying and selecting potential peer-review candidates. The HIA Core Group provided a list of potential sources for the review coordinator to seek out candidates to perform the review. Three reviewers outside the project, and removed from the decision, were secured to provide a critical evaluation of the HIA process. The reviewers included two HIA practitioners and one expert in the field of building systems and indoor air quality.

As a supplement to the peer-review, the HIA Core Group would provide an internal perspective on the successes, challenges, and lessons learned from performing the HIA. The HIA Project Leads established criteria for judging the HIA a success in the RESES proposal. The primary standard for success was that the HIA influenced the actions taken to improve air quality at Gerena, with the expectations that those actions would reduce asthma. The second standard was that the range of audiences, from community residents to school building authorities, would understand the reasons for the remediation decisions. If the HIA achieved these two goals then the HIA Core Group considered the HIA a success.

3.4. HIA Study Area

Gerena is located northwest of downtown Springfield, Massachusetts. According to school officials, most of the children and residents who use Gerena Community School live within a half-mile, walking distance from the school. Figure 6 displays a half-mile radius around the school, which represents the study area. This area intersects three Census tracts 8006, 8007, and 8008, which have been used historically to represent the community of North End (Spanish American Union Inc., 2006). Based on the renovations proposed, the population that would be most impacted included Gerena students, staff, and residents that live within the community of North End.

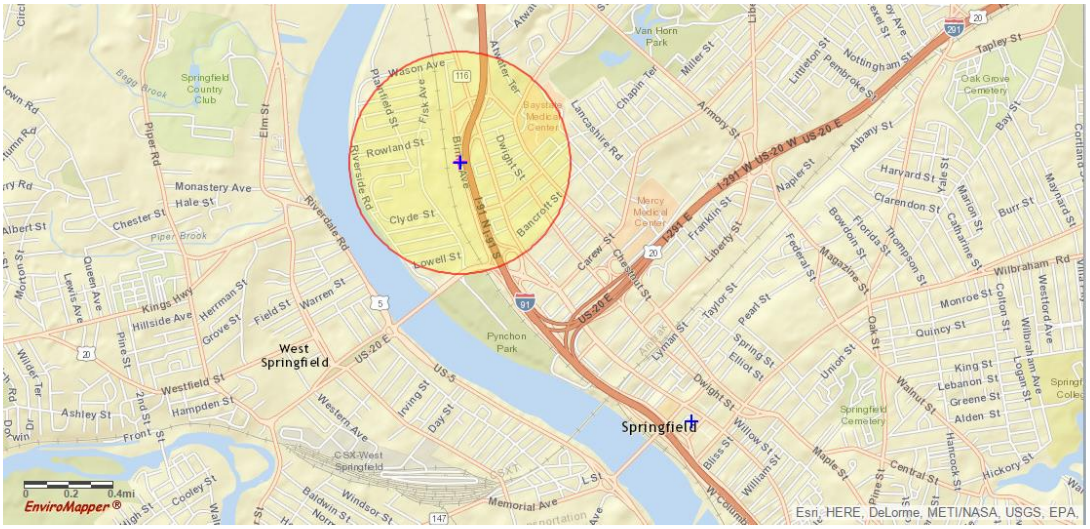

Figure 6. A screen snap-shot, from EPA's EJScreen, of the location of Gerena (i.e., represented with blue cross at the center of the half-mile buffer).


Approximately one-sixth of the student body (n=109 students) use the three school buses that serve Gerena, which travel up to a mile and a half from the school (i.e., Census tracts 8005 and 8009). Census data showed that the population in the two additional tracts had vastly different demographic and socioeconomic conditions compared to population immediately around the school. The HIA Core Group decided not to include the additional tracts in the HIA study area, because they would misrepresent the population that would be most impacted by changes inside Gerena.

3.5. Health Impacts Included

3.5.1. Interests and/or Concerns Identified by Stakeholders

On October 17, 2012, the HIA Core Group initiated the Scoping step with a kickoff meeting at Gerena. The discussions continued the next day to further define and/or refine the topics of interest and/or concern. Appendix A documents the notes from those meetings.

The HIA Core Group used the HIA Kickoff Meeting in October 2012 to gather historic experiences and observations at Gerena from among residents, parents, and school staff. It was clear from the discussion that stakeholders were very concerned about the quality of the learning environment at Gerena. The main concern regarded indoor air quality and respiratory health of students and other Gerena occupants. The perception of the school's condition was believed to be an influential factor in the student absenteeism (i.e., days away from school) and in the use of the facility by the community. Even though student attendance has improved over the past couple of years, one parent at the meeting referred to the perceived poor air as a common reason for keeping their student home. A parent at the meeting raised the issue that the school's underperformance might be related to inability to concentrate from the poor air quality.

Additional issues raised by community residents included: classroom noise, particularly for students with behavioral disorders (e.g., attention deficit hyperactivity disorder) and accessibility for public users. One resident explained that the closure of the tunnels at night and during the weekend limited resident travel through the neighborhood. One resident stated at the meeting, "Closing the community center under the school presented a major issue for parents and community residents as well as several community organizations." The community center and offices provided a safe space for children to play and the community to come together for social events, organizations, and other services. Overall, the poor condition of the tunnels gave the community an impression that the whole school was in disrepair, especially among those who only use the building for the tunnels. Stakeholders at the meeting agreed that they wanted to see Gerena used more by the community. Stakeholders urged the HIA Core Group to consider the positive impact re-opening this space would have on the community.

The HIA Core Group asked the stakeholders at the meeting to rank the identified interests and/or concerns as either high or low. This activity provided insight into which health issues should be the focus of the HIA. The higher priority items reflected the amount of time spent discussing impacts related to indoor air quality, especially among persons more vulnerable to poor air quality (e.g., persons with asthma). Table 6 lists the prioritized interests and/or concerns discussed at the stakeholder meetings.

Table 6. Prioritized Interests and/or Concerns Identified by Stakeholders

Higher Priority Concerns	Lower Priority Concerns
• Air quality • Mold • Levels of air pollutants in the school (e.g., particulate matter) • Asthma • Condition of carpet and its impact on air quality • Perception of physical conditions of the school and its influence on facility use • Unequal impact on vulnerable populations (socio-economically disadvantaged, the young and the elderly, and those with pre-existing conditions)	• Absenteeism • Classroom noise

The discussion that continued on the next day covered the equipment conditions, cost of replacing the school versus renovating the school, indoor air monitoring, noise-reduction equipment, and air quality in the building. The main consensus was that the HIA needed to address the following:

1) **Air Quality**– characterization of key outdoor and indoor air pollutants and how they affect indoor air quality at Gerena; recommendations will relate to the HVAC systems and sewage and water pumps.
2) **Respiratory Health**– recommendations to mitigate asthma exacerbation at school by either reducing moisture and water infiltration or improving indoor air quality.
3) **Classroom Noise Levels**– recommendations to improve classroom acoustics through policy or management recommendations.
4) **Community Perceptions**– characterization of community perceptions related to conditions at the school and a better understanding of the efforts to improve the school and promote health.
5) **Facility Use**– identification of perceived facility conditions and opportunity for improved facility use.

3.5.2. HIA Study Questions

Once the HIA's main topics were defined, initial research questions were developed. Table 7 lists the questions that served as the foundation for designing the assessment plan. These research questions were further refined in the Assessment step, when data gaps were identified and addressed.

Table 7. Initial Study Questions of the HIA by Topic

Topic	Baseline Research Question	Impact Research Question
Air Quality	What outcomes, in relation to air quality, are being affected at Gerena Community School?	How might these outcomes be impacted by renovating the school?
Respiratory Health	What are the symptoms experienced at Gerena Community School?	How might these symptoms be impacted by renovations?
Classroom Noise Levels	What contributes to the noise levels in the classrooms?	How might the acoustic conditions be impacted by renovations?
Community Perceptions	What is the current perception of the school from the community?	How might renovating the school influence community perceptions?
Facility Use	What are the current levels of use of the facility? Where do facility users come from?	How might use of the facility change due to renovation?

3.5.3. Pathways of Impact

On October 29, 2012, the HIA Core Group met to debrief after the scoping stakeholder meetings. The HIA Core Group took the input received at the scoping stakeholder meetings and developed a diagram of pathways in which the proposed renovations were anticipated to affect health. By developing the pathway diagram, the HIA Core Group determined that the proposed renovations would affect health through changes in the quality of the indoor air, perceptions of community residents, and noise in the classrooms.

Figure 7 explains that the choice of renovation options will determine the amount of funding spent and the implementation of new equipment and materials to improve indoor air quality. The choices made in renovating Gerena may change the levels of key air pollutants in side the school, which has (downstream) effects on respiratory health and perceptions about the facility. The renovations implemented and how they are implemented may also change the amount of noise in the classrooms, which may lead to changes in the perceived quality of the learning environment and/or use of the facility. As mentioned previously, Gerena provides many amenities to residents and students. The frequency in which stakeholders use Gerena can influence educational performance (among students), social cohesion (among residents), physical activity, personal safety, and/or health behaviors. Each of those determinants of health can lead to changes in specific health outcomes, including overall mental and physical health.

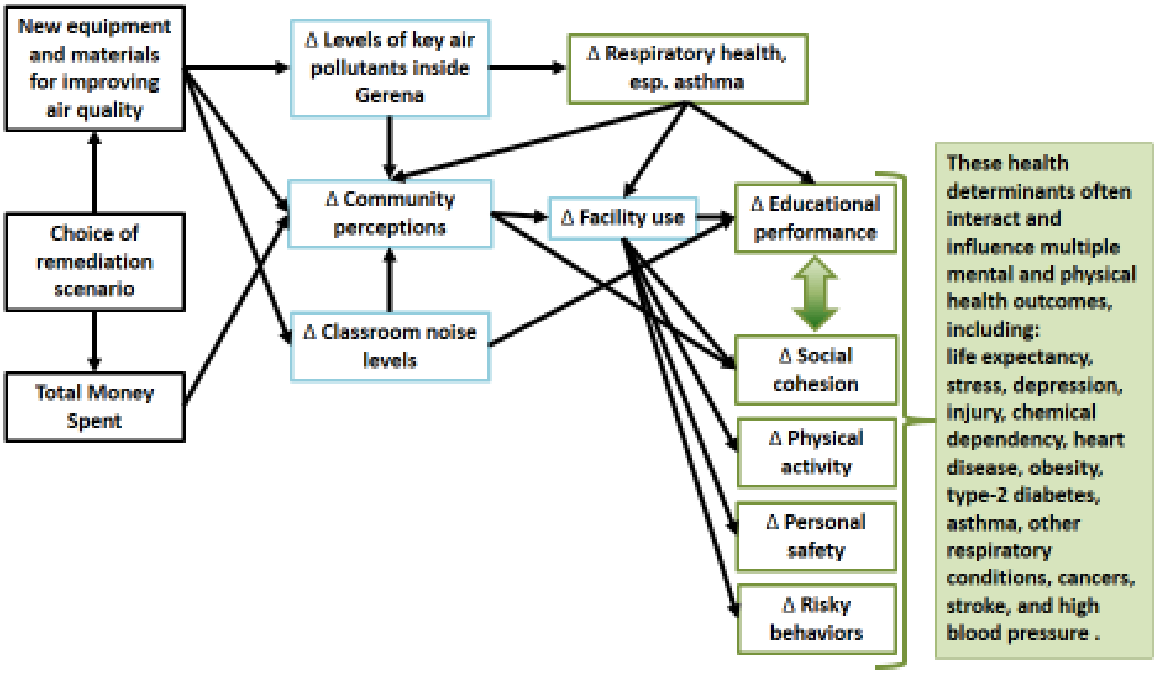

Figure 7. Theoretical impact pathway diagram in which renovations could lead to health outcomes.

3.5.4. Identified Vulnerable Populations

Vulnerable populations are populations that are more sensitive to and/or more affected (both either positively or negatively) by changes in health and/or health determinants (NRC, 2011). Renovations at Gerena may affect vulnerable impacted populations (VIPs) more than other groups using the school. The HIA Core Group identified the following groups as VIPs:

- Young children (population under age 5 years)
- Older adults (population over 65 years)
- Students with asthma
- Low-income households (population at or below twice the federal poverty level)
- Students with special needs (school reported)
- Students and residents with low English proficiency (households in which all members over age 14 years speak English less than "very well")

3.6. The Assessment Plan

The HIA Core Group searched for data sources and methods to answer the research questions and used a scoping worksheet (in Excel) to help organize that process. For each research question, the group identified data needed to answer the question, whether the data was publically available, potential data sources, and the person responsible for gathering the information. In addition, the HIA Core Group assigned a priority ranking for each research question based on three criteria: 1) Is the data available?; 2) Does the team have the necessary resources to answer the question?; and 3) does the research question respond to community (stakeholder) concerns? The questions with the highest ranking were given priority in the assessment plan. Appendix F documents the HIA Assessment Plan.

In the Screening step, the HIA Project Leads predicted that the assessment would include some form of data collection and analysis of the indoor air, including mold, moisture, combustion-source air pollutants, and health data. Thus, work began immediately to secure vehicles for performing those activities. EPA used an in-house mold specialist and environmental health researchers that could perform the mold contamination study at Gerena. EPA also used in-house contractors and an ASPH Fellow to collect and analyze available health data. The HIA Core Group needed additional personnel to collect and analyze data on moisture, indoor and outdoor air pollutants, and the conditions in the facility that contributed to their current state. In order to fulfill this need, the HIA Core Group solicited help from other researchers within EPA.

On November 20, 2012, the group hosted a meeting within ORD to discuss opportunities for other researchers in SHC and the Air, Climate, and Energy (ACE) research programs to collaborate and/or contribute to the HIA. Considering the goals and project timeline, ORD research and expertise could provide great value to the HIA. This meeting proved very beneficial, resulting in new researchers recruited to the HIA and methods identified.

The HIA was able to gain additional EPA Technical Leads that would lead the efforts to collect and analyze data on the building and its mechanical systems and perform an air sampling study. Combined with the mold contamination study, these on-site investigations would provide a systems-based perspective of the indoor environment.

3.6.1. Data that was Available

There was a relatively large amount of publically available information. The HIA Core Group obtained data on demographic and socioeconomic indicators from national surveys and asthma prevalence among students and other school-reported data from the Massachusetts Department of Elementary and Secondary Education (MA ESE), MA DPH, and the school nurse (with permission from Springfield Public Schools). Data on student asthma prevalence and symptom severity at Gerena was available through the school nurse, given that EPA verified that its use was for public health practice and not human subjects research. The health data that is collected will be used in a standard public health practice for the purpose of reducing exposures to building and environmental contaminants within the specific school. Local media provided a variety of stakeholder views/opinions. PBRM provided historic information on the facility and previous investigation reports. Furthermore, there was a wealth of peer-reviewed literature available to perform literature reviews on pediatric asthma, classroom acoustics, and the social environment related to the indoor environment.

National survey data provides the most accurate representation of population counts and estimates in a given geographic area. Indicators used to characterize the population included total population counts, demographic distribution (e.g., age, race, ethnicity, gender, etc.), housing status, income, and educational attainment. The American Community Survey (ACS) was used to acquire information on the social structure (i.e., family size, household type, gender of householder), primary language spoken at home, or country of origin, since this information is not collected by the decennial Census.

There are important differences between the Census and ACS data files. First, the data for the Census survey is collected every ten years, whereas the ACS collects information every year. Second, the Census data includes observed numbers (counts), whereas the ACS reports calculated estimates with margins of error. ACS averages are computed by aggregating data over five year periods. Thus, the 2008-2012 ACS estimates were matched with data from the 2010 Census. Third, Census data at fine resolutions (e.g., block group or block levels) was not available since only the abridged format Census (short format) was released in 2010.

3.6.2. Data Unavailable (Data Gaps)

No data existed on the levels of pollutants in the school or the extent of mold contamination. As anticipated in the Screening step, technical expertise and funding was available through EPA, to a limited extent, to perform (primary) data collection and analysis related to indoor air at Gerena.

Often, assessments are limited by the resources available (e.g., data, timing, personnel, funding, etc.). There were some instances where data needed for the assessment were not accessible or did not exist. For example, individual-level health data of North End residents was not publically available, with the exception of mortality data, due to privacy protection laws (e.g., Health Insurance Portability and Accountability Act Privacy Rule). Mortality rates are not optimal indicators of health status, since they do not provide information on existing health conditions among the living population. However, they can offer a proxy for inferring common health issues in the community. Some of the outdoor air monitoring and/or modeling approaches outlined in the RESES proposal were unavailable, due to resource restrictions. Instead, the HIA Core Group infused some of the outdoor air approaches with the indoor air sampling approach, wherever possible.

Only anecdotal information was available regarding the use of the facility. In order to acquire information sufficient for analysis, the HIA Core Group would have to make direct observations of persons who use the building or use surveys to collect the information. This type of study requires approval through an Internal Review Board, which was not included in the original plan and/or budget for this HIA. The HIA Core Group decided that research questions related to facility use would have to be answered with the limited information available.

3.6.3. Methods to be used to Characterize Health Impacts

In the Screening step, the HIA Project Leads anticipated having a group of graduate students perform modeling and/or estimations of changes in health outcomes as result of the different air quality scenarios. However, the vehicle for the graduate student could not be secured. Thus, the HIA Core Group could only qualitatively assess potential health impacts of the proposed renovations. The HIA Core Group used an impact characterization table, with pre-determined criterion and scales, to convey the anticipated health impacts. Table 8 lists the chosen criterion, their description and the scale (non-numeric) used.

Table 8. Criterion used to Characterize Impacts to Health in Assessment

Measurement	Description	Scale
Direction	Tells whether the renovation will promote or detract from health	Positive (↑), Negative (↓), Both positive and negative (↑↓), Uncertain (?), No effect
Likelihood	Tells how likely the renovation may impact health	Highly Likely, Somewhat Likely, Not Very Likely
Magnitude	Tells how many people may be impacted	Many, Moderate, Few
Distribution	Tells how the impact may be distributed among sub-groups within the population	Equal impact to all (0), Vulnerable populations will benefit more (+), Vulnerable populations will be harmed more (-)
Strength of Evidence	Explains the amount of evidence used to support the judgment	Many strong studies (***; n > 10), A few good studies (**; 3 ≥ n < 10), No specific study, but impact is plausible (*)

3.6.4. Refining the Assessment Plan

On December 10, 2012, the HIA Core Group discussed the HIA scope with PBRM and solicited feedback on the pathway diagram and initial research questions. The HIA Core Group used the feedback gleaned from this meeting and previous discussions to refine the HIA scope. The HIA Core Group met with PBRM on February 14, 2013 to discuss final details on data collection. Appendix A documents the notes from both meetings.

The HIA assessment plan included forensic review of historic investigative reports from PBRM's contractors, collecting and analyzing new and publically available data, as well as performing reviews of scientific and peer-reviewed literature. The HIA Core Group would use the collective information gleaned from each analysis to assess potential health impacts comprehensively. The three priority health impacts (outcomes and/or determinants of health) of focus were respiratory health, community perceptions, and classroom acoustics (noise). The HIA Core Group updated or further refined the assessment plan as the assessment progressed. Appendix F documents the HIA assessment plan.

The specific data collection and analysis methods for on-site investigations (performed by EPA and its sub-contractors) were each required to have an Agency-approved QAPP that outlined the scientific approach, study oversight, and procedures used. EPA finalized the QAPP for collecting data on the building infrastructure and systems in March 2013 and the indoor air in May 2013. ARCADIS served as the primary contractor, with additional support from Turner Building Science and Design. CSS-Dynamac and the ASPH Fellow provided support for literature reviews and other HIA activities. In March 2013, the HIA Core Group released a public flyer notifying stakeholders of the HIA's progress and that there was upcoming data collection planned.

It is important to note that the indoor air analysis was not intended to provide a comprehensive assessment of outdoor air quality around the school. The resources available to perform the air sampling were limited to evaluating selected combustion-source air pollutants and the scope was limited to evaluating the proposed renovations that would affect air quality inside the school. It is also important to consider where causal associations or inferences are indicated and where associations (i.e., could be causal or not causal) are described. The standards for establishing a causal relationship are intricate and typically include levels of certainty or confidence. Often, researchers must rely on circumstantial evidence to provide some insight into existing relationships and potential mediators in the pathway.

Chapter 4. Assessment Findings

There are two main components to the assessment step in HIA─ 1) characterizing the existing conditions and 2) predicting impacts to health that may result from a proposed project, program, policy, or plan. During the Assessment step, data is gathered and analyzed from an array of sources on existing conditions among the target population (i.e., who the final decision will affect) and the conditions related to health. Once a baseline is established, HIA practitioners can begin determining what changes to health and/or determinants of health may result from the decision.

4.1. Overview of the Assessment Step

Assessment activities continued from middle October 2012 to January 2014. This assessment of health impacts comprised numerous analyses that appraised the existing conditions among the population using Gerena and existing conditions inside the facility. The HIA Core Group used an interdisciplinary approach to create the baseline and predict potential impacts to health. EPA and its contractors performed data collection and analysis for both new and existing data. Analyses included a baseline population affected analysis; mold contamination analysis, analyses of the building conditions and systems, including a moisture control analysis, indoor air pressure and movement analysis, and HVAC operations analysis; indoor air quality analysis; qualitative analyses of literature on classroom noise, asthma, and social perceptions; and qualitative characterization of potential impacts to health. In addition to EPA staff and contractors, representatives from PBRM and MA DEP participated in designing the assessment and planning for new data collection. Figure 8 provides an overview of the activities involved with the Assessment step. Items with red flags are also considered Reporting activities. Appendix G provides details of the assessment methods and findings for each analysis.

On April 1, 2013, the HIA Core Group met with PBRM to debrief from the data collection process for the building conditions and systems analyses. The HIA Core Group solicited feedback on the process and lessons learned for future data collection protocols. The HIA Core Group used PBRM's feedback to make clarifications and refine subsequent analyses. Appendix A provides notes from this meeting.

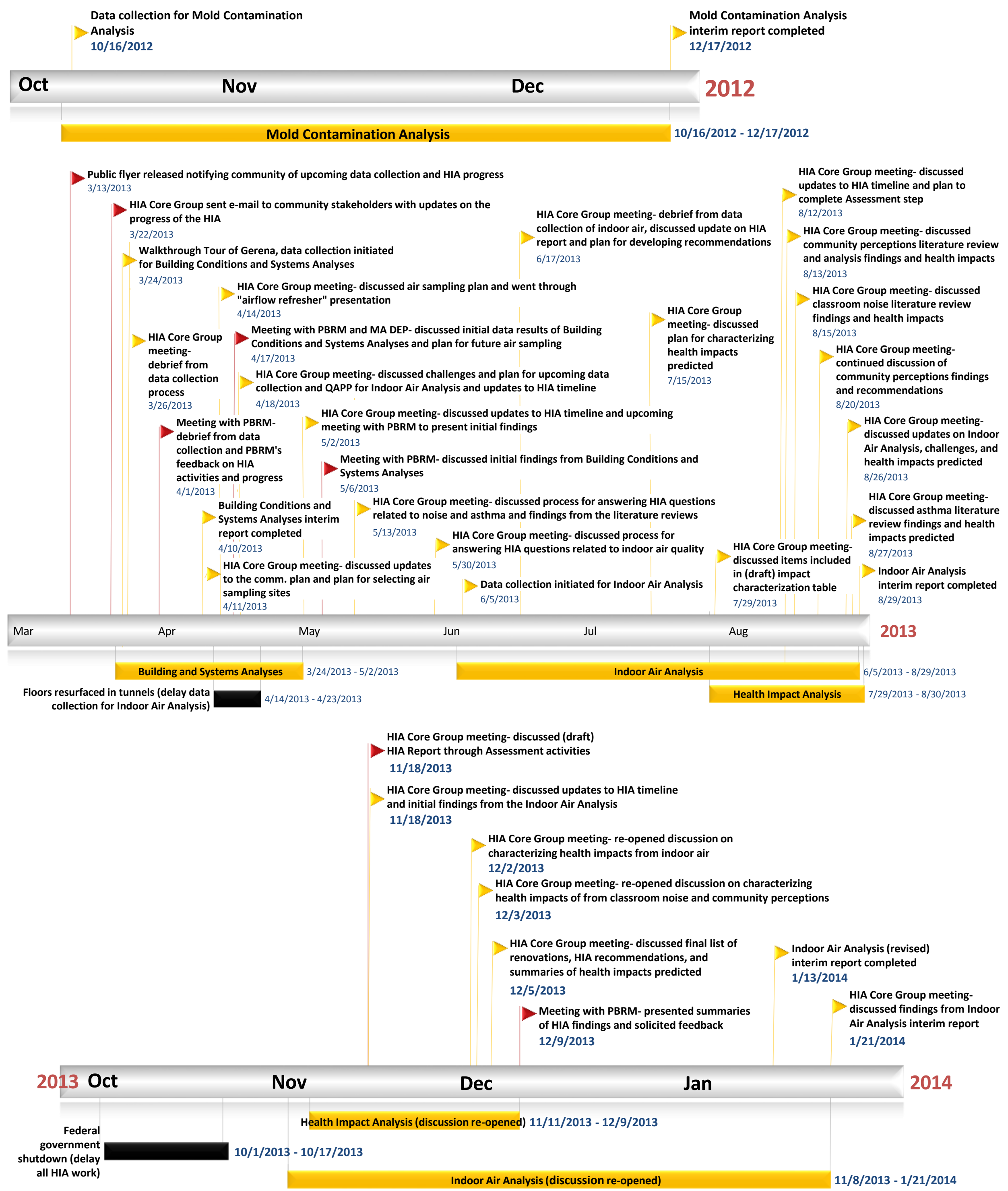

Figure 8. Timeline of activities in the Assessment step.

4.2. Existing Conditions among the Population Using Gerena

The following information describes the results from the baseline population analysis, in which the HIA Core Group established a baseline in which to compare potential health effects of the affected population. The baseline includes a characterization of the health status among the affected population and any socioeconomic and/or environmental variables known to influence health. Performing this analysis helped to understand the extent to which the proposed renovations may affect health and identify VIPs. Appendix G provides details of the methods used and findings from the baseline population analysis.

4.2.1. Population History, Demographics, and Socioeconomic Conditions

The community of North End was founded by immigrant workers in the 1800s and still shares a predominantly immigrant heritage (Gelin, 1984). Beginning in the 1960s, the Connecticut River Valley farming industry started employing a large amount of Puerto Rican laborers. The large influx of Hispanic/Latino population greatly influenced the social and cultural environment still seen in the area today. The 2010 Census reported 8,718 residents living in North End (U.S. Census Bureau, 2010). The density of the population was 7,861 individuals per square mile. Young children under the age of 5 years represented 9.7% of the residents. Older adults over the age of 65 represented 7.7% of the population. Over one-third of the population (36.1%) was under 18 years old.

In October 2012, Gerena had 667 students enrolled, which was up 6% from the previous year. The five-year average enrollment was about 694 students per year (MA ESE, 2013). With the exception of the 2013 year, total enrollment has been declining in the past five years. Gerena had a student to teacher ratio of 10.3 to 1. Of the students enrolled, 129 were pre-kindergarten (MA ESE, 2013).

In 2010, most (87%) residents living in North End were of Hispanic or Latino ethnicity; African Americans made up 14% of the population; and white, alone and non-hispanic represented 5.2% of the population (U.S. Census Bureau, 2010). Most households (estimated 77.0%) were low-income, living on an income below twice the federal poverty level (U.S. EPA, 2015). Table 9 compares the socioeconomic conditions in North End (Census tracts 8006, 8007, and 8008) and Springfield, MA.

Table 9. Key Socioeconomic Indicators for North End and Springfield, MA

Socioeconomic Indicators	North End*	Springfield, MA†
Total Population	8,625	153,276
Minority Population‡	96.0%	48.5%
Low Income Population§	77.0%	51.0%
Linguistically Isolated Households¶	36.0%	15.4%
Population with Less Than High School Education	50.0%	23.9%

* Source: EPA EJScreen 2015, user-specified polygon location, margin of error not included
† Source: U.S. Census Bureau, 2008-2012 American Community Survey, margin of error not included
‡ Minority population includes all people other than non-Hispanic, white-alone individuals
§ Percentage of population at or below twice the federal poverty level
¶ Percentage of people in household in which all member's over age 14 years speak English less than "very well"

Most of the students at Gerena were reported as "high needs" (93%), which is based on the percentage of students that are English Language Learners (ELL), students with disabilities, and/or are from low-income families (i.e., enrolled in the state lunch assistance program). Of the 667 students enrolled in 2013, 13.5% were students with disabilities, 28.0% were ELL, and 90.1% were from low-income families (MA ESE, 2013). Over one-third (37.2) of students spoke English as a second language. The special education students are taught on the second level of Building B (Rooms 208 and 209), instead of in the open-floor pods on the third level. Students were also predominantly (81.3%) Hispanic or Latino ethnicity (MA ESE, 2013).

In 2013, the State of Massachusetts recently upgraded Gerena to Accountability and Assistance Level 3 (previously at Level 4) for its recent improvement in student and teacher performance (Warwick & Sarno, 2013). Level 3 signifies the school is among the lowest performing 20% of elementary schools in the state, but are showing improvement; whereas Level 4 is reserved for schools that are among the lowest performing and least improving in the state (Office of Educational Quality and Accountability, 2005). Increased training for educators in conjunction with the efforts to improve the curriculum, was attributed to the school's improvement, which was the largest improvement margin seen of any level 4 school in the state (Warwick & Sarno, 2013).

4.2.2. Health Concerns among Residents and Students

The average mortality rate for the study area was 31.2 per 1,000 people over five years. Cancer (all types) was the leading cause of death in the study area, followed by coronary heart disease.

Approximately one in a thousand people die from lung cancer or diabetes mellitus (MA DPH, 2013a). Death from cardiovascular disease may be caused by multiple factors, including hereditary pre-disposition, prolonged high levels of stress, poor health behaviors (e.g., using tobacco products, recreation drugs, and/or high consumption of alcohol), and/or exposure to poor air quality. Exposure to poor air quality is also a common cause of death related to lung cancer.

The prevalence of asthma is considerably high in Springfield, MA compared to other parts of the state. Springfield, MA has a significantly higher prevalence of lifetime asthma at 18.1% (95% confidence= 16.6% to 19.5%), compared to the state's prevalence of 14.7% (95% confidence 14.3% to 15.1%) (MA DPH, 2013b). The prevalence of asthma is higher among residents of Hispanic ethnicity, compared to non-Hispanics, and females, compared to males (MA DPH, 2013b). Asthma prevalence is greater among low-income households (i.e., total household income less than $50,000 per year) at 13.7%, compared to only 7.9% prevalence among those with income greater than $50,000 a year (MA DPH, 2013b). Individuals with more formal education have a lower prevalence of asthma than those with less formal education.

The prevalence of asthma among students at Gerena has continuously been higher than the statewide school average. Table 10 lists asthma prevalence by year at Gerena compared to the state.

Table 10. Student Asthma Prevalence at the School and State Level

School Year	School Asthma Prevalence*	State Asthma Prevalence*
2003-2004	21.2 %	9.5%
2004-2005	20.9 %	10.0%
2005-2006	42.6 %	10.6%
2006-2007	20.7 %	10.8%
2007-2008	21.3 %	10.8%
2008-2009	24.7 %	10.9%
2009-2010	24.0 %†	Not Available
2010-2011	20.0 %†	Not Available
2011-2012	19.0 %†	Not Available

* Source: MA DPH Pediatric Asthma Surveillance Metadata

† Source: Values reported by Springfield Public Schools, but not yet verified by MA DPH

Recently, there has been an improvement in both student attendance and the reduction in asthma prevalence. Figure 9 graphs the asthma rate, student attendance (and teacher attendance) over time at Gerena. The data suggests that as asthma prevalence declined from 2009 to 2012, student and teacher attendance improved.

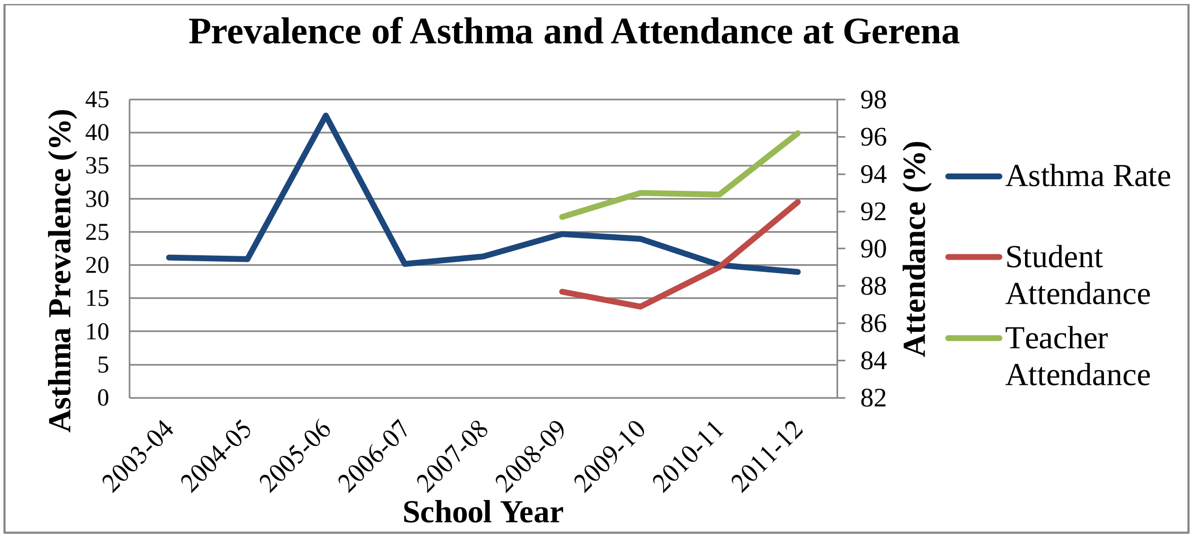

Figure 9. Prevalence of asthma among school-aged children and attendance at Gerena (Mass CHIP, 2013).

It is important to note that the cause for the very dramatic prevalence of 42.6 %, during the 2005-2006 school year, is unknown; but may have been the result of a reporting error.

The Pioneer Valley Asthma Coalition (PVAC), a local non-profit organization, has been working with school nurses on documenting visits to the school nurse related to asthma and respiratory health. This data has been used as a baseline to judge the success of community wide actions to improve the management of asthma symptoms. Typical asthma symptoms include difficulty breathing and wheezing.

Over two years, there were 7,343 visits to the school nurse, 1,512 of which were related to asthma, respiratory health, and/or other exposures. Of those visits, 6.3% were directly related to asthma, 0.7% were related to difficulty breathing, 1.2% were related to chest pain and/or tightness, 5.2% were related to headaches, and 3.8% were related to neurological concerns. Figure 10 breaks down the composite visits related to asthma, respiratory health, and/or other exposures. Both PVAC and the school nurses have focused on increasing the number of student asthma management plans filed with the school and increasing asthma awareness events.

It is important to note that visits to the school nurse does not account for multiple visits by one individual. The information presented is total counts of visits, not individuals.

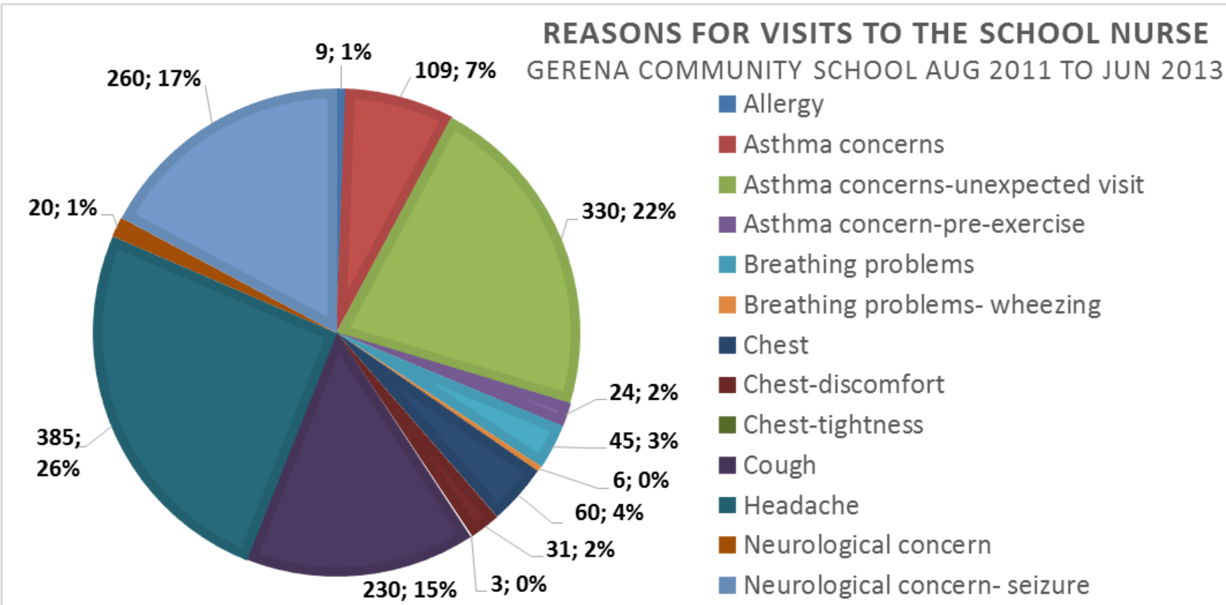

Figure 10. Reasons for visits to the school nurse at Gerena, from 2011 to 2013 (Springfield Public Schools, 2013).

4.3. Existing Conditions Related to the Indoor Environment

The HIA Core Group used an interdisciplinary, systems-based approach to address potential and/or perceived issues associated with the indoor environment at Gerena. The assessment appraised historic and existing states of the building's conditions, systems, and indoor pollutants to put together a comprehensive perspective of the factors that influenced the indoor environment. In addition, the HIA Core Group reviewed local media (e.g., newspapers, television segments, and interviews) to understand how the community perceived the conditions inside the building. Analyses of the building conditions and systems assessment included several sub-analyses, which evaluated historic mold exposure, HVAC system performance, air pressure and movement, air leakage, and the presence of key combustion-source indoor air pollutants. Appendix G provides the details for each analysis.

All (new) data collection and analysis performed by EPA and its contractors followed EPA-approved procedures, in accordance with the quality assurance project plans (QAPPs) designed specifically for this investigation. The data collection and analysis of the systems operations and building conditions were guided by best practices developed by the U.S. EPA, National Institute of Occupational Safety and Health, and the U.S. Department of Energy handbooks and manuals on building air quality and moisture control.

4.3.1. Mold Contamination Analysis

The presence of mold on building materials and/or a "moldy" odor has been a historic concern among Gerena users. Mold grows in oxygenated, damp areas and feeds on almost any organic material (EPA, 2008). Molds reproduce by making microscopic spores that are carried in the air to other locations or inhaled. When mold spores land on damp, porous building material (e.g., carpet, wood, paper, tiles, dry-wall, insulation, etc.), they begin growing and digesting the material, leading to releasing more spores and (in some) odors (EPA, 2008). As stated in the WHO Guidelines for Indoor Air Quality: Dampness and Mould (2009a), "exposure to microbial contaminants is clinically associated with respiratory symptoms, allergies, asthma, and immunological reactions." It is impossible to completely eliminate mold from the indoor environment. What is unknown is how much (or to what extent) mold contamination in a building becomes a health hazard. Knowing that moisture can never be completely eliminated in Gerena (due to the aforementioned design and location of the underground tunnels), PBRM performs ongoing cleaning, drying and/or and replacing of wet building material that could be a food source for mold.

The purpose of the mold contamination analysis (as stated in the RESES proposal) was to identify and quantify the extent of mold contamination in Gerena. The traditional method for identifying mold in a building involves visual observation of microbial growth in or on building materials and/or checking for odor, which is most often performed as a walk-through survey. Although this method is useful for identifying areas where mold is already growing, it is highly subjective and fails to determine the extent of mold contamination in the building and the species of mold (or other fungi) present. Different indoor environments can grow different types of mold. Scientific methods have evolved to identify the mold species that indicate water-damage and/or are related to (but not definitive causes of) specific health outcomes (Santilli, 2002). Therefore, identifying the species of mold in the school may inform the extent of water-damage and/or the potential risk to health for its occupants. It is important to note that there is no standard method for determining the extent of mold contamination in buildings; nor is there a consistent method for assessing the health impact of mold exposure among building users.

Previous investigations already applied the traditional methods of walk-through survey for identifying the presence of mold in Gerena. For example, in 2004, the Massachusetts Department of Public Health performed an indoor air quality assessment and found spots of water damaged ceiling tiles and carpet, and visible mold growth and “moldy” odor on a ceiling tile in Pod 1 of Building B third floor). Since then, PBRM replaced the roof and atrium skylight to address the sources of incoming water and replaced the carpet in the Pods. In 2012, PBRM’s contractors noted a “musty” odor in Building C (O'Reilly, Talbot & Okun Engineering Associates, 2012). Since renovations at Gerena have been ongoing, the HIA needed to use a method that also provided information on historic or long-term mold exposure.

The HIA Core Group selected a standardized DNA-based method, developed by EPA, to test for different mold species throughout the building, including species that indicate water damage and species commonly found even without water damage. On October 16, 2012, EPA collected a single sample of settled dust at thirty sites throughout the facility and used the DNA-based method to identify and count the spores of 36 indicator mold species. In order to quantify the areas where mold contamination was highest, EPA applied the Environmental Relative Moldiness Index (ERMI), which indicates areas where mold spore concentration from water-damage indicator species is highest.

Figure 11 maps the locations where EPA sampled the settled dust in the tunnels. Smaller black dots represent lower ERMI values, across the spectrum of samples, and larger black dots represent higher ERMI values.

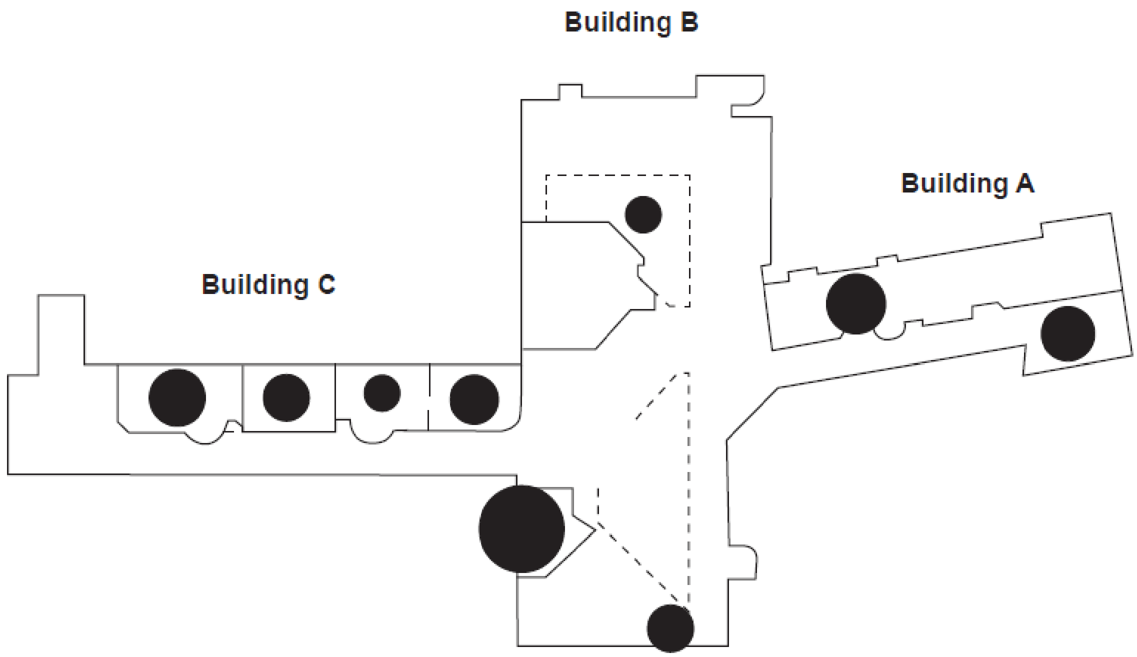

Figure 11. Locations of sample sites in the tunnels, with corresponding relative ERMI values.

The tunnels had the lowest average ERMI value of the three building levels. The lowest ERMI value, across the 30 sample sites, was in Office 5 of Building C (tunnel). The "afterschool room" located in the tunnel of Building B had the highest mold concentration in the tunnels. Figure 12 maps the sites where EPA sampled the settled dust on the second floor (level 2) of Building B. Figure 13 maps the sites where EPA sampled the settled dust on the third floor (level 3) of Building B.

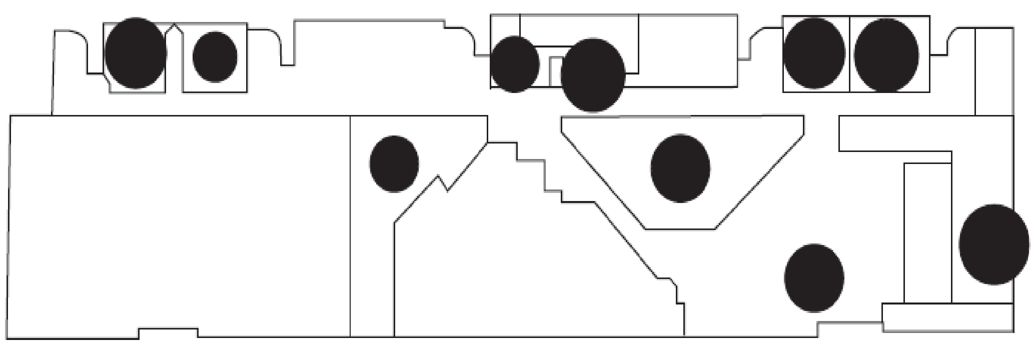

Figure 12. Locations of sample sites on second floor of Building B, with corresponding relative ERMI values.

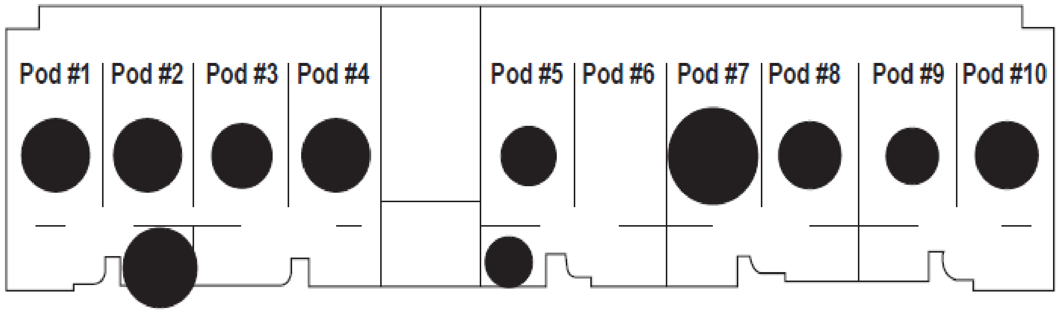

Figure 13. Locations of sample sites on third floor of Building B, with corresponding relative ERMI values.

The third level of Building B had the highest average ERMI value, among the three levels; the highest value (across the 30 samples) taken from Pod 7. Overall, mold contamination based on the ERMI values was found to be high throughout the building, which was similar to other tested schools with historic water damage (Thomas, Burton, Mueller, Page, & Vesper, 2012; Li, et al., 2011).


It is important to note that settled dust was collected from undisturbed locations (not included in routine cleaning schedule, such areas as tops of doorframes and bookshelves) to capture historic exposures. Therefore, the mold spores sampled from settled dust may not reflect current exposures.

4.3.2. Moisture Control Analysis

Since mold requires water to grow, the control of moisture in buildings is important for controlling mold growth, in addition to occupant comfort. As stated in the EPA's Indoor Air Quality Tools for Schools guide, "Humid weather in generally cold climates, like the Northeastern U.S., can cause condensation on un-insulated ground contact floor slabs or basement walls," which can lead to mold growth (U.S. EPA, 2012c). EPA recommends a relative humidity of 60% (or below), and the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) recommends a temperature remaining between 68-74 ^{o}F during winter and 72.5 to 78 ^{o}F during summer (ASHRAE Standard 55- 1992, Thermal Conditions for Human Occupancy).

Historically, Gerena faced on-going issues with water infiltration and moisture. In June 2012, PBRM's contractors found evidence of water-damage to the floor tiles in Building C and some minor water staining on carpeting and floor tiles of Pod 10 (level 3 of Building B); but reported that the majority of the remaining school classrooms, offices, and other occupied areas were clean, dry, and showed no visible evidence of water infiltration (O'Reilly, Talbot & Okun Engineering Associates, 2012).

In March 2013, EPA performed a 48-hour recording of temperature and moisture (relative humidity) in real-time to determine the HVAC systems' ability to control moisture. The sites where recording took place included the main office and science lab (second level of Building B), Mini Pod 6 and Pod 6 (third level of Building B). To help determine the variability in building conditions across campus, temperature and relative humidity measurements were taken twice daily at a number of indoor locations throughout the facility for six days in June 2013.

Overall, the HVAC systems seemed to be adequately controlling the temperature (between 70-78^{0}F) and relative humidity (50-65%) in the spaces where sensors were recording. With the active and historical water issues, it may be advantageous to control the humidity at a lower level. There were five locations with an average relative humidity slightly above 60%, which is considered the upper threshold based on ASHRAE guidance, that included the mechanical room in Building A (tunnel), the gym in Building D, and the special education room, library, and Principal's office on the second level of Building B.

It is unlikely the mechanical room was actively conditioned and some windows were open during this study. Based on nearby outdoor temperature readings (at the Springfield Airport), the HVAC systems were likely operating in both heating and cooling modes during this study.

4.3.3. Indoor Air Pressure and Movement Analysis

The HVAC systems bring outside air into the building (via air intakes), then circulates the air using a series of supply, return ducts, and air handling units. An ideal air pressure means there is an equal balance between the amount of air coming into a space and the amount of air leaving a space. A neutral balance between the air supplied and the air returned can prove very difficult, especially during changes in climate. A negative pressure will develop in a space where more air is removed than supplied. This causes the building space to draw air in from other places or (unplanned) pathways to make up the loss of air pressure. A slight negative pressure can be advantageous in colder climates to keep moisture (relative humidity) lower. A positive pressure develops in a space when more air is supplied than removed, leading to air being pushed out of the space to other places or through (unplanned) pathways, such as gaps in the building enclosure. A slight positive pressure can also be advantageous in warmer climates to control moisture. Measuring air pressure can help identify the movement of air in a building at the rate at which air is escaping the building enclosure. Infrared imaging was conducted in order to obtain an initial understanding of where was leaking from the building enclosure. Air leakage from a building can make it difficult to control air movement and maintain air pressure in a building space.

Adequate ventilation is important to the comfort and breathing ease for building occupants. When a space is occupied, there must be enough ventilation so that occupants can breathe easily and carbon dioxide (CO_2) levels remain low. Monitoring carbon dioxide levels helps determine if the HVAC systems are providing adequate ventilation.

From March 24 to 26, 2013, EPA contractors performed air pressure testing and mapped the direction of air movement throughout the facility. Contractors used blower door measurements to determine the current air leakage rate of the facility and the likely feasibility of making the enclosure more airtight to better gain control over the air quality inside the building. Infrared imaging was also used to identify specific areas of the facility where energy was being lost and if there were current wet areas along walls, ceilings, or floors that were not readily visible. EPA contractors performed continuous recording of CO_2 in selected occupied spaces to assess if existing ventilation rates are likely to meet current ASHRAE Standard 62 guidelines. Testing was performed under normal operating conditions.

A review of the results from the pressure mapping indicate that the current HVAC systems affect the movement of air within the facility. Some of the air-handling units no longer introduce outdoor air, either because they were closed or not function properly. In areas where the air-handing unit is not drawing in outside air (e.g., air conditioning units in the Main Office and Media Center), a low pressure gradient causes air to be drawn in from other areas, which overburdens the units serving those spaces.

Additionally, some of the building design features, including the atrium and the series of stair towers that connect the lower level of Building B to the upper levels, affect building pressures and transport pathways resulting in air movement from the street into the building. The atrium draws air from the lower levels (tunnels) and delivers it to the second level and third levels of Building B simulating a "chimney" effect. This finding helps explain why the average concentration of mold spores found on the third level of Building B was the highest of the three building levels when the suspected sources of mold growth came from the tunnels. Figure 14 maps the direction of air movement on the second level of Building B.

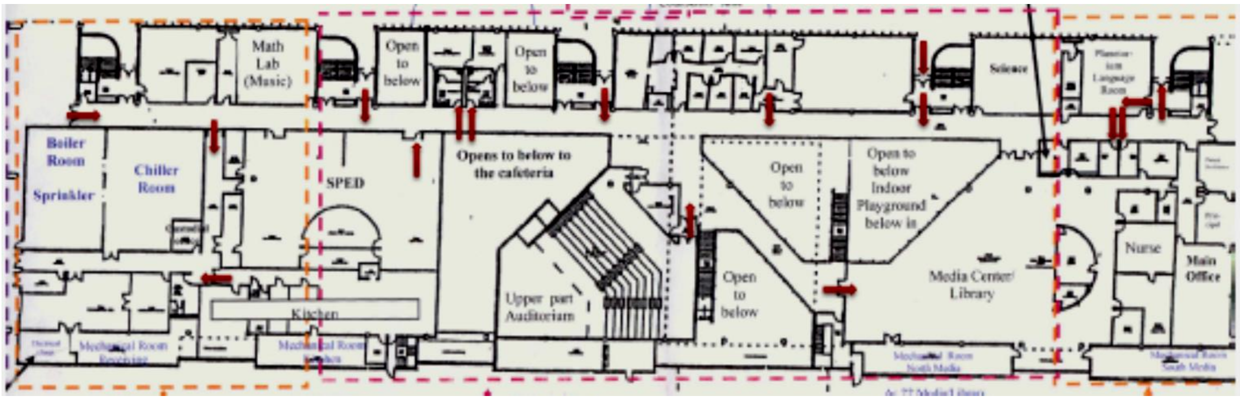

Figure 14. Air movement (indicated by red arrows) throughout the second level of Building B.

EPA found that the building has a high air leakage rate (1,238.6 cubic feet per minute; CFM) compared to any modern standard now in existence for building construction. In its current condition, the building would require approximately 25,000 to 30,000 CFM of make-up air simply to keep the building at neutral pressure. Such a high amount of make-up air undoubtedly uses a large amount of energy. As air pressure increases, air leakage also increases.

The infrared imaging identified air leakage sites at the wall-roof junction and the floor-wall junctions of Building B (where the third level overhangs the second level). Other areas of air leakage were found along the structural beams and where the structural columns and walls join. Figure 15 identifies one of the air leakage sites found using infrared imaging that was not readily identified. Air leak sites, such as the one found at the end of Building C (tunnel) near Building B, allow for indoor air to escape out of the building and untreated outdoor air to enter the building. The lost air does not get recycled through the HVAC system, which leads to the system working harder and using more energy to heat or cool the air.

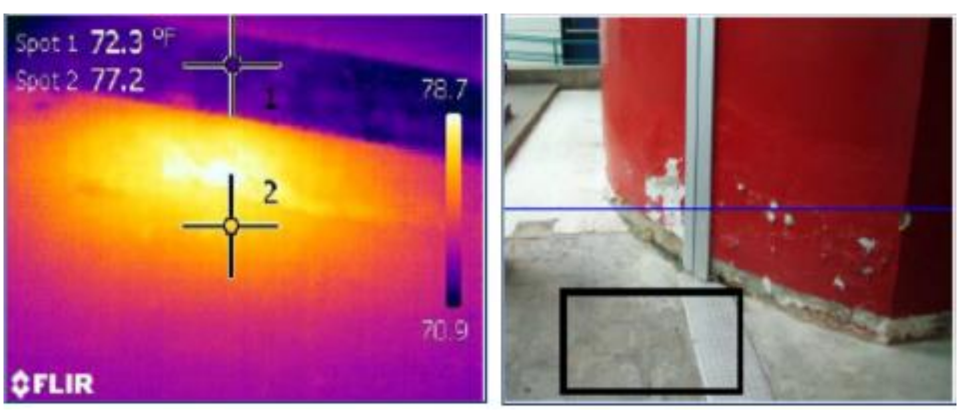

Figure 15. Example of a "hot spot," where Building B connects to Building C, identified by infrared imaging.

4.3.4. HVAC Operation Analysis

The technical portion of the building conditions and systems assessment requires an inter-disciplinary approach that includes evaluation of previously performed work and existing operations and maintenance. This approach helps prevent the duplication of work, improves the design of (new) data collection and analysis, and helps provide a more comprehensive perspective of the issues facing the operations and management of the facility.

EPA and contractors gathered information on the operation and maintenance of the HVAC systems from the building maintenance staff and the company contracted to perform maintenance on the systems to determine the current control logic for the HVAC air supply and exhaust fans. In addition, EPA and its contractors performed a forensic review of documents prepared by PBRM's contractors from previous investigations at the school related to the HVAC systems. In March 2013, EPA and its contractors performed a visual survey of the current conditions for some of the air handlers that were accessible. The interiors of four air-handling units were observed, including units 12, 23, 24, 33, and 36.

Based on the on-site observations, EPA and its contractors verified that the information gathered from the review of historic reports appeared reasonable regarding the status of the various systems and actions that are planned to address building and occupant needs. Some of the air handling units were found to be closed or operating with major malfunctions, broken equipment, and poorly maintained drain pans (units 12, 23, 24, 33, and 36). The access doors to the interior of some air handing units were malfunctioning making it difficult to gain access to provide routine maintenance (e.g., cleaning coil faces and drip pans). Visible microbial growth was found in the drain pans and coil faces of the observed units (units 12, 23, 33, and 36). In addition, several units were overdue for replacement. The condition of the four units observed suggest that the remaining (unobserved) units are likely in the same condition.

PBRM has been working closely with the school maintenance staff and hired new positions to help meet maintenance requirements. The areas served by overburdened air handling units combined with the high air leakage rate are likely contributing to the high-energy use for the facility.

4.3.5. Indoor Air Quality Analysis

The purpose of the indoor air quality analysis was to address stakeholders' perceived concerns regarding the potential influence of outdoor combustion-source (mostly nearby traffic) and indoor air pollutants on indoor air quality in Gerena. Multiple factors related to the design of the building and the efficiency of the HVAC system to treat the air control the levels of air pollutants in a building (EPA, 2013a). Air coming into the building through the fresh-air intakes can contain key pollutants that compromise the air, including particles and reactive gases from combustion reactions (e.g., automobiles and power plant emissions), as well as small particles from organic sources (e.g., mold spores and pollen from plants) (EPA, 2012a). When the HVAC system runs efficiently, it typically filters some of these pollutants from the incoming air, but not all. When the HVAC system is overloaded or malfunctioning, unwanted material is circulated with the incoming air throughout the building.

Because there are thousands of pollutants one can monitor, the following is a generalized characterization of key outdoor sources of air pollutants around Gerena and should not be considered a comprehensive air quality assessment.

Outdoor Air Pollutants around Gerena

Springfield, Massachusetts is a highly industrialized area and sits along a major transportation route with a lot of road and railway traffic going through the region. Springfield, MA is known as a transit hub for its central location and the main interstate and state highways routes that run through the city. On August 11, 2009, the Massachusetts Highway Department recorded 24-hour continuous traffic counts. Figure 16 plots the results of the traffic recording on I-91 near Gerena. A total 104,236 vehicles traveled on I-91 over the 24-hours, with a clear pattern of higher counts in the morning and afternoon “rush hours.” The recorded daily traffic count was consistent with historical average annual daily traffic counts recorded in Springfield, MA.

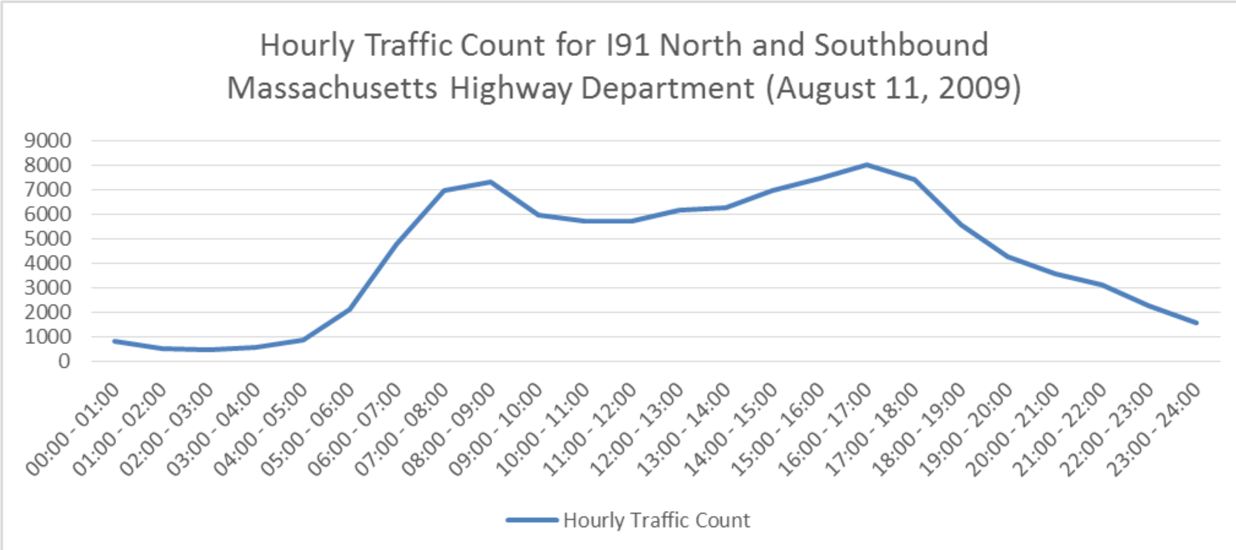

Figure 16. Hourly Traffic Counts for I-91 on August 11, 2009

Autobody shops, hospitals, manufacturing and metal working businesses, cold-storage facilities, salvage yards, and fuel distributors are just some of the emitters (in addition to road source) located within a half-mile of Gerena (based on EPA's Enforcement and Compliance History Online; ECHO maps). Many of these facilities have permitted releases of chemicals known to exacerbate asthma symptoms, the most common being nickel, formaldehyde, chromium and acetaldehyde. Members of the HIA Core Group occasionally noticed a metallic, burning odor outside during the data collection processes at Gerena. The HIA Core Group referred to the EPA-developed Community-Focused Exposure and Risk Screening Tool (C-FERST)[8], which uses National Air Toxics Assessments (NATA)[9] data, for a better understanding of the possible ambient air pollutant exposures and respiratory risk estimates for the region. The HIA Core Group acquired permission from EPA to pilot the tool for screening possible exposures to ambient air pollutants known or suspected of causing serious respiratory illness and/or exacerbate asthma.

Based on the C-FERST results of the NATA data query, there were a total of 24 EPA-registered facilities within a half-mile radius of Gerena, including 3 Toxic Release Inventory facilities, 15 Aerometric Information Retrieval System facilities, and 6 Assessment, Cleanup and

[8] At that time, C-FERST was in the pilot-stage. More information about the C-FERST tool is available at http://www2.epa.gov/healthresearch/community-focused-exposure-and-risk-screening-tool-c-ferst.
[9] At that time, the National-scale Air Toxics Assessment analytical tool used emissions from the 2005 calendar year as the most recent data. More information about NATA is available at http://www.epa.gov/airtoxics/natamain/.

Redevelopment Exchange System facilities. The registered emissions of these facilities include acetaldehyde, benzene, chromium, formaldehyde, and naphthalene. The estimated concentrations of acetaldehyde, chromium compounds, diesel particulate matter, and formaldehyde were in the 80th to 100th percentile range for the region around Gerena. This meant that on 20% to 0% of areas in the U.S. had higher estimated concentrations. The cumulative non-cancer respiratory health risk for Springfield, MA was also in the 80th to 100th percentile.

The HIA Core Group also used EPA's Air Quality System Data Mart (more information available at http://www.epa.gov/ttn/airs/aqsdatamart/index.htm) to better understand the overall air quality in Springfield, MA. The data mart provides graphical representations and downloadable data on air quality indicators monitored by EPA. Figure 17 plots the calculated air quality index based on ozone and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) in Springfield, MA during the year 2011. With the exception of a few days, air quality in Springfield remained good to moderate (below concern for sensitive groups). Some seasonal variation was observed with lower air quality in the winter and summer months.

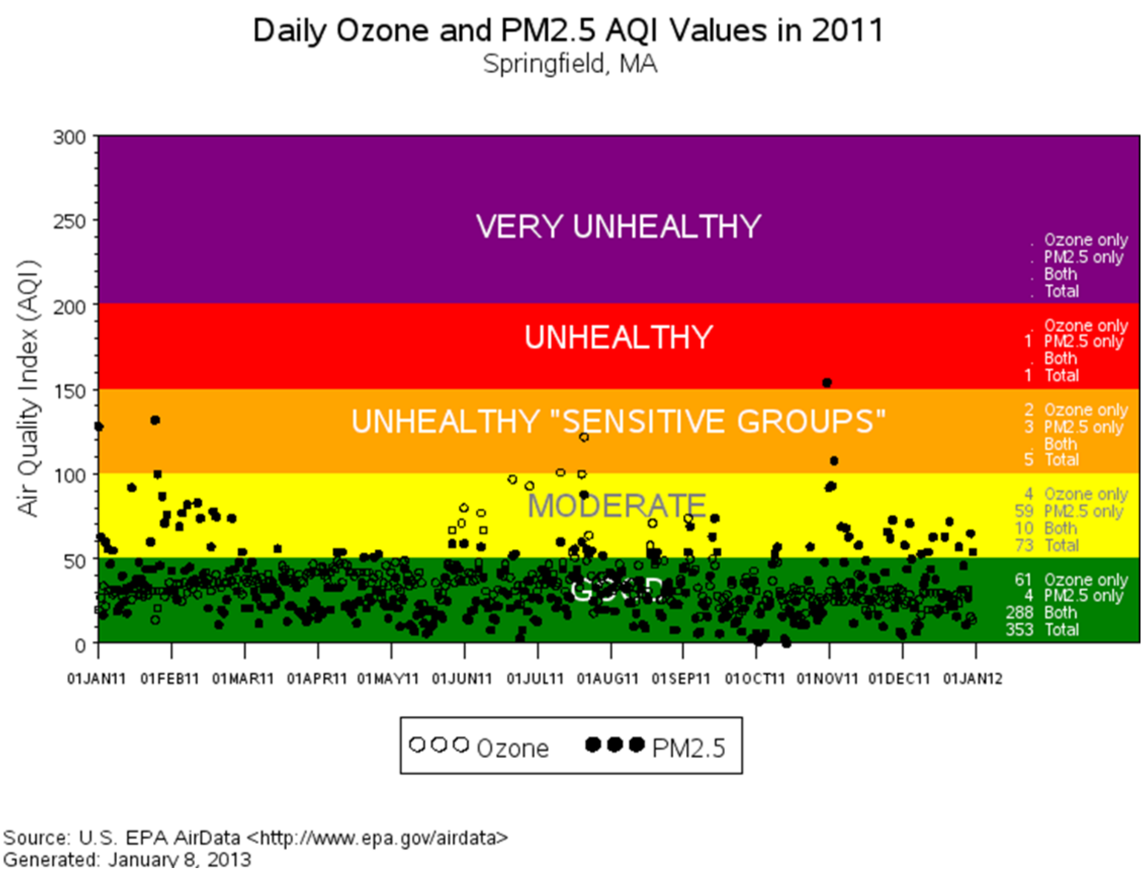

Figure 17. Daily Ozone and $PM_{2.5}$ Air Quality Index Values in 2011

The western regional office for MA DEP began an Urban Initiative in Ward 1 to improve the environmental conditions and quality of life in the North End Community of Springfield, MA. MA DEP monitors the ambient air in Springfield, including on the roof of Gerena, and will be releasing their report of the current sampling of pollutant concentrations in the near future.

Indoor Air Pollutants in Gerena

The HIA Core Group focused the air sampling study to test for combustion-source pollutants, including nitrogen oxides (NO_X), carbon monoxide (CO), $PM_{2.5}$, ultrafine particulate matter (particulate matter less than 100 nanometers in diameter), and black carbon (BC). Nitrogen oxides (NO_X), which includes compounds like nitrogen dioxide (NO_2) and nitric oxide (NO), are very reactive gases that are emitted from combustion reactions, such as automobile engines and power plants (EPA, 2012a). Carbon monoxide (CO) is an odorless, clear gas emitted from incomplete combustion reactions, commonly as automobile exhaust (EPA, 2012a). Particulate matter is a complex mixture of liquid droplets and extremely small particles made up of many components, including acids (nitrates and sulfates), organic chemicals, metals, and soil or dust particles (EPA, 2012a). Ultrafine particles are directly emitted from combustion reactions or when gases from combustion sources react in the air (EPA, 2012a). Black carbon (BC) is a component of ultrafine particulate matter emitted from incomplete combustion of fossil fuels, biofuels, and biomass (EPA, 2012a).

In March 2013, EPA contractors performed a short-term (48-hour) recording of particulate matter to determine if further study of possible indoor intrusion of combustion-source byproducts was warranted. EPA contractors performed continuous sampling of particulate matter for 48 hours inside the building. Gerena is a smoke-free zone and no tobacco odors were detected during this study. This initial test indicated that some combustion-sized particles were present in the indoor air, with spikes indicating morning and afternoon rush hour traffic, warranting further study.

In June 2013, EPA contractors performed the data collection for the air quality analysis. Air sampling was limited to 8-hour continuous recording (not 24-hour), due to security and building access limitations, and monitors recorded for a total of six days. Air sampling occurred on June 5 through 7 (Wednesday through Friday) on June 10 through 12 (Monday through Wednesday) during normal operations. There was no railroad traffic observed during the study, but EPA contractors reported high road traffic on both Birnie Avenue and I-91. The outdoor monitors were placed in the fresh air intakes, to prevent damage from the elements and to monitor the air going directly into the building. The indoor air monitors spent the first three days in the classrooms on the third level of Building B and the last three days of the study in Building A (tunnel).

Samples from the outdoor air intakes were taken for comparison with indoor levels to measure the filtration efficiency. Average values were also compared with regulatory and industry standards, from the National Ambient Air Quality Standards (NAAQS), Occupational Safety and Health Administration (OSHA), and the ASHAE. Meteorological conditions (wind speed and direction) were also monitored from the roof of Building B for the duration of the study.

NO_X Measurements

Daily NO_X average values for both indoor and outdoor measurements were typically below the published NAAQS at 100 parts per billion (ppb) per hour or an average of 53 ppb per year. The one exception for this occurred on June 7, 2013, when monitors recorded an average 66 parts per billion (ppb) outside Building A (tunnel) and winds were out of the north, drawing air from I91. The reduction in NO_X concentrations moving from outdoor to indoor spaces was easily observed. Indoor readings each day were approximately half that of the corresponding outdoor readings. However, the influence of mobile sources at the Building A air intakes and inside the tunnel was also readily observed.

The NO_X values sampled from the air intake for Tunnel A were typically higher than measured from the air intake for Building B, likely due to the proximity to road traffic and "upwind" location of Building A. According to the NAAQS, outdoor NO_2 values should not reach above 100 ppb (NO2 level maximum) in 1 hour or an annual average of 53 ppb. In addition, the NO_X values inside Building A were considerably higher than inside the classrooms, with respective averages of 4ppb and 14ppb.

CO Measurements

Indoor CO values, which were 3 parts per million (ppm) or less, were almost always below the detection ability of the instruments used (range is 0 to 1,000ppm). The NAAQS threshold for outdoor ambient CO is 9 ppm for an 8-hour period.

Ultrafine Particulate Matter Measurements

Daily average counts for ultrafine particles were consistently the highest at the air intake for Building A for all six days of the study. This may be due to the close proximity of Building A to traffic on the interstate and Birnie Avenue. There was a reduction in ultrafine particle counts moving from outdoor to indoor spaces. Indoor readings each day were approximately half that of the corresponding outdoor readings.

There was an occurrence of higher than normal ultrafine particles in the Pods around 1:00PM on June 6, 2013, likely attributed to the new flooring installation occurring in Building A (tunnel) and/or the increased lunch time activity. There was also some tile and carpet work occurring near the intersection of Buildings B and C (tunnel) that may have influenced the indoor particulate levels, but neither indoor sampling sites were near this work. Meals for the students were catered, reducing the risk of influence on the data from cooking activities.

BC Measurements

The air intake for Building A (tunnel) had the highest BC average values for all six days of the study. This is likely due to the close proximity of the interstate and Birnie Avenue traffic to the sampling location. There was a sharp fall in BC concentration outside Building A from June 10 to 12, 2013, most likely due to the change in wind direction from north to northwest.

Although the typical 50% reduction in particulates from outdoor to indoor air measurements was observed, BC measurements in the school also showed an influence of outdoor combustion sources inside Building A. When traffic volumes were highest, BC levels in Building A (tunnel) were also high. Increases in indoor concentrations of BC usually followed increases in outdoor levels. The permissible exposure limit for BC is 3.5ng/m^3, based on OSHA standards. The highest study average at all locations was less than half the OSHA PEL (at 1.6 ng/m^3).

$PM_{2.5}$ Measurements

Typical indoor $PM_{2.5}$ levels in the presence of human activity (for residences) is above 20µg/m^3. In general, indoor monitors revealed average $PM_{2.5}$ levels below 20µg/m^3, with the exception of a few isolated high levels for a short duration of time (i.e., “spikes”). There were no definitive time patterns observed over the course of the study to attribute the spikes in $PM_{2.5}$ to any one source or explanation. The outdoor sampling locations did show increased $PM_{2.5}$ levels with respect to the indoor concentration averages. Based on the data (normalized for worst-case scenario), there appeared to be some process where $PM_{2.5}$ were removed (scrubbed) from the indoor environment, either through physical filtration mechanisms and/or deposition (in the ductwork itself). Average indoor $PM_{2.5}$ concentrations were often well below half of the outdoor concentrations, with the exception of data from day five of recording that had an average $PM_{2.5}$ concentration of 40µg/m^3. It is important to note that HVAC operation may influence $PM_{2.5}$

levels, especially if operating in an economizer mode in which large volumes of outdoor air is introduced to indoor spaces to save energy costs for cooling.

4.3.6. Classroom Acoustics Analysis

A stakeholder at the HIA Kickoff Meeting in October 2012 raised the concern about the noise levels in the classroom learning spaces. The perceived concern was that high levels of noise (partly due to the open floor plan) in the pods was distracting and/or aggravating students and teachers, reducing performance among students. The intent of the HIA was not to evaluate classroom design or acoustic environment of the classrooms. However, the HIA addressed this concern within the context of proposed renovations on their potential to influence noise in the classrooms. Even though the proposed actions focus on improving the HVAC and other facets of the building infrastructure, decision-makers should consider the acoustic environment, in regards to learning spaces, when planning and/or implementing renovations.

Noise levels in the classroom was not considered in planning resource needs when developing the RESES proposal. The funding allocated by ORD was not adequate to include on-site noise level measurements or acoustic diagnostics in the classrooms, in addition to the other planned on-site diagnostics. Therefore, the HIA Core Group reviewed scientific literature and epidemiology studies to help inform stakeholders on the pathways of impact related to noise in schools and acoustic benchmarks in learning spaces.

Observations in the Classrooms

Gerena uses an open floor plan classroom design, in which different multi-aged classrooms share a learning space. There are ten learning spaces (i.e., "pods") on the third level of the main building (Building B). There were temporary (moveable) partitions placed between classrooms to address this issue, but may not provide adequate soundproofing between learning spaces. Sound reflects off the ceiling, off walls, and other surfaces to enter adjacent learning spaces. The carpeted floor provides some noise absorption benefit (albeit unknown). Figure 18 provides an example of one of Gerena's pods, with moveable partitions carpeted flooring, during summer camp. It is important to note that students with special needs are taught in a separate location — the special education room on the second level of Building B.

Figure 18. Children playing in one of the pods at Gerena during summer camp.

A good quality acoustic setting can be achieved in an open floor plan for learning. The Department for Education and Skills in London (UK) developed a guidebook, "Building Bulletin 93 Acoustic Design of Schools: A Design Guide" that provides recommendations for optimizing the acoustic environment in schools. For example, using partitions that extend the entire length between the ceiling and floor can help prevent noise from traveling to other classroom space. Simply angling partitions can help concentrate sound waves where they would better serve the learning experience. Establishing a schedule for "loud" times and "quiet" times across the floor helps avoid activity going on in one part of the room from disturbing another part of the room.

Background Information about Noise Levels

Scientists have devised a way to measure sound levels that humans hear, called the "A-weighted sound pressure level," expressed in dB(A) (Passchier-Vermeer & Passchier, 2000). Table 11 shows everyday noise sources with their relative sound levels according to WHO (2009b).

Table 11. Everyday Noise Sources and Relative Sound Levels

Source	Sound Level
Home appliances	78-102 dB(A)
Noise in hospitals	>70 dB(A)
Day-care institutions	75-81 dB(A)
Noise from toys (peak sounds)	79-140 dB(A)
Background noise in schools	46.5-77.3 dB(A)

When simply measuring ambient noise levels, one uses the decibel (dB). The majority of background noise in classrooms comes from near-by traffic (roads, railways, subways, and airports). In an environmental review study, researchers found that traffic was the major noise source for 86% of schools in London (UK) (Shield & Dockrell, 2003). Urban schools typically experience higher hourly-average noise levels that persist throughout the day, than suburban environments, because of traffic noise (Shield & Dockrell, 2003; WHO, 2009b; Passchier-Vermeer & Passchier, 2000; Lercher, Evans, Meis, & Kofler, 2002). Noise generated outside the classroom may intrude through walls, partitions, windows, openings, or reflected through ventilation ducts.

Noise from inside the classroom can be generated by children (e.g., scooting chairs, talking), the teacher, and/or mechanics (e.g., computer fans, air passing through vents, and overhead fans). Factors that affect noise in a classroom include the routing of HVAC air ducts, roofing/ceilings, door placement and their proximity to each other, classroom partition material and coverage, and placement (or lack of) soundproofing materials. The facility design and building materials can either help control or propagate noise.

The signal-to-noise ratio (SNR) is a key measure of classroom acoustics. This ratio is the relative sound level of a signal (e.g., teacher's voice or speaker) compared to the amount of background (ambient) noise. A positive SNR means the speaker's voice is louder than background noise. A negative SNR means the background noise is louder than the signal. The SNR permits a relatively quick way to assess the acoustic quality of a learning environment. Another key measure is reverberation time or how long it takes for a sound to decay in an enclosed space.

4.3.7. Community Perceptions of the Indoor Environment at Gerena

Investigators reviewed documented, anecdotal evidence from newspaper articles, social media, and television segments to gain a better understanding of how the school is perceived among community residents. There has been a lot of media coverage on the school, due to the quality of the conditions in the building and the vulnerable population the facility serves. Researchers coded the qualitative data acquired into common themes. The following three collective perceptions were expressed among community residents:

Perception #1: Conditions at Gerena Community School are <u>*unhealthy*</u> *and* <u>*not safe*</u> *for vulnerable populations, specifically asthmatics.*

There has been a lot of effort in investigating issues and repairing the facility in the past couple of years, but the continuous presence of mold, water, rust, and cracks in the floors and walls have contributed to the perceived "poor" state of the building. This perception is be mostly attributed to the conditions in the tunnels. The *New England Public Radio* interviewed one student passing through the tunnel, who stated "You can see [water] seeping down through the walls; and it was really noticeable. And it really doesn't look well" (Mostue, 2012). The tunnels, which are often residents' first and sometimes only exposure to the school, have contributed to an impression that the rest of the school is in disrepair (Mostue, 2012; Denney, Rivera, & Collins, 2013). The persistent issues with flooding and water coming into the building has caused rust buildup on metal surfaces and staining of floors, walls, and ceiling material.

> *"You can see [water] seeping down through the walls; and it was really noticeable. And it really doesn't look well."*
> *-Student using tunnel*

Among the different testimonials reviewed, residents and students continuously reported a heavy dampness and "musty" odor throughout the school. *The Republican* reported on a resident recalling his experience as a student at Gerena, stating "We didn't just have snow days; we had rain days at the school. There were days when it rained so much that school would be closed because there was flooding" (Roman, 2012). Jose Rosario, a community resident and parent of a student attending the school, told *Valley Advocate News*: "I saw the floor wet, the air smelled bad. [The air] was heavy. There were problems with the lights and the tunnel would be dark" (Kraft, 2012). For safety reasons, the offices and most of the community space in the tunnel were closed and blocked off (Sullivan, 2013).

Some parents reported that their children's asthma symptoms are hard to manage because of the conditions in the school (Mostue, 2012). School administrators believe that the difficulty in managing asthma symptoms in the school are more related to the overall exposures in the children's environment, such as in-home conditions and/or exposures on the way to school. This difference of opinion has led to increased use of asthma management plans for students and community outreach for improving awareness of factors that exacerbate asthma symptoms.

Other safety concerns related to the school involved the personal safety of students and people using the tunnel. In February 2012, the MA ESE performed a site visit to evaluate the conditions at Gerena. In the report, investigators cited the tunnel as an "unsafe public access way through the interior of the school," and "school leaders, teachers, and students reported feeling unsafe in the mall (tunnel) due to public access to the rest of the school" (MA ESE, 2012). The City of Springfield has already acted to address this issue by adding security cameras, a full-time security guard in the tunnel, and security doors to prevent public access to student areas during school hours. However, the safety measures have an unfavorable side effect: limiting the accessibility of the tunnel for residents after school hours. Jan Denney, Director of Elder Affairs for the City of Springfield, explained on *Connection Point* that flooding and air quality concerns have caused some residents to refrain from using the facility altogether (Denney, Rivera, & Collins, 2013).

Perception #2: Accessibility is a key determinant of facility use among community residents.

Many residents use the tunnels as the primary route for crossing the railroad tracks and interstate (I-91). Accessibility has been a historic issue to the community since the construction of the interstate and railroad segregated the neighborhoods. The tunnels under the school provide a safe and covered walkway that connects Brightwood neighborhood to other destinations, goods, businesses, and services. Other routes include accessing Highway 20 on the southern border and Wason Avenue on the northern border of the neighborhood.

Superintendent Daniel Warwick explained, in an interview on *Connection Point*, that the recent safety measures have improved safety, but also created some logistical challenges for keeping the tunnel accessible to the community (Sarno & Warwick, 2013). Due to funding and personnel limitations, the tunnel can only be open during school hours of operation (until 8:00 PM). Historically, the tunnel would stay open for residents on weekends and weekdays until 10:00 PM (Silva, et al., 2013). Until more funding is secured to hire more security personnel, the tunnel will have to remain closed to after-hour users.

Many residents have resorted to crossing the railroad tracks at non-pedestrian crossings as a quick and convenient alternative to the tunnels. Representative Cheryl Coakley-Rivera explained the dilemma of this trend on *Connection Point*, stating that "Children learned to cross the railroad tracks [from their parents]. They are now parents [themselves] and teaching their children to cross the railroad tracks" (Silva, et al., 2013). These individuals risk injury from being hit by a train and falling on the tracks. Plans have been drawn to expand the railroad line to serve high-speed industrial freight, posing a heightened level of danger to those who rely on this route. Not only is crossing the tracks hazardous, but the tracks are also on private property owned by the railroad company. Crossing the tracks is considered trespassing, a legally punishable offense. In addition, there have been reports of assaults and drug sales near the railroad tracks, which makes the tunnels all the more important to the safety of community residents.

Perception #3: Gerena Community School is an invaluable asset to the Community.

The school is viewed in large part as a historic and irreplaceable asset to the community. From its inception, the school was designed and built as part of the City of Springfield's plan "to achieve racial balance in the school system" (Office of Educational Quality and Accountability, 2005). In response to an order from the Supreme Judicial Court of the Commonwealth of Massachusetts, building the school would encourage racial diversity and provide needed social services and support to the vulnerable populations living in North End Community. Initially named "New North," Gerena Community School was intended to be the symbol of the "new" North End Community and the city's commitment to supporting the needs of residents (Gagnon, et al., 2013).

> *"As a student, you did not just attend the school, your whole family did. You grew up there, your kids went there, and memories were made there."*
> *-Zydalis Zayas, Latino Youth Media Institute*

Springfield historian, Fran Gagnon, explained that "the North End community was the top target area to place the community school due to the need being the greatest" (Gagnon, et al., 2013). English was not a common language in the homes of North End residents and the educational needs spanned multiple generations. In the past, many parents and residents attended night classes to learn English and earn their General Education Development (GED) certificate (Freedman & Figeretto, 2013). Zydalis Zayas, who reported on the history of the school, spoke on *Connection Point* stating, "As a student, you did not just attend the school, your whole family did. You grew up there. Your kids went there and memories were made" (Rivera, et al., 2013). The school has generated a rich history and social connectivity among residents. Social services were also provided in the community offices under the school. The added value of having the community offices in the school was that it greatly enhanced convenience for residents and parents to seek help and use support services (Manzi, Scavron, Perez, & Franco, 2013). Since the closure of these offices, community organizations have been gaining support to reopen these spaces.

According to North End resident, Ivette Hernandez, Gerena serves three functions: school, tunnel, and community space. Removing one of these functions would adversely affect residents, especially among different groups (Gagnon, et al., 2013). Amenities like the pool, gym, and underground tunnel provide residents with opportunities for year-round physical activity and social interaction. When this space is closed, residents must travel outside the community to find the same amenities. For those individuals with low incomes or disabilities, this presents a more burdensome challenge. Antonette Pepe, a member of the Springfield Schools Committee made the statement, "This is not just a school project; this is really a community project" (Roman, 2013).

Not everyone agrees the school is an asset. Some consider the school more of a hazard and a reason to rebuild. In a response to an article in the *Valley Advocate,* one North End resident protested renovating the school, stating "Gerena School is Springfield's most dramatic symbol of severe and chronic inequality; effectively diminishing the life chances of children that pass through these foreboding doors" (Kraft, 2012). There has been some misinformation about the amount of effort to address the concerns about the school. Many repairs to the facility were performed in areas not easily visible to the public, such as repairs to the HVAC unit and the purchase of new boilers. Patrick Sullivan, Director of PBRM, explained in an interview with New England Public Radio News that, "People don't usually see where we've put new water management pumps and motors in the building. It's understandable that people get frustrated, but a lot of work has been done" (Mostue, 2012). Frustrations have not necessarily been based on the amount of work that has been done, but in the work left to do. In an economic atmosphere of budget cuts and recession, not all received the estimated cost of $3 million well. Representative Cheryl Coackley-Rivera expressed her opinion stating, "Personally, I think a new school would be a better option, but the community has made it clear that they want to keep this school, and they want it repaired" (Kraft, 2012). Building a new school would require close to "ten years and an estimated $40 to 60 million" (Coakley-Rivera, Rolden, & Owens, 2013). Although this may be a solution for the long-term, it does not address the current issues facing the school. According to Mr. Sullivan, Gerena is a central asset to the community and stresses the importance of addressing the current issues, in addition to long-term planning (Sullivan, 2013).

4.4. Characterization of Respiratory Health Impacts

4.4.1. Review of the Evidence: How Indoor Air Affects Respiratory Health and Asthma

The properties of ambient and indoor air (e.g., presence of ambient pollutants, moisture, etc.) typically influences respiratory health by way of breathing comfort/ease, damaging tissue, and/or modifying symptoms of pre-existing conditions. Small particles in the air, specifically PM_{10}, can pass through the throat and lungs and even enter the bloodstream (EPA, 2012a). Researchers linked PM_{10} concentration in the ambient air to premature death in people with lung or heart disease, nonfatal heart attacks, irregular heartbeat, aggravated asthma, decreased lung function, and respiratory symptoms (EPA, 2012a). When inhaled, CO reduces oxygen delivery to the body's organs and can even cause death in large doses (EPA, 2012a). NO_X causes inflammation of airways and increased emergency room visits and hospital emissions for respiratory issues, especially asthma (EPA, 2012a). Typical asthma symptoms include wheezing, difficulty breathing, and irritated respiratory passages (EPA, 2012a). EPA developed the NAAQS based on scientific evidence linking exposure to ozone, nitrogen oxides, sulfur dioxide and particulate ambient air pollution to health risks, including asthma symptom exacerbation.

Asthma is a common public health problem with serious negative impacts, especially in young children. It is estimated that over 25.9 million Americans have asthma, in which over a fourth of that population is under 18 years old (CDC, 2011). The burden of asthma is not evenly distributed among ethnic or socio-economic groups. For example, asthma prevalence in the U.S. is highest among families living in poverty, persons of Hispanic ethnicity, and African Americans (Asthma Disparities Working Group, 2012). More specifically, asthma prevalence is 113% higher among populations of Puerto Rican descent, compared to “non-Hispanic Whites,” and 50% higher than “non-Hispanic African Americans” (CDC, 2011). The President’s Task Force on Environmental Health Risks and Safety Risks to Children developed an action plan aimed at increasing the understanding of the causes of pediatric asthma and reducing asthma-related disparities among children across racial and ethnic groups (President's Task Force on Environmental Health Risks and Safety Risks to Children, 2012). The recognition of asthma as a major public health problem has led to federal, state, and academic collaborative actions focused on reducing the burden of asthma, especially among vulnerable populations.

Children spend a lot of their time in school, about seven hours a day, which can be a potential source of asthma triggers. Those who participate in after-school activities or daycare have even longer exposure times. EPA recognized the importance of including the school environment when managing asthma and developed the Indoor Air Quality Tools for Schools Action Kit that provides recommendations to help manage asthma triggers. There are many challenges in controlling asthma triggers and managing asthma symptoms. For example, an individual with asthma may be sensitive to many asthma triggers, which can come from a variety of sources (National Asthma Education and Prevention Program, 2007). Therefore, each person should have an individualized comprehensive asthma management plan.

It is important to consider that school environment is not the only environment in which children are exposed to asthma triggers. It is important to consider that exposures can also occur inside the home and/or on the way to school via direct exposure to ambient (outdoor) air. Symptoms may not manifest until after students are in school.

Factors that Exacerbate Asthma Symptoms

There is strong research and agreement on the numerous environmental factors that exacerbate or trigger asthma symptoms (WHO, 2003; Massachusetts Medical Society, 2013). Asthma triggers are categorized into groups related to how they occur, such as environmental, emotional, physical activity-induced, medication-induced and food-related. In 2000, the Institute of Medicine (IOM) published a report identifying a list of exposures related to asthma symptom exacerbation, including dust mites, tobacco smoke, pet dander, cockroaches, fungi or molds, respiratory viruses, and combustion-source air pollutants (air pollutant byproducts of engine emissions or combustion reactions) (IOM, 2000). Since its release, the list of environmental exposures associated with asthma has expanded to over 300 chemicals and biological agents (Association of Occupational and Environmental Clinics, 2009).

To support the HIA, EPA researchers systematically reviewed the available evidence regarding exposures suspected to be risk factors for pediatric asthma and ranked them according to how often each was found to be a significant risk factor (refer to Appendix G for details). The list below provides the top fifteen most prominent risk factors associated with pediatric asthma (1 = most common, 15 = least common):

1. Dampness (in-home)
2. Mold (in-home)
3. PM_{10}
4. Cockroaches
5. SO_2 (sulfur dioxide)
6. CO (carbon monoxide)
7. Formaldehyde
8. Dog (dander and hair)
9. O_3 (ozone)
10. Cat (dander and hair)
11. Carpeting
12. NO_2
13. Proximity to major roads/traffic pollution
14. $PM_{2.5}$
15. Dust Mites

Although these categories are broad and may comprise of a group of sub-factors), researchers believed there was enough distinguishing information to identify the most common exposures with confidence. There are many other factors that contribute to adverse asthma symptoms, e.g., in-home conditions, allergies, etc., that were not considered in this ranking. Therefore, eliminating or controlling any one of these exposures may not reduce the occurrence of asthma symptoms.

The in-home environment is a considerable source of exposure to asthma triggers for both young children and adults. The National Center for Healthy Housing (2008) found that an average of 42% of homes have at least one structural defect, such as water leaks, roofing problems, damaged interior walls and signs of mice. The US Census Bureau's American Housing Survey data indicated that across metropolitan areas, rental properties tended to have more housing condition problems than owner-occupied homes. Dampness in homes was associated with a 50% increase for current asthma cases and a 30% risk increase for developing asthma (Fisk et al, 2007). Krieger and Higgins (2002) found a relationship between substandard housing and the incidence of asthma, respiratory diseases, and other health and safety problems.

4.4.2. Predicted Respiratory Health Impacts from Proposed Renovations

The HIA Core Group reviewed the evidence from each of the sub-analyses and relied on professional expertise to discuss and qualitatively characterize anticipated impacts to respiratory health that may result from the renovation options considered by PBRM. The HIA Core Group also considered the distribution of impact, especially among VIPs, drawing from the ranked risk factors for pediatric asthma. The characterization of respiratory health impacts were formed using the Delphi method (a structured, interactive discussion among a panel of experts) and the determined criteria established in the Scoping step.

Table 12 summarizes the predicted impacts of each of the proposed renovations on respiratory health, especially among those with asthma.

Table 12. Summary of Predicted Respiratory Health Impacts from Proposed Renovations

Proposed Renovations	Direction	Likelihood	Magnitude	Distribution	Strength of Evidence
1. Eliminate water and accumulation of moisture from entering the building. Continue investigations in the source(s) of water infiltration, and implement necessary repairs and upgrades as needed.	renovation will yield a health benefit	Highly Likely	Many	vulnerable populations will benefit more	many strong studies (n > 10)
2. Remove and discard porous building materials that have been wet for greater than 48-hours and not professionally dried and cleaned or show visible evidence of mold growth. Consider replacing removed materials with those not affected by water or moisture (i.e., ceramic tile flooring) in areas where water infiltration occurs.	renovation will yield a health benefit	Highly Likely	Many	vulnerable populations will benefit more	many strong studies (n > 10)
3. Continue with efforts to evaluate the HVAC system to ensure proper design and distribution (i.e., flow, balancing, fresh air introduction, etc.) is in place.	renovation will yield a health benefit	Highly Likely	Many	vulnerable populations will benefit more	many strong studies (n > 10)
4. Re-evaluate optimal location for fresh air intakes of Building A and, if appropriate, swap intakes for Building B with exhausts.	renovation will yield a health benefit	Highly Likely	Many	vulnerable populations will benefit more	many strong studies (n > 10)
5. Repair/upgrade all air handling units and exhaust systems in Building B, including fresh air intake dampers, controls, and associated equipment for air handling units. Rebalance system after replacements/upgrades are implemented.	renovation will yield a health benefit	Highly Likely	Many	vulnerable populations will benefit more	many strong studies (n > 10)

Proposed Renovations	Direction	Likelihood	Magnitude	Distribution	Strength of Evidence
6. Install a new exhaust fan and duct system for Tunnel C to exhaust air from outer tunnel space to exterior of building.	renovation will yield a health benefit	Highly Likely	Many	vulnerable populations will benefit more	many strong studies (n > 10)
7. Seal outer Tunnel C completely off from the inner tunnel space, in order to prevent air from traveling between spaces.	renovation will yield a health benefit	Highly Likely	Many	vulnerable populations will benefit more	many strong studies (n > 10)
8. Contract a qualified, certified professional to test the indoor air quality.	No Effect	[Blank]	[Blank]	[Blank]	[Blank]
9. Contract a qualified, certified professional to test for hazardous materials (HAZMATs) prior to any demolition.	No Effect	[Blank]	[Blank]	[Blank]	[Blank]
10. Conduct an outdoor air quality test and wind study at different locations on school campus, including the current locations, to investigate optimal locations for air intake louvers, and relocate louvers to optimal location, if appropriate.	No Effect	[Blank]	[Blank]	[Blank]	[Blank]
11. Complete comprehensive HVAC replacement program, including replacement of all of the existing air handling units and their controls, expanding the Building Management System (BMS), exhaust and return fans, boilers, pipes, associated appurtenances (i.e., valves, dampers, controls, louvers, air separator, expansion tank, etc.), and modifications to some of the mechanical piping and ductwork.	renovation will yield a health benefit	Highly Likely	Many	vulnerable populations will benefit more	many strong studies (n > 10)

Proposed Renovations	Direction	Likelihood	Magnitude	Distribution	Strength of Evidence
12. For Building B, replace and upgrade boilers, including associated appurtenances (e.g., flue, pumps, piping, ductwork, etc.) with higher efficiency, sealed combustion condensing type boilers.	No effect	[Blank]	[Blank]	[Blank]	[Blank]
13. For Buildings A and C, further investigate into the walls' interior construction and assess conditions and need for repairs, including seasonal monitoring of groundwater level, and replace stormwater pump stations, as needed.	renovation will yield a health benefit	Highly Likely	Many	vulnerable populations will benefit more	many strong studies (n > 10)
14. For Building A, replace roofing membrane; install a waterproof membrane; install new drains, a sill pan and new door weather stripping for exposed east end of tunnel; isolate the new roof from the roof beneath the overpass; and repair concrete masonry unity (CMU) walls.	renovation will yield a health benefit	Highly Likely	Many	vulnerable populations will benefit more	many strong studies (n > 10)

Discussion

Dampness and mold (indoors) were the two most common risk factors associated with asthma. Moisture and ample amounts of food (e.g., carpet, ceiling tiles, cardboard, paper, etc.) provide a favorable habitat for mold growth. Eliminating sources of water intrusion would not only provide better control of indoor humidity, but also limit mold growth. Removing building materials damaged by water, especially if they are already contaminated with mold, would help to limit mold from growing and dispersing spores. Mold remediation/clean-up efforts should be focused in the areas where high levels of mold spores were found – classroom pods, afterschool room (Lower Level of Building B), and Administration Office. Even if these areas do not have active or readily identifiable sites of mold growth, settled dust sampling showed high levels of historic mold spore contamination, which increases the risk for these areas to develop mold growth. Extensive cleaning and/or removing potential food sources for mold, where possible, will also help to control mold growth.

Continuing to evaluate and adjust the HVAC system control logic may help to improve airflow in the building simply by reducing pressure gradients between spaces. Swapping the current air intake locations for Tunnel A may help reduce the levels of combustion-source air pollutants coming into the building at that location, provided that more optimal locations for the intakes can be found. Further study is needed to identify the best locations for the intakes. Repairing/upgrading the AHUs in Building B and ensuring the damper doors are open will help to ensure that an adequate fresh, outdoor air is being supplied, which will better control carbon dioxide levels in occupied spaces. Efforts should be focused on the AHUs already identified that have malfunctions and do not currently meeting the code requirements for supplying fresh air (i.e., units 23 and 24, serving the Main Office and Media Center in Building B).

Installing a new exhaust fan and duct system in Tunnel C will not only help control dampness and the opportunity for mold development, but also help to address airflow concerns. It is important to keep in mind that Tunnel C is in actuality a tunnel within a tunnel. Currently, the inner tunnel space (occupied mall area) has a negative pressure, relative to the outer tunnel space (mechanical corridor). This pressure gradient causes air to be drawn from the outer tunnel space, which has excessive water intrusion and mold, into the inner tunnel space where people are. Adding an exhaust system will change the pressure in the inner tunnel space to a slightly positive pressure, relative to the outer tunnel, causing air to flow in the opposite direction (i.e., from occupied, mall space to unoccupied, mechanical space). This change may also affect the damp and "musty" odor observed in the inner tunnel. Simply adding an exhaust system will not be sufficient to changing the airflow between these two spaces. The outer tunnel must be completely air-sealed from the inner tunnel so that air cannot find an alternative pathway between the spaces and disrupt the intended airflow. In addition, sealing the inner tunnel from the outer tunnel (airtight) will also act as a barrier against moisture and mold intrusion.

Testing for hazardous materials (HAZMATs) was not performed as part of this HIA, considering building materials were not disturbed during the assessment. However, it is important that testing for HAZMATs be performed prior to any demolition or disturbing building materials so that no adverse health impacts occur. Due to the building's age, the risk for asbestos being used in the building material is great and disturbing materials with asbestos can cause significant health hazards. Further investigations in the tunnels are not expected to affect the indoor air, unless identified sites of water intrusion are fixed. Efforts to waterproof Tunnel A will help to further eliminate intrusion of water and better control humidity and mold development.

Performing an outdoor air quality test, in conjunction with a wind study, will help identify optimal locations for air intakes. Air intakes should be sited where there is the lowest amount of ambient pollutants, considering wind direction and turbulent drafts around structures. Relocating the air intakes will require extensive redesign of the HVAC system and ductwork. A comprehensive HVAC replacement program would ensure an adequate amount of fresh, outdoor air is delivered to all occupied spaces in the building and temperature and humidity are tightly controlled. Ambient air pollutants may be reduced if the HVAC replacement is designed efficiently and appropriate filters are used. Replacing the boilers in Building B with efficient and sealed combustion condensing type boilers will help ensure the combustion-source pollutants observed in the building are not coming from the school's boilers.

4.5. Characterization of Acoustic Health Impacts in the Classroom

4.5.1. Review of the Evidence: How Classroom Noise and Acoustics can Impact Health

Classroom Noise and Health

As part of this assessment, researchers reviewed the available evidence regarding classroom noise exposure, health, and student performance. In excess, noise can be a pollutant and an environmental stressor for health. Sounds heard at or above 116 dB(A) can cause physical pain in humans (Ann-Heng, 2012). The legally permissible sound level according to OSHA and the EPA is 90 dB(A), but the EPA must take action (e.g., setting controls and monitoring) when noise levels reach 85 dB(A) (Ann-Heng, 2012). Typical sound levels in the classroom register between 46-77 dB(A) (WHO, 2009b).

The reaction to noise can change from one individual to another, due to individual sensitivities (tolerance) and age. Sensitivity to noise in a classroom can depend on the noise source, sound level and duration of exposure. Several international committees were established to assess noise as a pollutant and its effect on health, including the Committee on Noise and Health (1994) and the International Commission of the Biological Effects of Noise (1988) (Passchier-Vermeer & Passchier, 2000). The American Speech-Language and Hearing Association (ASHA) Working Group on Classroom Acoustics specifically look at the health effects of ambient noise in the classroom (ASHA, 2005). There is sufficient evidence that exposure to noise, particular to level and duration, can affect physiological functions, mental stress, and individual attitudes and behaviors (Passchier-Vermeer & Passchier, 2000; Shield & Dockrell, 2003). The most reported, and thus studied, outcome from exposure to noise in the classroom was annoyance. Annoyance can lead to feelings of frustration, anger, and/or depression (Shield & Dockrell, 2003). Typically, it is through changes in behavior and attitudes that ambient noise affects school performance.

Classroom Acoustics and School Performance

Poor classroom acoustics and/or events of excessive noise have been found to influence cognition, specifically memory, information processing, attention, and speech recognition (Shield & Dockrell, 2003; Shield & Dockrell, 2008; WHO, 2009b; Nelson & Soli, 2000; Passchier-Vermeer & Passchier, 2000; Lercher, Evans, Meis, & Kofler, 2002; Hodgson & Nosal, 2002). Ambient noise affects cognition and memory by disrupting concentration or overloading the sensory system, which can lead to a reduced ability to process new information. Students may adapt to excessive ambient noise by “tuning-out” sounds, and incidentally nondiscriminatory “tuning-out,” leading to a student’s perceived poor attention (Shield & Dockrell, 2008). The combined effects can make learning more difficult, especially when learning a new language. Shield and Dockrell (2003) found that consonant identification in a poor acoustic environment doesn’t reach adult level until the late teenage years. In general, it is imperative to ensure the learning environment provides good speech intelligibility and removes or mitigates barriers to hearing.

Speech intelligibility is the hearing and understanding of speech (Shield & Dockrell, 2003). A high amount of background noise can make listening and understanding a speaker more difficult. The speaker’s voice level and clarity between the consonants and vowels can be masked or distorted from the sound waves of another noise (ASHA, 2005). Reflected sounds join together creating background noise, which can overpower a person’s voice making it hard for the listener to understand the speaker (ASHA, 2005). Vowels, when reflected, tend to mask consonants (especially final or end consonants) (ASHA, 2005). Speech intelligibility tests are often used in testing the sound acoustics of a classroom to optimize learning and language development. On average, listeners with normal hearing can only understand 75% of the words spoken in a classroom (Acoustical Society of America, 2013). Typically, speech intelligibility is greater in classrooms that do not reverberate sound. Raising the speaker's voice (so it could be heard above any potential background noise) can also help to improve speech intelligibility.

There is some anecdotal evidence that teachers are also affected by excessive noise in the classroom. In the UK, a greater incidence of teacher complaints about noise occurred when levels reached greater than 60 dB (Shield & Dockrell, 2003). One case study cited "almost 70% of Washington teachers reported that their classrooms and hallways were so noisy that it affected their ability to teach" (Buckley, Schneider, & Shang, 2004). However, the evidence that poor classroom acoustics may negatively affect teacher performance and physical health is very limited considering impacts are self-reported and there are many other influential factors.

It is important to consider other factors that can influence student performance too, such as learning ability, primary language spoken, and residual effects from the home environment. When researchers controlled for source types of noise and socio-economic status, there was still a statistically significant relationship between noise levels in school and average SAT scores among elementary students (Shield & Dockrell, 2008). This finding suggests that students who continually perform low on standardized tests, either due to not "listening" or not physically being able to hear/understand different factors of speech, may benefit from improving the acoustic environment. Several of the studies reviewed found that poor classroom acoustics was a common condition among low-performing elementary schools.

Unexpectedly, there have been some instances where a short exposure of excessive noise temporarily benefited scholastic performance. In one particular case study, children exposed to excessive internal and external noise for a short period of time performed significantly better (based in a widely accepted scientific standard) than children in normal (i.e., control) conditions (Shield & Dockrell, 2008). Investigators explained that short periods of increased arousal conditions would increase performance on tasks temporarily due to required focusing and concentration. However, continued high levels of arousal resulted in concentration fatigue and lowered performance. Therefore, it is unlikely that children in this condition would continue to perform at a higher level over a long period of exposure.

Populations More Sensitive to Classroom Noise and the Acoustic Environment

Differences in health outcomes related to noise exist among sub-groups in the United States. Children with temporary ear infections and/or are on ototoxic medication are more sensitive to excessive noise because their hearing organ cells are already damaged. Noise-induced hearing threshold shifts (NITS) was more frequent in males than females; in older children than younger children; among children of lower socio-economic status compared, and urban versus rural areas (Niskar, 2001). In an earlier study by Berglund and Lindvall (1995), older children (13<18 years) were thought to be more affected by excessive noise levels than younger children (<13 years) because they have been exposed to high noise levels longer, increasing their risk for permanent shifts (Berglund & Lindvall, 1995). It was later found that younger children are more annoyed by noise than older children are, but older children are more aware of noise when it occurs (Shield & Dockrell, 2008). Children, who suffer from prolonged NITS or share temporary symptoms due to colds or infection, may require special educational needs to assist with reduced hearing ability.

Many studies have shown a relationship between higher ambient noise levels in school and children, with pre-existing special education needs, who experience disproportionate negative physical, psychological, and cognitive effects (Shield & Dockrell, 2008; ASHA, 2005). Children with behavior disorders, such as attention deficit disorder and attention deficit hyperactivity disorder, are more sensitive to any stimulation and easily distracted. Students with special needs require a strict SNR, especially if they are less than 15 years old (ASHA, 2005). At 6+ SNR, which means the speaker's voice is only 6 dB above the background noise, minimum hearing loss is 13% lower in special needs children (ASHA, 2005). At -6 SNR, the background noise is 6 dB above the speaker's voice, hearing loss is reduced by 33% (ASHA, 2005). Poor acoustic learning environments disproportionately hinder students learning a new language or who do not have English as their primary language, even if they have normal hearing.

The Opportunity to Benchmark

Although this HIA did not analyze in-classroom noise measures, it is commonly recognized that classroom acoustics are important to the scholastic performance and psychosocial development of all children. Thus, the HIA Core Group suggests performing noise measurements in the classrooms (both during occupied and unoccupied states) and compare observations to set standards for adequate sound quality.

Eight European countries, as well as Australia and New Zealand, have implemented their own guidelines for classroom acoustics (Mazz, 2013). In the U.K., the Department for Education and

Skills published guidelines to meet their national standards titled *Building Bulletin 93: Acoustic Design of Schools (A design Guide)*. The WHO also published standards and guidelines regarding optimal acoustics for the learning environment. In the U.S., national standards and guidelines were established by the American National Standards Institute (ANSI), titled *ANSI S12.60-2002 Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools*. According to the ANSI standards, the recommendations for noise in an unoccupied classroom must not exceed 35 dB(A), the SNR should be at least +15 dB at the child's ear, and the unoccupied reverberation times must not surpass 0.6 seconds in smaller classrooms (0.7 seconds in rooms 10,000 ft^3 – 20,000 ft^3) (Acoustical Society of America, 2013). In a 2002 survey of American elementary classrooms, investigators found that many classrooms did not meet the preferred acoustical standards for classrooms (Knecht, Nelson, Whitelaw, & Feth, 2002). Table 13 provides a comparison between national and international standards.

Table 13. Summary of classroom acoustic standards and guidelines

Acoustic Parameter	ANSI (USA)[†]	BB93 (UK)	WHO*	ASHA*(USA)
Noise Level (unoccupied)	35dB(A)	35dB(A)	35dB(A)	30-35dB(A)
Reverberation Time (unoccupied)	0.6 sec (<283m^2) 0.7 sec (≤566m^2)-	< 0.6sec	0.6sec	0.4sec
Signal to Noise Ratio	[None Found]	[None Found]	≥ 15 dB	≥ 15dB
Open-Plan Teaching Areas ($L_{Aeq, 30\ min}$) Hearing-Impaired	35 dB 40dB (>566 m^2)	40dB 30 dB	[None Found]	[None Found]

[*] Did not indicate acoustic parameters for open-plan teaching areas
[†] Uses background noise level for 1 hour ($L_{Aeq,1\ hour}$)

4.5.2. Predicted Impacts from Proposed Renovations

The HIA Core Group reviewed the evidence from each of the sub-analyses and relied on professional expertise to discuss and qualitatively characterize anticipated impacts to classroom acoustics that may result from the renovation options considered by PBRM. The HIA Core Group also considered the distribution of impact, especially among VIPs. The characterization of respiratory health impacts were formed using the Delphi method (a structured, interactive discussion among a panel of experts) and the determined criteria established in the Scoping step.

Table 14 summarizes the predicted acoustic-related health impacts of each renovation option.

Table 14. Summary of Predicted Acoustic-Related Health Impacts from Proposed Renovations

Proposed Renovation Option	Direction	Likelihood	Magnitude	Distribution	Strength of Evidence
1. Eliminate water and accumulation of moisture from entering the building. Continue investigations in the source(s) of water infiltration, and implement necessary repairs and upgrades as needed.	No Effect	[Blank]	[Blank]	[Blank]	[Blank]
2. Remove and discard porous building materials that have been wet for greater than 48-hours and not professionally dried and cleaned or show visible evidence of mold growth. Consider replacing removed materials with those not affected by water or moisture (i.e., ceramic tile flooring) in areas where water infiltration occurs.	renovation will yield a health harm	Highly Likely	Moderate	vulnerable populations will be harmed more	many strong studies (n > 10)
3. Continue with efforts to evaluate the HVAC system to ensure proper design and distribution (i.e., flow, balancing, fresh air introduction, etc.) is in place.	No Effect	[Blank]	[Blank]	[Blank]	[Blank]
4. Re-evaluate optimal location for fresh air intakes of Building A and, if appropriate, swap intakes for Building B with exhausts.	renovation will yield a health benefit	Some-what Likely	Moderate	vulnerable populations will benefit more	a few good studies exist (n > 3 < 10)
5. Repair/upgrade all air handling units and exhaust systems in Building B, including fresh air intake dampers, controls, and associated equipment for air handling units. Rebalance system after replacements/upgrades are implemented.	renovation will yield a health benefit	Not Very Likely	Few	vulnerable populations will benefit more	a few good studies exist (n > 3 < 10)
6. Install a new exhaust fan and duct system for Tunnel C to exhaust air from outer tunnel space to exterior of building.	No Effect	[Blank]	[Blank]	[Blank]	[Blank]

Proposed Renovation Option	Direction	Likelihood	Magnitude	Distribution	Strength of Evidence
7. Seal outer Tunnel C completely off from the inner tunnel space, in order to prevent air from traveling between spaces.	No Effect	[Blank]	[Blank]	[Blank]	[Blank]
8. Re-evaluate optimal location for fresh air intakes of Building A, if appropriate, and swap intakes for Building B with exhausts.	renovation will yield a health benefit	Some-what Likely	Moderate	vulnerable populations will benefit more	a few good studies exist (n > 3 < 10)
9. Contract a qualified, certified professional to test the indoor air quality.	No Effect	[Blank]	[Blank]	[Blank]	[Blank]
10. Contract a qualified, certified professional to test for hazardous materials (HAZMATs) prior to any demolition.	No Effect	[Blank]	[Blank]	[Blank]	[Blank]
11. Conduct an outdoor air quality test and wind study at different locations on school campus, including the current locations, to investigate optimal locations for air intake louvers, and relocate louvers to optimal location, if appropriate.	No Effect	[Blank]	[Blank]	[Blank]	[Blank]
12. Complete comprehensive HVAC replacement program, including replacement of all of the existing air handling units and their controls, expanding the Building Management System (BMS), exhaust and return fans, boilers, pipes, associated appurtenances (i.e., valves, dampers, controls, louvers, air separator, expansion tank, etc.), and modifications to some of the mechanical piping and ductwork.	renovation will yield a health benefit	Highly Likely	Many	vulnerable populations will benefit more	many strong studies (n > 10)
13. For Building B, replace and upgrade boilers, including associated appurtenances (e.g., flue, pumps, piping, ductwork, etc.) with higher efficiency, sealed combustion condensing type boilers.	No Effect	[Blank]	[Blank]	[Blank]	[Blank]

Proposed Renovation Option	Direction	Likelihood	Magnitude	Distribution	Strength of Evidence
14. For Buildings A and C, further investigate into the walls' interior construction and assess conditions and need for repairs, including seasonal monitoring of groundwater level, and replace stormwater pump stations, as needed.	No Effect	[Blank]	[Blank]	[Blank]	[Blank]
15. For Building A, replace roofing membrane; install a waterproof membrane; install new drains, a sill pan and new door weather stripping for exposed east end of tunnel; isolate the new roof from the roof beneath the overpass; and repair concrete masonry unity (CMU) walls.	No Effect	[Blank]	[Blank]	[Blank]	[Blank]

Discussion

The design and placement of building materials is critical in the control of the acoustic environment. Materials related to the HVAC system, such as ductwork, fans, diffusers, could contribute to the amount of background noise in a classroom. For example, longer ductwork makes it harder for noise to travel between classrooms. Broken or poorly placed diffuser inlets/outlets can increase background noise. Renovations that would alter the ductwork or related equipment would affect the ability of noise to travel between rooms. Using material that has high noise absorption coefficients helps to reduce the amount of background noise. Absorptive materials work best when spread throughout the room and not concentrated on just one section of wall or ceiling. When not replaced, removing noise-absorbing material (e.g., carpeting or upholstery) can negatively affect the acoustic environment. Ceramic floor tiles or other similar material reverberate noise in a room, often causing echoes. Renovations that would remove or decrease the amount of noise-absorbing material will negatively affect the noise levels in that space.

4.6. Characterization of Health Impact Related to Community Perceptions

4.6.1. Review of the Evidence: How Community Perceptions Can Affect Health

Researchers performed a review of the available scientific evidence regarding factors that influence perceptions or the collective opinions and feelings among residents in a community. Based on the evidence found, there are two main factors that influence the development and perpetuation of perceptions – the social and physical environments. The perceived environment, including both physical and social features, may influence health by inducing stress and/or influencing human behavior and attitudes. Stress (i.e., psychosocial stress) is the mental-physiological response caused by perceived and actual stressors in the environment (Wandersman & Nation, 1998). The body's response to stress can be external (e.g., a change in attitudes and behaviors that influence social interactions) or internal (e.g., increased blood pressure and hypersensitivity to stimulus). When stress persists for a long time, mental and physical health can deteriorate leading to chronic illness and disability; e.g., hypertension, cardiovascular disease, and immune dysfunction (McEwen, 2008; Latkin & Curry, 2003; Glaser & Kiecolt-Glaser, 2005).

Community Perceptions, the Social Environment, and Health

Demographics (e.g., age, race, ethnicity, etc.), family or household structure, and native language (i.e., primary language spoken at home) are all features of the immediate social environment that can influence human behavior and attitudes. Social interaction is greatly influenced by the perceptions (i.e., feelings and opinions) of those individuals within a group, immediate social structures, and cultural norms (Savolainen, 2000; Larsen, et al., 2004). In a community-based study, the odds of self-reported poor health were higher in areas perceived as less neighborly, than areas perceived as more neighborly (Bowling, Barber, Morris, & Ebrahim, 2006). Berkman et al (2000) found that once ill, socially isolated individuals had a higher risk of premature death than those with stronger social networks. When perceptions are unified, or when many people share the same opinions and feelings, the community is described as having high level social cohesion (Friedkin, 2004). Social cohesion can benefit the community because it increases the capability or capacity for a community to bond and come together to support a common goal.

Community norms and values determine the social status of an individual in that community. Having a large group of individuals with a high social status and shared norms and values can lead to positive health impacts in the community (Aneshensel & Sucoff, 1996). In a literature review by Kim (2008), lower collective neighborhood socioeconomic status was found to be strongly linked with a higher risk of depression among residents. Larsen et al (2004) found that residents with high social status and longer residency were more likely to participate in activities that built stronger social ties and trust in other residents in the community. A positive social environment can protect health against the effects of other environmental stressors, such as poverty and crime (Bowling, Barber, Morris, & Ebrahim, 2006; Savolainen, 2000).

When a perceived dysfunction or environmental stressor in the community persists, the social environment can follow a downward cycle of adverse impacts, called the cycle of social decline, which greatly limits the community's collective ability to address issues. When environmental conditions become deteriorated, residents may perceive a loss of control over their environment. The perceived "lack of control over one's life" can lead to unhealthy attitudes and behaviors, such as anxiety and depression. When behaviors become uncivil, such as increased violence and vandalism, residents and visitors are discouraged from socializing further, which limits the ability to bond and develop social ties. Increased social disorder and physical decline of the community can lead to increased fear of crime, anxiety, and the severity of depression (Kim, 2008; Ross C. , 2000; Wandersman & Nation, 1998). In contrast, some studies that have shown an "informal social control" can greatly influence behaviors and attitudes (Berkman, Glass, Brissette, & Seaman, 2000). The social environment was found to be independently linked to overall risk of disease and pre-mature death in a community (Yen & Syme, 1999). Thus, conditions that detract from the social environment may also detract from health.

Community Perceptions, the Physical Environment, Health, and Neighborhood Facility Use

Researchers have observed that when the physical environment begins to deteriorate, individuals living in that environment begin to feel less healthy, also referred to as the "sick building syndrome." In a study looking at relationships between building conditions and perceived health, researchers reported that schools perceived to be in poorer condition had teachers with lower self-reported health (Buckley, Schneider, & Shang, 2004). Bowling et al (2006) found a strong connection between poor conditions of neighborhood facilities and the odds of perceived poor health among neighborhood residents. In their 2006 study, residents were twice as likely to rate themselves with the lowest level of perceived health, if they lived in a neighborhood with deteriorated facilities, than if they lived in a neighborhood with facilitates in good condition (Bowling, Barber, Morris, & Ebrahim, 2006). Kim (2008) found that the physical conditions of a neighborhood and its assets seemed to affect social capital and mental health, more so in the U.S. than in other countries studied.

Researchers have found that the perceived physical environment also plays an important role in the use of neighborhood facilities and health-related behaviors. For example, areas perceived as safe and secure encourage use and occupancy of those areas. Miles (2008) found that in communities that seemed safer and in less disorder, residents were more likely to let their children play in local public playgrounds than those that lived in neighborhoods that were perceived as less safe. Utilizing public spaces create an opportunity for social interaction and physical activity, which may decrease stress.

Accessibility and perceived barriers to destinations is another influential factor in using neighborhood facilities (Saelens, Sallis, Black, & Chen, 2003; Patnode, et al., 2010). The placement and accessibility of a neighborhood facility can also influence occupancy of that space. Neighborhoods perceived as pedestrian-friendly, aesthetically pleasing, highly populated, and well-connected seemed to encourage more outdoor physical activity than other neighborhoods. Being physical active is important to overall health because of its comprehensive protective effects against disease and disability (Warburton, Nicol, & Bredin, 2006). Physical activity strengthens bones and muscles; prevents the clogging of arteries and veins; protects against certain cancers (e.g., colon and breast cancer); reduces obesity; and can help control type-2 diabetes (Warburton, Nicol, & Bredin, 2006; Ross C. , 2007). Physical activity has also been found to improve mental health by reducing stress and the risk and severity of depression and anxiety (Fox, 1999). Public spaces that encourage physical activity benefit community health.

In contrast, areas perceived to be unsafe or insecure can act as a barrier to facility use and even deter residents from using neighborhood space. The presence of social disorder (e.g., vandalism, harassment, etc.), especially in combination with previous experiences, can lower a person's perceived safety and security. The amount of deteriorated buildings in a neighborhood was found to predict levels of perceived safety among residents (Kim, 2008; Kruger, Reischl, & Gee, 2007; Wandersman & Nation, 1998). Crime levels in a neighborhood were also found to be closely connected to the perceptions of neighborhood disorder (Kruger, Reischl, & Gee, 2007; Latkin, German, Hua, & Curry, 2009). In areas where social disorder is high, residents tend to avoid that space to reduce their risk of injury or harm. Avoidance of public spaces that provide opportunities for physical activity and social interaction can detract from overall health and well-being.

Although there are many studies that found strong evidence linking the physical environment with physical activity, very few studies dispute the connection. Specifically, little to no evidence of an association existed when researchers looked at only a few factors at a time, or they looked at affects among sub-groups in the population (e.g., minorities or adolescents) (Norman, et al., 2006; Steptoe & Feldman, 2001; Dulin-Keita, Thind, Affuso, & Baskin, 2013). The mechanisms related to human behaviors are often complex and may rely on multiple mediators. Therefore, studies that investigate human behavior must be comprehensive and inclusive of all potential mediating factors.

Populations More Sensitive to the Perceived Environment

Perspectives of the environment do not influence everyone equally. Economically disadvantaged individuals are also more likely to be influenced by the social environment; as stated previously, social effects accentuate impacts of economic disadvantages. Elderly adults, especially those who suffer from decreased physical mobility and mental decline, may experience the effects of social isolation more so than others (Yen, Michael, & Perdue, 2009); however, the evidence of neighborhood influence on elderly adult health was limited. Children are highly susceptible to the influences of the social environment. Being of younger age has been linked to more negative opinions of the community (Latkin, German, Hua, & Curry, 2009; Sampson & Raudenbush, 1999). This may be because children are more impressionable and are highly influenced by peers, more so than adults are. The effects of perceived environment are different between males and females. The protective effect of neighborhood walk-ability against depression was greater in men than women (Berke, Goltlieb, Moudon, & Larson, 2007). Girls are more susceptible to perceived safety and its impacts on mental health and depression. In their 2010 study, which examined barriers to physical activity, Patnode et al. (2010) found that girls reported being impacted more by perceived safety than boys, and that self-efficacy was the only significant barrier for physical activity levels among boys. In addition, many adolescent mental health disorders (such as anxiety and depression), which can stem from community perception, often carry into adulthood (Aneshensel & Sucoff, 1996; McEwen, 2008).

4.6.2. Predicted Impacts from Proposed Renovations

The HIA Core Group reviewed the evidence from each of the sub-analyses and relied on professional expertise to discuss and qualitatively characterize anticipated impacts community perceptions that may result from the renovation options considered by PBRM. The HIA Core Group also considered the distribution of impact, especially among VIPs. The characterization of perception-related health impacts were formed using the Delphi method (a structured, interactive discussion among a panel of experts) and the determined criteria established in the Scoping step. Table 15 summarizes the predicted health impacts each renovation option may have on the perceived environment in Gerena.

Table 15. Summary of Predicted Perception-related Health Impacts of Proposed Renovations

Proposed Renovation Option	Direction	Likelihood	Magnitude	Distribution	Strength of Evidence
1. Eliminate water and accumulation of moisture from entering the building. Continue investigations in the source(s) of water infiltration, and implement necessary repairs and upgrades as needed.	renovation will yield a health benefit	Highly Likely	Many	vulnerable populations will benefit more	many strong studies (n > 10)
2. Remove and discard porous building materials that have been wet for greater than 48-hours and not professionally dried and cleaned or show visible evidence of mold growth. Consider replacing removed materials with those not affected by water or moisture (i.e., ceramic tile flooring) in areas where water infiltration occurs.	renovation will yield a health benefit	Highly Likely	Many	vulnerable populations will benefit more	many strong studies (n > 10)
3. Continue with efforts to evaluate the HVAC system to ensure proper design and distribution (i.e., flow, balancing, fresh air introduction, etc.) is in place.	No Effect	[Blank]	[Blank]	[Blank]	[Blank]
4. Re-evaluate optimal location for fresh air intakes of Building A and, if appropriate, swap intakes for Building B with exhausts.	renovation will yield a health benefit	Some-what Likely	Moderate	equal impact to all	no specific study but pathway of impact is possible
5. Repair/upgrade all AHUs and exhaust systems in Building B, including fresh air intake dampers, controls, and associated equipment for air handling units. Rebalance system after replacements/upgrades are implemented.	No Effect	[Blank]	[Blank]	[Blank]	[Blank]

Proposed Renovation Option	Direction	Likelihood	Magnitude	Distribution	Strength of Evidence
6. Install a new exhaust fan and duct system for Tunnel C to exhaust air from outer tunnel space to exterior of building.	renovation will yield a health benefit	Some-what Likely	Moderate	equal impact to all	no specific study but pathway of impact is possible
7. Seal outer Tunnel C completely off from the inner tunnel space, in order to prevent air from traveling between spaces.	renovation will yield a health benefit	Not Very Likely	Moderate	equal impact to all	no specific study but pathway of impact is possible
8. Contract a qualified, certified professional to test the indoor air quality.	No Effect	[Blank]	[Blank]	[Blank]	[Blank]
9. Contract a qualified, certified professional to test for hazardous materials (HAZMATs) prior to any demolition.	No Effect	[Blank]	[Blank]	[Blank]	[Blank]
10. Conduct an outdoor air quality test and wind study at different locations on school campus, including the current locations, to investigate optimal locations for air intake louvers, and relocate louvers to optimal location, if appropriate.	No Effect	[Blank]	[Blank]	[Blank]	[Blank]
11. Complete comprehensive HVAC replacement program, including replacement of all of the existing air handling units and their controls, expanding the Building Management System (BMS), exhaust and return fans, boilers, pipes, associated appurtenances (i.e., valves, dampers, controls, louvers, air separator, expansion tank, etc.), and modifications to some of the mechanical piping and ductwork.	renovation will yield a health benefit	Highly Likely	Many	vulnerable populations will benefit more	many strong studies (n > 10)

Proposed Renovation Option	Direction	Likelihood	Magnitude	Distribution	Strength of Evidence
12. For Building B, replace and upgrade boilers, including associated appurtenances (e.g., flue, pumps, piping, ductwork, etc.) with higher efficiency, sealed combustion condensing type boilers.	No Effect	[Blank]	[Blank]	[Blank]	[Blank]
13. For Buildings A and C, further investigate into the walls' interior construction and assess conditions and need for repairs, including seasonal monitoring of groundwater level, and replace stormwater pump stations, as needed.	renovation will yield a health benefit	Highly Likely	Many	vulnerable populations will benefit more	many strong studies (n > 10)
14. For Building A, replace roofing membrane; install a waterproof membrane; install new drains, a sill pan and new door weather stripping for exposed east end of tunnel; isolate the new roof from the roof beneath the overpass; and repair concrete masonry unity (CMU) walls.	renovation will yield a health benefit	Highly Likely	Many	vulnerable populations will benefit more	many strong studies (n > 10)

Discussion

The lower level of Gerena Community School (Gerena) doubles as a community center providing a covered, climate controlled passageway between neighborhoods. Residents are encouraged to socialize or use the community space in the tunnels for physical activity, social activities, and building capacity (e.g., obtaining GED and learning English). However, members of the community have raised concerns with the physical conditions of the school, accessibility, and safety of the facility. Residents have cited these concerns as reasons to avoid using the building.

The evidence justifies that the primary influential factor to perceptions regarding Gerena is the presence of environmental stressors in the tunnels. The presence of deterioration, damage, standing water, and perceived poor air quality lower a person's perceived accessibility and safety in that area. Perceived and actual accessibility are greatly hindered when the tunnel closes early or when there are flooding and air quality hazards. Frequent closures or overcrowding of the tunnel may lead to residents perceiving the building as another barrier instead of an asset.

In order for the community to react and develop a perception, the change must be observed. Many "behind the scenes" improvements are not likely to impact perceptions of the school, simply because the changes may go unnoticed. Renovations that focus on improving the quality of the tunnel environment will have the greatest beneficial impact in regards to improving community perceptions. Renovation options that addressed safety and accessibility include those that will improve the air quality in the tunnel space, eliminate water intrusion into the tunnels, and remove evidence of structural damage or vandalism. As an asset, Gerena encourages residents in the community to interact and be more physically active. As a barrier, the school can inhibit physical activity and add to psychosocial stress among residents. Therefore, it is imperative that the conditions of tunnel remain accessible and safe to protect and promote health among those that use the facility.

On May 6, 2013, members of the HIA Core Group met with PBRM to discuss the initial findings from the analyses of data collected at the school and solicited input from PBRM to supplement the findings. The group used the input provided by PBRM to make clarifications, verify findings, and help develop recommendations. Appendix A provides notes from this meeting.

Chapter 5. HIA Recommendations

Recommendations are developed in HIA by identifying strategies for each decision alternative that would promote positive health impacts and mitigate and/or avoid adverse health impacts predicted. Recommendations are often conceptualized and refined throughout the HIA process, but finalized in this step. Recommendations should be evidence-based, responsible to predicted impacts, specific and actionable, enforceable, and feasible. The collective set of recommendations comprises the Public Health Management Plan.

5.1. Overview of Recommendations Step

Recommendation activities occurred from July 2013 to July 2014. Once all of the interim reports from the EPA-led investigations were complete, the HIA Core Group reviewed the evidence gathered and used professional judgement to deliberate and organize a set of recommendations for PBRM. Once the key findings and set of recommendations were established, the HIA Core Group developed the Executive Summary of HIA Findings and Recommendations as the main communications piece for sharing that information with stakeholders. Figure 19 captures the timeline of activities in the Recommendations step. Items with red flags are also considered Reporting activities.

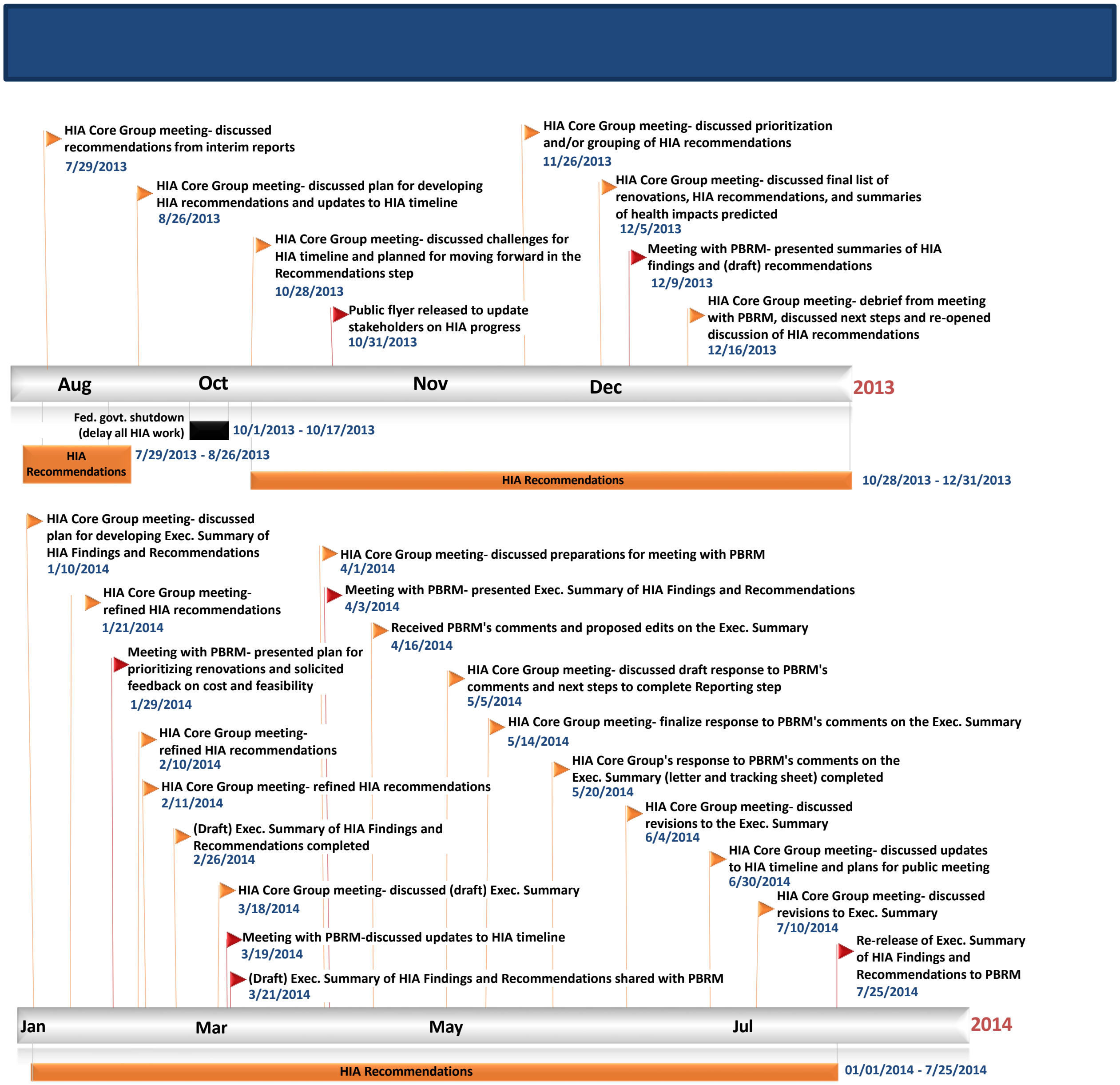

Figure 19. Timeline of activities completed in the Recommendations step.

5.2. Method for Developing HIA Recommendations

5.2.1. Interim Recommendations from EPA-led Investigations

Each sub-analysis resulted in EPA identifying additional actions aimed at improving the quality of the indoor environment at Gerena. The HIA Core Group compiled the list of interim recommendations from each of the reports. Table 16 lists each of the EPA-led investigations performed at Gerena and the interim recommendations that resulted from those investigations.

Table 16. List of EPA-Identified Actions

EPA-led Investigation	Interim Recommendations
Mold Contamination Analysis	1. Correct the water leaks throughout the school. 2. All carpeting should be removed from the school. Also, all other food sources (e.g., ceiling tiles, paper, cardboard, natural fabrics, etc.) for mold should be eliminated, to the best extent possible. (This recommendation should be implemented when the school is unoccupied and by a professional team.) 3. After completing items 1 and 2, the entire school needs to be exhaustively cleaned. 4. Replace the carpeting and ceiling tiles that have been removed; this should not be done until all water problems have been corrected.
Building Conditions and Systems Analyses	1. Monitor combustion-sized particles during future data collection. 2. Design a cost effective, energy recovery, air drying system in future HVAC design efforts. 3. Design continuously wet areas to be exhausted. 4. Follow interim and long-term recommendations in RDK report (April 12, 2012), add air drying. 5. Study locations for best air intake locations. 6. Follow the three recommendations in the ORD (October 16, 2012) mold contamination report: a) stopping water leaks; b) carefully remove porous materials that have been water-damaged and suspected of mold contamination, including carpeting and ceiling tiles; and c) extensively, carefully, and exhaustively clean the school after suspected mold contaminated, porous materials have been removed. 7. Plan for future air movement directions. 8. Reduce make-up air needs by reducing obvious air leakage sites in building enclosure. 9. Seal facility air-tight to reduce uncontrolled air leakage from the building's enclosure. 10. Continue to assure the delivery of adequate outside air and temperature control. 11. Further investigate the impact of combustion-sided particles in the indoor environment. 12. Provide increased cleaning of air conditioning drain pans. 13. Incorporate easy access doors in new HVAC design. 14. Improve the HVAC Preventative Maintenance Program (PMP).

EPA-led Investigation	Interim Recommendations
	15. Improve the energy management of HVAC.
Indoor Air Quality Analysis	Initial efforts to improve the indoor air quality should focus on moisture intrusion into the building envelope and mold remediation and prevention in all parts of the building, especially Tunnel A.

Several of the interim recommendations aligned closely with the proposed renovations, while some were unique. Furthermore, some of the items were sequential, meaning some items must be completed before subsequent actions could occur. For these reasons, the HIA Core Group overlaid the interim recommendations with the list of proposed renovations into a complete set of action items and organized (grouped) the items by sequence order. Items that should be implemented together were combined.

Before the HIA Core Group could prioritize and finalize the HIA recommendations, the U.S. Government shutdown for sixteen days and all work on the HIA ceased. PBRM had to submit the draft budget to the Mayor and City Office of Management and Budget for funding items in the next fiscal year. PBRM used the interim recommendations from the Building Conditions and Systems Analyses interim report to supplement the budget items proposed for the next fiscal year. After the federal government re-opened, the HIA Core Group continued efforts to finalize the HIA recommendations. A one-page flyer was developed and released in October 2013 to update PBRM on the HIA's progress. Appendix E provides a copy of the flyer.

5.2.2. Prioritizing Recommended Actions

The HIA Core Group prioritized the combined list of action items based on two criteria:

- Timing for implementation─ phase in which the HIA Core Group recommended that the item be accomplished (i.e., immediately, in near-term, in longer-term);
- Predicted health value─ the most positive effect on health and well-being, relative to the other proposed items (e.g., high, medium, and low).

The items that would provide the greatest health benefit were ranked higher in priority. Information gained from the literature reviews and professional expertise informed the assigned health value. The resulting framework for renovations served as the HIA recommendations.

On December 9, 2013, the HIA Core Group met with PBRM to present the key findings from the assessment and (draft) HIA recommendations. A handout that summarized each of the health impact analyses was used to facilitate the discussion. PBRM provided EPA notes from the meeting with comments on the HIA findings and (draft) recommendations. The group used PBRM's input to make clarifications and further refine the HIA recommendations. Appendix A provides notes from this meeting and Appendix E provides the handout used.

5.2.3. Additional Considerations for PBRM

The HIA Core Group recognized that recommendations should be practical and feasible, in addition to providing a health value. Performing a cost-benefit analysis for each action item was outside the scope of this HIA. The primary intent of the HIA recommendations was to help inform PBRM's decisions regarding renovations at Gerena based on health value. Therefore, the group established a set of criteria to help inform further considerations regarding the HIA recommendations, including:

a. First cost— the relative cost of implementing the proposed item;
b. Operating cost (or savings)— the relative cost/savings associated with operating/maintaining the proposed item;
c. Ease of operation and maintenance— the relative amount of time needed to operate/maintain the proposed item;
d. Durability— the life span expected before the item needs to be replaced or redone; and
e. Occupancy— whether the item is safe to be performed when the school is occupied.

On January 29, 2014, members of the HIA Core Group traveled to Springfield, MA to meet with PBRM and solicit their input to help qualify the resource values for each of items. The HIA Core Group developed a handout explaining the proposed approach for characterizing the practicality and feasibility of implementing each item. Together, EPA and PBRM filled out the sheet. Appendix A provides notes from this meeting and Appendix E provides the handout used.

5.3. Final HIA Recommendations

After meeting with PBRM, the HIA Core Group spent a considerable amount of time reviewing and refining the language of the action items for the final HIA recommendations. The final HIA recommendations for PBRM include the proposed renovation options with the EPA-added actions (in *italics*). Items should be completed in their entirety and in numerical order, within the assigned immediate-, near-, and long-term phase.

Because the building was built before 1980, testing for HAZMATs must be performed by a certified professional prior to any demolition or disturbance of building materials.

<u>Immediate Term Action Items (To be completed within 1 year)</u>

1. *Seal building enclosure air-tight at identified air leak sites in building enclosure, which includes:*
    - *Using approved weatherization materials and techniques to seal the identified cracks and openings. For examples, see the areas noted in the Turner Building Science & Design (TBS) report.*
2. *Seal building enclosure air-tight at identified air leak sites in building enclosure, which includes:*
    - *Using approved weatherization materials and techniques to seal the identified cracks and openings. For examples, see the areas noted in the Turner Building Science & Design (TBS) report.*
3. *Change the air flow between outer mechanical space and inner community space of Tunnel C so that the mechanical space becomes negative pressure relative to the community space, which includes:*
    - Installation of new exhaust fan and duct system for Tunnel C to exhaust air from outer tunnel space to exterior of building; and
    - Air sealing outer tunnel space completely off from inner tunnel space in order to prevent air from traveling between spaces.
4. Inspect and repair every air handling unit (AHU) in Building B, to ensure that at least minimum delivery of outdoor air supply is reached, which includes:
    - *Repairing and adjusting the ventilation systems as identified in the EPA Indoor Air Quality Tools for Schools HVAC checklist. For example, repairing broken belts and air dampers that do not open, etc.; and*
    - Adjusting outdoor air supply ventilation component systems as needed.
5. *Provide increased cleaning of air conditioning drain pans, which includes:*

- *Following EPA and industry guidance on cleaning and treating drain pans (EPA IAQ Tools for Schools Kit);*
- *Ensuring drain pans drain properly; and*
- *Enhance ease of access to air conditioning drain pans, filters, etc. for routine maintenance. For example, upgrading to latch system for doors.*

6. *Ensure consistent use of all checklists in EPA IAQ Tools for Schools kit, within one month of completing #3 and #4. Then, follow the recommended schedule to ensure proper continued operation (Gerena has been following EPA's IAQ Tools for Schools Kit checklists, but some improvements can be made).*

<u>Near Term Action Items (To be completed within 2-3 years)</u>

7. Implement *on-going program of waterproofing below-ground areas (tunnels), which includes*:
   - Replace roofing membrane and install new drains for exposed east end of Tunnel A (Building A). Isolate the new roof from the roof beneath the overpass;
   - Repair concrete masonry unit (CMU) walls, install a waterproof membrane, and install a sill pan in the opening and weather stripping around the door of Tunnel A;
   - Further investigate into the walls' interior construction and assess conditions and need for repairs of Tunnels A and C, including seasonal monitoring of groundwater levels;
   - *Sealing water leaks throughout the facility; and*
   - Replacing water pump stations in tunnels, as needed.
8. Remove and discard porous building materials (e.g., carpet, furniture coverings, etc.) that have been damaged by water intrusion for longer than 48 hours and not professionally dried or cleaned (AFTER water intrusion is stopped), which includes:
   - *Following guidance from EPA IAQ Tools for Schools Kit checklists;*
   - *Extensive cleaning of building, including shelves, counters, floors, ceilings, walls, etc; and*
   - *Replacement of discarded building materials with nonporous moisture resistant materials, only AFTER water intrusion is stopped.*

<u>Long Term Action Items (To be completed after 3 years)</u>

9. Complete redesign and replacement of HVAC systems, which includes:
   - *If changes in HVAC system, pollutant levels and/or pollutant sources are expected,* re-evaluate optimal locations of air intake louvers *and filters used through long-term air sampling (i.e., multi-seasonal).* Air sampling should include a wind study and monitoring of outdoor air pollutant levels, sources, and impacts on indoor air quality. If findings from longer air monitoring support the recommendation, relocate fresh air intakes from Building A to a more optimal location;

- *Planning for future air movement throughout the facility;*
- *Incorporate easy access doors for equipment in new HVAC design;*
- Swapping the fresh air intakes for the five mechanical rooms in Building B with exhausts.
- Replacing and upgrading all air handling units, exhaust systems (especially Chiller Room exhaust), and existing controls with high efficiency electronic-controlled models. This includes relocating thermostats to a location that provides more accurate temperature readings;
- Replacing any damaged/missing equipment (e.g., diffusers, grilles, insulation, etc.) and install new security measures for building equipment external to building (i.e., air intakes and AHUs on Building D roof);
- Extensive cleaning of any ductwork or materials *not being replaced within the next five years*;
- Installation of a new energy management system (EMS) with local computer, communications network, equipment controllers, valve controllers, sensors, air flow and temperature monitors, etc.;
- Installation of new security measures to prevent vandalism or damage of equipment outside facility; and
- Rebalancing HVAC system after new installation.

10. *Rebuild and reopen community spaces once they are deemed safe for occupancy, which includes:*
    - *Replacing corroded building systems components.*

5.4. Executive Summary of HIA Findings and Recommendations

The compilation of the HIA's key findings and final recommendations are represented in the Executive Summary of HIA Findings and Recommendations. Beginning in February 2014, this document underwent eight iterations before the HIA Core Group finalized the document in July 2014. The Executive Summary was sent to PBRM on March 21, 2014 to review and verify the information presented. PBRM reviewed the document and provided feedback in written and verbal format.

The HIA Core Group met with PBRM on April 3, 2014 to discuss the (draft) Executive Summary of HIA Findings and Recommendations. The HIA Core Group answered questions from PBRM on the HIA process and findings. Appendix A provides notes from this meeting. PBRM transmitted written comments and proposed edits on the document to the HIA Core Group on April 14, 2014, who used the input received to refine the document.

After the meeting with PBRM, the HIA Core Group continued to revise the Executive Summary to address PBRM's needs and concerns with the document. In addition, the HIA Core Group prepared a Response to Comments from PBRM, including a tracking sheet that addressed each comment and proposed change so that PBRM could track in the revised version how their input was addressed/incorporated. The final Executive Summary was re-released July 25, 2014.

The HIA Core Group recognized that the HIA Report might be too cumbersome for most readers. Instead, the HIA Core Group intended the Executive Summary of the HIA Findings and Recommendations to be the main document shared among stakeholders.

Chapter 6. HIA Reporting Activities

The purpose of the reporting step in the HIA process is to communicate the HIA progress and findings. Reporting raises awareness of the pending decision and builds understanding about the HIA process and the relevance of the decision to health. Although reporting is the sixth step in the HIA process, reporting activities occur throughout the HIA and may include presenting on the HIA to stakeholders and fellow HIA practitioners; creating educational materials or handouts; and preparing a final report and/or official letter.

6.1. Overview of HIA Reporting Activities

The Reporting step progressed over the full timeline of the HIA. Information about this HIA was shared with community residents; local community organizations and advocacy groups; local, state, and national government entities; researchers at academic and professional institutions; and the HIA community of practice. The HIA Core Group used several formats for reporting information in order to accommodate a diverse group of audiences. Appendix E provides examples of the different formats used during the HIA. The final task signifying the end of the HIA was the completion of the HIA Report. Figure 20 provides a timeline in which reporting activities took place.

In addition to the work completed, there were a few reporting actions planned, but were not fully achieved. The following lists the activities that were planned but not completed by the end of the HIA:

- Short, educational factsheet about in-home cleaning products that do not exacerbate asthma symptoms (planned for May 2013 release)
- Presentation to public (community stakeholders) on initial HIA findings and recommendations (planned for June 2013, indefinitely postponed)
- Factsheet to update public on initial HIA findings (in place of public meeting; planned for June 2013 release)
- Presentation to public (community stakeholders) on final HIA recommendations (planned for July 2013, moved to October 2013, indefinitely postponed)
- Presentation to Mayor and/or City Council (decision-makers) on final HIA recommendations (planned for March 2014, moved to October 2014, indefinitely postponed)

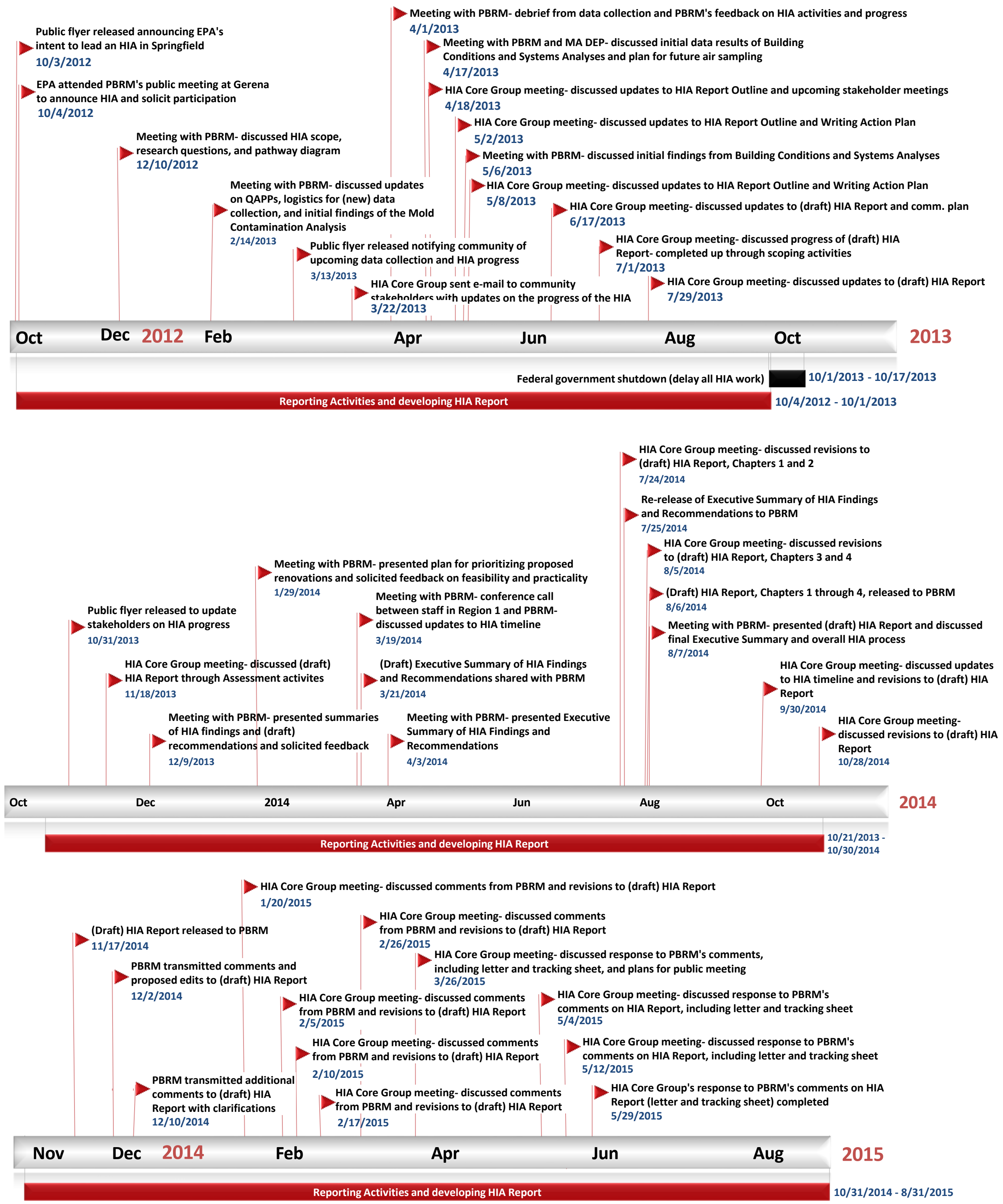

Figure 20. Timeline of activities performed as part of the Reporting step (2012 to 2015).

In addition to sharing information among the HIA stakeholder groups, EPA provided information about the HIA to groups outside the HIA at different venues. Table 17 provides information about the other outlets (external to the HIA communications plan), where information about the EPA-led HIA was promoted. In addition to those listed, periodic updates on the HIA were provided to internal EPA audiences, such as supervisors and fellow research programs.

Table 17. External Reporting Outlets for Promoting Information about the HIA

Reporting Outlet	Format	Date	Purpose	Primary Audience
EPA Research Newsletter	1-page Factsheet	Ongoing	Provide ongoing updates on HIA progress and raise awareness of EPA's HIA work	EPA ORD
EPA Regional Children's Health Coordinators Forum	Webinar + PowerPoint Presentation	1/31/2013	Provide an example of how HIA is being used to protect children's health	EPA's Regional Children's Health Coordinators
(Academic) Environmental Health class	PowerPoint Presentation	Jan. 2013	Discuss the HIA process and illustrate how EPA is using HIA to evaluate a community-level decision	Boston University, Environmental Health Students
EPA ORD Sustainability Workshop	PowerPoint Presentation	4/16/13	Present HIA as an example of community sustainability assessments performed by EPA	ORD Management and scientists
National Prevention Council 2014 Annual Status Report	150 word highlight	3/4/14	Highlight EPA's efforts to evaluate and implement the HIA process at the community level.	National Coverage
President's Prevention Advisory Group Meeting	PowerPoint Presentation and Q & A	4/28/14	Provide remarks on HIA implementation by a federal agency and present the Gerena Community School HIA overview as an example.	President's Advisory Group to the National Prevention Council
Formal HIA Report	Pdf	September 2015	Document the process, findings and recommendations from an EPA-led HIA.	All

6.2. Developing the HIA Report

This report is the result of compiling the documentation from all of the activities performed as part of this HIA. Appendix E provides copies of the many communication materials prepared for this HIA. Work on the HIA Report began in March 2013 and proceeded as new information was gathered and more HIA activities were completed. Beginning in July 2014, the HIA Core Group started reviewing and refining the HIA Report, by chapter. The (draft) HIA Report, through Chapter4: Assessment, was completed by August 5, 2014 and transmitted to PBRM for input.

On August 7, 2014, the HIA Core Group met with PBRM to present the (draft) HIA Report, through Chapter 4: Assessment, and answer any remaining questions from PBRM regarding the findings and/or recommendations. Together, PBRM and the HIA Core Group discussed the findings and recommendations, using a PowerPoint presentation to facilitate the discussion. The input from PBRM was used to verify the information in the (draft) HIA Report and incorporate needed changes. Appendix A provides the notes from this meeting. Appendix E provides the PowerPoint presentation that facilitated the discussions.

The HIA Core Group continued to revise the document after the meeting with PBRM. By November 2014, the group had a fully drafted HIA Report, which was transmitted to PBRM and the EPA peer-review coordinator to undergo a final review. On December 2, 2014, PBRM provided written comments and proposed edits to the report and sent additional comments for clarification on December 10, 2014. The HIA Core Group spent the next several meetings reviewing comments from PBRM and revising the HIA Report as needed. From March 2015 to May 2015, the HIA Core Group prepared a written letter to PBRM addressing their comments and provided responses to each proposed edit and comment by line. The Response to PBRM's Comments on the (draft) HIA Report was completed at the end of May 2015.

By the beginning of April 2015, the HIA Core Group received all of the results of the external peer-review and the HIA Report underwent final revisions before its completion in August 2015. EPA made the final report publically available on EPA's Health Research- HIA website (available for free download at: http://www2.epa.gov/healthresearch/health-impact-assessments).

Chapter 7. Monitoring and Evaluation

The last step in the HIA process is monitoring and evaluation. Monitoring describes the follow-up activities performed after the HIA recommendations have been presented. The monitoring step should either include a period for monitoring changes to the decision, decision-making process, and health impacts of the decision or propose a plan for monitoring those changes. Monitoring is used to answer questions related to how the HIA affected the decision or decision-making process (i.e., impact evaluation), how the decision affected health outcomes or health determinants (i.e., outcome evaluation), and whether the methods used to predict impacts to health were appropriate (i.e., process evaluation). Tasks completed in this step include: a) establishing a monitoring and evaluation plan that delineates indicators (measurements) and resources available for monitoring (i.e., data sources, tools, analysis methods, and potential funding vehicles); b) identifying the individual or team that will be in charge of leading the follow-up and responsibilities; and if possible c) performing the monitoring and evaluation and sharing the results with others involved in the HIA.

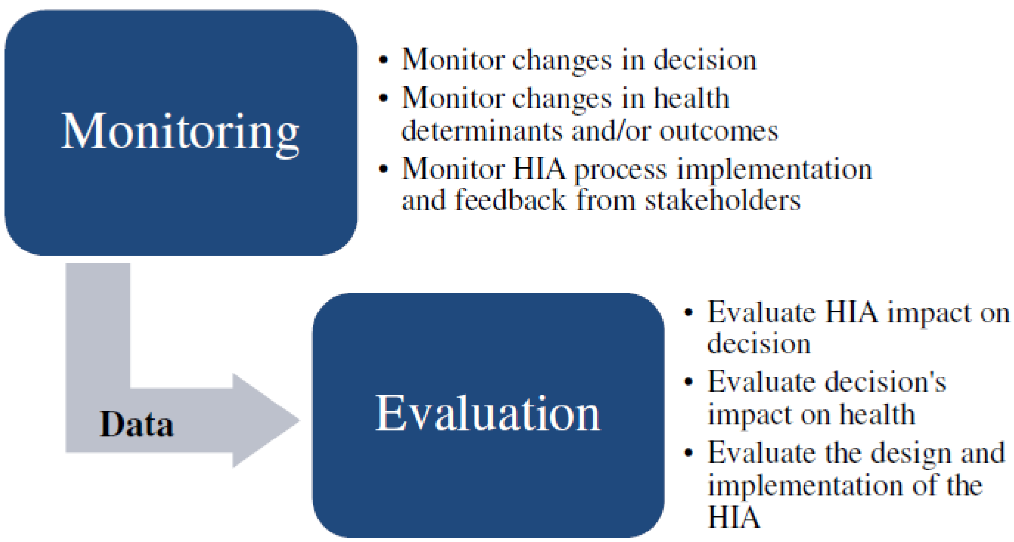

Figure 21. Figure explaining the Monitoring and Evaluation activities.

The purpose of monitoring is to:

- Encourage accountability in the decision-making;
- Build a better understanding or demonstrate the added value of HIA; and
- Protect health by enabling early detection of negative outcomes.

7.1. Monitoring Activities *after* the HIA

Observing changes in health outcomes or even health determinants can take several years beyond the timeline of the HIA. Because of this, the HIA Project Team is (at a minimum) responsible for providing a monitoring plan for follow-up activities. The monitoring plan involves following a set of key indicators for changes over time and implementing planned actions to manage the health impacts of the proposal (i.e., enacting a health impact management plan).

7.1.1. Monitoring the HIA's Impact on the Decision

The HIA Core Group monitored the decision-making process while the HIA progressed. In August 2015, PBRM provided a compilation of the work performed and work planned in the near future for Gerena. Appendix H provides the information given by PBRM as an addendum to this report. The addendum provides background information about the structural and electrical issues Gerena has endured over the years and the resources invested to address those issues as they arose. The addendum also provides a list of planned actions and funding sources for continued renovation work. Based on the information provided, PBRM adopted a few, but not all, of the HIA- recommended items.

Although PBRM is still contemplating the results of the HIA, the department has made a few changes that supports the conclusion that the HIA made an impact on the decision. PBRM reported in October 2013 that the department's draft budget (submitted to the City's Office of Management and Budget on October 25, 2013) was developed based on the recommendations from the interim report provided in the Building Conditions and Systems Analysis. More specifically, the recommendation to increase the air exchange in Tunnel C and seal the building envelope where air leakage sites, where identified. However, it is unclear as to whether the other recommendations and/or subcomponents all of the adopted recommendations will be implemented. The HIA Core Group recommends stakeholders continuously monitor the renovations performed at Gerena to determine whether each action item was implemented as recommended.

Some of the long-term recommended action items planned at Gerena can be found in the 2015-2019 Capital Improvement Plan (CIP) for the City of Springfield, MA. Specifically, renovations to Tunnel C and the railroad bridge are planned in 2015 and 2016; actions to replace the HVAC system, water pumps, seal walls, and renovations to Tunnel A and the interstate ramp are planned between 2015 and 2017. PBRM does plan to continue architect/engineering studies across the city in the near-term (see Fiscal Years 2014-2018 CIP).

7.1.2. Monitoring the Decision's Impact on Health

Monitoring outcomes after the decision is made enables stakeholders to better understand the decision's consequences and make corrective actions earlier when adverse impacts are observed. For this HIA, a monitoring plan is proposed for outcomes related to the three health determinants assessed in the HIA (i.e., indoor air quality, classroom noise/acoustics, and community perceptions), with a health impact management plan for when negative outcomes are observed. Table 18 outlines the suggested approach for monitoring the health determinants evaluated in the HIA, including follow-up questions, indicators to monitor, and timelines for follow-up activities. Funding for follow-up activities may be available through the City's annual budget and/or grants from state and federal agencies. Further monitoring may be limited by the resources available.

The specific health outcome of interest identified in this HIA was respiratory health, especially asthma. Respiratory health is complicated to evaluate, simply due to the complex network of factors that increase the probability of a person developing respiratory illness, such as family history of asthma and allergies, and exposures inside the home. The HIA Core Group proposes a monitoring plan for tracking changes in respiratory symptoms among students occurred and whether those changes can be related to renovations at the school. Table 19 identifies two specific outcomes for the outcome evaluation, which are already monitored by the school nurse department (i.e., data is readily available):

- Number of school nurse visits for respiratory-related health issues among all students (i.e., students who presented with nasal problem, allergy inflammation/reaction, asthma concerns, breathing problems, chest pain, discomfort or tightness, cough, throat problem, and upper respiratory symptoms); and
- Number of school nurse visits for asthma-like symptoms among children with asthma (i.e., students who presented with asthma concerns; breathing problems; chest pain, discomfort, or tightness).

It is important to note that monitoring changes in health does not directly determine whether the outcomes observed were a direct result of the actions taken/not taken at the school. Furthermore, changes in health may not be observed for many years. Health outcomes and risk factors should not be reported lower than the school-level, to protect the privacy of the students.

Table 18. Proposed Outcome Monitoring Approach for Identified Health Determinants

Outcome Impact Question	**Has the indoor air quality at Gerena changed since the HIA was completed?**	**Has there been any changes in the levels of noise in the classroom or overall acoustic learning environment since the HIA was completed?**	**Have the collective perceptions of the school among the community stakeholders changed since the HIA was completed?**
Indicator(s)	• Perform thermal imaging and blower tests following building treatment • Establish Pressure differentials following facility HVAC changes • Visually inspect AHU components and drain pans • Inspect below ground areas for visible water and test relative humidity in localized areas • Re-test mold contamination levels using ERMI methods • Perform ACGIH/ASHRAE evaluations of indoor air quality	• Measure sound levels in classrooms using sound level meter (dB(A)) • Survey Teachers, students, and parents (Teacher, student, and parent complaints related to noise in classrooms)	• Survey community residents, teachers, parents, and students using satisfaction surveys (TELL Mass Survey) • Monitor General school environment grading and comments from MSBA School Needs Survey
Potential Lead Agency/ Organization	EPA for follow-up mold assessment MA DPH Bureau of Environmental Health (performed an IAQ study at Gerena in 2004) for IAQ follow-up	Measuring classroom noise levels= PBRM has a sound level meter (see Lynn Rose) Monitoring complaints= Gerena Community School	Gerena Community School Community Liaison

Outcome Impact Question	Has the indoor air quality at Gerena changed since the HIA was completed?	Has there been any changes in the levels of noise in the classroom or overall acoustic learning environment since the HIA was completed?	Have the collective perceptions of the school among the community stakeholders changed since the HIA was completed?
		Administrator/Community Liaison	
Follow-up time	12-month intervals beginning in 2015 and continuing at least through 2017 (provided that the 2015-2019 CIP is followed)	6-month intervals beginning in 2015	6-month intervals beginning in 2015
Health impact management plan (if adverse changes are observed)	If ERMI values do not change or even increase: 1. Re-evaluate the areas where mold is present in significantly higher values; 2. Determine causes for high values; 3. Develop new action items to reduce mold contamination or modify current renovation priorities to expedite those that will reduce mold. If ACGIH/ASHRAE evaluations find insufficiencies: 1. Re-evaluate renovation priorities to expedite renovations that control indoor	If average classroom noise levels reach above 70 dB(A) and/or complaints related to classroom noise increase: 1. Establish a Noise Reduction Task Force (NRTF) responsible for investigating the noise complaints and possible solutions. 2. Identify the sources of noise complaints. 3. Review the guidelines identified in this report (e.g., BB93) to identify potential solutions to improve the acoustic learning environment.	If community perceptions of the Gerena do not improve or become more negative after renovations have been implemented: 1. Develop a School Environment Task Force, composed of representatives from Gerena Community School, PTO, PBRM, and other local organizations with a vested interest in Gerena, that will be responsible for identifying and addressing opportunities for improving conditions in the facility.

Outcome Impact Question	Has the indoor air quality at Gerena changed since the HIA was completed?	Has there been any changes in the levels of noise in the classroom or overall acoustic learning environment since the HIA was completed?	Have the collective perceptions of the school among the community stakeholders changed since the HIA was completed?
	air pollutants (i.e., sealing building enclosure, re-location of air intakes, and HVAC system replacement). 2. Develop school-specific protocol for incoming air regulation (including HVAC operations and open-window policy).	4. NRTF work with school engineers, building maintenance, and PBRM to ensure sources of noise (related to the air handling systems and mold/moisture renovations) are eliminated or mitigated and ensure an optimal acoustic learning environment.	2. Develop a strategic plan, including objectives that will target identified needs. 3. Report yearly progress to represented agencies and Springfield ECOS.

Table 19. Proposed Monitoring Approach for Respiratory Health Symptoms

Outcome questions	Indicator(s)	Follow-up time	Additional risk factors (potential confounders) to consider	Potential analyses
Did the total number of school nurse visits for respiratory symptoms change significantly from the 2012 school year?	# school nurse visits for respiratory-related health issues[‖]	At end of every school year, post 2012 and continuing past 2017	• History of Asthma(Y/N)[*] • History of allergies (Y/N) • Family history of asthma (Y/N) • NSLP Participant (Y/N)[†] • Smoking in home environment (Y/N) • Male (Y/N) • Racial/Ethnic minority (Y/N)[‡] • Mold in the home (Y/N; ERMI Values)[§]	First, analyze whether significant changes occurred over time.[¶] If yes, then a second analysis should determine whether the additional risk factors may be influencing the change in outcome.
Did the total number of school nurse visits related to asthma-like symptoms among children with asthma significantly change from the 2012 school year?	# school nurse visits for asthma-like symptoms among children with asthma[‖]	At end of every school year, post 2012 and continuing past 2017	• History of allergies (Y/N) • Family history of asthma (Y/N) • NSLP Participant (Y/N)[†] • Smoking in home environment (Y/N) • Male (Y/N) • Racial/Ethnic Minority (Y/N)[‡] • Mold in the home (Y/N; ERMI Values)[§]	First, analyze whether significant changes occurred over time.[¶] If yes, then a second analysis should determine whether the additional risk factors may be influencing the change in outcome.

[*] Students who have not been physician-diagnosed does not verify whether or not they have asthma.

[†] Students who participate in the national school lunch program (NSLP) is sometimes used in placement of socioeconomic status.

[‡] The U.S. Census Bureau determines persons of racial/ethnic minority as African American, Asian, American Indian and Alaskan Native, Native Hawaiian and Pacific Islander, and persons of Hispanic or Latino heritage.

[§] Mold testing in the home using ERMI would provide objective and comparable data to mold contamination found in the school.

[¶] Account for changes in population from year to year.

[‖] School nurses should not change their reporting procedures during the follow-up to ensure consistency.

There are some limits to this outcome evaluation plan. The data reported by the school nurse is subject to reporting error and more reliable measures exist. For example, children tested for asthma are often subjected to a spirometry test, which is a standard method for testing lung function. This test can be easily performed in an office and provides an objective measurement, which is more reliable and consistent. However, the availability of such tests to the school nurses is unknown and the data collected by physicians would be relatively difficult to obtain due to privacy laws. The use of objective measures are recommended, however, the indicators identified in the outcome evaluation plan appear to be the most readily available at this time.

7.2. Evaluation of the HIA Process

As stated in the Scoping step, the evaluation of the HIA Report would be evaluated through an external review among peers in HIA and internal environments. The external peer-review would determine whether the methods used in the HIA were appropriate, how well the HIA was implemented as planned, and whether the HIA provided the anticipated benefit. As a supplement to the peer-review, the HIA Core Group would provide an internal perspective on the successes, challenges, and lessons learned from performing the HIA. The HIA Project Leads established criteria for judging the HIA a success in the RESES proposal.

7.2.1. Overview of HIA Evaluation

Figure 22 provides a timeline of the activities related to evaluating the HIA process. The evaluation of the HIA involved submitting the HIA Report to undergo an external peer-review and reviewing the results of that review and addressing opportunities for improvement.

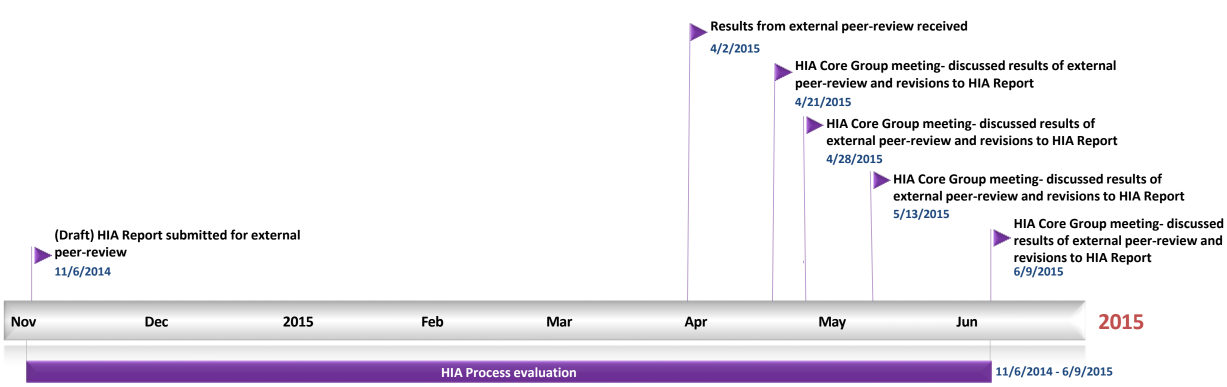

Figure 22. Timeline of activities for evaluating the HIA.

7.2.2. Results of External Peer-review

The reviewers included two HIA practitioners and one expert in the field of building systems and indoor air quality. The experts who were available and agreed to provide a critical review were provided monetary compensation for their time and effort. While all comments were invited, the review was facilitated by use of process and technical focused charge questions. Table 20 provides the set of process-focused charge questions, related. Additional technical charge questions for the building systems and indoor air expert are provided after the table.

Table 20. Charge Questions to Reviewers Targeting Aspects of HIA Process

HIA Process	Charge Questions for Peer-Review
Context of HIA	Was the HIA undertaken to inform a proposed decision (e.g., policy, program, plan, or project) and conducted in advance of that decision being made? Were the need for and value and feasibility of performing the HIA assessed and clearly documented? Do the authors acknowledge sponsors and/or funding sources for the HIA? Is the screening process clearly documented in the report?
Scope of HIA	Are the goals and/or objectives of the HIA clearly defined? Is the scope of the HIA clearly defined (i.e., decision to be studied and its alternatives; potential impacts of the decision on health, social, environmental, economic, and other health determinants and their pathways; populations and vulnerable groups likely to be affected by the decision; demographic, geographic, and temporal scope of analysis; health impacts and research questions selected for examination in the HIA and why)? Is the scoping process clearly documented in the report? Are the participants in the HIA and their roles clearly identified?
Stakeholder Engagement	Are stakeholder groups, including decision-makers and vulnerable population groups, clearly identified? Is a stakeholder engagement and participation approach, including plans for stakeholder communications, clearly described in the report? If so, was input from stakeholders solicited and utilized as planned in the HIA process? Did the HIA utilize community knowledge and experiences as evidence and in what ways? Where stakeholders given the opportunity to review and comment on the findings of the HIA?
Evidence and Analysis	Are the methods for evidence gathering and analysis clearly described and justified? Was evidence selection and gathering reasonable and complete (i.e., was the best available evidence obtained)? Are the existing conditions (e.g., demographics, socio-economic conditions,

HIA Process	Charge Questions for Peer-Review
	health determinants and health outcomes, presence of vulnerable groups, etc.) clearly described? Is the profile of existing conditions appropriate as a baseline against which to assess the impacts of the proposed decision? Are the potential health impacts of the proposed decision identified? If so, is the characterization of impacts reasonable and complete (e.g., direction, magnitude, likelihood, distribution, and permanence of impacts addressed; affected populations clearly identified; etc.)? Are the methodologies, data sources, assumptions, limitations, and uncertainties of the assessment clearly identified? Are the conclusions of the analysis based on a transparent and context-specific synthesis of evidence (i.e., are the conclusions reasonable and supported by the evidence)?
Recommendations	Are recommendations, mitigations, and/or alternatives identified that would protect and/or promote health? Are these recommendations reasonable and supported by the evidence? If prioritization of recommendations took place, was the method of priority-setting documented, reasonable, and appropriate? Is an implementation plan identified for the developed recommendations (e.g., responsible party for implementation, timeline, link to indicators that can be monitored, etc.)?
Reporting	Is the layout and format of the report clear and logical, with information clearly organized in sections that are easy to follow? Is the writing style such that the report is easily read and understood (e.g., clearly written, complex or unfamiliar terms described, examples and graphics used to illustrate text, etc.)? Is documentation of the overall HIA process transparent (i.e., are the processes, methodologies, sources of data, assumptions, strengths and limitations of evidence, uncertainties, findings, etc. of the HIA clearly documented)? Does the report identify any other methods to be used for documenting and disseminating the HIA and its findings (e.g., briefings, presentations, factsheets, flyers, newspaper or journal articles, etc.)?
Monitoring and Evaluation	Was an evaluation of the HIA process conducted (e.g., who was involved, strengths and weaknesses of the HIA, successes and challenges, how effective the HIA was in meeting stated objectives, engagement and communication with stakeholders, lessons learned, etc.)? Was a plan proposed for monitoring implementation of the decision and the effect the HIA had on the decision-making process (i.e., impact evaluation)? Was a plan proposed for monitoring the impact of

HIA Process	Charge Questions for Peer-Review
	the decision implementation on health determinants and health outcomes (i.e., outcome evaluation)?
Overall HIA Process	Are the methods and procedures used in the HIA appropriate? What aspects of the HIA process appeared to be implemented effectively or successfully and what aspects of the HIA process could have been strengthened or improved?

Additional Charge questions for the Buildings and Systems Technical Expert:

Were the series of investigative studies conducted at the school and used as evidence in this HIA designed and conducted in an appropriate manner? Are there any uncertainties in the assumptions, parameters, and/or methodologies used in these studies? Were the claims reported by these studies reasonable and consistent with indoor air and building system principles? Were the results of these studies and the findings of the literature review used appropriately to describe the current conditions at the school as they relate to indoor air and building systems? Were the results of these studies and the findings of the literature review used appropriately to characterize the potential health impacts of the indoor air and building system-related renovation options?

Speak to the following analyses:

- Settled dust sampling to test mold contamination;
- Air pressure mapping throughout the facility;
- Building enclosure air tightness testing and infrared imaging;
- A visual survey of HVAC equipment and maintenance plan;
- 3-day continuous recording of indoor carbon dioxide, temperature, relative humidity, and laser particle counting in selected areas; and
- 6-day recording of indoor temperature, relative humidity, and select combustion source pollutants (particles and gases).

The External Peer-Reviewers

Dr. Dannenberg is an affiliate professor in Environmental and Occupational Health Science and Urban Design and Planning at the University of Washington, School of Public Health. Dr. Dannenberg has served on the American Board of Preventative Medicine and American Board of Family Practice. His research includes performing and reviewing HIAs.

Dr. Alam has worked as the Director of Environmental Health Services at the Cincinnati Health Department for the past 20 years. Dr. Alam is also currently an associate professor in environmental health at the University of Cincinnati, Ohio and member of the Environmental

Health Sciences Advisory Committee (Former Chairman) at Ohio University in Athens. His work has included practicing and reviewing HIAs.

Dr. Mendell works as a Scientist/Epidemiologist in the Indoor Environment Group of Energy Technologies Area and an Air Pollution Research Specialist at the California Department of Public Health. Dr. Mendell is on the editorial board of the journal Indoor Air and a member of the International Academy of Indoor Air Sciences. He was formerly at the Centers for Disease Control/National Institute for Occupational Safety and Health, where he was head of the National Occupational Research Agenda Team on Indoor Environments.

The following text provides a summary of the comments given by the external peer-reviewers on the (draft) HIA Report. Appendix I provides the reviewers' comments (by line) and comment resolution from the authors. The page numbers referenced in the (draft) version may not be the same in the final HIA Report.

Context of the HIA

The decision timeliness was clearly outlined and adequate, but not ideal. Some budget decisions and renovations were performed while the HIA was underway (i.e., this was a concurrent not a prospective HIA). One reviewer also commented that the authors' inclusion of the initial investigations by PBRM seemed appropriate. The information gleaned from those reports provided substantial evidence and a set of proposed renovations for the HIA to use. Overall, the chapter on the Screening step was appropriate, comprehensive, and well documented.

Scoping

Overall, the authors documented the Scoping step well. The discussion on data availability, data gaps, and vulnerable populations was very transparent. The HIA team considered a good range of possible topics with input from stakeholders and appropriately focused on a smaller number for the full assessment. It was clear the HIA team utilized community knowledge and experiences in the Scoping process (e.g., the inclusion of noise levels and community perceptions of the school appear to have originated with community input and may not have been on the list of issues initially considered by the HIA team). However, the issue of safety and security of school (both students and residents) could have received more attention in the assessment and recommendations. In addition, the difference between baseline research questions and impact research questions could have been clearer in the Scoping section as it was clear in the Assessment section.

The goals and scope were clearly defined in the report but slightly different from the goals documented in the Executive Summary, which should have been the same. Furthermore, the goal "to improve air quality and asthma" was too narrow as an overall goal for an HIA. It was not completely clear in the Scoping section what was the "decision to be studied," which later appeared to be the selection and sequencing of the renovation options to pursue.

Stakeholder Engagement

The authors described the stakeholder engagement and communications processes well in the report. The stakeholder groups were appropriately identified and invited to participate in the process. One concern, however, was that the majority of groups invited did not participate. Only 7 out of 27 invited groups attended the Scoping meetings and only 4 out of 7 represented community residents. The report indicates that the HIA Project Team tried every possible way to convince them to participate, but did not succeed. It would be helpful to clarify which viewpoints were absent that may have been different form the viewpoints present. Nevertheless, the value of the school to the community came across clearly and served as a major reason not to demolish the building. It was clear the community's knowledge and experiences served as the backbone of this study.

The draft communications plan in Appendix A indicates the opportunities for review and comment among stakeholders in 2014. In the report, however, the authors documented meetings with PBRM for review and comment but did not document any meetings with other stakeholder groups or the public.

Evidence and Analysis- Overall

The authors' described the methods for evidence gathering and analysis well, including the existing conditions (to the best extent possible) and the selection and analysis of the evidence. Although the authors documented the methods and data sources in the Appendices, more detail related to assumptions, limitations, and uncertainties would improve the discussion. All reviewers agreed that the conclusions made were reasonable, appropriate, transparent, context-specific, and based on the evidence.

The report identified the potential health impacts for asthma, noise, and community perceptions and the characterizations were reasonable and transparent. However, one reviewer noted that the characterization of magnitude did not include likelihood/probability of effect per person, and instead was a qualitative characterization. The reviewer stated that this was an important dimension to include and recommended using an odds ratio, risk ratio, or relative risk available from prior health studies for specific health risks. Regardless of methods used, the characterization of potential health impacts were reasonable in terms of direction and rough likelihood, but not for magnitude, distribution or permanence.

Evidence and Analysis- Profile of Population Affected

One reviewer commented that the demographic, economic, and other community data were appropriate. Individual-level data on facility use or health status was not feasible to obtain. Two reviewers commented that mortality data (as a less-sensitive measure of health status) would not be of much use in decisions about renovations, especially for asthma and other respiratory diseases that have high morbidity but low mortality. Furthermore, some of the mortality data were based on small numbers, so trends may not be meaningful. It would help if those numbers were compared with statewide averages.

One reviewer commented that the profile of existing conditions related to asthma was adequate but not ideal for comparing subsequent impacts. Another reviewer disagreed, explaining that the described asthma prevalence rates for the community and students were useful for showcasing the unusually high asthma prevalence and would be helpful for future "before and after" studies. The authors could improve the report by providing a standardized clinical measurement of asthma.

One reviewer mentioned that the evaluation of outdoor air pollutants by Census tract should have concluded that the levels of motor vehicle emissions and the proximity of the school to the highway was more likely to *underestimate* health risks in relation to time spent outside, thus supporting the consideration of filtering mechanisms. The recommendation to increase filtration of the indoor air at Tunnel A was mentioned (on page 105), but not included as one of the high priority renovations.

Evidence and Analysis- Indoor Air Quality

One reviewer said the "systems approach to investigate levels of key air pollutants […]" (i.e., the assessments and data interpretation for temperature and relative humidity, HVAC systems and operation, air movement/pressure, combustion pollutants and ultrafine and fine particles) seemed appropriate in regards to current scientific practice. However, there was some disagreement among reviewers regarding specific methods and/or conclusions drawn from the findings. The following items are comments from the reviewers referring to specific analyses and/or conclusions discussed in the (draft) HIA report.

1. The HIA Team should note that there was no specific investigation category listed that related to the issue of moisture intrusion. This is likely due to the adequate/appropriate investigations already performed in 2012.
2. One reviewer stated concerns related to measuring indoor air quality and mold. Specifically, the mold section did not document a literature review. Thus, it appears that the HIA Team chose to use a preferred internal EPA method of quantifying mold. The same reviewer commented that this is not the decision that would have likely resulted from performing a thorough literature review on health effects of indoor dampness and mold. The most well documented investigations of dampness and/or mold-related health risks in the indoor environment employed a visible survey of dampness, water damage, mold, and/or a "moldy" odor, which have been causally linked to asthma symptom exacerbation. Since the literature evidence linking ERMI or any quantitative measurement of mold and/or microbials to asthma exacerbation is lacking, using this method did not seem appropriate or justified. ERMI might be used extensively within EPA or some commercial laboratories as a recognized and validated method for indicating water damage; but it is not used in the broader scientific community working in indoor air, microbiology, and health. The reviewer states further that the use of the ERMI and no other subjective indicators of dampness and/or mold was a major limitation of this HIA.

   Contrary to the above comments, another reviewer stated, "The use of ERMI for mold detection is a smart and convenient choice. It is a relatively newer technology that is known for reliable qualitative and quantitative information." The authors considered the comments (above) as a missed opportunity to provide references validating the ERMI methods and provide clarification for its application in this setting.
3. Mapping the air pressure throughout the facility was an important assessment to perform (that is not always done in practice). However, the report documents mixed conclusions about the relationships of airflow. For example, the conclusion (on page 74) "continuing to evaluate and adjust the HVAC system control logic may help improve airflow in the building simply by reducing pressure gradients between spaces," seemed simplistic, considering that some air pressure differences are desirable. The authors could improve this section by providing further clarification. Overall, the building enclosure and air tightness testing, infrared imaging, and visual survey of HVAC equipment and maintenance plan were useful, valuable, and appropriate.
4. The approach used to decide what air pollutants to assess was appropriate. One reviewer thought the number of sampling locations (n=4) was too small, but conceded that an indoor air quality expert would be a better judge. Another reviewer said the site locations were

appropriate to characterize the problems with the facility. The HIA Team was charged with clarifying the statement (in Appendix E) "Carbon dioxide levels were elevated above 800 ppm in 5/23 areas surveyed, indicating a ventilation problem in some areas of the school." Adding a statement saying that these measurements would only be valid if they were taken in an occupied space after a substantial period during the day would improve the discussion. Also, the 800 ppm threshold seems conservative, given that outdoor CO_2 was at least 400 ppm, which does not suggest a widespread problem of inadequate ventilation. However, it does seem that this approach enabled investigator to identify units with closed dampers, so it was helpful. In general, the report contains some odd language about CO_2- "when a space is occupied there must be enough fresh, outside air […]." Outside air does not help occupants breathe easily. In addition, CO_2 is generally not considered to be an indoor pollutant per se, but just an indicator of whether the ventilation systems are working effectively. The sentence (referred above) does not make this relationship clear.

5. One reviewer commented that the ranking of exposures as risk factors for triggering asthma symptoms (on page. 73) was not clear in meaning (i.e., is the un-numbered figure indicating how many studies or how many review articles were used to deem the exposure as a risk factor for asthma exacerbation?). It was also not clear as to whether this was a good way to rank the importance of exposures.
6. One reviewer stated that the methods for determining the values in the table on page. 74-76 was not clear and the process for filling in the table was not transparent. Given that the conclusions overall seem reasonable, there was an omission regarding the potential for additional filtering of incoming air as an immediate action or for even moving intake locations in the future if they are still near a major road.

Evidence and Analysis- Classroom Noise

One reviewer commented that the literature review for noise is a good thorough review. However, the two other reviewers agreed that, because baseline noise measurements were not taken, it would be difficult to assess subsequent improvements in classroom noise. In addition, the method for determining the values (in Table 17) were unclear and the table seems to mix short-term noise increases from renovation activities with long-term effects. The authors had not yet discussed the issue of HVAC systems and noise. This is often an issue, especially in portable classrooms, but may not be relevant in this facility.

Evidence and Analysis- Community Perceptions

The method of investigating perceptions among community residents was reasonable. One reviewer suggested adding two references: Quansah et al. 2012 and Jaakkola et al. 2013. These references support the conclusion that "heavy dampness and a 'musty' odor throughout the school" is the single factor most strongly associate with both new asthma and allergic rhinitis in available health studies and warranted the study of moisture and mold-related health risks in this facility.

Recommendations

All reviewers agreed that the recommendations seemed reasonable, evidence-based, and actionable. However, the presentation of the recommendations would be improved by adding a table that explicitly links each recommendation to the assessment findings that support it. The absence of documenting these links between assessments and recommendations was also noted by PBRM (on page 113). The report does a good job in separating the phased recommendations in a way that is helpful to decision-makers. The table in Appendix B provides an excellent way to set priorities, but the right hand columns were not filled, making it difficult to tell which renovations would receive the highest priority. The implementation plan was appropriate and reasonable. However, the report would benefit from more transparency in the decision-making of which action items were higher priority.

One reviewer questioned why item #7 (removal of water-damaged porous materials) was not listed under immediate actions, as compromised materials may be responsible for much of the dampness/mold exposures. While it may be economically reasonable to complete this item after all water intrusion has stopped, this decision is not led by a health-protection perspective. Delaying the replacement of such items is ill-advised.

On page 106, one reviewer was concerned about the statement: "PBRM may have to consider replacing the school, but leaving the tunnel for the community." This option was not noted previously in the discussion and may need greater consideration in future decisions.

Monitoring and Evaluation

Reviewers agreed that the monitoring plan for specific renovation outcomes and health outcomes was detailed, thorough, and used a variety of approaches. One reviewer commented that the Monitoring and Evaluation section was more detailed than found in most HIA reports. However, the definition of the process evaluation needed clarification. The challenges identified on pages

140-145 were a valuable part of the process evaluation and will contribute to improving future HIA practice. The external peer-review was also a valuable part of the process evaluation and provided an independent review of how well the HIA process worked. It is important to note, however, that the impact evaluation form was more complicated than described and obtaining information to complete the form would prove difficult for any person without sufficient knowledge of buildings and renovations.

Table 22 (on page 119-23) provided a good proposed outcome monitoring plan. However, the table could be improved by adding a column indicating baseline levels in which to compare. One reviewer recommended monitoring the student asthma prevalence over time, after specific renovations are performed, because it would still add value and help future analyses to be more accurate. In addition, monitoring should involve the same data collection methods used before and after the renovations are implemented, and would be strengthened if school nurses collected data on asthma inhaler use at the school, adjusting for differences in socio-economic factors and whether the student was diagnosed with asthma on a year to year basis.

The reviewer who did not agree with the application of ERMI did not recommend including ERMI in monitoring activities. Instead, the reviewer recommended using a more subjective method of identifying dampness and/or mold. In addition, it is not clear what ACGIH/ASHRAE evaluations of IAQ are, which would benefit from more explanation.

Documentation

The language of the report was very readable and the authors highlighted all of the important aspects of the HIA practice well. All of the reviewers agreed that the authors did a great job documenting the HIA process in a transparent manner and identified real-world problems that occur in HIA practice, citing that the layout and format was clear and logical. However, all reviewers agreed that the report would benefit from including a short, executive summary at the beginning since the report is so lengthy. One reviewer suggested adding more photos of various places in the school to help the reader visualize the setting and problems discussed in the report. In addition, the authors could provide more details regarding the assessment limitations and uncertainties.

Two of the three reviewers commented that the readers had to work hard to figure out if the tunnels also served as buildings with office spaces, community rooms, and/or classrooms and whether the tunnels were open to anyone or just school staff and students.

The HIA Project Team used all available methods to communicate with stakeholders (e.g., flyers, personal phone calls, e-mails, etc.) and went further to hire a Spanish translator to address a potential language gap. The predicted impacts are explained in an easy to understand language- a nice feature of communication with people of different educational and English language proficiency levels. However, the plan for disseminating the final report was less specific.

Overall HIA Process

The overall HIA process was well done for each of the steps of HIA. However, some areas that could be improved include better timeliness of the recommendations (given before renovations started), obtaining baseline measurements of noise, and tying each recommendation more specifically to the assessments. The HIA met most of its goals identified in Scoping. One reviewer commented that it was "admirable that this HIA successfully completed the tasks while facing many challenges that started in the Scoping step." This HIA has all the qualities to serve as a mini-training booklet in HIA process and HIA-related materials and forms. However, the reviewer found that the title of the HIA was not easily searchable and suggested adding keywords, such as renovation, demolition, degraded tunnels, mold remediation/control, water intrusion, schools, community health, etc.

Based on the comments received, the (draft) HIA Report underwent further revisions, as the HIA Core Group discussed and addressed each of the comments, before its finalization in August 2015.

7.2.1. Evaluation of HIA Implementation by HIA Core Group

As expected, there were some differences between what was planned and what transpired during the process. Several changes, both internal and external to the HIA process, required some of the planned activities to be postponed or altered. The HIA Core Group identified the successes and challenges that arose while the HIA progressed.

Successes Identified

The HIA Core Group set the HIA goals, outlined in Scoping, as the criteria for judging success of the HIA. The HIA Core Group evaluated whether the HIA met its intended goals and identified the evidence supporting that conclusion. Table 21 provides the results of goal evaluation. From the evaluation, the HIA achieved most, albeit not all, of its anticipated goals.

Table 21. Evaluation of HIA Goal Achievement

HIA Goal	Achieved Y/N/?	Supporting Evidence
The HIA will present a set of recommendations to be considered in the decision-making that would maximize potential benefits to health and avoid and/or mitigate potential harmful impacts of implementing the proposed renovations.	Yes	The HIA Core Group developed and prioritized a set of recommendations based on the health impacts predicted in assessment. The recommendations were presented to the decision-makers as anticipated, but not in the timeline planned.
The EPA will deliver a fully developed HIA that examines health and environmental impacts of the proposed school renovation options being considered.	Yes	The HIA Core Group developed this report, which documents the completed HIA, its activities, and supplemental materials.
The HIA will provide educational materials that are context-specific and science-based to the community and other stakeholders regarding air pollution and ways to mitigate asthma triggers.	No	This was a missed opportunity that was not realized during the HIA.
The EPA will use tools and approaches to conduct the HIA that will generate lessons learned and best practices for implementing HIA by a federal agency.	Yes	The EPA used an array of analyses in the HIA across different sectors, as well as performed a process evaluation, that yielded valuable insight for conducting an HIA by a federal agency. The lessons learned are provided later in this section.

Challenges Identified

The HIA Core Group identified the following list of challenges faced during the implementation of the HIA. For each challenge, the HIA Core Group also developed and implemented countermeasures to ensure the HIA remained relevant to the decision and valuable to stakeholders.

1. A sliding HIA timeline and limited resources

The amount of time used to complete each step in the HIA process exceeded the estimated time. This is a common challenge shared by many practitioners in HIA. However, there were some nuances unique to a federally led HIA that proved challenging. For example, designing the assessment plan that was responsive to the stakeholder-identified concerns and scientifically viable took longer than expected, as did acquiring approval to perform on-site data collection from the Agency. EPA maintains quality assurance protocols and internal review boards for data collection and Quality Assurance Project Plans that must be approved before any data collection can begin. Additional time for internal Agency protocols and approval processes was not included in the planning process.

The assessment step expanded over ten months, due to changes in conditions both external and internal to the HIA. For example, the school underwent floor resurfacing in April 2013 after the building assessment. Resurfacing the floors added dust and particulate matter into the air, which would have compromised the air sampling. The air sampling could not occur until after clean-up from the flooring work was appropriately performed. Furthermore, once the air sampling was completed, the results of that assessment were not available for six months (January 2014), due to issues with contractor funding and timing for deliverables. Additional resources were acquired to obtain the final interim report for the indoor air analysis.

During the Assessment step, the federal government shutdown for sixteen days (October 1 to 17, 2013) causing a complete stop-work for the HIA. For the month of October, there was no progress. The shutdown occurred during a period of time when project deadlines were critical and resulted in a temporary shift of project priority within the Agency and the City (due to budget deadlines).

Another persistent challenge to the HIA was the limited funding available to perform all of the anticipated activities. For example, the funding resources needed to perform the indoor and outdoor air analyses outlined in the RESES proposal was underestimated, which limited the data collection methods available. In addition, the graduate student vehicle, which would perform the outdoor-source attribution analysis, was not be secured. Coupled with the sliding HIA timeline, these challenges proved difficult to manage stakeholders' expectations of the HIA. Some of the expectations, such as identifying optimal locations for the air intakes, could not be met. Additional funding for the HIA would have allowed for more extensive air quality assessment than what was able to be performed.

Countermeasure: Maintain Vigilant Communication with Decision-maker

The HIA Core Group was aware of the need to be sensitive to the decision timeline. When the initial decision timeline was surpassed, the HIA Core Group met with PBRM to determine if the HIA could still inform the selection and implementation of renovation options. PBRM communicated that the information from the HIA could still be used to inform the selection and implementation of renovations, since the renovations evaluated were not planned to be implemented for several years. Maintaining close communication with the decision-makers helped to ensure the HIA recommendations remained relevant to the decision.

2. Stakeholder Engagement and HIA Participant Roles

One of the shortcomings of this HIA was the low and unequal inclusion of stakeholder groups. After the HIA Core Group and participant roles were established, strong differences of opinion regarding the level of involvement among stakeholder groups and participant roles (i.e., who is a partner, a member of HIA Core Group, and whether internal vs. external stakeholders) persisted throughout the HIA. This difference resulted in unequal communication and participation among stakeholder groups.

Countermeasure: Continuously re-visit purpose and goals of HIA

The HIA Core Group held several discussions to build a consensus regarding HIA participant roles, addressing each person's concerns. The purpose and goals of the HIA were re-visited and used as the foundation for developing a consensus among the group. Once a consensus was reached, the roles were more specifically defined and communicated to external parties.

3. Communication with groups external to the HIA Core Group

In part due to the difference of opinions regarding HIA roles, there were several instances where unfinished reports and analyses, that had not been verified by the HIA Core Group, was shared with outside entities prior to consensual agreement among the core members. These instances led to an unnecessary overburden of information to review and miscommunication of information that was coming from the HIA. Incomplete information not only confused stakeholders, but also led to wrongful expectations of what came from the assessments performed. Even though a communications plan was drafted at the beginning of this HIA, it was not enforced or updated to meet the evolving needs of the decision-makers.

Countermeasure: Update communications plan and assign a single gatekeeper

One of the countermeasures used to resolve this issue was updating the communications plan and assigning one gatekeeper for the transmission of information between the HIA Core Group and other entities. This extra control measure helped to mitigate any confusion, moving forward, regarding who was responsible for sharing information and when the information would be shared.

4. Unanticipated needs of performing on-site assessments

The HIA Core Group met with the school and PBRM to plan logistics of each site visit before data collection took place. Even with the planning sessions, there was still some unanticipated expenses and access issues. For example, the data collection for the Building Conditions and Systems Analyses required assistance from the maintenance staff and overtime for security personnel. There were areas that took longer to gain access because the maintenance staff were not notified earlier which areas needed to be accessible for the investigators.

Countermeasure: Develop a checklist for all resources/materials needed, including the areas that would need to be accessible, prior to arriving on-site. Allocate a portion of HIA funds for unexpected costs.

Having a comprehensive checklist of the resources/materials needed will help ensure time is efficiently used during the investigation and those responsible for providing access to the site are well-prepared. Also, developing a contingency plan for additional resources needed/costs incurred either before, during, or after data collection takes place will help ensure the investigation goes smoothly and conflicts are avoided.

Lessons Learned

The HIA Core Group would like to offer the following recommendations for future HIA practice, based on the lessons learned while implementing this HIA.

1. Develop and implement a Rules of Engagement Memorandum that clearly (explicitly) defined roles and responsibilities for those involved in the HIA.
2. Once the purpose and scope of the HIA are clearly defined, these items need to be continuously repeated or referred to throughout the HIA process.
3. Develop a clear (explicit) communications plan early on in the HIA process that includes the format of communications material, the person responsible for developing the material, and the route of dissemination. Communication is defined both among the internal HIA team and between the internal HIA team and external stakeholders.

4. Include someone with HIA experience on the HIA Core Team. Having someone well versed in the HIA field of practice can help ensure the HIA is meeting practice standards as it moves forward and can help provide HIA best practices when challenges arise.
5. If on-site assessments/investigations are planned, those involved in the HIA should discuss and outline specific resources needed and who will fund any added or unexpected costs associated with performing on-site investigations.
6. Openness about the HIA needs to be provided equally to the different stakeholder groups.

Using a Rules of Engagement Agreement will help ensure those involved in the HIA fully understand what is expected of them, better manage time commitments and availability, and enable accountability for completion of HIA-related work. Confusion and miscommunication may arise during the HIA, as a result of many moving parts and groups involved. The direction of the HIA can be easily influenced if the purpose and/or scope of the HIA is not clearly defined and made obvious to all parties involved. Having a clearly defined communications plan avoids unnecessary confusion and establishes when information will be communicated.

On-site visits require several levels of planning to ensure a successful event and resources are efficiently used. That being said, having a contingency plan for unexpected outcomes and/or costs should be included in the planning process. For example, on-site investigations planned at a school during the weekend need to consider funding sources for overtime costs of custodians

Stakeholders involved in the HIA may (should) come from various backgrounds and fields of expertise with their own preconceived idea of what the HIA should involve. HIA is a specific process that requires a minimum amount of elements to be incorporated and a different perspective of how a proposed decision should be evaluated. Thus, having someone well-versed in the best practices of HIA helps to manage expectations by ensuring everyone involved in the HIA understands what is to be expected. Those performing the HIA must keep in mind and respect that the different stakeholders may prioritize issues/actions differently and to not presume to know what those priorities are or how the stakeholder will react to the given information. An inclusive and collaborative framework is essential to the success of the HIA and helps to ensure the HIA is not the product of a single viewpoint.

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Appendix A. Notes from Stakeholder Engagement Meetings

Stakeholder Meeting Notes from October 4, 2012

Date: October 4, 2012
Subject: PBRM's Update on School Renovations (HIA Screening meeting)
Location: Gerena Community School, 200 Birnie Avenue, Springfield, MA 01107
Meeting Attendees:

The City of Springfield Department of Parks, Buildings, and Recreation Management (PBRM) was represented by Director Patrick Sullivan, Jim Avezzie, Mike Gibbons, Noelle Owens, Dave Meehan and Lynn Rose. Jay Dunnigan was present from Springfield Public Schools. PBRM's contractors performing investigations at the school were also in attendance, including representatives from Simpson Gumpertz & Heger, RDK Engineers, O'Reilly, Talbot, & Okun, and Timothy Murphy Architects. In the audience, there were representatives from Charlie Arment Trucking, Massachusetts Department of Transportation (MA DOT), the U.S. Environmental Protection Agency (EPA), Universal Electric, and WMECO. There was a total of 30 to 40 people in attendance.

Meeting Notes:

Mr. Sullivan reported that, based on recent testing PBRM identified the source of water leaks at Building C (tunnel), room A104 (the wrap-around), upper ramp and lower Ramp of Building A (tunnel); and room A109 (formerly NEON offices). The leak at room A109 is theorized to be coming from waterproofing membrane underneath Birnie Ave. Investigators believe that the membrane is damaged, permitting water infiltration under the membrane and into the tunnel. The membrane will need to be replaced and the road would need to be rebuilt. Repair will require additional State assistance, permissions and funding needed to test, confirm, and fix. PBRM is working with Simpson Gumpertz & Heger, MA Department of Environmental Protection (MA DEP), EPA, and MA DOT.

Simpson Gumpertz & Heger was commissioned to begin designing solutions at:

- overhead section of the Main St. Entrance
- Portions of the I91 Exit 10 ramp abutments
- Highway fencing and vegetation

EPA and MA DEP are planning to:

- conduct additional environmental testing to help determine the final designs for the indoor air ventilation systems

MA DOT is planning to:

- monitor the I91 Bridge overpass for water leaks

PBRM wants to work with community leaders on designing future renovated spaces. The final cost for improvements is not yet known, the bids for contractors are out.

George Frantz (EPA Region 1) presented a little of the history, process and purpose behind a Health impact assessment (HIA) and invited all stakeholders to attend the Scoping meeting planned on October 17, 2012. Marybeth Smuts (EPA Region 1) presented on what the EPA will be doing in terms of data collection at the school and reiterated the intended impact of the HIA for this project.

A community member mentioned that there was a suggestion years ago to bury the school and build a new school. He mentioned that people are concerned about the cost and talked about how this (area) used to be a lake and that this is (school is located on) water. This was the first time investigations looked at where the water was coming into the building. Discussion ensued regarding the improvements to air quality in the school over time. A former employee mentioned that the facility is now a lot dryer; there used to be puddles of water in the building. Since Gerena will be an operating school for another 10-12 years, PBRM will fight for money to keep the school safe.

Stakeholder Meeting Notes from October 17, 2012

Date: October 17, 2012
Subject: HIA Scoping Meeting (6:15pm – 8:15pm)
Location: Gerena Community School, 200 Birnie Avenue, Springfield, MA 01107
Meeting Attendees:

Last Name	First Name	Organization
Szegda	Kathleen	Partners for a Healthier Community
Skiba	Catherine	MA DEP
Wood	Ben	MA DPH
Bewsee	Michaelann	Arise for Social Justice
Askwith	Debra	SEA (Ret)
Rivera	Luz	Gerena Staff/Parent
Roller	Devon	Arise for Social Justice & WNEV
Robles	Jafet	Voices of the Community
Rosario	Jose	Voices of the Community
Sibley	Destry	Voices of the Community
Sullivan	Patrick	City of Springfield
Gagnon	Diane	Gerena School
Escribano	Cynthia	Gerena School

Pohlman	Karen	Brightwood
White	Steve	OPHI (HIA Advisor)
Fulk	Florence	EPA, NERL
Zartarian	Valerie	EPA, SHC
Murphy	Jim	EPA, Region 1
Paré	Janice	ASPH Fellow c/o EPA ORD
Smuts	Marybeth	EPA, Region 1 OEP
Frantz	George	EPA, Region 1 OES
Zimmerman	Emily	EPA, Region 1
Rose	Lynn	PBRM

**A Spanish translator attended the meeting, but was not needed.*

Meeting Notes:

Jim Murphy (from EPA Region 1 New England) opened the meeting at 6:30pm. He covered the purpose of the meeting and that EPA will bring another tool to the process of repairing Gerena School. There were a few minutes allowed for audience introductions.

Steve White (from Oregon Public Health Institute) introduced concept of health impact assessment (HIA).

- Health Impact Assessment: recognizes that social and environmental conditions drive health outcomes, especially differences in health outcomes.
- Many decisions that shape our environment don't consider health impacts.
- Health can be influenced by individual factors, public services and infrastructure, living and working conditions, social economic and political factors.
- HIA evaluates how a specific decision or set of decisions may effect all of the various factors that influence health

George Frantz gave overview of the planned HIA that will be performed here at Gerena and spoke about some of the exposures at the school (water, allergens) and partners involved. Marybeth gave overview of the anticipated data collection process, including indoor and outdoor air monitoring, mold sampling, moisture analysis, and evaluation of the building conditions and systems. The HIA will not be collecting information on individual students and their management of asthma. The HIA will draw from other studies that have evaluated risk factors for asthma.

Steve White led a general discussion on health covering:

Definitions
Health Outcomes = a change in health status
Health Determinants = things that influence a change in health status

Health Outcomes:

- Asthma
- Diabetes

- Chronic coughing
- Seasonal Allergies
- Cancer
- Rash
- Cardiovascular disease
- Colds
- ADHD
- Depression
- Obesity

Behaviors that influence health outcomes:
- Smoking
- Poor nutrition
- Lack of exercise
- Sleep
- Drug or alcohol abuse
- Taking your medication

Social and environmental conditions that influence behavior and health outcomes[10]:
- Racism
- Language barriers
- Poverty
- Community safety as it relates to leading an active life (safety from crime and accidents)
- Absentee landlords
- Abandoned Property
- Housing issues (property maintenance/code enforcement)
- Classism
- Opportunities for physical activity (parks and recreation)
- Health supportive resources (physical activity, goods and services, food)
- Food/transportation access

Health outcomes related to Gerena School:
- Obesity
- Asthma
- Depression
- Anxiety
- ADD/ADHD
- Chronic coughing
- Allergies

Behaviors that influence these health outcomes:

[10] These are the root causes of disease and health impacts. When we do an HIA, we have to figure out how social and environmental conditions are impacted as well.

- Absenteeism (point was made that absenteeism is not all due to illness, but it affects both health outcomes and influences the social conditions that influence behavior)
- Inability to concentrate for various reasons
- Physical activity
- Keeping kids inside all the time during summer and after school hours because parents don't think there are safe places for kids to go
- Parents with infants or toddlers would rather have kids bussed to other schools because of the way the school looks. Not having child in community you're in has impacts on building community (improving social cohesion) and getting parents involved in school.

Social and environmental conditions that influence behavior and health outcomes:

- The pod system of the classrooms = loud classrooms (classroom design); could affect kids with ADHD (there is disagreement expressed; disagreement that it is causal to the health outcomes: we have to be careful not to put our conception as adult learners on what the children are doing)
- Acoustics/Noise pollution
- Income/poverty
- Employment
- Education quality
- Parental/citywide/community perceptions (these things can influence the relationships between the school and these groups)
- No safe place to play
- External perception (physical condition of school not properly maintained or lacking equipment)

There are different schools of thought on what should be a "priority." The HIA will consider both scientific evidence and what stakeholders (decision-makers, educators, students, and residents) need. This HIA will be a pragmatic exercise that balances the basic health issues with education quality issues. The bottom line should be the health of teachers, students and staff.

There are community perceptions of this school regarding low performance, environmental factors, low parental involvement (perception different from reality). A lot of negative perception that may not be factual. The HIA will investigate perceptions of the community regarding the facility. The first thing people see when they come into the school is mold/environmental problems in the tunnel (giving a bad impression), which plays a role in how the school is viewed within the community. There is a misconception that the rest of the building looks like the tunnel. It is important to note that the negative perceptions is related to the condition of the building as a school and community center, but not the staff and teachers. For living in a high crime area, residents don't like that kids don't have a safe place to play. Community center issue is major concern of parents. There is a perception that the people in charge of the school don't make Gerena a higher priority and that the conditions in the school are not improving. The HIA will look at how to help the City direct their resources, eliminate physical problems, and inform the community on the work performed and/or progress made.

The meeting participants ranked the following items as high or lower priority:

High Priority

- Air quality
- Mold
- Particulate Matter
- Asthma
- Condition of carpet and its impact on air quality
- Perception of physical conditions of the school or investment priorities (commitment of city and school board to improve school)
- Vulnerable populations (demographics, pre-existing conditions)

Lower Priority

- Absenteeism (93% attendance rate now; used to be 88%) 3 and 4 year olds are absent more often than others (significant population of students with special needs here and they tend to have a very good attendance rate)
- Classroom noise

It is important to consider that school and home are both environments that can have asthma triggers. There a perception that the school is causing asthma symptoms. Absenteeism is thought to be linked to asthma, but not known. The audience charged the HIA to look at:

- Unexpected asthma attacks at the school to better identify if there are triggers happening at the school that are exacerbating the problem;
- Prevalence rates versus unexpected episodes;
- Air Quality – prevalence is good to look at because it shows that there is a population of vulnerable students who are more sensitive to poor air quality;
- School nurse-collected asthma data
- (If possible) Number of people using the facility over time (5 years)

Although there is no binding contract that the City will have to adopt and implement the HIA recommendations, there is a strong likelihood that the City will consider the recommendations. EPA will be working closely with City, along with other state and federal agencies, to provide recommendations. The hope is that the HIA will help the City get more funding/resources to do more repairs.

Next Steps

- Begin studies, begin sampling, begin monitoring
- The next public meeting to project will probably be in February, and the recommendations meeting will probably be in May.

Stakeholder Meeting Notes from October 18, 2012

Date: October 18, 2012

Subject: HIA Scoping Meeting (continued)

Location: Gerena Community School, 200 Birnie Avenue, Springfield, MA 01107

Meeting Attendees:

Last Name	First Name	Organization
Rose	Lynn	PBRM
Wood	Ben	MA DPH
Sibley	Destry	Voices of the Community
Robles	Jafet	Voices of the Community
Pohlman	Karen	Brightwood
Szegda	Kathleen	Partners for a Healthier Community
White	Steve	OPHI (HIA Advisor)
Zimmerman	Emily	EPA, Region 1
Frantz	George	EPA, Region 1 OES
Skiba	Catherine	MA DEP
Smuts	Marybeth	EPA, Region 1 OEP
Paré	Janice	ASPHA Fellow (c/o EPA)
Murphy	Jim	EPA, Region 1
Fulk	Florence	EPA, ORD- NERL
Zartarian	Valerie	EPA, ORD- SHC
Sullivan	Patrick	PBRM

Meeting Notes:

The goal of this meeting was to refine what was said last night to make sure EPA captured the information accurately and discuss next steps of the HIA. Steve White provided a short summary from the previous meeting. Mr. White will take the information gleaned from the Scoping meetings and draft a pathway diagram in which the decision may affect health. Topics may include:

Air Quality Improvement Actions:

- New equipment/carpet
- Monitoring Plan
- Education component
- Occupant performance (occupational and educational)
- Money/cost

Air Quality Improvement (indirect results)

- Cleaner Air
- Changes in facility use (if we could improve air quality we could open up more parts of the building and/or change perceptions)
- Community perceptions

Health issues identified:

- Asthma
- Physical activity
- Social Cohesion
- Multiple Health Impacts
- Other respiratory illnesses (allergies: itchy eyes, runny nose, stuffy head, headaches)

There are things that can be done to mitigate the noise issues, while renovations are taking place. EPA will keep in mind that there may be noise issues related to the renovations.

The HIA needs to be completed as early as possible to inform the renovations. EPA plans to complete the HIA by June 2013. The HIA is intended to help the City prioritize issues and/or solutions.

Public meetings may be moveable, but the deadline for finishing in June is not moveable.
Oct and Nov '12 = public outreach,
Dec '12– April '13 = data collection and formulating problem,
March - May '13= drafting report and recommendations; dissemination
June '13= final report

<u>Developing HIA Research Questions</u>
Potential Question: What are the respiratory health outcomes and symptoms related to AQ at Gerena?

We can use literature review and data collected by Matt Sadof (Springfield Schools pediatrician), Pioneer Valley Asthma Coalition, and school nurses to help answer the question.

Potential Question: How might these outcomes/symptoms be impacted by remediation?

We can use EPA modeling to answer the question.

Potential Question: What are the symptoms (e.g., coughing, allergies, etc.) attributed to?

It's very difficult to find specific correlations between exposures and symptoms. Thus, data gathering is critical in this area. Matt Sadof and Health Advisory Board for Springfield Schools could be a data source. This should be a general question. For example, what types of symptoms happen for different things? Asthma is the most tangible outcome to look at right now, but EPA would like to keep in mind the other respiratory health issues as we continue through this process. C-FERST databases could be useful to the various community groups, especially the Health Advisory Board, since there are constraints on collecting surveys.

Potential Question: Why is attendance low and would low attendance improve with improved air quality?

The community is interested in knowing about the reasons why kids aren't coming to school.

Potential Question: What types of things does air quality impact with health?

Potential Questions: How do we measure improving air quality? What are we measuring? What are the other media and components? How will the amount of PM 2.5 change based on the different remediation plans? Which of the options will target the higher areas?

The HIA will not assess indoor air quality comprehensively. The goal is to assess the remediation plans and how they will affect air quality. MA DEP air quality monitoring will enhance the HIA work. DEP monitoring uses a composite sample over 24 hours of PM2.5. There are ambient air quality monitoring standards for PM2.5. There is no indoor air standard to compare things against, so there is no way to determine if things are unhealthy or not. Mold sampling was done on 36 types of molds and there will be ranking of the mold. EPA will rank areas to show where remediation should be focused. EPA can sample and test sources, such as trucks, nearby roadways and railroads and an analysis of the building systems. We can do indoor air and outdoor air sampling and mold sampling to evaluate changes and developments from sources. The goal is to understand the variation in the things we are measuring that represent air quality. We need to look at the variability as it compares to occupancy.

Voices of the Community performed a survey that found the priorities were:

- Community center (after school homework help)
- Therapy and counseling
- GED counseling
- Workforce Development

Potential Question: What is the current need and demand for facilities?

This is the only community center. If Gerena is shut down, there is no other place for kids to go.

Data may be available from the community survey.

Potential Question: Where do users come from? How might facility use change?

Look to history of facility, such as the data on number of users (building permits; student body size, etc.) and type of users.

Lynn Rose provided a history of the facility:

- Original Use of Building, how it has changed, and what it is now…
  - Originally: housed grades 5-6. Top floor was the pod system. Bernie Ave. was arts, music…etc. Downstairs area was the gym and pool, open to community. Where we sit now was the public library. Other downstairs room was used for adult education. Down in the tunnel, North End community Center, craft center, King center. Park office. On the opposite side of the tunnel, we had a heath center and a preschool. Activity downstairs was continual during the day time. School used to stay open until 9pm. Used to have weekend classes on the weekends…etc
  - Now the building closes at 8pm. During the summer it is 7pm, and on weekends it is closed.
  - Since the water filtration struggles, there have been drastic changes to the original use
  - In 1990, when the water main broke there were severe flooding damages.
  - Air handling units were modified, but never upgraded (original air handling units had fiberglass filters)
  - Energy management system was partially upgraded

    - Water infiltration started basically when the building opened.
    - Some of the water infiltration has come about through the life of the building—example is by the auditorium
    - Water table issues: floor actually rose 9 inches during a flooding period, and then has sunk 6 inches to where it sits now.
    - Current users of facility: Wraparound, WGBY (public TV), community center, dental clinic, North End community, Park Dept, after school program
    - When the water main broke: they abandoned the utilities under the building, and we are dealing with that legacy; and stormwater structures now leak
    - Air handling system was never updated (in terms of motors and shifts). Outside dampers are not operating properly.
    - Building is living with the legacy of what happened after the flood: Old utilities underground were abandoned and other things were built, but the old conduits underground are now pathways for water.
- New installation of doors:
    - Caused concern (two sided)
        - Used to be concern of security because anyone could walk through
        - Flip side: concern/fear that city would limit access of the school for the community
        - Building closing at 8pm is problem for community because hard to cross the highway. The only other way is to cross live railway, which will, in the future, be a high speed railway. Railroad tracks are also very dark. Reports of assaults and drugs near the railroad.
            - Another solution: keeping tunnel doors open later at night

Potential Question: What community groups use the school?

The school is designed to bring in the entire city. It still draws mostly from the north end community in Springfield. The school was built because there was a need for a new elementary school because the North End had a large influx of Puerto Rican population. This school area is considered mutual territory during periods of gang violence.

Identifying Vulnerable Populations:
Improving air quality is going to be less of a concern for adults coming into the building, but more of a concern for the children using the building. There is a subset of vulnerable populations among the child population. Hot spots within the building could inform planned use for the space and who uses what. Important to know where the vulnerable populations are in the school. Level of use also dictates level of exposure. Walking through the tunnel is different level of exposure than the level of exposure of people using the facility for longer periods.

Having good security and keeping the doors open would be a good solution for the need for access to the tunnel for people crossing the highway, and keeping the building safe. The tunnels are the only safe way to travel between the neighborhoods. One side is residential while the other side has a grocery store and commercial retail. Costs for managing the tunnels comes out of the school's budget. In order to provide level of community access the City needs to address the cost of keeping the tunnel open.

Potential Question: What are the existing perceptions related to AQ at school? Are there other data sources to give an idea of perceptions as they relate to AQ?

In the press, there are newspaper articles (e.g., the Republican has many articles on the issues of school). Sometimes documenting what happened in the past can possibly give us an indication of what might happen in the future. EPA can look to media to see what a fully functioning community center has done for the community.

Question: How might this project change perceptions?

- reduction in asthma
- increased facility use
- improved community perception
- improved physical activity and social cohesion- needs to be described in a credible manner

The HIA will consider both positive and negative impacts. When it comes down to making a choice, the HIA must advocate for health.

Steve White explained matrix that can explain multiple scenarios:

How do options impact the potential to improve AQ overall?	**potential to improve hot spot areas?**	**potential to improve facility for students?**	**Potential to improve facility for community?**
XX	XX	XX	XX

After reviewing the HIA recommendations, the bottom line for PBRM will be deciding the best return on investment.

Immediate Next Steps

- Ranking Criteria, and what will actually be assessed
- Refine Research Questions
    - For each question rank by data, methodology and level of importance
    - ACTION ITEM: Steve will draft these out and share with the research team to refine and revise
- Communications Strategy and Dissemination Plan
    - ACTION ITEM: George, Emily and Marybeth to develop initially, Emily to review and revise
    - Find HIA examples (healthimpactproject.org); UCLA CLIC – good general examples and pathways info
- Monitoring Plan
    - What is it we are basing the improvements on – where is the data coming from
    - What does the existing system look like?
- Clarification of Roles and Responsibilities of the Corps team
    - ACTION ITEM: George will draft and circulate
- Lessons Learned

- Documenting lessons learned throughout process
- Evaluation Plan to document lessons learned

Marybeth Smuts iterated that this is EPA's first HIA, so the lessons learned will be translated throughout EPA and will be translated to other communities impacted by being near roadways. Lessons learned will have long-range impact. Members of the HIA core team took a guided tour of the building to better understanding for sources of asthma triggers and the school layout.

Stakeholder Meeting Notes from December 10, 2012

Date: December 10, 2012

Subject: HIA Scoping Meeting

Location: Conference call

Meeting Attendees:

First Nate	Last Name	Organization
Bob	Thompson	EPA
George	Frantz	EPA
Gregg	Furie	EPA
Jim	Quackenboss	EPA
Gregg	Furie	EPA
Lynn	Rose	PBRM
Marian	Rutigliano	EPA
Marybeth	Smuts	EPA
Ron	Williams	EPA
Shannon	O'Shea	EPA
Janice	Paré	ASPH Fellow
Valerie	Zartarian	EPA
Emily	Zimmerman	EPA
Brian	Dyson	EPA
Steve	White	OPHI (HIA Advisor)
Rick	Ziegler	EPA

Meeting Notes:

Steve White presented on the pathway diagram. Noise may be an issue because parts of the school use an open-floor plan and removing carpet would affect noise levels in those areas. On the second floor (which has a regular layout) staff can open the windows but choose not to because of traffic pollutants and noise. Also, the School has been asking for a redesign of the third floor (i.e., dividing the area into regular classrooms), which will require a redesign of the air system.

The main issues from the Scoping meeting are identified in the pathway diagram. Other issues that were discussed, but were excluded in the pathway diagram, are light and flooding. Resident and building occupant perceptions are not the same and may need to be differentiated. All details do not need to be on pathway diagram. Details on what is evaluated will be reflected in the research questions and assessment plan. The criteria to consider the identified issues includes technical feasibility to evaluate the issue, stakeholder interest, and likelihood of health impact. Certain issues may need to be addressed chronologically.

PBRM is moving forward with some renovations that were already planned. For example, PBRM is already performing lighting retrofits. But, PBRM will wait on ventilation system upgrades for the HIA recommendations. For example, there may be specific recommendations that come from the noise literature review to prevent corrections later. Another issue to consider is long-term feasibility and/or costs from extreme weather events and groundwater intrusion.

There are many questions posed for the HIA to answer. It was agreed that the questions related to asthma exacerbation are most critical for this study.

Stakeholder Meeting Notes from February 14, 2013

Date: February 14, 2013
Subject: HIA Scoping Meeting
Location: Conference call
Meeting Attendees:
(not documented)
Meeting Notes:
We had a brief call with Lynn Rose (PBRM) and Diane Gagnon this morning to discuss the walk-through tour at Gerena. The dates are not determined, but Diane gave us a few to work with and sounded like she was comfortable with the plan for the tour and the data collection. Lynn expressed some concerns about EPA publishing the mold data. She will confer with PBRM about these concerns. The QAPP for air sampling is still in-progress. It is important to note that no data collection can take place without an approved QAPP. The approval process may take up to five days, once the QAPP is submitted. As of now, it seems that a team of about 9 EPA employees will be part of the walk-through tour. EPA will need to collect data to get a basic understanding of how the school operates, including air movement, location and flow of in-coming water, and general characteristics of the land (where the school was built). EPA will need access to HVAC vents, pipes, etc. All visitors will need visitor passes and complete the

sign-in process. EPA will minimize the number of people in classrooms while they are in session and will be flexible with work if it will be too disruptive while students in classroom.

The schedule is as follows: Walk-through and data collection: 2 days. Sunday and Monday are ideal in order to get a look at school while it is and is not occupied.

Proposed dates: February 24 to 25, 2013 (QAPP approval pending).
March 3 to 4, 2013 (There will not be MCAS testing at this time)
March 24 to 25, 2013 (May be last option).

Stakeholder Meeting Notes from April 1, 2013

Date: April 1, 2013
Subject: HIA Assessment Meeting
Location: Conference Call
Meeting Attendees:

Name	Organization
Lauren Adkins	CSS-Dynamac (c/o EPA)
Florence Fulk	EPA
Janice Paré	ASPH Fellow (c/o EPA)
Valerie Zartarian	EPA
Emily Zimmerman	EPA
Lynn Rose	PBRM
Marybeth Smuts	EPA
Bob Thompson	EPA
Ron Williams	EPA
Jim Murphy	EPA
Steve White	OPHI (c/o CDC/EPA)
Steve Vesper	EPA

Meeting Notes:

The Walk-through tour and data collection went well. The timeline of activities was as follows: Sunday= HVAC contractors meeting and walk-through; Monday= building walk-through, PBRM's presentation, and discussion; Tuesday= presentation of preliminary findings and discussion. PBRM conveyed that the City is committed to a long-term, high quality solution. The data collection included short-term air sampling and thermal-infrared scan of roof, concrete material, and walls. The data collection identified a lot of causes and short-term solutions. Where the roof and walls meet, there is a lot of energy loss. Structural steel with bolts became separated from the walls over time and now there is a big gap between them. With the renovations over time, there was a lack of integrated expertise, which is leading to issues now. For example, when boilers were removed, the pressure released caused air to be cycled from bottom (underground) to top floors of school. There was a lack of defined parameter/specificity of "clean" and it has affected health. The results from the Mold Contamination Analysis interim report lined up with what found in this analysis. The interim report will be available in approximately 2 weeks. The next step is performing longer air sampling related to nearby traffic and/or indoor environment conditions.

PBRM appreciated the value of the integrated approach. The City does not want to spend a huge investment on issues that will not solve the problems at the school. The comprehensiveness of the analysis was the most important value gained from using the HIA approach. The pre-planning for collecting data left some to be desired (as expressed in a previous email). For example, PBRM needed to know where/what will need to be deactivated/opened for the contractors to see/monitor, which required unexpected security expense. PBRM also needed to know where data collection was going to occur to ensure EPA had access. PBRM wants to make sure the HIA report includes these "lessons learned." There were two specific questions that the City will need from the report:

- Can the building be renovated so that it is healthy enough to inhabit/occupy?
- What products/documents can be prepared that include information of the assessment/recommendations that other schools/city buildings can use?

Lessons Learned: The walkthrough timeline was well-designed. It was good that the contractors had a chance to familiarize themselves with the building before presentations, so that they could ask specific questions of the school contractors and City folks. The HIA team needs to be sure to give PBRM at least a five-day notice before the air sampling phase begins.

HIA Timeline Update:
May 13th-20th (Closed) Meeting with PBRM
May 21-20 Meeting on integrating repairs to health outcomes (discuss the main deliverable- the HIA Report)
June 3 or 8th (Public) HIA community meeting for prioritizing recommendations of HIA (need to be aware of the stakeholder groups at meeting, there were several groups who were not on board with the renovations proposed, we need to be sure that we're getting feedback from as many stakeholders as possible)
The air sampling study is planned after floor resurfacing on April 14-23, 2013. Marybeth, PBRM, MA DEP, Ron and Bob will work on locating sites for air sampling and timeline. Lynn will put together her lessons learned so that we can share them and a factsheet on the

renovations/items completed at the school. Mary Beth will forward the information on the building's history (from Jim Murphy) to the rest of the HIA group. The next meeting for the HIA Core Group is set for Wednesday, April 10th, 2013 to start planning the assessment phase and incorporating the quantitative data with the qualitative data.

Stakeholder Meeting Notes from April 17, 2013

Date: April 17, 2013
Subject: HIA Assessment Meeting
Location: Gerena School
Meeting Attendees:

Marybeth Smuts (EPA), Lynn Rose (PBRM), Dave Holland (MA DEP)

Meeting Notes:

Topic of discussion was selection of air sampling sites and proposed data collection process. Dave Holland MassDEP (Regional Engineer is one of the original contractors commissioned for building the school. He was the person that recommended the school not be built there (in its current location) due to the proximity to Hwy (because lead-based gasoline and semi-truck exhaust from 100-400 trucks per day), the proximity to hospitals (airborne phenol exposure from hospital), and the proximity to industry factory (Pioneer company tanks with thousands of gallons of ammonia). The air data (collected from the Building analyses) showed spikes of CO2 emissions throughout the day (especially at 3am and 10pm when the HVAC would turn on/off). PBRM is disappointed that the air pressure flow information was not in the Building assessment report, but the information is available.

The school underwent flooring resurfacing, which was a huge detriment to the indoor air study plan. The flooring company did not follow the guidelines on contamination of the fine particles (sand used to resurface floors). The HVAC unit was also "on" and blew fine particles everywhere and up in the high loft of the atrium (unreachable). The classroom doors were open. Therefore, all of the fine dust (sand) particles got everywhere and there is a haze all around the school. There is only a head custodian for a clean-up crew, and no clean-up plan in place. The school reopens next Monday (it has been closed for spring break). The fine particles from the floor resurfacing may contaminate the indoor air quality data and a decision has to be made on next step in air monitoring plan. A minimalist plan is needed for getting school cleaned up.

Stakeholder Meeting Notes from May 6, 2013

Date: May 6, 2013
Subject: HIA Assessment Meeting
Location: Springfield PBRM Office

Meeting Attendees:

Marybeth Smuts and George Frantz from EPA (Bob Thompson from EPA on phone), Lynn Rose from PBRM

Meeting Notes:

The following comments are on the interim building conditions and systems analyses report (dated April 10, 2013).

-The final report can follow the format of including an executive summary and a summary of onsite sampling and observations although the body of the report should include the methodology, observations and results and or impacts of the observations.
The body of the report should provide a brief overview of the operations of the building and its systems.

-The summary of the recommendations should be ranked by needs for operation of school and then another prioritization of the recommendations by cost: high, medium or low. Using these rankings, the HIA will rank based on health impacts.

-It would be better to start the recommendations based on the onsite observations. The next section should be recommendations from the reviewed documents and then the summary will be the prioritizations of both sets of recommendations.

-The recommendations based on reviewed documents should only include the results of the Mold contamination report, which was included to assist in the building evaluation diagnostics and not the conclusions with remediations.

-Many units of the HVAC system are not functioning so air handlers that are operating are handling the occupants load for areas that they weren't designed to handle. In many cases, such as in the pods, air movement is adequate but in some areas, such as the media and office, the occupant load is not handled by the existing operating systems. If the air handlers can't be put back into operations by obtaining spare parts or having parts tooled, then the areas should be prioritized for needed repairs. The RDK report with its recommendations should be prioritized for which systems need repairs.

-Describe the recommendations for tunnel C with more specific areas and equipment suggestions. Also, areas for de-humidification or air drying should be delineated with very focused areas sited and estimate energy recovery savings.

-Within the report there should be some description of the HVAC system with reference to what unit is operating and serving what area. Particular attention should be given to describing air flow and pressure differentials in the minipods/teacher lounge areas due to concern about the ventilation design for this area.

-It might be beneficial to develop after the prioritization, a developed workplan/timeline for action items.

Stakeholder Meeting Notes from December 9, 2013

Date: December 9, 2013

Subject: HIA Assessment/Recommendations Meeting

Location: Springfield PBRM Office

Meeting Attendees:

Name	Organization
Marybeth Smuts	EPA
Bob Thompson (via phone)	EPA
George Frantz	EPA
Noelle Owens	PBRM
Lynn Rose	PBRM
Michael Gibbons	PBRM
Pat Sullivan	PBRM

Meeting Notes:

The following are related to the impact summaries provided:

- Executive summary needs to be revised. (Marybeth) I have not had a chance to review it.
- PBRM will review documents and comment first before EPA disseminates to public in order to prepare to discuss when the work can get completed.
- Public comment period could be as soon as the end of January.

MSBA schedule and how recommendations can be integrated.

- MSBA funding schedule for projects other than green repairs is due in January, Feb and then April.
- Gerena (renovation) funding proposals will probably be submitted Feb or April.

Testing for outdoor air

- Needs to be conducted for a longer period based on the findings. EPA may be able to provide some equipment.
- PBRM is concerned that waiting for more testing could cause the community to feel that actions were being delayed. PBRM thought that this HIA was going to accomplish what EPA is now recommending.

Documents and information included in the report:

- Highest risks were based on asthma and mold, not contaminants from the outside.
- Recommendations for immediate actions related to the subsystems of the building (City still needs to assess the long term viability of the building):

  Immediate Actions:

  1. Seal the building:
     - Too many unplanned airflows. There are major gaps where the walls meet the roof. Must control these in order to plan the redesign of the ventilation effectively.
     - Can be insulated with rock wool, or poly ceiling foam. Issues with poly ceiling form due to the asthmagen in the isocyanates. It is the best product for this purpose, but must be installed properly, which EPA will guide us. EPA will also help to determine if there is a less hazardous foam product available.
     - Pat was concerned whether the gaps are a sign of structural issues from settling. There was some evident work conducted to reinforce the area between the roof where are metal plates are installed on all 3 floors and along the A Tunnel. (Lynn went back to confirm this after the meeting)
  2. Change the airflow between the air flow between the inner and outer tunnel C. This will be done by installing an exhaust system to exhaust 100% of interstitial tunnel to the outside.
  3. HVAC - Short-term:
     - Notes from EPA:
       - Judge on cost, O&M, operating requirements, feasibility during occupied times, etc.
     - Notes from PBRM:
       - City is looking at bonding across City to address HVAC systems in City.
       - Add column for community input, concerns, etc. in the planning worksheet PBRM has been developing.
       - Some of these items are at different states of being addressed – some are completed, some are already underway, some need to be bid out, etc.
       - Cooling tower has failed and is a 6 figure cost. EPA has offered to assist us to develop specs for this.
     - Upgrade status of by-pass and fresh air intakes on existing systems.

  Near Term Actions (year or two out)

  4. Further investigate waterproofing (PBRM recommendation to change investigate stage to "implementation" stage) – status:

- Done for A tunnel. Implement proposal.
- Underway for C tunnel

5. Reseal leaks in tunnels.
6. Further investigate outdoor air quality at various locations around the building for long-term decisions about placement of intakes. If we do this additional testing which will delay some of the HVAC remediation, we would need to do earlier as a planning step. We have enough data to know that the most contaminants of concerns are the microbial contaminants. This will involve:
    - A Wind study
    - Further investigation of combustion particulates to enable us to plan for location of intakes.
    - Would need to be to do at worst case scenario, as the EPA HIA study was done at best time of year.
    - BU has equipment but students had no transportation. UMass could maybe help us and EPA could help us design study.
    - Can reduce impacts of roadway through increased filtration. This is for any impacts to tunnel A. It is not the number one issue. It does affect asthma but is not the highest impact.

Long Term Actions

7. Frontload HVAC work.
8. Assess the impacts of the air drawn up in the stairwells through the chimney affect to the pods. Lynn rechecked and there are heating units in the stairwells.

Miscellaneous:

- Report doesn't address issues of air movement from the mall area up into the stairwells acting as a chimney effect, and the area where the glass wall meets the ceiling in the pods – there is a gap. This allows air from the tunnel to be drawn up into the pods.
- (PBRM) It is starting to appear that the replacement costs are close to the repairs for this building.
- (EPA) Maybe keep the tunnel and replace the building.
- EPA's Table is designed to help us to make short and long term decisions based on health and cost issues.
- Go to EPA's IAQ Tools for schools guideline for new design criteria.
- RR changes may impact structural issues in the tunnel. Is the tunnel designed to bear any additional weight caused by double decker trains. Needs to be assessed.

PBRM action items:

- Major cleaning of building
- Assessment and removal of all moldy materials where feasible. Lynn checked the abandoned areas after this discussion and there is some materials to be removed, but much of the materials, such as carpets and ceiling tiles, have been removed over times.

- Remove all stored materials in moldy areas. Teachers use some of the abandoned areas as storage.
- Assess all furniture. Possibly: Remove all upholstered materials. Classes in the pods have upholstered couches. Maybe replace with nonporous materials

Overall comments from the meeting:
Pat Sullivan, Lynn Rose, Noel Owens (the architect) and Mike Gibbons (lead technician) were all pleased that the recommendations being offered seemed to fit well in the framework for renovation that they had thought appropriate, but it will push things in a few areas and maybe turn aside some ideas that appeared to be of lower value.

Overall, the response was very positive. However, because of the short turnaround on the draft summaries, we weren't able to re-order the piece, so we simply started our discussions with the chart on page 11. While everyone recognizes the importance of the public perception and noise issues, for this group, mechanical, scientific and health related issues were the order of the day.

One thing the client group noted was that based on preliminary findings, ambient air pollution appeared not to be a significant issue, contrary to the expectations of many citizen groups. But they strongly emphasized that we must have the indoor/outdoor air report by the end of the year so that supporting data can be integrated into the next level report. Pat said they liked the EPA format, but would probably add a column for "client response" and one for "public input." Lynn and (George) both took notes and we're in the process of combining for a synthesis. We'll send draft notes in the next day or so.

So as an initial response, PBRM was pleased. They will come back in a week or so with comments that they would encourage us to consider before they have to go to the city and state funders re: money for school renovations. For the first time, there was some real discussion of a replacement school. Pat said looking at our recommendations, he could easily see $12-16 million dollars on immediate and mid-term work. This in comparison to $30-40 million for a new school, with the state being able to put up a substantial chunk of that, whereas they wouldn't for renovation. So perhaps we were looking at a scenario where the city would implement the short-term recommendations, especially those judged to have a high value for health improvement, and possibly then recommend moving toward tapering expenditures until a new school could be completed.

Stakeholder Meeting Notes from January 29, 2014

<u>Date: January 29, 2014</u>
<u>Subject: HIA Recommendations Meeting</u>
<u>Location: Springfield PBRM Office</u>
<u>Meeting Attendees:</u>

Marybeth Smuts, George Frantz, and Ron Williams (on phone) from EPA, Patrick Sullivan and Lynn Rose from PBRM

Meeting Notes:

There was good participation from the PBRM team members, including finance, engineering, architectural and overall management. As a result of their input, many of our evaluations of anticipated first cost, O& M costs, etc., may change significantly. So rather than making modifications to the presentation materials that Marybeth and I used yesterday, it's my suggestion that you wait for a few days until we get our notes regarding the suggested changes transcribed and agreed to by PBRM. They see a great deal of use of filling in the Table and do want to have all of the renovations added so that the mayor, school board and community will see the complete picture of Gerena. This is great, but we will have a lot of work with all of it going through the review team again and then back to PBRM. Of course it's important to have materials agreed-upon by our project team. At the same time, I think it's important to leave a small range of flexibility to the presentation team.

Pat Sullivan suggested yesterday that our next presentation to city officials including the mayor's office, school board, and finance team would likely be on March 11, although that date will need to be confirmed and scheduled by PBRM when they are comfortable with the Table. We gave ourselves a target date of early next week to have an updated version of the Handout back to the client. In addition, since we have included some of the client-contractor based recommendations in our charts, it was suggested that some of the other recommendations generated by those client contractors also be included, in order to provide a comprehensive review, all in the same format. We believe that at the mayor and funders meeting, only the summary of the findings/recommendations be presented, perhaps along with summary slides from each EPA-led investigative reports. So perhaps a brief factsheet on mold, air sampling and building evaluation methods, findings, recommendations. Much will depend upon how much time is allotted for the presentation to the city officials and (when we get it) the MA DEP summary of their air monitoring findings. There will likely be a separate meeting with MA DEP to present their findings (which they did already) along with the EPA-led investigations. This presentation might be hosted by the Pioneer Valley Asthma Coalition.

There was a high level of confidence demonstrated by PBRM in our discussions yesterday. Marybeth and I left the meeting yesterday feeling very positive about our contribution to the overall result of providing for a healthier school environment for the students staff and faculty of Gerena school. We realize that a lot more work with drafting and agreeing on wording is needed, but we will also need to build in time for the back and forth with PBRM, since the meeting might be a joint presentation.

Some elements, for example- ceiling air leaks along the top of the building, were possibly going to be very expensive and difficult, depending on the specific barriers encountered. Noel, the architect, said there could be a real issue of electrical conduit and other associated piping in that area, making it difficult to access either from the inside or the outside. Then, as Marybeth and I discussed, there's the issue of successfully filling the gap with expanding foam. Obviously, since the foam is isocyanate-based, it will off-gas during the period before it sets up and so will require protective equipment for the applicators. PBRM will have to make sure that children are removed form that area during application. I'm sure our team can draw on extensive experience with this type of foam to address Noel's concerns.

There were other areas where PBRM indicated that the costs would be very high and the whole issue of funding sources was discussed. Pat Sullivan will present to the school funding group the plans for renovation and upkeep on all the City's schools in the next two weeks. We don't know yet whether or not Gerena is included in that specific budget request or whether specific projects will be handled via a separate funding mechanism. For example, the work of installing new pumps in the tunnels will be funded by MA DOT, as a high expense item, but will not come out of PBRM's annual budget. The entire school maintenance budget of approximately $5 million, divided among 53 schools across the city, allows for approximately $100,000 per school. Some schools are very new and require minimum upkeep, while others are older and require much more upkeep. There is no question of the commitment of PBRM to complete the work at Gerena, but the funding sources and the time in which various funding mechanisms can be accessed is something Pat Sullivan will know.

The following Tables documents PBRM's input on the HIA recommendations and updates to proposed renovation options, including cost and feasibility.

Table 1. PBRM's Proposed Changes to HIA Recommendations and Input on Cost and Feasibility (Immediate Actions, 2 years or less)

Recommendation Origin (#)	**Renovation Option** *(Proposed edits from PBRM in italics. PBRM's values in shaded boxes.)* *Renovations will follow all recommendations of handling asbestos, lead, PCBs, mold and other hazardous materials.*	**Health Value-**	**First Cost**	**Estimated Cost & Source of Funding (provided by PBRM contractors)**	**O & M Cost**	**Ease of O & M**	**Durability**	**Occupancy**
Building Assessment Report (#8, 9)	1) Seal building enclosure airtight at identified air leakage sites in building enclosure, using approved weatherization materials *and techniques and retest pressurization of building. Weatherproof stairwell doors per fire department regulations.*	H	$$	?	$	M	L	Unocpd
Building Assessment Report (#3); Air Sampling Report (#2)	2) Change the airflow between outer mechanical space and inner community space of Tunnel C *by continuously exhausting wet areas and sealing outer tunnel C from inner tunnel C space.* *Reroute the ductwork in outer structural tunnel-maintenance corridor, preventing any infiltration of air into inner tunnel.(To be done as part of installing negative pressure ventilation system in outer C tunnel for 100% exhaust)* *Assess tunnel C structure: determine if tunnel can withstand changes from the planned high speed and double-decker trains (check with PV PC).*	H	$$	?	$	M	H	Any Time
Building Assessment Report (#10)	3) *Tune-up and* upgrade of bypass and fresh air intake dampers for every AHU in Building B *to ensure delivery of adequate outside air and temperature control.*	H?	$$$	?	$	M	H	Any Time
Building Assessment Report (#12)	4) Provide increased cleaning of air conditioning drain pans *and ensure proper drainage and improve access to drain pans. Front-load cost, change latching mechanisms to provide ease of access for repeated cleaning.*	H?	$$	?	$	M	L	Any Time
Building Assessment Report (#14, 15)	*5) Replace pitted piping (plumbing lines) and corroded switch gear to eliminate water leaks*	H	$$$	?	$	L	L	Any Time
Building Assessment Report (#14, 15)	6) Improve HVAC Preventative Maintenance Program using checklist of EPA IAQ Tools for Schools kit within one month of completion of #3 and #4, then follow the recommended schedule to ensure proper continued operation.	L	$	?	$	L	L	Any Time

Table 2. PBRM's Proposed Changes to HIA Recommendations and Input on Cost and Feasibility (Near-Term Actions, 3 to 5 Years)

Recommendation Origin (#)	**Renovation Option** *(Proposed edits from PBRM in italics. PBRM's values in shaded boxes.)* *Renovations will follow all recommendations of handling asbestos, lead, PCBs, mold and other hazardous materials.*	**Health Value-**	**First Cost**	**Estimated Cost & Source of Funding (provided by PBRM contractors)**	**O & M Cost**	**Ease of O & M**	**Durability**	**Occupancy**
Building Assessment Report (#6)	7) *Implement waterproofing and resealing* of wall construction, and tunnel ceiling (chase) around tunnel A and C to stop water leakage and reseal areas causing water leakage in tunnels. *a) Re-roof roof as it is and replace drain (no redesign or additional roofing system). Concrete deck and waterproofing will replace existing roofing materials.* *b) Only addresses removing soil. See GZA proposal.* *c) Landscaping adjacent to I 91 bridge-re-grade per GCA proposal.* *d) Access to roof from outside of building. Obtain access agreement from mass highway. GCA to generate access plan from outside of building. Need to determine where roof drains empty* *e) mitigate leak in wraparound area at the vestibule; entrance door and inside corner of room* *f) mitigate leak in tunnel A wall at Main Street and fix leaking expansion joint on Highway* *g) repair crack/leak in ceiling area in A tunnel* h) *repair crack in A ramp floor by stairway near public toilets*	H	$$$ (DOT as source of funding)	a) $100,000 construction to be bid; $15,000 construction administration; and bid and construction design costs TMA. Ready to be bid for summer projects, TMA to provide proposal b) $18,080 to be encumbered c) included in GCA's unfunded proposal of $18,080 regarding embankment TMA d) $5000 to $6000 for two doors and door casings e) $6000 cost, part of $100,000 tunnel redesign, covered by DOT funds.	L	N/A	H	N/A
Mold Assessment Report (#2, 3); Building Assessment Report (#6)	8) Remove and discard building materials, *furniture and storage items* that have been damaged by water intrusion for longer than 48 hours and not professionally dried or cleaned AFTER water intrusion is stopped *and replace with cleanable material*	H	$$$	?	$	L	L	M
Building Assessment Report (#7)	9) *Plan for future air movement and ensure airflows from occupied areas to unoccupied areas.* ***What does this mean for renovations?***	H	?	?	?	?	?	?
Building Assessment Report (#1, 5, 11); Air Sampling Report (#1)	10) *If HVAC altered, air sources, such as traffic or trains, or levels change, re-evaluate optimal locations of air intakes and filters used and consider protection of air intakes. Design HVAC to ensure airflow from occupied to unoccupied areas.*	H	$$$	?				
	11) Replace pump stations in tunnels	H	$$$	?	$$	L	H	Any time
Building Assessment Report (#15)	*12) Improve energy management of HVAC by adjusting HVAC operating times.*	No Effect	?	?	?	?	?	?

Table 3. Phase 3: Long Term Actions

Recommendation Origin (#)	**Renovation Option** *(Proposed edits from PBRM in italics. PBRM's values in shaded boxes.)* *Renovations will follow all recommendations of handling asbestos, lead, PCBs, mold and other hazardous materials.*	Health Value-	First Cost	Estimated Cost & Source of Funding (provided by PBRM contractors)	O & M Cost	Ease of O & M	Durability	Occupancy
Building Assessment Report (#2,13)	13) *Redesign* and replace (upgrade) all HVAC air handing units and associated return fans, controls, ductwork, piping in Building A, B, C, and D with high efficiency electronic-controlled models. Include installation of easy access doors. *a) HVAC unit one serves tunnel Main Street to building B* b) *HVAC unit two serves radio station, NEON suite and medical unit etc.*	H	$$$	Costs have been incurred for design. Funded for 50% design development. Partially completed, waiting EPA recommendations	$$	L	H	Unoccupid
	14) Replacement of large boilers and associated equipment with higher efficiency boilers.	L	$$$	?	$$	L	H	Any Time
	15) Upgrade chiller room exhaust system	L	$	?	$	L	H	Any Time
	16) Install new security measures for building equipment external to building. ***a)*** *Install new glassed-in guard station*	L	$$	?	$	L	L	Any Time
Birnie Avenue repairs	***Implement DPW plan for Birnie Avenue repairs check on tunnel inspection responsibilities***	?	?	Use of DOT funding is applicable due to A and C tunnel designation as federal bridges	?	?	?	?
Two community suites	***Rehab and rebuild two community suites. Requires complete rebuilding: electrical, plumbing, finishes, utilities etc. design cost estimated at $45,000***	L	$$$	Estimated $450,000 for construction of these two suites	?	?	?	?

Stakeholder Meeting Notes from March 19, 2014

Date: March 19, 2014
Subject: HIA Recommendations Meeting
Location: Conference Call
Meeting Attendees:

Marybeth Smuts and George Frantz from EPA, Patrick Sullivan and Lynn Rose from PBRM

Meeting Notes:

Marybeth and I (George) sat in on a conference call this AM with Pat Sullivan and the PBRM crew. They are most anxious to have an opportunity to see and comment on the Executive Summary. Pat reiterated that he would want EPA to do the main presentation to the Mayor, Superintendent of Schools (etc.), and they will follow us with supporting comments, assessments of cost and feasibility, etc. Since we are considered the national experts in the field, having us up front will help them get to "yes." The meeting with the Mayor is scheduled for Wednesday, April 9th. We all agreed on having draft presentations ready by April 2, 2014. For us, this means getting the Executive Summary to PBRM as quickly as possible (Friday 3/21?), allowing them a few days to comment, having a conference call to iron out questions and issues and getting the presentation and Executive Summary ready to go. Proposed Timeline: Exec Sum draft by April 2nd, final by April 7th. After that session, we will plan for a meeting with community organizations and finally with the public. Marybeth will be out of town from April 9th to 23rd, so Pat indicated there was a possibility that the meeting with the mayor could be postponed until she returned.

Stakeholder Meeting Notes from April 3, 2014

Date: April 3, 2014
Subject: HIA Recommendations Meeting
Location: Conference Call
Meeting Attendees:

Florence Fulk, Lauren Adkins (CSS-Dynamac c/o EPA), Emily Zimmerman, Valerie Zartarian, Bob Thompson, Jim Murphy, and Ron Williams from EPA; Lynn Rose from PBRM

Meeting Notes:

The discussion started with an overview of the purpose of the meeting, which was to obtain feedback from PBRM on the Executive Summary and document input to ensure transparency in stakeholder engagement.

The two purposes of the Executive Summary are as follows:

1. To convey overall findings of the Assessment (details in full report)
   a. Executive Summary is not to be used as a substitute for the full report, but as a supplement to the full report,
2. To provide outreach to the community and decision makers for future decision making.
   a. Caveat- this document is still in draft form, so minor changes may take place after this discussion but the overall content will not change.

PBRM had put a lot of time and effort in filling out the [feasibility values] in the handout shared on 1/29/14. More clarity was needed in which document was being referred to as the executive summary because PBRM had received too many documents with lists of recommendations. It was assumed that "Bob's table" was the executive summary (the handout shared on 1/29/14). Lynn listed the documents that she had received:

- "Bob's Table" Observations and Guidance Table
- Time Table of Recommendations
- Final Recommendations Summary document
- HIA Final Recommendations document
- Handout for the meeting with client document
- Impact Characterization Summaries
- Original Renovation Options document

The city's technical team had not had time to go through the full executive summary. But, there was confusion on how the recommendations were developed. The perception of the executive summary was that the [HIA team] does not understand the building and what is going on at the school, or what has been done at the school. PBRM investigated many of the renovation options, which were further defined, implemented, or removed from consideration. The HIA appraised only the renovation options considered at the start of the HIA (fall 2012), as it was designed. The recommended actions reflect the data and observations gathered from October 2012 to June 2013. There was confusion as to why the findings from the mold analysis were included in the report, considering someone on the HIA team told Lynn that the Mold report was not going to be used neither in the study nor in the development of the recommendations, and the Air Sampling Study was inconclusive.

PBRM did not agree with the recommendation for "implementing ongoing waterproofing program" and "replacing water management systems." Simply saying remove the carpet was too broad of a statement and the recommendation needs to say exactly where materials should be replaced. PBRM commented that there were too many sweeping statements and that the Executive Summary was too complex needed to be more streamlined. There was some confusion on how the recommendations were developed and that the renovations have evolved since the October 2012 list. PBRM requested that a temporal context should be added in the final recommendations table or include a column explaining the work PBRM has performed since the start of the HIA. The discussion on the noise section provided too much academic information and was misleading since no noise measurements were taken in the classrooms.

The group agreed that the challenge with an Executive Summary is finding the balance between the details needed and using overview statements to preserve length.

Action Items: Lynn will send Lauren her documented comments/mark up of the executive summary. The HIA Core Group will review the feedback from PBRM and discuss at the next group meeting. Flo and Lauren will put together a timeframe for the next steps of the HIA, including meetings and presentation of the final report.

Stakeholder Meeting Notes from August 7, 2014

Date: August 7, 2014
Subject: HIA Reporting Meeting
Location: Conference Call
Meeting Attendees:

In-person: Patrick Sullivan (PBRM), Lynn Rose (PBRM), Noelle Owens (PBRM), Mike Gibbons (PBRM), Bob Thompson, Florence (Flo) Fulk, George Frantz, Marybeth Smuts, Jim Murphy, Emily Zimmerman; On-call: Lauren Adkins, Ron Williams, Valerie Zartarian

Meeting Notes:
Meeting Agenda

I. Presentation on Executive Summary
    1. Discussion with PBRM on Executive Summary
    2. Discussion with PBRM on draft HIA report (Chapters 1-4 sent on 8/6/2014)
II. Next steps in HIA process and community meeting prep
    1. Written materials needed
    2. Presentations
    3. Schedule/logistics
III. Value of HIA in Springfield and Lessons Learned

1. City’s perspective
2. EPA’s perspective

Presentation on the Executive Summary:

- Brief overview about HIA, the HIA process, and where we are at in the process
- HIA as a science-based assessment (not a scientific assessment)
- HIA goals and EPA’s goals for the project

The Screening process:

Screening took place April 2012 to March 2012. Marybeth, George, Patrick, the Director of Pioneer Valley Asthma Coalition, and PHC met at Gerena. They recognized issues and an opportunity to address those concerns through the HIA. On October 4, the EPA went to PBRM’s meeting at the school to inform the community about the HIA.

The Scoping process:

The initial scope was for the HIA to be completed in 1 year (completion date July 2013) because of the limited time (decision timeline) and money (from EPA and City) that limited the scope of the HIA. Cost effectiveness was important and the City had already started renovations. The HIA team selected/chose the issues that would be covered in the HIA based on the community input at the scoping meetings. The HIA information can be leveraged by PBRM to get funding from Massachusetts School Building Authority (MSBA).

The Assessment process:

Information for the assessment came from many different stakeholder sources. Extensive literature reviews were performed. The EPA-led analyses included the mold assessment, the Building Conditions and Systems assessment, and the air sampling assessment.

Results of the Onsite Analyses:

The assessment built on the initial assessments, observations and testing. He noted that the tendency of previous study methods is to compartmentalize testing- which does not provide for a comprehensive look at Building and Systems as a whole. Using the information from previous studies helped to increase the resource efficiency of the HIA. The building assessment provided a holistic look at the facility. Known issues were widespread asthma, moisture, mold, nearby air traffic sources, etc. PowerPoint slides showed the building’s cross-section and how all of the issues inter-relate to one another. For example, water in the tunnels increased the growth of mold, the mold spores and moisture in the tunnels travels to the upper levels of the building through via the “chimney” effect (i.e., gaps in the walls of the ceiling and side walls allow for air to leak out (identified in infrared imaging) which pulls air from the tunnels.

The 6-day sampling was only a "snapshot" in time. Mold is a problem, but it is not the only issue in the school. One thing to note is that there is not a boiler room in Tunnel C (as shown in the slides) but a heat exchanger room. Changing the air pressure flow may not be possible due to the design of the building. Fixing the air pressure gradient can be done, especially if a quality assurance person is there to make sure efforts are worthwhile (i.e., everything is done completely and do not lead to other issues). As seen in the pressure mapping, air moves from the tunnels to the pods (chimney effect). Anything carried in the air in the tunnels, such as mold spores, can get to the pods via the air pressure gradient. Air sealing will cause air to stop moving to the pods. PBRM should focus on areas where mold is seen and smelled. As long as water is coming in, mold will continue to grow. There is some impact that occurs when kids come in a see mold (i.e., impact on perceptions). Deep cleaning everywhere in the building may not be as impactful in this regard. We suggest a focused cleaning effort.

The Predicted Health Impacts:

The impacts were rated in a way that the community and other stakeholders can understand. The HIA Team took the health impacts and values and added considerations for cost, timing, operation and management, etc. Then categorized them based on short-term, near-term, and long term timing of implementation. The immediate action items are considered "low-hanging fruit" or easily and less costly to fix. You still need to have someone who is an expert in quality assurance or in a comprehensive oversight role present while these actions are being implemented. As one moves down the list, complexity increases, money requirements increase, and timing required for planning increases. PBRM already tried upgrading the air intake filters, but the new filters were not compatible (did not function well) with the existing system. It is important to note that the AHUs were built into the building, so replacing them and/or moving them will be a huge undertaking.

These recommendations regarding the cosmetics of the building and targeting the tunnels and exterior of the building will improve the aesthetics of the building. Anything that will help make it look better, feel better, smell better, etc. (e.g., provide "eye candy") will help improve perceptions. However, the community has to see the change in order to react to it.

There is a collaborative opportunity for PBRM and EPA to put a factsheet together with the information on what needs to be done, like a checklist, that the community can follow and check off- improves accountability and visibility that change is occurring. PBRM can put a poster with a to do list up in the tunnels when kids leave for summer, then when kids come back, they can see what's been checked off.

There has been a lot of work on asthma in the community and Gerena has been a model for controlling asthma exposures in school (e.g., anti-idling zones, nurses' data and asthma management plans). PBRM will make a factsheet about challenges for renovations, funding, and upcoming projects to show that PBRM is taking the information gleaned from the HIA and using it. PBRM's goal is to improve the learning environment, regardless of future plans of the building.

Discussion of HIA Report:

PBRM has not had enough time to go through the (draft) HIA Report yet.

Next steps in HIA process:

The meeting with the City Mayor is scheduled in mid-September (Thursday 25, 2014). Thus, the community meting was to occur late September or early October (October 22, 2014). Emily can help set up this meeting.

Value of HIA in Springfield and Lessons Learned Action Items:

The City's Perspective is that there is an issue with the recommendations for future study. The City was waiting on the HIA to determine if air intakes needed to be moved. But, the HIA did not determine/provide this information. However, what the HIA did with the onsite diagnostics was very helpful.

End.

Appendix B. RESES Proposal for the HIA

** The RESES proposal for the HIA was developed using the RESES guidelines and includes information used in the deliberations for selecting the proposal.*

Region 1 Regional Sustainable Environmental Science (RESES) Proposal

1. Project Overview

<u>1.1. Project Title</u>:

A Health Impact Assessment (HIA) in a Springfield, MA, an Environmental Justice (EJ) Community Elementary School to Evaluate Proposed Remediation Scenarios for Indoor Sources and Near-Roadway Transportation Exposures

German Gerena Community School

Department of Parks, Buildings and Recreation Management
City of Springfield, Massachusetts

<u>1.2. Regional partner</u>:

MaryBeth Smuts, Ph.D.
Office of Ecosystem Protection (OEP), Region 1 (New England)
smuts.marybeth@epa.gov
617-918-1512

George Frantz
Office of Environmental Stewardship (OES), Region 1 (New England)
frantz.george@epa.gov
617-918-1883

<u>1.3. ORD partner</u>:

Valerie Zartarian, Ph.D.
Sustainable and Healthy Communities, Office of Research and Development (ORD) (SHC) research program
zartarian.valerie@epa.gov
617-918-1541

Florence Fulk
National Exposure Research Laboratory (NERL), ORD
fulk.florence@epa.gov
513-569-7379

1.4. Other partners: Note: None of these will be considered for funding.

Springfield: City of Springfield Departments, such as Springfield Department of Parks, Buildings and Recreation Management (PBRM), Springfield Public Schools Department, and Springfield Health Department; Partners for a Healthier Community, Inc., Baystate Children's Hospital and community groups such as the School Committee, Springfield Education Association (SEA), North End Organizing Network (NEON), New North Citizen's Council, and Pioneer Valley Asthma Coalition (PVAC).
State of MA: Department of Public Health (MA DPH), Environmental Protection (MA DEP), Education and Transportation
Region 1: OEP, OES, and Region I Lab
ORD: ORD scientists in SHC's Community Public Health, Environmental Justice, Children's Health, and Transportation projects; ORD air modeler and measurement researchers in the Air, Climate, and Energy (ACE) program and indoor environments program at the National Risk Management Research Laboratory (NRMRL).
Other: Potential involvement of EPA Office of Air and Radiation (OAR), U.S. Department of Housing and Urban Development (HUD), Department of Transportation (DOT), and Centers for Disease Control and Prevention (CDC).

1.5. Proposed project start/end date:
August, 2012 to July, 2013 * with some potential for follow-up after remediations. * One year HIA project is critical for city and community engagement, and to be responsive to stakeholders' needs.

2. Project Background

2.1. Regional Problem the Project Will Address

The City of Springfield, MA is an environmental justice community and a focus of the Pioneer Valley Geographic Initiative within Region 1 (New England)'s coordinated communities program. The German Gerena Community School was built over 30 years ago in a Hispanic neighborhood that was split in two by the construction of the Interstate 91. The school was constructed partially beneath an I-91overpass with a community tunnel pathway/mall, swimming pool and community center within the school connecting the two neighborhoods. Over time, the school and its community linkage areas have deteriorated due to fires, floods, vandalism, water intrusion and vibration from the highway and rail line. It has extremely high maintenance for multiple storm, sewage and water pumps and heating, ventilation and air conditioning (HVAC) systems.

Springfield is one of MA's five hotspots for high pediatric asthma rates. In the 2007-2008 reporting from school nurses to MA Department of Public Health, Gerena's 760 students had a 21.3% prevalence rate compared to the state's average rate of 10.8%. The Environmental Protection Agency (EPA) has been working closely with the PVAC to reduce asthma severity in the area and assisting PBRM to evaluate indoor air quality and energy efficiency in the schools. The City is already heavily involved in remedial action at the school to address issues of poor or inadequate ventilation and moisture and mold, and has recently proposed to spend over $2 million in renovation projects related to air intakes close to the highway deck, air intakes adjacent to freight rail lines at a distance of < 50 meters, and moisture getting inside the school in several areas.

The community and city stakeholders have requested EPA support to understand which renovations could be most successful in reducing health impacts, considering total costs and benefits. Region 1 is interested in extending previous efforts in Springfield, and in integrating health impact assessment into the PBRM's assessment of repairs and their costs, in collaboration with ORD.

2.2 Other work

Springfield Partners for Healthier Community, a local non-profit, is currently working with EPA on an ongoing Community Action for a Renewed Environment (CARE) level 1 project, the goal of which is to determine, evaluate and quantify environmental risks to the community, and begin the process of recommending feasible solutions to the most pressing problems. The project has nearly completed its second year, and requested a no-cost extension, which will extend the project until September 30, 2013.

SHC researchers have previously collaborated with Region 1 and Springfield, MA to pilot the Community-Focused Exposure and Risk Screening Tool (C-FERST) (http://www.epa.gov/heasd/c-ferst) for identifying and prioritizing issues of concern. This project would extend the collaboration to focus on an HIA for this school renovation. Tools and data used for this project could be incorporated into the C-FERST HIA Roadmap for other communities to consider for potential solutions and best practices for transportation and buildings-related HIAs. The methods and tools used to develop the model to assess impacts of outdoor and indoor pollution sources on health and evaluation of various remediations estimated reductions in health impacts might be used by other schools near transportation sources. This project will also provide experience to EPA in conducting HIAs and communicating the results to a variety of audiences ranging from the community to the Massachusetts School Building Authority.

Additionally, this will be an opportunity for ORD's SHC group to demonstrate their commitment to working with regional and community partners to provide technical scientific assistance for time-sensitive community-based projects.

2.3 Objectives

The primary objective of the proposed project is a fully developed HIA that examines the health, environmental, and economic impacts of the planned PBRM school renovation options being considered by the city. Although the specific questions of the HIA will have to be determined with the stakeholders, both the City and community, the decisions on remediation must be made quickly and neither group has evaluated the health impacts of each of the sources or subsequent remediation. Another objective is producing generalizable tools and approaches to conduct HIAs that other communities can use for sustainable solutions and to generalize lessons learned regarding previous school siting and potential remediations.

The school is a contentious issue for the community and the city. Many parents blame the school conditions for causing or aggravating their children's asthma and do not think repairs are actually being done. Part of the split Hispanic community views the school renovation studies as a tactic to justify the need for a new school. The community knows that under the current MA guidelines for school reimbursements, if a new school were proposed, the community would lose their swimming pool, daycare, health and community meeting space.

The primary criterion for success of this project is that the HIA influences the actions taken to improve air quality at the Gerena School, with the expectations that those actions would reduce asthma. Evaluation of a successful project will also be that the range of audiences from community residents to school building authority understands the reasons for the remediation decisions.

Another objective is to provide student and community education on air pollution (inside and out), scientific methods to assess its impacts and on comprehensive asthma triggers.

3. Approaches

Planned Research to be Conducted *(Note: This will need to be discussed with the Community Stakeholders during the HIA Scoping Process. It is assumed that at least one stakeholder will bring up school replacement for the HIA to consider. The city will address that responsibility in their long range planning. Repairs still must continue to be evaluated since it is estimated to take 10 years for planning, funding and construction of a new school and the old school must continue to operate until then.)*

The following approaches will be employed in this project:

- Health Impact Assessment: approaches a) and b) are essentially the data collection portion of the HIA
    a. Indoor Environments Assessment of Air, Mold, Moisture, and Health Data
    b. Outdoor Air Monitoring and Impact Assessment on Indoor Air
    c. Assessment of Health Impacts from Remediation Strategies

3.1 Health Impact Assessment

The project hinges on the development of a Health Impact Assessment (HIA) that examines each proposed remediation scenario based on its estimated impact on health of the students and school staff. There are several steps in developing an HIA that will be followed. The screening step, that determines if a health assessment will add value to choices made in selecting repair options to remediate the school, has already been conducted to initiate this RESES proposal. During the scoping process, all of the stakeholders should participate in order to clarify and include their concerns. The collection of the data and its analysis will determine if inclusion is feasible. Sampling the indoor air and outdoor air monitoring are essentially the data collection and analysis portions of the HIA. The report will detail the extent of health impacts that each remediation option will provide.

Each step of the HIA requires extensive communication to gain input and acceptance from the stakeholders. Documentation will provide information that will inform each step and will also be used to assist other HIA projects.

A. Scoping.

The scoping step requires participation and input of the stakeholders to incorporate their concerns regarding the school's status and repairs. This proposal is designed to address the known concerns but stakeholders may provide others. To the greatest extent possible, all concerns will be addressed since this project is designed as a community partnership.

The CDC will provide a funded vehicle for the HIA technical contractor from the National Network of Public Health Institutes, which will provide the following deliverables for the whole project:

- assist in convening the stakeholders
- assist in facilitating an interactive workshop
- assistance in selection of the scoping pathway
- provide advice and consultation on data
- assistance in developing a plan to integrate health into the environmental data, and
- assistance in developing a communication plan by providing models and templates.

In addition to the CDC-funded partner, there will be technical support provided by a NERL contractor who will assist in convening the stakeholders and provide support for documentation. This support for the whole project is estimated to be 550 hours for $20,000, which will provide technical writing, assistance in literature review and support for the communication pieces.

A full time Association of Schools of Public Health (ASPH) Fellow with NERL will also assist in convening the stakeholders and documenting each step as a case study for use in C-FERST.

Region I will work on convening the stakeholders and developing an agenda for the first scoping session. This step will require extensive time in communicating with individual stakeholders on the purpose and intent of the project and meeting. This scoping step will require the assistance of staff from the Regional Alternative Dispute resolution team and the project's Regional leads.

Documentation of these steps may be also filmed by the Regional media team.

B. Preliminary Collection and Analysis of Data

Region 1 staff, assisted by stakeholders, will collect and review current data, such as city and state monitoring information by MA DEP, evaluation of general National-scale Air Toxics Assessment volatile organic compounds modeling data, truck and traffic counts on roadways, train schedules and type of background and other sources' emissions. Indoor data will be evaluated, such as the MA DPH indoor sampling and school reports, EPA's Indoor Air Quality Tools for Schools inventory of indoor sources and data from the school's contractors. Analysis and other data collection will be described under the separate sections 3.2 and 3.3 for each approach.

C. Presentation of Findings

Throughout the course of the project, there must be continual communication with stakeholders. Regional staff, in consultation with the HIA contractors, NERL, and ASPH Fellow, will develop the best vehicle for communication to the stakeholders, such as a website, newsletters or factsheets or smaller community meetings in additions to the three main HIA meetings.

There will be a mid-course full meeting of stakeholders to provide an update on the status of the analysis. The presentation of findings and recommendations at a meeting seeking stakeholders' input will be in late spring. The final report will be developed after that input. All those involved in the HIA will contribute to the development of the presentation and final report.

3.2. Collection and Analysis of Indoor Air, Mold, Moisture, and Health Data

A. Collection and Analysis of Available Health Data

The Springfield school system must decide if it will release health data from an individual school. The school nurses who collect the information report to the Springfield Department of Education. The School System Physician, Dr. Matt Sadof, will work to assist EPA in obtaining school approval since EPA was a partial funder of the school system obtaining asthma school champions and increasing asthma action plans from asthmatic students.

- Aggregate information obtained for the school will be: number of students with asthma as a diagnosis, number of asthma action plans, number of asthma treatments. The number of absences can be obtained but it is not related to any health reasons.
- From the MA Department of Education, the school performance scores can be obtained for past years.
- All of the above data can be obtained and potentially provided to EPA without accessing individual student records.
- Dr. Sadof will assist EPA in obtaining a third party data exemption.

B. Collection and Analysis of Mold Data

In this component of the RESES Region 1 study, the level and extent of the mold problems will be mapped in the school and associated tunnel. In order to identify and quantify the mold problems in the school, NRMRL researchers will use a DNA-based method of analysis called mold specific quantitative PCR (MSQPCR). To perform MSQPCR, settled dust is collected, the DNA is extracted, and 36 indicator mold species are quantified in each sample (Vesper et al., 2007). These 36 molds include 26 Group 1 molds that indicate water-damage and 10 Group 2 species that are commonly found, even without water damage. The concentrations of these 36 molds are mathematically combined to provide a single value called the Environmental Relative Moldiness Index (ERMI) value. ERMI was created by the EPA, with assistance from HUD. The ERMI scale ranges from approximately -10 to 20 (low to high). The upper quartile (highest mold contamination quartile) starts at an ERMI value of approximately 5 (Vesper et al., 2007).

The German Gerena Community School contains three floors and a tunnel system. It is proposed to obtain seven settled dust samples on each floor and in the tunnel. Selection of the sites for sampling will be done after the continuous relative humidity and temperature readings throughout the school. Collection of the samples will be done with appropriate safety equipment and may be collected by the NRMRL Indoor Environments technical lead.

The samples will be collected using a Swiffer Duster™ to wipe the surfaces like tops of light fixtures, bookcases, and doors, etc. (i.e., areas not normally cleaned). The Swiffer Duster™ will be placed in a sealable bag and sent to the EPA laboratory for ERMI analysis.

Quantification and mapping of the ERMI values will be performed for the German Gerena Community School. This should inform the priority selection for remediation. Based on the

NRMRL Indoor Environments technical lead's past experience working in schools, we expect to be able to locate areas in the school and tunnel that are impacted by mold. By mapping the relative ERMI values major sources of mold will be located. This understanding should contribute to the prioritization of the remediation plans. It also might help in the containment of the various areas of the school during the remediation to reduce the possible spread of the mold during remediation. With this data collection and mapping, remediation efforts to remove mold damage can be prioritized. Although this HIA project is projected to end within a year, there are follow-ups which could add value, such as repeating the sampling after the school renovations. It is expected that effectiveness of remediations on reducing the mold burden in the school can be evaluated.

C. Collection and Analysis of Moisture Data– Relative Humidity and Temperature
Preliminary indications suggest that water infiltration into the school and the resulting increase in unfavorable relative humidity is of primary concern. This is true on both a human comfort level as well as high levels setting the stage for increased mold occurrence. Therefore, a primary component of the study will be a saturated monitoring program in which continuous relative humidity and temperature sensors will be positioned throughout the building components. This data collection may be performed by the school contractors and may be directed by a NRMRL contractor. To the greatest extent possible, data collection periods will be performed seasonally to capture potential HVAC changes and their impacts on indoor relative humidity and heating during cooling and heating seasons.

School-hired contractors are currently working with numerous agencies, such as the MA DOT, the City Department of Public Works and the Utilities to determine the sources and locations of rain, storm and ground water entering the school. These school contractors will use dyes in several locations to determine the specific location and entrance of water into the school. The NRMRL technical lead for Indoor Environments will work with the school contractors to determine the need and location of relative humidity and temperature monitoring. This collaboration will also inform the location of the mold sampling. Analysis of this moisture and mold data will determine what type of remediation is needed for the various sources of moisture. It will also be used to evaluate if dehumidification should be added to the HVAC system. The NRMRL technical lead will assist the city contractors on that issue.

D. Collection and Analysis of Indoor Air Pollutants and Other Environmental Data
Based on evaluation of the school's current data, such as the Indoor Air Quality Tools for Schools (TfS) inventory, use of pesticides and cleaners and scoping concerns, the plan for monitoring of indoor air pollutants will be determined. If a TfS inventory and checklists has not been fully compiled for the year, the stakeholders along with Regional staff will assist the school in implementing TfS. It is known that the PBRM has set policies that identified and established how to handle any asbestos and lead within the building. All activities in the buildings follow lead regulations and treat discarded building material as if polychlorinated biphenyls (PCBs) were present. Indoor pest managment and green cleaners are used. Therefore, it is expected that major indoor pollutants for the HIA would be from combustion sources, such as those used in heating and in the cafeteria, some cleaners, and chlorine used to treat the swimming pool. The major indoor pollutants are expected to be nitrogen dioxides and oxides, particulate matter and chlorine and its breakdown products. Equipment and analysis of these pollutants may be

performed by the school contractors, along with the assistance of a NRMRL technical contractor and a graduate student. Some equipment and real time analysis for pollutants may be available but some equipment for nitrogen oxides and chlorine and byproducts may be needed.

The school represents a probable multi-zonal air exchange rate facility. This is because its campus consists of multiple buildings, some of which are underground or protected from direct wind effects (e.g. under highway thoroughfares). It is expected that the patchwork of HVAC systems and the nature of the building locations play an unknown role in the uniformity of air exchange within the buildings. Understanding such air filtration characterization represents key information relative to good indoor air quality principles. Air leak rate (ALR) tests such as pressurized door tests may be used to evaluate how well sealed the buildings are. Blower door testing may not be feasible since currently the building envelope has numerous leaks. The NRMRL technical contractor will determine if it would provide necessary information as to determine if the tunnel was sealed from the school buildings although the school contractors stated that it is operating independently from the school buildings. Airflow and leakage will use PFT tubes to understand the air exchange.

The NRMRL technical contractor will collaborate with the school contractors as to evaluating the performance of the HVAC system. The school contractors have been analyzing the air delivery of the current HVAC system and estimating its length of reliable service. There are at least 27 air handling systems within the buildings and tunnel. Each system will be reanalyzed by the school contractor so this is an appropriate time for involvement of the NRMRL contractor. Various filtration devices will be evaluated to determine if the air handlers can perform with higher grade filters. Another remediation may be to evaluate if different treatment methods may be used on the swimming pool to eliminate pool chemical pollutants. It is expected that the NRMRL technical contractor will be able to assist the school contractors.

3.3. Outdoor Air Monitoring and Impact Assessment on Indoor Air

Although this task will not be funded sufficiently to provide for a true source apportionment, investigation on nearby combustion source influence on indoor air quality, it is extremely high probability that truck and train combustion sources are infiltrating the school. This likelihood is based on recent EPA and non-EPA near road research that indicates that local transportation emission sources have an impact on local air quality up to distances of 300 meters for some constituents with the greatest impact often isolated to the first 100 meters distance from near transportation sources. There are several known outdoor sources adjacent to the school: traffic from the roadways, especially I-91 with its diesel traffic, a diesel rail line less than 50 meters from the school facing the majority of the air handlers, and background sources of an industrial city.

Monitoring the impacts of outdoor sources and their impacts on indoor levels would be done by a graduate student under the supervision of an academic professor who has experience in source monitoring and along with evaluating health impacts. With academic and NERL supervision, the student will monitor real time particulate matter ($PM_{2.5}$) simultaneously at inside and outside locations, and if possible black carbon. Nitrogen oxides will also be sampled but over a multiday time frame both inside and outside from various locations to determine the source of the pollutant. Correlation with diesel truck traffic and train schedules will be used to estimate the source location and time of impact on the school. The MA DEP monitors in Springfield will provide background information. Also, some site-specific as well as area-wide meteorological data will be used to interpret the monitoring data. Some seasonal variation monitoring may be done. Measurements of these particular pollutants provide insight not only as to the general states of ambient air outside the school but indoor measurements will provide for a general understanding on the degree of infiltration.

Based on locally done and published studies, it is proposed that source contribution can be modeled or provide some insight to estimate indoor air. (Some references for the modeling: Hsu et al. (2012) "The relationship between aviation activities and ultrafine particulate matter concentrations near a mid-sized airport," *Atmos Envir* 50: 328-337; Zwack et al (2011) "Modeling spatial patterns of traffic-related air pollutants in complex urban terrain," *Envir Health Perspect* 119: 852-859; Baxter et al (2007) "Predictors of concentrations of nitrogen dioxide, fine particulate matter, and particle constituents inside of lower socioeconomic status urban homes," J Expo *Sci Envir Epidemiol* 17: 433-44; Hahn et al (2009) Characterization of traffic-related PM concentration distribution and fluctuation patterns in near highway urban residential street canyons," *J Envir Monit* 11: 2136-2145; and Clougherty et al (2011) "Source apportionment of indoor residential fine particulate matter using land use regression and constrained factor analysis," *Indoor Air* 21: 53-66.)

A graduate student under the supervision of an academic, ORD experts and Regional staff will be assigned to conduct this modeling using available data.

3.4. Assessment of Health Impacts from Remediation Strategies

Scenarios using potential abatements will also be evaluated. Some of those remediations evaluated will be filtration, change of intake locations and effect of trees and barriers on source reduction into intakes. Potentially, MA DOT might assist in monitoring the rail operation since the majority of the air intakes face the tracks and their assistance with potential remediation will be needed.

Evaluating the health impacts, primarily on asthma outcomes (such as nurse visits or modeled lung function), will rely on estimates and event simulation modeling. This type of modeling, although new, has been used to evaluate building interventions in residential settings and can be modified to predict school spaces. (J. Levy, unpublished studies).

4. Confounders and Citizen-science Outreach

Stakeholders, with assistance from Region 1 staff and ORD scientists, will evaluate some of the confounders for an asthma-based school study, such as the locations and conditions of students' homes. In addition to the ongoing CARE level 1 project, a Region I project in this Springfield neighborhood has been funded by the EJ Small Grants program to establish neighborhood based Environmental Action Councils to collect and educate the community on air pollution and to take action to reduce the pollution. Either the EJ Small Grants project or this proposal will evaluate ORD new approach of encouraging citizen-science research using available monitors. Activities on this proposal will include education for community residents as well as Gerena School students, faculty, and staff concerning the types of air pollution, impacts on health, and the steps planned to improve respiratory health in the home, school, and community. Stakeholders and scientists will be involved in developing the modules.

5. Resources Needed
Quality Assurance: This project will produce one or more Quality Assurance Project Plans (QAPPS) as appropriate within 90 days of project approval, as specified in the RESES requirements.

4.1. Monetary Extramural Resources for:
A. HIA- no QAPPS expected

- CDC-funded HIA technical partner for assistance with scoping, consultation, and communication services from August through November 2012 with possible no-cost extension.
- NERL technical contractor- supervised by Florence Fulk in NERL, 550 hours, plus deliverables of documentation and final report
- NERL/ASPH Fellow-supervision by Valerie Zartarian and assistance by Region 1 staff from September 2012 to September 2013

B. Indoor Environments Assessment- QAPPS expected

- NRMRL lead- mold assessment performed in-house by Steven Vesper in NRMRL from September 2012 to post-HIA, QAPP prepared
- NRMRL technical contractor- supervised by NRMRL from September 2012 to January 2013, work with school's contractors on HVAC performance and moisture assessment

C. Outdoor Air Monitoring and Assessment of Impacts to Indoor Air and Health- QAPPS expected

- Graduate student- student services contract vehicle supervised by Clyde Owens in NRMRL, from September 2012 to June 2013
  - The student will have an MS in Environmental Health Science and be accepted into the PhD. Program. The student must be based in a School of Public Health or University within a two-hour drive of Springfield (most likely Boston), based at Boston University School of Public Health, Harvard School of Public Health, or Tufts School of Public Health. Although, there may be applicants from University of Massachusetts-Amherst or Yale University.
  - The student must be working under the supervision of an academic faculty member who has experience in air pollution monitoring, source apportionment or attribution, using a systems approach to evaluating the impacts on indoor environments and health parameters.
  - QAPPS will be developed by student and assisted by NRMRL.

4.2. Equipment, Analysis, Travel, Contracts, and Oversight Provided by NRMRL
This is dependent on selection of graduate student and sampling needs.

Travel is dependent on technical contractors and NRMRL assistance.

There should be potential to shift funds between contractors, if needed through the general contract.

Anticipated Oversight: 2.75 Full Time Equivalents (FTE) for one year.

- 0.75 from Region 1 and 2 from ORD (across multiple SHC and ACE projects)
- Note: ORD Team members, roles, and available FTE will need to be discussed in the Labs if this proposal is selected. Success of the project depends in part on available FTE and commitment from all team members.

5. **Specific Proposed Tasks for Region, ORD, and Contractors** (also outlined in approach sections)

5.1. Region 1 Staff Responsibilities

Region 1 in-house FTE will be used for project management and coordination, community outreach, contractor technical direction, community liaison, community presentations and communication materials, and HIA input.

5.2. ORD Staff Responsibilities

ORD in-house FTE will be used for project management and coordination, prepare funding vehicles, modeling, monitoring, data analysis, contractor management and technical direction, publications, HIA input (assuming support and potential FTE reallocation from ORD Labs if full proposal accepted).

5.3. Extramural Responsibilities

Secure extramural funding for air monitoring/modeling student contractors and an HIA technical partner.

6. Project's Demonstration of EPA Researcher Capabilities

This proposal fits into multiple parts of the major research areas in the ORD's SHC plan, including data and tools to support community decisions; forecasting and assessing community health; near-term approaches for sustainable solutions; and integrated solutions through actual community case studies (focusing on the transportation and buildings/infrastructure sectors). The ORD lead partners are initiating a cross-EPA HIA workgroup and have taken HIA training. They will manage HIA technical contractors and connect the research needs for the buildings and transportation sector-focused HIAs to expertise in the SHC Community Public Health, Environmental Justice, Children's Health, and Transportation projects, and to ORD air modeler and measurement researchers in ACE program. Other proposed ORD leads on this project have expertise in school assessments, and conducting air monitoring and modeling for near-roadway and indoor air pollutants.

This proposed work directly supports SHC Community Public Health Project Task 2.2.1.6 focused on HIA case studies, but would require collaborations among various EPA and external partners.

7. Detailed Project Timeline

Project Duration: 1 year (August 2012 to July 2013)

To be useful to the City and community stakeholders, the HIA would need to be completed by July 2013, so findings and recommendations could be integrated with the PBRM's assessment of the building, and included in the next round of school renovations.

Note: A one-year HIA project is critical for city and community engagement, and to be responsive to stakeholder needs.

Additionally, this will be an opportunity for ORD's Healthy Communities group to demonstrate their commitment to working with regional and community partners to provide technical scientific assistance for time-sensitive community-based projects.

- **July-August, 2012 full proposals approved by ORD**
  - conference call to finalize team members and roles, FTE commitments, timeline
  - consult with HSRO on asthma analysis using data on asthma prevalence and school nurse visits
- **September-October 2012 extramural vehicles prepared**
  - Early-September: team conference call to review progress and logistics for meetings with partners/stakeholders
  - HIA scoping with partners and develop HIA data collection
  - Work with school contractors on data needs
  - Communicate air and mold monitoring plans to partners and stakeholders
  - Communicate modeling & assessment plans to partners and stakeholders
  - Mid to late-October: team conference call to address feedback
  - Late-October: HIA progress briefing for R1/ORD management
- **November-January 2012 data collection**
  - Collect and analyze asthma data
  - Conduct air monitoring
  - Conduct mold sampling
  - Prepare model for assessment phase
  - Mid-November: team conference call to review progress
  - Mid-December: team conference call to review progress
  - Mid-January: team conference call to review progress
  - Mid-January: site visit/conference call to touch base with partners along with ongoing with ongoing communication
  - Late-January: progress briefing for R1/ORD management
- **February-April 2013 analysis of data and modeling**
  - Assessment phase of HIA
  - Mid-April: site visit/conference call to touch base with partners
  - Late-April: progress briefing for R1/ORD management
- **May-July 2013 communicate findings and recommendations to partners and then stakeholders**
  - Address feedback and respond
  - July: final briefing for R1/ORD management
  - R1/ORD final report and presentations
- **July 2013-July 2014 prepare research manuscripts for publication**
- **Post-July 2014 follow-up monitoring and evaluations after some remediation measures in place**

8. Expected Results

8.1. Anticipated End-products

The primary end-product will be an HIA report assessing the proposed Springfield, MA remediations of the Gerena Community School, completed and reflecting collaborative input from the community and city with assistance from Region 1, ORD, and HIA consultants. The end-products will help Region 1 support the Springfield, MA city and community directly by providing an HIA analysis of proposed remediation scenarios to reduce health impacts such as childhood asthma. The project will help prioritize the repairs based on feasibility and health benefits.

8.2. Use of End-products

The Springfield Department of Parks, Buildings and Recreation Management will use the results to prioritize their repairs. We anticipate that the community and city might accept the results as being practical and benefit the students and performance of the school. The city will use the results to present their long term projected repairs and use of the school to the MA School Building Authority.

The community will accept and potentially utilize HIA to resolve other air pollution issues within the county, such as in permitting of biomass facilities.

Since there are other schools within Springfield and hundreds across the Region that are near roadways, these studies evaluating sources and health impacts to evaluate remediation methods would provide information to other schools where health is impacted by transportation and indoor air sources.

8.3. Dissemination of End-products

The project results, disseminated through journal publications, presentations, videos, and the C-FERST HIA roadmap, would provide useful, generalizable information that could be applied for HIAs in other Regions regarding renovations and remediations of near transportation sources in EJ communities.

Locally, the results as video, slides, and reports will be presented to numerous audiences from community groups, city officials and voters to the state School Building authority that funds renovations and new construction.

It is expected that the end product will be presented as a case study, in video, web based and written format, to be used to present the steps of an HIA, as well as how to prioritize school repairs. Also, the lesson learned in community involvement will inform the Regions on how to engage communities in HIAs.

End.

Appendix C. Reports Included in Technical Review of Previous Investigations at Gerena and Original Proposed Renovations

Reports Included in Technical Review of Previous Investigations at Gerena

Source[1]	Document Title	Date of Release
Springfield, MA Department of Parks, Buildings, and Recreation Management	Germán Gerena Community School Building Environmental Review Poster Series	April 6, 2012
O'Reilly, Talbot & Okun Engineering Associates	Industrial Hygiene Assessment Services Report, Gerena Community School	June 19, 2012
RDK Engineers	Germán Gerena Community School HVAC Study, Springfield, MA	August 23, 2012
Simpson Gumpertz & Heger	Tunnel Leakage Investigation, Germán Gerena School, Springfield, MA	August 24, 2012
Timothy Murphy Architects	Phase 1 Investigation Report, Germán Gerena School, Springfield, MA Tunnel and Air Quality Study	August 28, 2012

[1] All technical reports reviewed by EPA and contractors were provided by the City of Springfield Department of Parks, Buildings and Recreation Management (PBRM).

Original Proposed Renovations

Note: PBRM's permission to review and document information from the Building Poster Series was acquired, but then later retracted.

Table 1. Proposed renovations from the Industrial Hygiene Assessment (O'Reilly, Talbot & Okun Engineering June 19, 2012)

Issue[a]	**Proposed Renovation Option[b]**	**Responsible Party**	**Pre-HIA Progress**
A report of concern was filed with the COS regarding Room 208 (Developmental/Pre-K classroom) regarding safety of occupancy. Results: The building areas assessed (Room 208/209) were determined to have indoor air quality data that was within recommended standards and therefore acceptable for occupancy.	1. Inform the occupants of the building the results of the industrial hygiene sampling.	City of Springfield	Item completed (2012).
There were two areas noted to have evidence of minor to moderate water infiltration: the second floor hallway ceiling where several suspended ceiling tiles were observed with minor water staining, and Pod 10C where carpet and resilient floor tile staining was observed. Visible evidence of water infiltration was observed in the Mall Tunnel areas A, B, C.	2. Eliminate water and accumulation of moisture from entering the building. Continue investigations in to the source (s) of water infiltration, and implement necessary repairs and upgrades as needed. [Recommendation #2]	City of Springfield	Not yet completed.
See above.	3. Remove and discard porous building materials that have been wet for greater than 48-hours and not professionally dried and cleaned or show visible evidence of mold growth.	Gerena Maint. Staff	On-going

Appendix C. Reports Included in Technical Review of Previous Investigations at Gerena and Original Proposed Renovations

Issue[a]	Proposed Renovation Option[b]	Responsible Party	Pre-HIA Progress
See above.	4. Consider using building materials that are not affected by water or moisture (i.e., ceramic tile flooring) in areas where water infiltration occurs.	Gerena Maint. Staff	On-going
Concerns were raised on the air quality of certain areas within the school. Total particulate data in the spaces monitored were within EPA NAAQS limits. No VOCs were detected. On average, the temperature and relative humidity levels throughout the monitored areas were within the ranges recommended by ASHRAE (Temp. 70-73^0, RH 30-60%).	5. Continue with efforts to evaluate the HVAC system to ensure proper design and distribution (flow, balancing, fresh air introduction, etc.) is in place.	Gerena Maint. Staff	On-going

[a] Exact phrasing from the report is provided in quotations (""). In the absence of quotations, paraphrasing was used.

[b] Action option number is based on the order in which the item was listed in the report. It does not reflect priority or sequence.

Table 2. Proposed renovations from the HVAC Study (RDK Engineers August 23, 2012)

Issue[a]	Proposed Renovation Option[b]	Responsible Party	Pre-HIA Progress
"The school's location greatly limits the amount of fresh, clean air available to the air handling units. The air intakes to the air handling equipment should not be located at or near ground level. Air handling units AC-1 and AC-2 in Building A have intakes in the worst location under I-91. The intakes for AC-1 and AC-2 should be extended to an area that has better air quality, such as above the roof or out to the parking lot at the end of the	1. Relocate fresh air intakes for Buildings A and B.	City of Springfield	Not yet completed.

Issue[a]	**Proposed Renovation Option**[b]	**Responsible Party**	**Pre-HIA Progress**
tunnel on the east side of the highway. The intakes for the air handling units in the five mechanical rooms in Building B should be swapped with the exhausts. The swap will require significant ductwork alterations. All of the supply and return ductwork should be cleaned thoroughly. However, ductwork should only be cleaned if the air handling equipment is not going to be replaced within the next five years. Duct cleaning would need to be repeated after replacement of air handlers."			
"The building's current make up air needs are not met per the 2009 International Mechanical Code. To satisfy the intake air needs, the current status of the bypass and intake air dampers needs to be addressed. It is understood that the current pneumatic controlled dampers are non-functioning and frozen in place, which prevents any modulation."	2. Repair/replacement of fresh air intake dampers for air handling equipment. • Verify proper operation of all space thermostats. Relocate thermostats to a location that provides a more accurate temperature reading. • Replace outdoor air/return air dampers for each air handling unit. • Replace existing pneumatic controls in outdoor air/return air damper actuators for each air handling unit. New controls shall be electric. • Install control valves at each air handling unit. Control valves	City of Springfield	Not yet completed.

Appendix C. Reports Included in Technical Review of Previous Investigations at Gerena and Original Proposed Renovations

Issue[a]	**Proposed Renovation Option**[b]	**Responsible Party**	**Pre-HIA Progress**
	will have a minimum flow rate when the outside air temperature is below 40^0F to prevent the coils from freezing. • Provide a low limit discharge air temperature (DAT) sensor and verify that it is operating properly. • Verify proper night setback operations.		
See above.	3. Rebalance system after replacements/upgrades are implemented.	Gerena Maint. Staff	Not yet completed.
There is continual presence of moisture and water intrusion in the interstitial space of Tunnel C (Building C). "A new exhaust fan and duct system should be provided for Building C. The exhaust ductwork should pull air from the maintenance corridor and exhaust it to the outdoors. This will aid in the improvement of the indoor air quality. This will also provide pressurization of the inner occupied tunnel and allow odors in the outer tunnel to be contained and exhausted to the outdoors."	4. Install a new exhaust fan and duct system for Tunnel C interstitial space, and associated mechanical room.	City of Springfield	Not yet completed.
"The outdoor tunnel shall be sealed off from the inner tunnel and associated mechanical room."	5. Seal off outer tunnel C from the inner tunnel and associated mechanical room.	City of Springfield	Not yet completed.

Appendix C. Reports Included in Technical Review of Previous Investigations at Gerena and Original Proposed Renovations

Issue[a]	**Proposed Renovation Option**[b]	**Responsible Party**	**Pre-HIA Progress**
"Indoor air quality needs to be tested by the qualified, certified professional. A report should then be provided with further recommendations to alleviate any existing issues."	6. Contract a qualified, certified professional to test the indoor air quality.	City of Springfield	Elicited EPA in 2012
"Due to the age of the building and mechanical equipment, RDK recommends testing for HAZMATs (i.e., lead paint, asbestos, etc.). This testing needs to be done prior to any demolition. All testing should be provided by a qualified and certified professional.	7. Contract a qualified, certified professional to test for Hazardous Materials (HAZMATs) prior to any demolition	City of Springfield	Required by Law. Not yet completed.
"Due to Gerena's close proximity to I-91 and the railway lines, the concern is that it may be experiencing poor air quality associate with location the existing air handling equipment. There could be number of the intake air louvers requiring relocation to alleviate this possible problem, an outdoor air quality test should be done at different locations on the school campus. This study should identify areas surrounding Gerena where the air may be of better quality. Once these locations are identified, they would be prime candidates for intake air louvers. If air quality testing proves that the air quality is to acceptable standards, the existing intake air louver locations may remain. If air quality exceeds acceptable thresholds, the possibility of relocating the intake air louvers should be explored."	8. Conduct an outdoor air quality test at different locations on the school campus, including the current locations, to investigate optimal locations for air intake louvers.	Unknown	Not yet completed.
"As there may be areas surrounding the school where pollutants from highway and railway exhaust tend to stagnate, a wind study should also be done. Wind will	9. Conduct a wind study around the school campus.	Unkown	Not yet completed.

Issue[a]	Proposed Renovation Option[b]	Responsible Party	Pre-HIA Progress
tend to disperse the pooling of pollutants and create areas where fresher air can be supplied to the school and its occupants."			
"All short term recommendations should be implemented in addition to the following HVAC replacement recommendations. […] *Building A:* The air handling units, return fans, controls, ductwork and piping should be replaced in their entirety. […]The intake louvers shall be removed. New intake ductwork shall extend to the roof and terminate with a gooseneck a minimum of 10 feet above the roof. […] The AHS have long supply and return duct runs. All of the supply and return ductwork shall be cleaned thoroughly. […] *Building B:* The boilers, associated flue, pumps, piping, and appurtenances should be replaced in their entirety. […] The refrigerant exhaust fan shall be removed. Ductwork shall be removed to allow installation of the new exhaust fan. […] The 100% intake unit (located n the boiler room) shall be replaced in its entirety." *Building C: (report missing pg. 19)* Install new exhaust system in maintenance corridor of Tunnel C to exhaust air from interstitial space to outside of building. Seal outer tunnel space from inner tunnel space […] *"Building D:*	10. Complete comprehensive HVAC replacement program, including replacement of all of the existing air handling units, controls (including new BMS and plans to expand the existing BMS), exhaust and return fans, boilers, pipes, associated appurtenances (i.e., valves, dampers, controls, louvers, air separator, expansion tank, etc.), and modifications to some of the mechanical piping and ductwork. • Include a new energy management system (EMS) • Include appropriate airflow monitoring and temperature sensors for the new air handling units. • Include security measures to protect equipment and their appurtenances. *Refer to RDK report*	City of Springfield, with State assistance	Not yet completed.

Issue[a]	Proposed Renovation Option[b]	Responsible Party	Pre-HIA Progress
The air handling units, return fans, controls, ductwork, and piping in both mechanical rooms should be replaced in their entirety. […]"			

[a] Exact phrasing from the report is provided in quotations (""). In the absence of quotations, paraphrasing was used.
[b] Action option number is based on the order in which the item was listed in the report. It does not reflect priority or sequence.

Table 3. Proposed renovations from the Tunnel Leakage Study (Simpson, Gumpertz & Heger, August 24, 2012)

Issue[a]	Proposed Renovation Option[b]	Responsible Party	Pre-HIA Progress
"Water intrusion into the daycare and east end of Tunnel A is caused y failure of and poor drainage off of the buried roof membrane above the east entrance of the tunnel and extending beneath the overpass. The exposed roof above the entrance requires replacement of the roofing membrane and installation of new drains. The roof beneath the overpass, which is sheltered from weather, should be isolated from the new roof to prevent water from draining off of the tunnel ceiling and onto the CMU tunnel walls, which are not waterproofed and leak."	1.Replace roofing membrane and install new drains for exposed east end of Tunnel A (Building A). Isolate the new roof from the roof beneath the overpass.	City of Springfield	Not yet completed.
"The Tunnel A atrium walls and exit door cause leakage into the space below. The CMU walls should be overlaid or repaired with a waterproof membrane, and the door should be properly flashed by installing a sill plan in the opening and providing new weather stripping around the door."	2.Repair concrete masonry unity (CMU) walls and install a waterproof membrane, and install a sill pan in the opening and weather stripping around the door.	City of Springfield	Not yet completed.

Appendix C. Reports Included in Technical Review of Previous Investigations at Gerena and Original Proposed Renovations

Issue[a]	Proposed Renovation Option[b]	Responsible Party	Pre-HIA Progress
"Further investigation into wall's interior construction is needed to determine whether other repairs to the through-wall flashing are needed and to assess concealed conditions."	3. Further investigate into the wall' interior construction and assess conditions and need for repairs.	City of Springfield, with support from Simpson Gumpertz & Heger (Phase 2)	Completed (2012-2013).
"We were unable to conclusively identify the causes of leaks into the north wall of the NEON space or from the metal infill panels beneath duct banks in Tunnel A. Past leakage has caused significant corrosion of the steel deck under the duct banks. We suspect that waterproofing is discontinuous around the duct bank, as seen in Tunnel C."	4. Further investigate the condition of the waterproof membrane around the duct bank, including removal of the additional concrete slab.	COS, with support from Simpson Gumpertz & Heger (Phase 2)	Completed (2012-2013).
"Given the difficulty in identifying leakage and likelihood of additional damage to the membrane caused by excavation, a repair program short of re-waterproofing the entire tunnel roof is unlikely to stop all leaks."	5. Develop a comprehensive repair program that replaces the waterproofing of the Tunnel A roof, extending several feet down walls and beneath duct banks, with addition of drained backfill.	City of Springfield, with contracted support	Implemen-tation began in Sep. 2012-
"Tunnel C experiences leakage through the chase that crosses the tunnel near Building B. This chase lacks any waterproofing and allows significant amounts of water to enter the tunnel."	6. Reconstruct ceiling chase of Tunnel C, including waterproof membrane.	City of Springfield	Not yet completed.

[a] Exact phrasing from the report is provided in quotations (""). In the absence of quotations, paraphrasing was used.

[b] Action option number is based on the order in which the item was listed in the report. It does not reflect priority or sequence.

End.

Appendix D. The [Draft] HIA Communications Plan

Communication Format	Target Audience	Date Due	Responsible Party
1. **HIA flyer** (one-pager) for notifying public of upcoming HIA meeting at Gerena Community School	City of Springfield, External Stakeholder Group, General Public	10/03/12	Draft by G. Frantz and M. Smuts Edited by: E. Zimmerman and Region 1
2. **HIA Flyer** (same as above) in Spanish	Spanish speaking community members	10/03/12	E. Zimmerman Reviewed by: Region 1 Office of Regional Administrator
3. **Calls** to Community Groups for Oct 17 Scoping Meeting	External Stakeholder Group; translation to Spanish if needed	10/16/12	E. Tonkin, J. Paré, E. Zimmerman
4. **Presentation to Public** on HIA process and discuss scoping of assessment	City of Springfield, External Stakeholder Group, General Public	10/17/12	G. Frantz, V. Zartarian, F. Fulk, MB. Smuts, J. Murphy, S. White Reviewed by: ORD and Region 1
5. **Factsheet** for outlining preliminary results from data collection and assessment (i.e., impact summaries)	City of Springfield; later to External Stakeholder Group and Public	12/5/14	HIA Core Group Reviewed by: ORD and Region 1
6. **Presentation to City** to discuss previously distributed factsheet outlining preliminary results from data collection and assessment (impact summaries)	City of Springfield	12/9/14	M. Smuts, G. Frantz, E. Zimmerman, J. Murphy
7. **Executive Summary** for communicating overall findings from the HIA	City of Springfield, External Stakeholder Group, General Public	8/6/14	HIA Core Group Reviewed by: ORD and Region 1
8. Draft HIA Report	City of Springfield, later to External Stakeholder Group and General Public	8/6/14	HIA Core Group Reviewed by: ORD and Region 1
9. **Presentation to City** to discuss previously	City of Springfield	8/7/14	HIA Core Group

Communication Format	Target Audience	Date Due	Responsible Party
distributed Executive Summary			Reviewed by: ORD and Region 1
10. **Presentation to Public** discussing assessment findings, Executive Summary, and preliminary recommendations	City of Springfield, External Stakeholder Group, General Public	To Be Determined	HIA Core Group Reviewed by: ORD and Region 1
11. Final HIA Report	City of Springfield, External Stakeholder Group, General Public	8/30/14	HIA Core Group Reviewed by: ORD and Region 1 and External Peer-Reviewer

End.

Appendix E. Documentation of HIA Communication Materials

HIA Kickoff Meeting Flyer (English; October 2012)

U.S. EPA New England

HEALTH IMPACT ASSESSMENT

US EPA Health Impact Assessment at the Gerena School, Springfield MA

U.S. EPA | UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

KEY CONTACTS:

EMILY ZIMMERMAN
EPA New England
Community Involvement Coordinator
(617) 918-1037
zimmerman.emily@epa.gov

MARYBETH SMUTS
EPA New England
Air Toxicologist
(617) 918-1512
smuts.marybeth@epa.gov

GEORGE FRANTZ
EPA New England
State Assistance Programs Coordinator
(617) 918-1883
frantz.george@epa.gov

GENERAL INFO:

EPA NEW ENGLAND
5 Post Office Square
Suite 100
Boston, MA 02109-3912
(617) 918-1111
www.epa.gov/region1/

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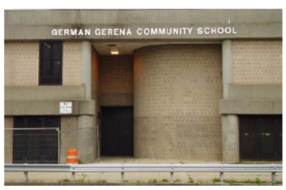
HEALTH IMPACT ASSESSMENT (HIA)

The US EPA will conduct a Health Impact Assessment (HIA) at German Gerena Community School in Springfield, MA. A meeting to explain this process will be held at the Gerena School cafeteria on October 17th, from 6:15 - 8:15 PM. The goal of the HIA is for EPA to provide information to help the City of Springfield narrow down the options for renovation and improvement at Gerena School to those that will best address environmental problems and reduce potential negative health impacts. This is the first time EPA will be conducting an HIA. In addition to assisting the City of Springfield and the community, EPA hopes to gain experience that can be used in similar projects in other areas.



HIA Next Steps:
EPA will be gathering both environmental data and available health data for the Gerena School. Most of the data will relate to air quality and asthma in the school.

Some initial research has been done to get the HIA started, but EPA needs more information and input from the community. Gathering this information is part of an initial phase of the HIA called the 'Scoping Phase,' in which EPA works with a variety of people and organizations within the City to get input and suggestions on:

- identifying how improvements to the Gerena School might impact community health
- identifying which health impacts to assess as part of the HIA based on community concerns and available data
- how the assessment will be done, for example indoor and outdoor air monitoring

After these things have been identified, EPA will work with the community to assess and compare specific proposed renovation options from a public health perspective. This assessment will then be compiled into a formal recommendation to the City, which will then be considered in the renovations decision process.

What We Need From You Now:
On October 17, 2012, EPA will begin the information gathering stage of the Health Impacts Assessment with the community stakeholders. We will hold a workshop, where we will present our plans for moving forward with the HIA. We hope to get feedback and input from the community on this draft plan, and to identify and discuss any community thoughts and concerns with the school renovations, especially as they relate to health. This workshop will be held at Gerena School on October 17th from 6:15 - 8:15 PM.

EPA United States Environmental Protection Agency

October 2012

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Appendix E. Documentation of HIA Communication Materials

HIA Kickoff Meeting Flyer (Spanish; October 2012)

EPA de EE. UU. Nueva Inglaterra

EVALUACIÓN DE IMPACTO EN LA SALUD

Evaluación de Impacto en la Salud de la Agencia de Protección Ambiental – EPA de EE.UU. en la Escuela Gerena, Springfield MA

U.S. EPA | UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

CONTACTOS CLAVE:

EMILY ZIMMERMAN
EPA Nueva Inglaterra
Coordinadora de Participación Comunitaria
(617) 918-1037
zimmerman.emily@epa.gov

MARYBETH SMUTS
EPA Nueva Inglaterra
Toxicóloga Ambiental
(617) 918-1512
smuts.marybeth@epa.gov

GEORGE FRANTZ
EPA Nueva Inglaterra
Coordinador de Programas de Asistencia Estatal
(617) 918-1883
frantz.george@epa.gov

INFORMACIÓN GENERAL:

EPA NUEVA INGLATERRA
5 Post Office Square
Suite 100
Boston, MA 02109-3912
(617) 918-1111
www.epa.gov/region1/

EPA - LÍNEA GRATUITA DE SERVICIO AL CLIENTE

1-888-EPA-7341

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EVALUACIÓN DE IMPACTO EN LA SALUD
(HIA, POR SUS SIGLAS EN INGLÉS)

La EPA de EE.UU. efectuará una Evaluación de Impacto en la Salud (Health Impact Assessment, HIA) en German Gerena Community School en Springfield, MA. El 17 de octubre, de 6:15 a 8:15 PM, se realizará una reunión en la cafetería de la Escuela Gerena con el fin de explicar este proceso. El objetivo de la HIA es que EPA pueda proporcionar información para ayudar a la ciudad de Springfield a reducir las opciones de renovación y mejoras en la Escuela Gerena a aquellas que contemplarán de la mejor forma posible los problemas ambientales y reducirán los efectos negativos en la salud. Esta es la primera vez que EPA efectuará una HIA. Además de ayudar a la Ciudad de Springfield y a la comunidad, EPA espera obtener una experiencia que pueda usar en proyectos similares en otras áreas.

Siguientes pasos de la HIA:
EPA recopilará la información ambiental e información sanitaria disponible de la Escuela Gerena. La mayor parte de la información estará relacionada con la calidad del aire y el asma en la escuela.

Se ha realizado alguna investigación inicial para hacer que empiece la HIA, sin embargo, EPA requiere que la comunidad proporcione mayor información y comentarios. La recopilación de esta información es parte de una fase inicial de la HIA llamada "Fase de fijación de alcance", en la que EPA trabaja con una variedad de personas y organizaciones en la Ciudad con el propósito de obtener comentarios y sugerencias sobre:

- identificación de la forma en que las mejoras podrían impactar la salud de la comunidad de la Escuela Gerena
- identificación cuáles impactos de la salud se deben evaluar como parte de la HIA tomando como base las inquietudes de la comunidad y la información disponible
- como se realizará la evaluación, por ejemplo, monitoreo del aire interior y exterior.

Una vez que se hayan identificado estos puntos, EPA trabajará con la comunidad para evaluar y comparar las opciones específicas de renovación propuestas desde una perspectiva de salud pública. Esta evaluación se compilará en ese momento en una recomendación formal a la Ciudad, que se considerará en el proceso de decisión para efectuar las renovaciones.

Lo que necesitamos de ustedes ahora:
El 17 de octubre de 2012, EPA iniciará la etapa de recopilación de información de la Evaluación de Impacto en la Salud con los grupos de interés de la comunidad. Realizaremos un taller donde presentaremos nuestros planes para proseguir con la HIA. Esperamos obtener los comentarios y sugerencias de la comunidad en cuanto a este plan preliminar e identificar y discutir los pensamientos e inquietudes de la comunidad en lo que respecta a las renovaciones de la escuela, especialmente en lo que se relaciona con la salud. Este taller se celebrará en la Escuela Gerona el 17 de octubre, de 6:15 a 8:15 PM.

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October 2012

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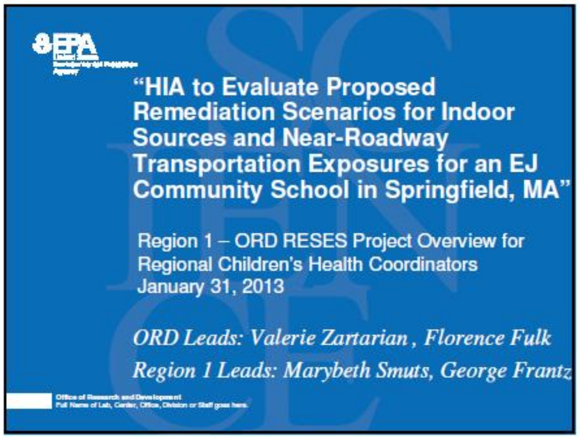
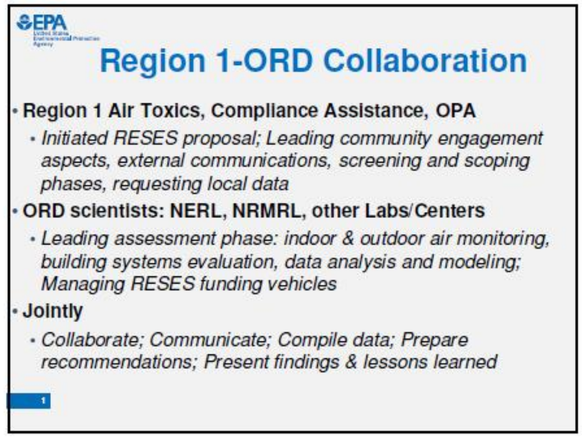
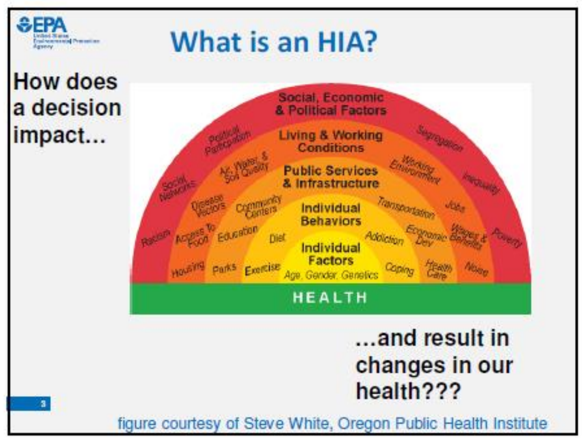
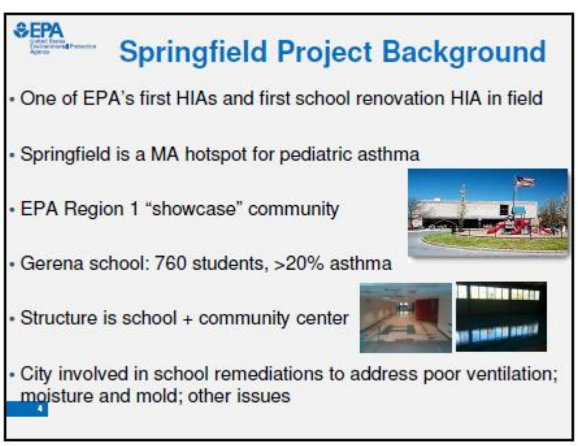
Appendix E. Documentation of HIA Communication Materials

PowerPoint Presentation to EPA's Regional Children's Health Coordinators on January 31, 2013









Springfield Project Partners

- EPA Region 1 and ORD, and HIA consultants
- City of Springfield school administration
- City) Dept. of Parks, Recreation & Bldg Mgmt
- Mass DEP and DPH
- Pioneer Valley Asthma Coalition
- Partners for a Healthier Community (EPA CARE)
- New North Citizen's Council
- Community organizations
- Parents, students, others

6

Springfield HIA Goals

(1) Add value to decisions on which school improvements & repairs will have greatest potential for health improvements

- *based on science, community input ,& cost/benefits*

(2) Learn lessons that can inform future EPA HIAs

7

Overarching Question

Which proposed school renovations will have greatest impact on health and well-being?

8

Choice of Remediation Scenario Drives Activity

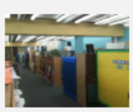
EPA will recommend remediation activities which may:

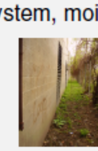
- Lead to > in health for students, faculty & staff
- Change community perception of the school as "risky" or "unhealthful"
- Increase utility of the facility including community resources, e.g.,
  - senior center, teen center, daycare center
- Lead to > educational performance, < incidence of respiratory illness (asthma), > social cohesion, and > personal safety for students, faculty & staff

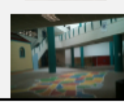
9

Scientific Approach

- Research component will include:
  - –collection and analysis of available health data
  - –outdoor and indoor air monitoring and modeling
  - –building assessment of ventilation system, moisture







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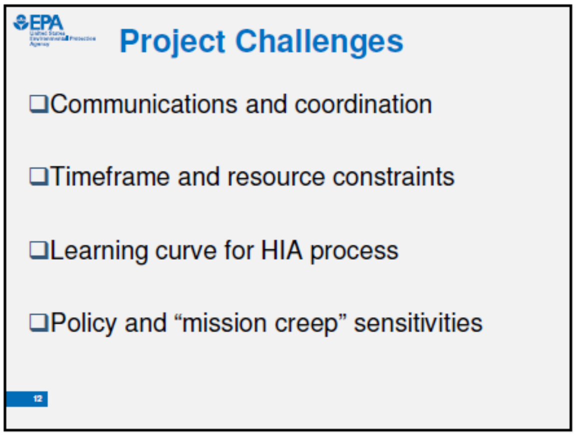
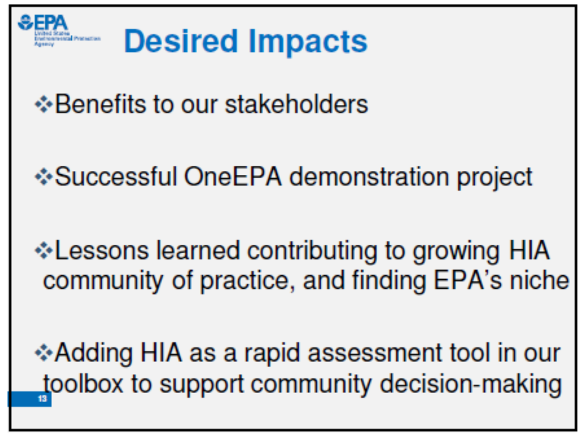
HIA Process and Project Timeline

Screening	Determines the need and value of a HIA	Summer 2012
Scoping	Determines which health impacts to evaluate, methods for analysis, and a workplan	Fall 2012
Assessment	Provides: 1) a profile of existing health conditions 2) evaluation of potential health impacts 3) strategies to manage identified adverse health impacts	Winter/Spring 2013
Reporting	Includes: 1) development of the HIA report 2) communication of findings & recommendations	Spring/Summer 2013
Monitoring	Tracks: 1) impacts on decision-making processes and the decision 2) impacts of the decision on health determinants	Post-renovations TBD

Human Impact Partners; 2011


EPA
Project Challenges
❑Communications and coordination
❑Timeframe and resource constraints
❑Learning curve for HIA process
❑Policy and "mission creep" sensitivities
12


EPA
Desired Impacts
❖Benefits to our stakeholders
❖Successful OneEPA demonstration project
❖Lessons learned contributing to growing HIA community of practice, and finding EPA's niche
❖Adding HIA as a rapid assessment tool in our toolbox to support community decision-making
13


EPA
QUESTIONS?
14

Appendix E. Documentation of HIA Communication Materials

HIA Update Flyer (March 2013)

U.S. EPA New England

HEALTH IMPACT ASSESSMENT

US EPA Health Impact Assessment at the Gerena School, Springfield MA

U.S. EPA | UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

KEY CONTACTS:

EMILY ZIMMERMAN
EPA New England
Community Involvement Coordinator
(617) 918-1037
zimmerman.emily@epa.gov

MARYBETH SMUTS
EPA New England
Air Toxicologist
(617) 918-1512
smuts.marybeth@epa.gov

GEORGE FRANTZ
EPA New England
State Assistance Programs Coordinator
(617) 918-1883
frantz.george@epa.gov

GENERAL INFO:

EPA NEW ENGLAND
5 Post Office Square
Suite 100
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HEALTH IMPACT ASSESSMENT (HIA)

The US EPA is in the process of conducting a Health Impact Assessment (HIA) at the German Gerena Community School in Springfield, MA. The goal of the HIA is for EPA to provide information to help the City of Springfield narrow down the options for renovations and improvement at the Gerena School to those that will best address environmental problems and reduce potential negative health impacts.

What We Are Working On Now:
EPA is working to complete the data collection phase for the Health Impact Assessment at the Gerena School. The next step is to gather information on the building structure. EPA will conduct a building evaluation of the school from March 24-26, 2013. For this evaluation, technical specialists will evaluate the entire building and the grounds to analyze how the building operates. Some of the areas being evaluated are: how air moves through the building; how the ventilation system works; and how water moves through and around the building. The evaluation will include taking some physical measurements, such as pressure differentials, temperature and humidity readings and thermal imagery for energy and water leaks.

The information that EPA gathers on the evaluation will be incorporated into the overall health impact assessment, which will then inform recommendations for remediation at the Gerena School. The building evaluation will help EPA scientists plan their upcoming in-depth monitoring of indoor air and how it is impacted by outdoor sources. Specifically, it will help to determine where air monitors will be placed. This more in-depth monitoring will take place over a period beginning in the next month, and will be a final step in our data collection process.

Once EPA has finished collecting the data over the next few months, there will be a public meeting to update interested citizens on our findings.

For questions or concerns, contact Emily Zimmerman at 617-918-1037 or zimmerman.emily@epa.gov

EPA United States Environmental Protection Agency

March 2013

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HIA Update Email to Stakeholders (March 22, 2013)

From: Zimmerman, Emily
Sent: Friday, March 22, 2013 11:48 AM
Subject: EPA Health Impact Assessment, Update

US EPA Health Impact Assessment
at the Gerena School, Springfield MA
U.S. EPA | UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Hello,

I am writing to you because you have expressed interest in the Health Impact Assessment that EPA is working on at the German Gerena Community School in Springfield, MA. The goal of the HIA is for EPA to provide information to help the City of Springfield narrow down the options for renovations and improvements at the Gerena School to those that will best address environmental problems, considering health consequences on the school community.

What We are Working on Now:

EPA is working to complete the data collection phase for the Health Impact Assessment at the Gerena School. The next step is to gather information on the building structure. EPA will conduct a building evaluation of the school at the end of March. For this evaluation, technical specialists will evaluate the entire building and the grounds to analyze how the building operates. Some of the areas being evaluated are: how air moves through the building; how the ventilation system works; and how water moves through and around the building. The evaluation will include taking some physical measurements, such as pressure differentials, temperature and humidity readings and thermal imagery for energy and water leaks.

The information that EPA gathers on the evaluation will be incorporated into the overall health impact assessment, which will then inform recommendations for remediation at the Gerena School. The building evaluation will help EPA scientists plan their upcoming in-depth monitoring of indoor air and how it is impacted by outdoor sources. Specifically, it will help to determine where air monitors will be placed. This more in-depth monitoring will take place over a period beginning in the next month, and will be a final step in our data collection process.

Once EPA has finished collecting the data over the next few months, there will be a public meeting to update interested citizens and stakeholders on our findings.

Thank you for your interest.

Best,

Emily Zimmerman
US EPA

Appendix E. Documentation of HIA Communication Materials

Impact Summary Handouts Shared with PBRM (December 9, 2013)

Gerena Community School Health Impact Assessment
Initial Findings and Health Impact Characterization

Summary of Impact for Renovation Options on Community Perception

Based on the information reviewing the literature and anecdotal evidence, renovation options were evaluated on the potential to affect community perceptions. Investigators predicted the direction of impact, likelihood, magnitude, impact on vulnerable populations, and strength of existing evidence (see legend at end of table) available to help prioritize which options would yield the greatest benefit related to community perceptions. Vulnerable populations in this instance refer to the individuals in the community that rely heavily on the school (walkway tunnel) for mobility, and/or use the school on a frequent basis. There are a large proportion of low-income and young individuals who may not be able to afford a vehicle, to which the walkway tunnel serves as a major access route the downtown area and other neighborhoods. Individuals with physical disabilities or elderly also use the walkway frequently because it provides a walkway that is covered, climate-controlled, and handicap accessible.

The literature shows that the top factor that influences an individual's perception of their environment is the presence of environmental stressors. Environmental stressors can change a person's perceived accessibility and safety, which can influence their decision to use the school and its amenities. Environmental stressors also cause people to lose perceived control of their environment. The responsiveness of school administrators and building officials to the needs of the community can also impact the community's perceived ability to change conditions in the environment. The loss of control of one's life induces stress that can lead to mental health and behavioral changes. Often people avoid environmental conditions that may increase stress or their risk for harm. Renovation options that addressed safety and accessibility were therefore considered highly influential for changing community perceptions.

For many community members, who do not have students at Gerena, the tunnel area is often the first and sometimes only impression they develop of the school. The presence of deterioration, damage, standing water, and poor air quality can lower a person's perceived accessibility and safety. In addition, perceived social disorder can deter social interaction and limit the space's ability to develop community capacity. Therefore, renovations that focus on improving the quality of the tunnel environment will have the greatest beneficial impact in regards to improving community perceptions. Renovation options that fall in this category are those that focus on improving the air quality in the tunnel space, eliminating water intrusion into the tunnel, and removing evidence of structural damage or vandalism.

Appendix E. Documentation of HIA Communication Materials

In order for the community to react and develop a perception to a change, the change has to be seen. Because of this a lot of “behind the scene” improvements do not really end up impacting the community’s opinions of the school. Because of this, the changes that may improve the facility’s energy recovery may go unnoticed since a lot are in areas not seen by the community. Also, energy efficiency is not a high priority to the community, and therefore those renovation options that address energy recovery will not significantly impact perceptions of the school.

No net effect was expected for any renovation options that proposed further investigation of issues. The rationale behind this was that any potential positive influence gained from the increased knowledge about existing conditions is negated by the negative perception that further study may not be cost effective and prolongs change, There have already been numerous studies conducted at Gerena that give a basic understanding of the conditions, but have not provided assurances for permanent solutions to the issues facing the school. The table below summarizes the predicted impacts each renovation option will have on community perceptions.

Appendix E. Documentation of HIA Communication Materials

Table 1. Community Perception Impact Characterization Table

Recommendations for Immediate Action

Renovation Option Legend for impacts located at end of table. Added renovation options identified by the baseline condition findings are provided in *italics*. Grouping of renovation options are indicated by highlighting. Sequence within group follows numbered order.	**Direction**	**Likelihood**	**Magnitude**	**Vulnerable Population**	**Strength of Evidence**
1. *Seal building enclosure air-tight at identified air leakage sites in building enclosure, which includes:* - *Using approved weatherization materials and techniques to seal the unplanned cracks and openings as noted in the consultant report.*	↕				
2. Change the air flow between outer mechanical space and inner community space of Tunnel C, which involves: - Installation of new exhaust fan and duct system for Tunnel C (to exhaust air from outer tunnel space to exterior of building) - Resealing outer tunnel space completely off from inner tunnel space air-tight (to prevent air from traveling between spaces)	↑	+++	+++	+	*
3. Upgrade status of bypass and fresh air intake dampers for every AHU in Building B, which involves: - Relocation of thermostats to areas that provide more accurate temperature readings (i.e., classroom area) - Replacement of outdoor supply/return dampers for each AHU - Replacement of existing pneumatic damper controls with electronic controls - Installation of control valves with minimum flow rates set at 40 ^{0}F at each AHU - Installation of a low-limit discharge air temperature (DAT) sensor at ever y AHU - Verification of proper night setback operations and rebalancing HVAC system - *Repair and adjust the ventilation systems as needed*	↑	++	+++	0	***
4. *Provide increased cleaning of air conditioning drain pans, which includes:* - *Following EPA and industry guidance on cleaning and treating drain pans (EPA IAQ Tools for Schools Kit)* - *Ensuring drain pans drain properly*	↕				
5. *Use checklist of EPA IAQ Tools for Schools kit within one month of completion of #3 and #4, then follow the recommended schedule to ensure proper continued operation*	↕				

Recommendations for Near Term Action

Renovation Option Legend for impacts located at end of table. Added renovation options identified by the baseline condition findings are provided in *italics*. Grouping of renovation options are indicated by highlighting. Sequence within group follows numbered order.	**Direction**	**Likelihood**	**Magnitude**	**Vulnerable Population**	**Strength of**
6. Further investigation of waterproof membrane, wall construction, and tunnel ceiling (chase) around tunnel A and C to develop repair program to stop water leakage (may not be cost-effective), which may include: - Seasonal monitoring of groundwater levels at existing monitoring wells adjacent to Tunnels A,C	↕				
7. *Based on findings from #6,* reseal areas causing water leakage in tunnels, which may include: - Replacing waterproof membrane around underground areas and areas where tunnel connects to main building	↑	+++	+++	+	***
8. Remove and discard porous building materials that have been damaged by water intrusion for longer than 48 hours and not professionally dried or cleaned (AFTER water intrusion is stopped), which involves: - *Following guidance from EPA IAQ Tools for Schools Kit* - *Extensive cleaning of building, including shelves, counters, floors, ceilings, walls, etc.* - Replacement of discarded building materials with nonporous moisture resistant materials, only AFTER water intrusion is stopped	↑	+++	+++	0	***
9. Further investigation of outdoor air quality at different locations on school campus, which includes: - Incorporating a wind study - *Further investigation of the impact of combustion sized particles to better locate proper placement of fresh air intakes*	↕				
10. *Further monitoring of the indoor air quality with longer-term air sampling data of combustion sized particles, which includes:* - *Planning for future air movement* - *If data indicates need for further removal of outdoor air pollutants, add filtration that will remove particles and gases as appropriate*	↕				
11. *Based on results of #9 and #10,* relocate fresh air intakes for Building A (Tunnel A) to a more healthy location if needed, which may include: - Significant alteration of supply and return ductwork - Extensive cleaning of ductwork that is not replaced	↑	+	+	0	*

Recommendations for Long Term Action

Renovation Option Legend for impacts located at end of table. Added renovation options identified by the baseline condition findings are provided in *italics*. Grouping of renovation options are indicated by highlighting. Sequence within group follows numbered order.	**Direction**	**Likelihood**	**Magnitude**	**Vulnerable Population**	**Strength of Evidence**
12. Replace and upgrade all AHUs and associated return fans, controls, ductwork, piping in Building A, B, C, and D with high efficiency electronic-controlled models, which includes: - Replacement of any damaged/missing equipment, such as diffusers, grilles, insulation, etc. - Extensive cleaning of any ductwork or materials not being replaced - Installation of a new energy management system (EMS) with local computer, communications network, equipment controllers, valve controllers, sensors, airflow and temperature monitors, etc. - Removal of all fresh air intake louvers and replacement on building roof with gooseneck terminal at min. 10 ft. above roof (prevent damage from snowplowing on I-91) - *Incorporate easy access doors for equipment in new HVAC design* - Rebalancing HVAC system	↑	++	+++	+	***
13. Replacement of large boilers and associated flue, pumps, piping, etc., with higher efficiency, sealed combustion, condensing type boilers, which includes: - Re-routing of combustion air intake pipe to exterior of building (per manufacturer's instructions) - Installation of new VFD compatible pumps - Installation of electronic controls compatible with EMS	↕				
14. Replace and upgrade chiller room exhaust system, which includes: - Remove refrigerant exhaust fan and reinstall new 2-speed fan with grille 12" above floor and verify air flow (CFM) against 2009 IMC - Replace 100% air intake unity with 2-speed unit that has equal air flow with exhaust fan air flow - Remove grilles in boiler room and seal air-tight blocking any air flow from room	↕				
15. Install new security measures for building equipment external to building (i.e., air intake/return terminals and AHUs on Building D roof).	↑	+	+	0	*

Impact Legend

Direction of Impact: (↑) = changes may improve health; (↓) = changes may detract from health; (?) = impact uncertain how health will be impacted; (↕) = no net effect

Likelihood: the chances that the renovation option will impact community perceptions (+ = low; ++ = medium; +++ = high)

Magnitude: the number of people that will be affected, if renovation is implemented (+ = low; ++ = medium; +++ = high)

Vulnerable Populations: "-"= there will be disproportionate harms for vulnerable groups; "0" = vulnerable groups will likely be as impacted the same as others; "+" = there will be disproportionate benefits for vulnerable groups or restorative equity in health; "?"= unknown effect/not enough information

Strength of Evidence: "***" = many strong studies (n>10); "**"= a few good studies (n≈3); "*" no clear studies, but generally consistent with principles of public health

Summary of Impact for Renovation Options on Noise

A single occurrence or prolonged exposure to high levels of noise can negatively impact hearing and increase stress. In addition, high background noise can cause distraction and distort speech. Renovation options were evaluated, based on the reviewed literature of factors that affect noise and the acoustic environment in classrooms, for their potential impact on noise levels and speech intelligibility in the school. Investigators predicted the direction of impact, likelihood, magnitude, impact on vulnerable populations, and strength of existing evidence (see legend at end of table) available to help prioritize which options would yield the greatest benefit related to the acoustic environment. Vulnerable populations in this instance includes those who have special education needs due to hearing impairment, learning English as second language, or who have mental or behavioral disorders that make them sensitive to noise.

Using material that has high noise absorption coefficients helps to reduce the amount of background noise. Absorptive materials work best when spread throughout the room and not concentrated on just one section of wall or ceiling. When not replaced, removing noise-absorbing material (e.g., carpeting or upholstery) can negatively impact the acoustic environment. Ceramic floor tiles or other similar material reverberate noise in a room, often causing echoes. Renovations that would remove or decrease the amount of noise absorbing material will negatively impact the noise levels and speech intelligibility in that space. Building materials that absorb noise or are well insulated greatly impact the level of background noise in a learning space.

The design and placement of building materials is critical in the control of the acoustic environment. Materials related to the HVAC system, such as ductwork, fans, diffusers, contribute to the amount of background noise in a classroom. For example, internally insulated ductwork makes it harder for noise to travel between classrooms. Poorly designed or installed diffuser inlets can increase background noise. Renovations that would alter the ductwork or related equipment could result in unwanted noise traveling between rooms. The table below summarizes the predicted impacts each renovation option will have on noise levels and speech intelligibility.

Appendix E. Documentation of HIA Communication Materials

Table 2. Noise Impact Characterization Table

Recommendations for Immediate Action

Renovation Option Legend for impacts located at end of table. Added renovation options identified by the baseline condition findings are provided in *italics*. Grouping of renovation options are indicated by highlighting. Sequence within group follows numbered order.	**Direction**	**Likelihood**	**Magnitude**	**Vulnerable Population**	**Strength of Evidence**
1. *Seal building enclosure air-tight at identified air leakage sites in building enclosure, which includes:* - *Using approved weatherization materials and techniques to seal the unplanned cracks and openings as noted in the consultant report.*	↕				
2. Change the air flow between outer mechanical space and inner community space of Tunnel C, which involves: - Installation of new exhaust fan and duct system for Tunnel C (to exhaust air from outer tunnel space to exterior of building) - Resealing outer tunnel space completely off from inner tunnel space air-tight (to prevent air from traveling between spaces)	↕				
3. Upgrade status of bypass and fresh air intake dampers for every AHU in Building B, which involves: - Relocation of thermostats to areas that provide more accurate temperature readings (i.e., classroom area) - Replacement of outdoor supply/return dampers for each AHU - Replacement of existing pneumatic damper controls with electronic controls - Installation of control valves with minimum flow rates set at 40 ^{0}F at each AHU - Installation of a low-limit discharge air temperature (DAT) sensor at ever y AHU - Verification of proper night setback operations and rebalancing HVAC system - *Repair and adjust the ventilation systems as needed*	↕				
4. *Provide increased cleaning of air conditioning drain pans, which includes:* - *Following EPA and industry guidance on cleaning and treating drain pans (EPA IAQ Tools for Schools Kit)* - *Ensuring drain pans drain properly*	↕				
5. *Use checklist of EPA IAQ Tools for Schools kit within one month of completion of #3 and #4, then follow the recommended schedule to ensure proper continued operation*	↕				

Recommendations for Near Term Action

Renovation Option Legend for impacts located at end of table. Added renovation options identified by the baseline condition findings are provided in *italics*. Grouping of renovation options are indicated by highlighting. Sequence within group follows numbered order.	**Direction**	**Likelihood**	**Magnitude**	**Vulnerable Population**	**Strength of Evidence**
6. Further investigation of waterproof membrane, wall construction, and tunnel ceiling (chase) around tunnel A and C to develop repair program to stop water leakage (may not be cost-effective), which may include: - Seasonal monitoring of groundwater levels at existing monitoring wells adjacent to Tunnels A, C	↕				
7. *Based on findings from #6,* reseal areas causing water leakage in tunnels, which may include: - Replacing waterproof membrane around underground areas and areas where tunnel connects to main building	↕				
8. Remove and discard porous building materials that have been damaged by water intrusion for longer than 48 hours and not professionally dried or cleaned (AFTER water intrusion is stopped), which involves: - *Following guidance from EPA IAQ Tools for Schools Kit* - *Extensive cleaning of building, including shelves, counters, floors, ceilings, walls, etc.* - Replacement of discarded building materials with nonporous moisture resistant materials, only AFTER water intrusion is stopped	↑ (or ↓)	+++	++	+ (or 0)	***
9. Further investigation of outdoor air quality at different locations on school campus, which includes: - Incorporating a wind study - *Further investigation of the impact of combustion sized particles to better locate proper placement of fresh air intakes*	↕				
10. *Further monitoring of the indoor air quality with longer-term air sampling data of combustion sized particles, which includes:* - *Planning for future air movement* - *If data indicates need for further removal of outdoor air pollutants, add filtration that will remove particles and gases as appropriate*	↕				
11. *Based on results of #9 and #10,* relocate fresh air intakes for Building A (Tunnel A) to a more healthy location if needed, which may include: - Significant alteration of supply and return ductwork - Extensive cleaning of ductwork that is not replaced	↑	+	+	+	*

Recommendations for Long Term Action

Renovation Option Legend for impacts located at end of table. Added renovation options identified by the baseline condition findings are provided in *italics*. Grouping of renovation options are indicated by highlighting. Sequence within group follows numbered order.	**Direction**	**Likelihood**	**Magnitude**	**Vulnerable Population**	**Strength of Evidence**
12. Replace and upgrade all AHUs and associated return fans, controls, ductwork, piping in Building A, B, C, and D with high efficiency electronic-controlled models, which includes: - Replacement of any damaged/missing equipment, such as diffusers, grilles, insulation, etc. - Extensive cleaning of any ductwork or materials not being replaced - Installation of a new energy management system (EMS) with local computer, communications network, equipment controllers, valve controllers, sensors, airflow and temperature monitors, etc. - Removal of all fresh air intake louvers and replacement on building roof with gooseneck terminal at min. 10 ft. above roof (prevent damage from snowplowing on I-91) - *Incorporate easy access doors for equipment in new HVAC design* - Rebalancing HVAC system	↑	+++	+++	+	***
13. Replacement of large boilers and associated flue, pumps, piping, etc., with higher efficiency, sealed combustion, condensing type boilers, which includes: - Re-routing of combustion air intake pipe to exterior of building (per manufacturer's instructions) - Installation of new VFD compatible pumps - Installation of electronic controls compatible with EMS	↕				
14. Replace and upgrade chiller room exhaust system, which includes: - Remove refrigerant exhaust fan and reinstall new 2-speed fan with grille 12" above floor and verify air flow (CFM) against 2009 IMC - Replace 100% air intake unity with 2-speed unit that has equal air flow with exhaust fan air flow - Remove grilles in boiler room and seal air-tight blocking any air flow from room	↕				
15. Install new security measures for building equipment external to building (i.e., air intake/return terminals and AHUs on Building D roof).	↕				

Impact Legend

Direction of Impact: (↑) = changes may improve health; (↓) = changes may detract from health; (?) = uncertain how health will be impacted; (↕) = no net effect

Likelihood: the chances that the renovation option will impact noise (+ = low; ++ = medium; +++ = high)

Magnitude: the number of people that will be affected, if renovation is implemented (+ = low; ++ = medium; +++ = high)

Vulnerable Populations: "-"= there will be disproportionate harms for vulnerable groups; "0" = vulnerable groups will likely be as impacted the same as others; "+" = there will be disproportionate benefits for vulnerable groups or restorative equity in health; "?"= unknown effect/not enough information

Strength of Evidence: "***" = many strong studies (n>10); "**"= a few good studies (n≈3); "*" no clear studies, but generally consistent with principles of public health

Summary of Health Impact Characterization for Renovations on Asthma

Each renovation option was evaluated, based on the ranking of factors that trigger asthma, for potential impact on asthma symptom reduction. Investigators predicted the direction of impact, likelihood, magnitude, impact on vulnerable populations, and strength of existing evidence (see legend at end of table) available to help prioritize which options would yield the greatest benefit related to asthma. Populations particularly vulnerable to air quality include asthmatics and those who are sensitive to air pollutants and allergens.

Based on the scientific literature reviewed, the elimination of dampness and indoor mold would provide the best public health impact on asthma. Dampness and mold ranked among the top two contributing factors that increase the risk for exacerbation of asthma symptoms. Other particulate matter smaller than 10 microns (PM_{10}) ranked third highest for factors that increased risk of developing asthma symptoms. Renovation options that relate to the elimination of these risk factors should be considered highest priority.

The review of the literature available on key air pollutants found that elimination of particulate matter would improve breathability for all facility occupants, especially asthmatics. Those who suffer from asthma are more reactive to particulate matter and combustion particles related to traffic pollution, such as NO_2, CO, and particulate matter smaller than 2.5 microns. ($PM_{2.5}$). Therefore filtering these pollutants from the indoor air should be considered as the second highest priority for the reduction of asthma symptoms.

The school cannot prevent the intrusion of every asthma trigger into the school. Asthmagens, such as dust mites, pet dander and hair typically enter the school on student and staff clothing or book bags. Control of these triggers, therefore relies heavily on the extensive and professional cleaning of building and its materials. Cleaning is performed on a regular basis by custodial and maintenance staff. However, extensive and professional cleaning involves areas that are not in the regular maintenance schedule, such as HVAC system ductwork, shelves and bookcases, ceilings, walls, carpets and upholstery. Renovation options that indicate extensive and thorough cleaning would greatly help in the reduction of asthma symptoms caused by those particular asthma triggers that are difficult to control. The table below summarizes the predicted impacts each renovation option will have on asthma symptom mitigation.

Appendix E. Documentation of HIA Communication Materials

Table 3. Asthma Impact Characterization Table

Recommendations for Immediate Action

Renovation Option Legend for impacts located at end of table. Added renovation options identified by the baseline condition findings are provided in *italics*. Grouping of renovation options are indicated by highlighting. Sequence within group follows numbered order.	**Direction**	**Likelihood**	**Magnitude**	**Vulnerable Population**	**Strength of Evidence**
1. *Seal building enclosure air-tight at identified air leakage sites in building enclosure, which includes:* - *Using approved weatherization materials and techniques to seal the unplanned cracks and openings as noted in the consultant report.*	↑	+++	+++	+	***
2. Change the air flow between outer mechanical space and inner community space of Tunnel C, which involves: - Installation of new exhaust fan and duct system for Tunnel C (to exhaust air from outer tunnel space to exterior of building) - Resealing outer tunnel space completely off from inner tunnel space air-tight (to prevent air from traveling between spaces)	↑	+++	+++	+	***
3. Upgrade status of bypass and fresh air intake dampers for every AHU in Building B, which involves: - Relocation of thermostats to areas that provide more accurate temperature readings (i.e., classroom area) - Replacement of outdoor supply/return dampers for each AHU - Replacement of existing pneumatic damper controls with electronic controls - Installation of control valves with minimum flow rates set at 40 ^{0}F at each AHU - Installation of a low-limit discharge air temperature (DAT) sensor at ever y AHU - Verification of proper night setback operations and rebalancing HVAC system - *Repair and adjust the ventilation systems as needed*	↑	+	+	+	*
4. *Provide increased cleaning of air conditioning drain pans, which includes:* - *Following EPA and industry guidance on cleaning and treating drain pans (EPA IAQ Tools for Schools Kit)* - *Ensuring drain pans drain properly*	↑	++	++	+	***
5. *Use checklist of EPA IAQ Tools for Schools kit within one month of completion of #3 and #4, then follow the recommended schedule to ensure proper continued operation*	↑	+	+	+	*

Recommendations for Near Term Action

Renovation Option Legend for impacts located at end of table. Added renovation options identified by the baseline condition findings are provided in *italics*. Grouping of renovation options are indicated by highlighting. Sequence within group follows numbered order.	**Direction**	**Likelihoo d**	**Magnitud e**	**Vulnerabl e**	**Strength of**
6. Further investigation of waterproof membrane, wall construction, and tunnel ceiling (chase) around tunnel A and C to develop repair program to stop water leakage (may not be cost-effective), which may include: - Seasonal monitoring of groundwater levels at existing monitoring wells adjacent to Tunnels A, C	↑	+++	+++	+	***
7. *Based on findings from #6,* reseal areas causing water leakage in tunnels, which may include: - Replacing waterproof membrane around underground areas and areas where tunnel connects to main building	↑	+++	+++	+	***
8. Remove and discard porous building materials that have been damaged by water intrusion for longer than 48 hours and not professionally dried or cleaned (AFTER water intrusion is stopped), which involves: - *Following guidance from EPA IAQ Tools for Schools Kit* - *Extensive cleaning of building, including shelves, counters, floors, ceilings, walls, etc.* - Replacement of discarded building materials with nonporous moisture resistant materials, only AFTER water intrusion is stopped	↑	+++	+++	+	***
9. Further investigation of outdoor air quality at different locations on school campus, which includes: - Incorporating a wind study - *Further investigation of the impact of combustion sized particles to better locate proper placement of fresh air intakes*	↑	+++	+++	+	***
10. *Further monitoring of the indoor air quality with longer-term air sampling data of combustion sized particles, which includes:* - *Planning for future air movement* - *If data indicates need for further removal of outdoor air pollutants, add filtration that will remove particles and gases as appropriate*	↑	+++	+++	+	***
11. *Based on results of #9 and #10,* relocate fresh air intakes for Building A (Tunnel A) to a more healthy location if needed, which may include: - Significant alteration of supply and return ductwork - Extensive cleaning of ductwork that is not replaced	↑	++	+++	+	***

Appendix E. Documentation of HIA Communication Materials

Recommendations for Long Term Action

Renovation Option Legend for impacts located at end of table. Added renovation options identified by the baseline condition findings are provided in *italics*. Grouping of renovation options are indicated by highlighting. Sequence within group follows numbered order.	**Direction**	**Likelihood**	**Magnitude**	**Vulnerable Population**	**Strength of Evidence**
16. Replace and upgrade all AHUs and associated return fans, controls, ductwork, piping in Building A, B, C, and D with high efficiency electronic-controlled models, which includes: - Replacement of any damaged/missing equipment, such as diffusers, grilles, insulation, etc. - Extensive cleaning of any ductwork or materials not being replaced - Installation of a new energy management system (EMS) with local computer, communications network, equipment controllers, valve controllers, sensors, airflow and temperature monitors, etc. - Removal of all fresh air intake louvers and replacement on building roof with gooseneck terminal at min. 10 ft. above roof (prevent damage from snowplowing on I-91) - *Incorporate easy access doors for equipment in new HVAC design* - Rebalancing HVAC system	↑	++	+++	+	***
17. Replacement of large boilers and associated flue, pumps, piping, etc., with higher efficiency, sealed combustion, condensing type boilers, which includes: - Re-routing of combustion air intake pipe to exterior of building (per manufacturer's instructions) - Installation of new VFD compatible pumps - Installation of electronic controls compatible with EMS	↕				
18. Replace and upgrade chiller room exhaust system, which includes: - Remove refrigerant exhaust fan and reinstall new 2-speed fan with grille 12" above floor and verify air flow (CFM) against 2009 IMC - Replace 100% air intake unity with 2-speed unit that has equal air flow with exhaust fan air flow - Remove grilles in boiler room and seal air-tight blocking any air flow from room	↕				
19. Install new security measures for building equipment external to building (i.e., air intake/return terminals and AHUs on Building D roof).	↕				

Impact Legend

Direction of Impact: (↑) = changes may improve health; (↓) = changes may detract from health; (?) = uncertain how health will be impacted; (↕) = no net effect

Likelihood: the chances that the renovation option will impact asthma symptoms (+ = low; ++ = medium; +++ = high)

Magnitude: the number of people that will be affected, if renovation is implemented (+ = low; ++ = medium; +++ = high)

Vulnerable Populations: "-"= there will be disproportionate harms for vulnerable groups; "0" = vulnerable groups will likely be as impacted the same as others; "+" = there will be disproportionate benefits for vulnerable groups or restorative equity in health; "?"= unknown effect/not enough information

Strength of Evidence: "***" = many strong studies (n>10); "**"= a few good studies (n≈3); "*" no clear studies, but generally consistent with principles of public health

Appendix E. Documentation of HIA Communication Materials

HIA Update Flyer (October 2013)

EPA United States Environmental Protection Agency

Gerena Community School Health Impact Assessment (HIA)

U. S. Environmental Protection Agency, Region 1 and Office of Research and Development

Background

Gerena Community School

The German Gerena Community School was built in 1973 in the North End community of Springfield, Massachusetts. At that time, the North End community had been split in two by the construction of Interstate 91. The interstate and industrial railroad line to the west of the interstate made it difficult for residents to travel safely between the two North End neighborhoods of Brightwood and Memorial Square. The school was designed to meet this need by incorporating underground tunnels that crossed both the interstate and railroad line, providing a safe passage for residents and reconnecting the two neighborhoods. Today, the school is in need of upgrades to meet building code specifications and improve the overall conditions inside the school. There are several renovation options under consideration. The Department of Parks, Buildings and Recreation Management (DPBRM) is responsible for prioritizing these and selecting the best option(s) for implementation.

Problems Facing the School

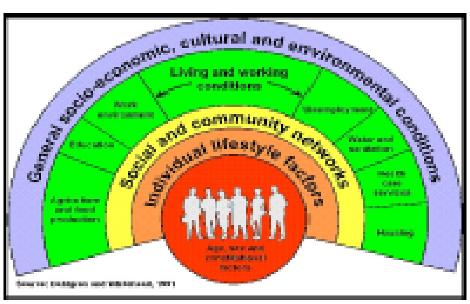
- Structural damage and aging equipment
- Pervasive flooding
- Operating below functional capacity
- Perceived poor air quality
- High energy and maintenance costs
- Low scholastic performance

Community Concerns

- The school is a valuable and irreplaceable asset to the community.
- The perceived poor condition of the school is negatively affecting students' health and scholastic performance.
- The community has been historically disfranchised and left out of the decision-making process.

What is HIA?

HIA is a "systematic process that uses and array of data sources and analytic methods and considers input from stakeholders to determine the potential effects of a proposed policy, plan, program, or project on the health of a population and the distribution of the effects within the population; and provides recommendations on monitoring and managing those effects" (National Research Council 2011).



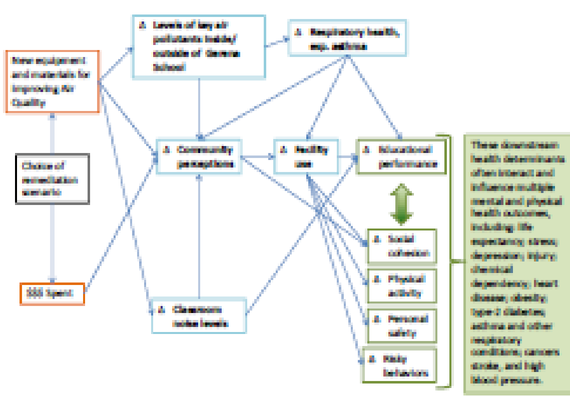
Social Determinants of Health Model

Purpose of This HIA

The Gerena Community School HIA will help inform the DPBRM decision-making process by identifying the renovation options that would best meet both school and community needs, while mitigating potential negative health impacts to maximize total benefit.

Renovation Options Assessed
Careful removal of suspected damaged or microbial-contaminated building materials (i.e., ceiling tiles, dry-wall, carpeting, upholstery, insulation)
Replacement of suspected damaged or microbial-contaminated building materials (i.e., ceiling tiles, dry-wall, carpeting, upholstery, insulation)
Extensive, careful, and exhaustive cleaning of permanent building materials (e.g., walls, ceilings, floors, bookshelves, etc.)
Extensive, careful, and exhaustive cleaning of air supply materials (i.e., supply/return ducts, registers/grilles, fans)
Upgrade (redesign if needed) of air-exhaust system, including fan and ducts
Redesign and relocation of fresh-air intakes and duct system to more optimum areas (above ground-level and away from train and roadways)
Replacement/upgrade of heating, ventilation and air conditioning (HVAC) systems, including: Air Handling Units (AHU), AHU control valves, dampers, etc., and re-balancing of system after upgrades
Redesign and replacement/upgrade of water-management systems, including pumps, valves, dampers, controls, louvers, expansion tank, and piping
Replacement of water-proof membrane seal on ground-level foundation, walls and ceiling chase of Buildings A, B, C, and D (especially Building B); includes replacement of soil around foundation to a more permeable substrate
Sealing areas of air leakage around Building B

Effect pathways were used to assess how the decision could influence social and ecological health determinants and potentially impact the health of the community.



Gerena Community School Impact Pathway Diagram

EPA United States Environmental Protection Agency

Gerena Community School Health Impact Assessment (HIA)

U. S. Environmental Protection Agency, Region 1 and Office of Research and Development

Assessment

Assessments were performed, based on the pathway diagram, to gather baseline information and evaluate whether the predicted health impacts might be realized. The HIA project team assessed impacts at Gerena Community School in these four general areas:

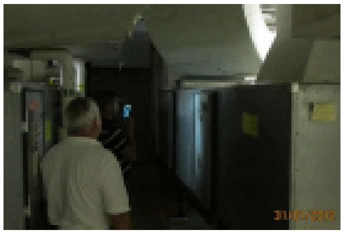
1. Indoor Air Quality
2. Respiratory Health (Asthma)
3. Classroom Acoustic Environment
4. Community Perspectives of the Facility

Methodologies

Several methodologies were used during the assessment process, including:

- ✓ Literature Reviews
- ✓ Community Engagement
- ✓ Pressure Mapping
- ✓ Enclosure Air Tightness Analysis
- ✓ Infrared Imaging
- ✓ HVAC Systems and Equipment Survey
- ✓ Air Particle Sampling

Air monitor on roof of school



HIA project team surveying the HVAC systems

General Findings

The HIA project team evaluated conditions at the school and in the community as part of the HIA. General findings are presented here.

The School

Indoor Air Quality

The high rate of air leakage out of the facility and the irregular patterns of air pressure flow have attributed to high energy requirements and overstrain on the HVAC systems. Irregular patterns of air pressure flow are due to the malfunction of some air handling units and air leaks in the walls, wall-joints, and floors of the building. The HVAC equipment and systems are outdated and need extensive upgrades to meet building code standards and air quality requirements.

Air particle sampling indicated high concentration levels of combustion particles and carbon dioxide during certain hours of the day. Mold contamination levels were abnormally high throughout the facility and indicate extensive water damage of dry materials.

Respiratory Health

Asthma is a major concern for residents in the community and students at the school. On average, one in five students at the school suffers from asthma. There are several factors that influence asthma symptom onset. Mold, excessive moisture, and air pollutants are common asthma triggers found in the school.

Classroom Acoustic Environment

High noise levels in the classroom have been reported by parents and staff. Excessive noise can damage hearing, cause voice strain, and induce stress in students and teachers. Poor classroom acoustics can also disrupt the learning process and make speech intelligibility very difficult.

The Community

The HIA project team used 2010 U.S. Census data (census tracts 8006, 8007, and 8008) to characterize the community. In general, the community consists of a younger population that is predominantly female and of Puerto Rican descent. The predominant language spoken at home is Spanish. Socio-economic factors indicate that only 20-30% of the population has graduated high school or received their GED. The percent of unemployment ranges from 21-31%, and the median household income in the area is $15,000-16,000. Upon reviewing state-reported health data, the major health concerns for this community involve respiratory health, diabetes, and cardiovascular disease.

Community Perspectives of the Facility

The school is a prominent feature that influences the social environment of the community. The school doubles as a community center in which social capital is developed. There is a generalized perception of poor conditions at the school from parents and community members. Parents have reported air quality concerns at the school as a major cause of student absenteeism and lack of use of the facility. The school, being a direct influence on resident mobility, may also influence health outcomes related to physical activity.

Recommendations

Based on the findings of the assessment phase, recommendations will be developed to steer the decision towards the greatest positive health benefit. The next step for the HIA project team is to develop preliminary recommendations and elicit community and decision-maker feedback on those recommendations. Input from these stakeholders will then be incorporated into the final prioritization of renovation options, and final recommendations will be presented to decision-makers and the public.

CONTACTS:

EPA, Region 1 Office

George Frantz
Frantz.george@epa.gov

MaryBeth Smuts
Smutz.marybeth@epa.gov

EPA, Office of Research and Development

Florence Fulk
Fulk.florence@epa.gov

Valerie Zartarian
Zartarian.valerie@epa.gov

Appendix E. Documentation of HIA Communication Materials

PowerPoint Presentation to PBRM (January 29, 2014)

Draft Recommendations for Remediation

Gerena Community School
Health Impact Assessment (HIA)

Discussion Presentation
January 29,2014

1 — 1/29/2014

Overview of Gerena School HIA

- Joint project by EPA Region I and Office of Research and Development (ORD), funded by ORD's Sustainable and Healthy Communities Project
- Client: Springfield Dept of Parks, Buildings, Recreation Management
- Stakeholders: Gerena Community School staff, students, and parents, City of Springfield officials, and residents of North End community
- Product: a set of recommendations for renovating the school and guidance for prioritizing recommended renovations based on health and community concerns (overlaid with time and funding ability)

2 — 1/29/2014

Timeline & Activities for Next Steps in HIA

- Draft list of recommended renovations, prioritized by EPA IAQ experts
- Draft list of recommended renovations, prioritized by health impacts and community concerns
- NEXT → Draft list of recommended renovations, prioritized by cost and feasibility- requires input from clients (DPBRM)
- Present list of recommended renovations to:
  - Springfield School Board and Mayor- mid February 2014
  - Community stakeholders- March 2014
- Finalize list of prioritized renovations- March 2014
- Complete HIA and finalize full report- April 2014

3 — 1/29/2014

Suggested Prioritization Criteria

- Health Impacts: based on science and community concerns
- Costs: initial and operating costs (or savings)
- Feasibility: ease of operation/maintenance, durability and occupancy
- Timing and Phasing of Actions: immediate, near term and longer term actions

The purpose of standardizing prioritization criteria is to improve understanding of renovation selection by all stakeholders

NOTE: understanding does not always mean consensus was made

4 — 1/29/2014

Renovation Options

Immediate Actions

Renovation Option	Health Value for Asthma	Value for comm.P ,noise	Final value
Seal air leakages in Building Envelope	High	High	High
Exhaust and reseal outer tunnel C	High	High	High
Upgrade Air Handling Units, bypass and intakes in B	High	Mod.	High
Increased cleaning of drain pans	Mod.	No Effect	Mod.
Use Checklist of Tools for Schools	Low	No Effect	Low

5 — 1/29/2014

Renovation Options

Near Term Actions

Renovation Option	Health Value for Asthma	Value for C.P., Noise	Final Value
Implement waterproofing to stop water leakage in tunnels C & A	High	High	High
After leak repair, discard damaged porous materials, furniture and coverings and replace with cleanable materials	High	High	High
If HVAC or air pollutant sources or levels change, such as traffic or train, re-evaluate air intakes locations or filters used	High	No Effect	High
Clean ductwork that is not replaced	Mod.	Low	Mod.

6 — 1/29/2014

Appendix E. Documentation of HIA Communication Materials

Renovation Options

Longer Term Actions

Renovation Option	Health Value for Asthma	Value for C.P., Noise	Final Value
Replace and upgrade all air handling units and associated systems in all buildings (A,B,C and D)	Mod.	High	High
Replace large boilers with higher efficiency and sealed boilers	No Effect	No Effect	No Effect
Replace and upgrade chiller room exhaust	No Effect	No Effect	No Effect
Install security for building equipment	No Effect	Low	Low

7 1/29/2014

Suggested Prioritization Criteria

- First Cost
  - $, $$, $$$
- Operating Cost (or Savings)
  - $, $$, $$$
- Ease of Operation/Maintenance
  - High, Moderate, Low
- Durability
  - High, Moderate, Low
- Occupancy
  - High, Moderate, Low

8 1/29/2014

Renovation Options

Immediate Actions

Renovation Option	First Cost	Operating Cost (or Savings)	Ease of O/M	Durability	Occupancy
Seal air leakages in Building Envelope					
Exhaust and reseal outer tunnel C					
Upgrade Air Handling Units, bypass and intakes in bld. B					
Increased cleaning of drain pans					
Use Checklist of Tools for Schools					

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Renovation Option	First Cost	Operating Cost (or Savings)	Ease of O/M	Durability	Occupancy
Implement waterproofing to stop water leakage in tunnels C & A					
After leak repair, discard damaged porous materials, furniture, coverings and replace with cleanable materials					
If HVAC or air pollutant sources or levels change, such as traffic or train, re-evaluate air intakes locations or filters used					
Clean ductwork that is not replaced					

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Renovation Options

Longer Term Actions

Renovation Option	First Cost	Operating Cost (or Savings)	Ease of O/M	Durability	Occupancy
Replace and upgrade all air handling units and associated systems in all buildings (A,B,C and D)					
Replace large boilers with higher efficiency and sealed boilers					
Replace and upgrade chiller room exhaust					
Install security for building equipment					

11 1/29/2014

Bases for Recommendations

- Identification of health impacts: asthma- school data and science; noise- science and community concerns; and community perceptions of school IAQ
- Data collection for school renovations:
  1. Evaluation of school contractors' reports
  2. ORD's Mold Research Analysis
  3. Turner's Building Assessment Report
  4. Arcadis Air Sampling Report
- Draft Priorization of Renovations based on science and expert judgment

12 1/29/2014

Results and Recommendations from ORD Mold Analysis Report

Indicator Mold spores (use of ORD research tool ERMI) present in settled dust in upper pods

- Correct water leaks
- Remove damaged porous materials and replace with easily cleanable material
- Conduct thorough cleaning

13 1/29/2014

Turner Building Assessment Report Findings and Recommendations

Use of blower dr testing for air exchange rate, limited COx and pressure testing and observations identified unplanned air flows

- Seal bld for air leakages
- Exhaust/dry Tunnel C tunnel within tunnel moisture
- Upgrade Air handling units
- Evaluate air intake placements if outdr sources change

14 1/29/2014

Arcadis Air Sampling Findings and Recommendations

Screening level 6 d. study of key combustion pollutants. Outdr. Pollutants, NOx and BC, impact IAQ in tunnel area but Indr. Levels well below outdr levels. In 1/3 sampling days when N wind, higher pollution levels.

- If HVAC or outdr sources, such as traffic or train, change, reevaluate placement or filtering of intakes by completing wind tunnel study and longer, comprehensive air monitoring.
- Seal air leakages so all air enters through air intakes.

15 1/29/2014

Thank You!

For additional thoughts, comments, suggestions, please contact:
MaryBeth Smuts at Smuts.marybeth@epa.gov
George Frantz at Frantz.george@epa.gov

16 1/29/2014

Handout for Meeting with PBRM (January 29, 2014)

Observations and Guidance Regarding Gerena Community School

Recommendations for Remediation Actions

HIA Core Research Group

January 2014

During the past several years, contractors and consultants have provided many recommendations regarding improvements to Gerena Community School. These recommendations span a wide range of costs, complexity, and potential impacts on the school facilities and on the health and well being of the school occupants. Not all recommendations can be accomplished at once due to factors such as cost (e.g., budget constraints), the need for extended periods of no occupancy (e.g., summer break) to perform some of the recommendations, and because some of the recommendations should be performed in a sequential manner. It is essential that all stakeholders (i.e., those who will be affected by the decision) have the opportunity to understand and comment on the actions, the priority order for the actions, and the overall timeline for completion of each of the phases, and that there is an overall agreement on the plan. Therefore it becomes necessary for the school authorities and community to identify and come to agreement on what actions will be taken, and in what order.

The HIA looked at baseline conditions, identified community and stakeholder concerns, and predicted potential impacts of each renovation option proposed. Based on the findings from the HIA, the core research team drafted a set of priority criteria and a sequence of phases for the set of recommendations proposed[11].

First, the renovation options need to be sorted into phases of implementation (i.e., action). Since the renovations cannot be accomplished all at once, it is recommended that two (2) or more phases of action are developed. For an example, three action phases were used to sort the renovation options proposed for Gerena.

Phase 1: Immediate Actions

[11] The following observations and guidelines are based on the experience of the authors, and do not necessarily reflect official policies of the EPA. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

These are actions that can be accomplished immediately based on the criteria. These can likely be completed within one school year.

Phase 2: Near-Term Actions

The timeline for these actions are highly dependent on the available budget and require more extensive planning and preparation before work begins. They likely can be accomplished within two (2) or three (3) years after work has begun, or when the budget has been approved by the City Council.

Phase 3: Long-Term Actions

These are likely actions that will require a significant budget and therefore will take the longest to accomplish. Some of these actions may also require completion of actions in Phase 2.

Second, the renovation options need to be prioritized based on a set of criteria deemed appropriate for the school and agreed upon by all stakeholders. The following are some criteria the HIA recommends for the decision-makers to consider when attempting establishing the most efficient and effective remediation plan for the school. Note that most of the following criteria are rated as being High (H), Medium (M), or Low (L) in the example tables. This makes it easier to see and compare the rating of each action item. In this case, H is better than M and L, and actions with a single $ symbol have lower first costs (requires less initial funding) than an action rated as $$$.

Health Value

Establish a simple scale (e.g., score of High, Moderate, and Low) for identifying which projects are expected to have the most positive effect on health and well being (score = H) and those that have the lowest expected effect (score = L). Although the other criteria have an impact on prioritization, since this criterion is directly related to the health and well--being of the school occupants, it likely will carry significantly more weight in determining the priority of an action when compared to any of the other criteria.

First Cost

Establish a simple scale (e.g., one to three $ symbols) to associate with the first cost for each action. A single $ symbol could represent those actions that can be accomplished at no cost or low cost, such as with currently available funding sources (e.g., annual operations budget). Two symbols ($$) could represent those actions requiring funding that could be available in two (2) to three (3) years, after work has begun. Three symbols ($$$) could represent those actions that may take several years before funding is available.

Operating Cost (or Savings)

Establish a similar scale as the First Cost criterion (e.g., one to three $ symbols) to associate with the operating cost for each action. Some actions will have an ongoing operating cost or savings associated with them. A single $ symbol could represent those actions that can be operated at no cost, low cost, or even at a savings (over current operating expenses), such as actions that result in reduced utility bills. Three symbols ($$$) could represent those actions that may result in significant increases to the operating cost of the school.

Ease of Operation and Maintenance

Actions that require little to no time for proper operation and maintenance would be rated as H, while actions that may not continue to work properly without investing a significant amount of time for operation and maintenance would be rated as L.

Durability

Actions that are expected to have a long life (e.g., 15 or more years) before needing replacement or overhaul would be rated as H. Actions lasting 5-15 years would be rated as M, and actions lasting less than 5 years would be rated as L.

Occupancy

An action would receive an H rating if it could be performed at any time during the school year, but would receive an L rating if for safety reasons it could only be performed when the school is not occupied, e.g., during summer, fall or spring break.

Phase 1: Immediate Actions

Recommendation Origin (#)	**Renovation Option** Added renovation options identified by the HIA are provided in *italics*. Grouping of renovation options are indicated by highlighting. Sequence within group follows numbered order.	**Health Value-**	**First Cost**	**O & M Cost**	**Ease of O & M**	**Durability**	**Occupancy**
Building Assessment Report (#8, 9)	1. *Seal building enclosure air-tight at identified air leakage sites in building enclosure*.	H					
Building Assessment Report (#3); Air Sampling Report (#2)	2. Change the air flow between outer mechanical space and inner community space of Tunnel C by continuously exhausting wet areas and sealing outer tunnel C from inner tunnel C space.	H					
Building Assessment Report (#10)	3. Tune-up of bypass and fresh air intake dampers for every AHU in Building B to ensure delivery of adequate outside air and temperature control.	H					
Building Assessment Report (#12)	4. *Provide increased cleaning of air conditioning drain pans*.	H					
Building Assessment Report (#14, 15)	5. *Improve HVAC Preventative Maintenance Program using checklist of EPA IAQ Tools for Schools kit within one month of completion of #3 and #4, then follow the recommended schedule to ensure proper continued operation*.	H					

Prioritization Criteria Legend

Health Value: H= actions that are expected to have the highest positive effect on health and well being , M= actions expected to have a moderate effect on health and well being, L= actions expected to have a low effect on health and well being

First Cost: $= actions that can be accomplished at no or low cost, $$= actions require funding that could be available in two to three years, after work has begun, $$$= actions may take several years before funding is available

Operating Cost (or Savings): $= actions that can be operated at no cost, low cost, or even at a savings, $$= actions that may result in moderate increases to the operating costs of the school, $$$= actions that may result in significant increases to the operating cost of the school

Ease of Operation and Maintenance: H= actions that require little to no time for proper operation and maintenance, M= actions that may require a moderate amount of time for proper operation and maintenance, L= actions that may not continue to work properly without investing a significant amount of time for operation and maintenance

Durability: H= actions expected to have a long useful life (e.g., 15 or more years) before needing replacement, M= actions lasting or having a useful life of 5-15 years, L= actions lasting less than 5 years of useful life

Occupancy: H= actions that can be performed at any time during the school year, M= actions that can be performed when the school is at minimum occupancy, L= actions that can only be performed when the school is not occupied

Phase 2: Near-term Actions

Recommendation Origin (#)	**Renovation Option** Legend for values located at end of table. Added renovation options identified by the baseline condition findings are provided in *italics.* Grouping of renovation options are indicated by highlighting. Sequence within group follows numbered order.	**Health Value**	**First Cost**	**O & M Cost**	**Ease of O & M**	**Durability**	**Occupancy**
Building Assessment Report (#6)	6. Further investigation of waterproof membrane, wall construction, and tunnel ceiling (chase) around tunnel A and C to develop repair program to stop water leakage (may not be cost-effective).	H					
Mold Assessment Report (#1); Building Assessment Report (#4, 6):); Air Sampling Report (#2)	7. *Based on findings from #6,* reseal areas causing water leakage in tunnels.	H					
Mold Assessment Report (#2, 3); Building Assessment Report (#6)	8. Remove and discard porous building materials that have been damaged by water intrusion for longer than 48 hours and not professionally dried or cleaned (AFTER water intrusion is stopped).	H					
Building Assessment Report (#7)	9. Plan for future air movement and ensure airflows from occupied areas to unoccupied areas.	H					
Building Assessment Report (#15)	10. Improve energy management of HVAC by adjusting HVAC operating times.	No Effect					
Building Assessment Report (#1, 5, 11); Air Sampling Report (#1)	11. Continue to evaluate impact of outdoor combustion sized particles on indoor air quality. If air pollutant sources or levels change, re-evaluate optimal locations of air intakes and filters used.	H					

Prioritization Criteria Legend

Health Value: H= actions that are expected to have the highest positive effect on health and well-being , M= actions expected to have a moderate effect on health and well-being, L= actions expected to have a low effect on health and well being

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Occupancy: H= actions that can be performed at any time during the school year, M= actions that can be performed when the school is at minimum occupancy, L= actions that can only be performed when the school is not occupied

Phase 3: Long-Term Actions

Recommendation Origin (#)	**Renovation Option** Legend for values located at end of table. Added renovation options identified by the baseline condition findings are provided in *italics.* Grouping of renovation options are indicated by highlighting. Sequence within group follows numbered order.	**Health Value**	**First Cost**	**O & M Cost**	**Ease of O & M**	**Durability**	**Occupancy**
Building Assessment Report (#2,13)	12. Redesign and replace (upgrade) all HVAC air handing units and associated return fans, controls, ductwork, piping in Building A, B, C, and D with high efficiency electronic-controlled models. Include installation of easy access doors.	H					

Prioritization Criteria Legend

Health Value: H= actions that are expected to have the highest positive effect on health and well being , M= actions expected to have a moderate effect on health and well being, L= actions expected to have a low effect on health and well being

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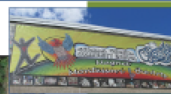
Appendix E. Documentation of HIA Communication Materials

PowerPoint Presentation to PBRM (August 7, 2014)

Gerena Community School
Health Impact Assessment (HIA)



1

DRAFT AGENDA

1. EPA Presentation on Executive Summary:
   a. Discussion on Executive Summary
   b. Discussion on Report
2. Next Steps Necessary and Community Meeting Prep
   a. Written Materials
   b. Presentations
   c. Schedule/Logistics
3. Value of HIA in Springfield and Lessons Learned
   a. City Perspective
   b. EPA Perspective

2

Overall HIA Goals

1. Bring a health focus and add value to decisions on school improvements & repairs
   - *based on scientific data, health expertise & public input*
2. Gain experience in HIAs

3

HIA Process

Screening	Determines the need and value of a HIA
Scoping	Determines which health impacts to evaluate, methods for analysis, and a workplan
Assessment	Provides: 1) a profile of existing health conditions 2) evaluation of potential health impacts 3) strategies to manage identified adverse health impacts
Reporting	Includes: 1) development of the HIA report 2) communication of findings & recommendations
Monitoring	Tracks: 1) impacts on decision-making processes and the decision 2) impacts of the decision on health determinants

4

HIA Goals, Gerena School

- Influence actions to improve indoor air & well-being at Gerena, with expectation that those actions would remove or mitigate environmental factors that influence asthma symptoms
- Increase range of community groups participating in the decision-making process and their understanding of reasons behind decisions made
- Provide recommendations so they could be incorporated in repair decisions

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HIA Process for Gerena School

Screening

- Springfield Department of Parks, Buildings, Recreations Management (PBRM) led several investigations to identify improvements
- Time and funding are limiting factors for renovations
- PBRM selecting and implementing renovation options as the HIA started

Scoping

- Focused on environmental conditions in Gerena and how renovations could influence health and well-being of facility users especially among vulnerable populations

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Appendix E. Documentation of HIA Communication Materials

HIA Process for Gerena School (cont'd)

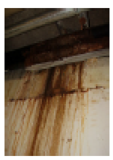
Assessment

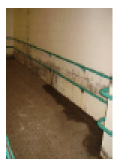
- Study designed to address stakeholder concerns
- Literature reviews of peer-reviewed scientific journals and published reports
- Building Integrated Assessment (BIA) and Diagnostics:
  - Building enclosure air tightness testing and infrared imaging
  - Visual survey of HVAC equipment and maintenance plan
  - Settled dust sampling to test mold contamination
  - Air pressure mapping throughout facility
  - 3-day continuous recording of indoor CO_2, temperature, relative humidity, and laser particle counting in selected areas
  - 6-day recording of indoor and outdoor temperature, relative humidity and indoor/outdoor monitoring for select combustion source pollutants

7

Gerena School
Building Integrated Assessment

- Provides an integrated assessment that characterizes the building and how it is operating relative to occupant health
- Ensures a holistic perspective that connects the HIA results with likely solutions
- Helps establish a prioritized set of recommendations
- Goes several steps beyond typical reports provided by mechanical (HVAC) contractors and architectural consultants
- Example: Wet hidden tunnel + Major air leak where walls meet roof deck + central atrium + boiler room converted to pool room + kids = high potential for asthma incidents





8

HIA Key Elements for Gerena School

- **Community Perceptions (page 4)**
  - Conditions at Gerena are unhealthy and not safe for vulnerable populations, especially asthmatics
  - Accessibility is a key determinant of facility use among residents
  - Gerena is an irreplaceable asset to the community
- **Ranking PBRM Renovation Options in Terms of Health (page 6)**
- **Final HIA Recommendations (page 7-8)**

9

Discussion of Executive Summary and Report

10

Agenda Item Number 2:

Reporting and Community Meeting Prep

11

HIA Process, Gerena School

Reporting

- HIA Executive Summary
- HIA Report
- Next Steps:
  - Bring Draft Final HIA Exec. Summary and Report to Springfield PBRM for review and discussion on August 7, 2014
    - *EPA to emphasize report is preliminary and will undergo external peer review*
  - Schedule Public Community meeting to present and take comments on Draft Final HIA Executive Summary and Report
  - EPA wants to emphasize the HIA results are preliminary and need to undergo both external peer review and community input before finalizing
  - Finalize and disseminate on EPA website

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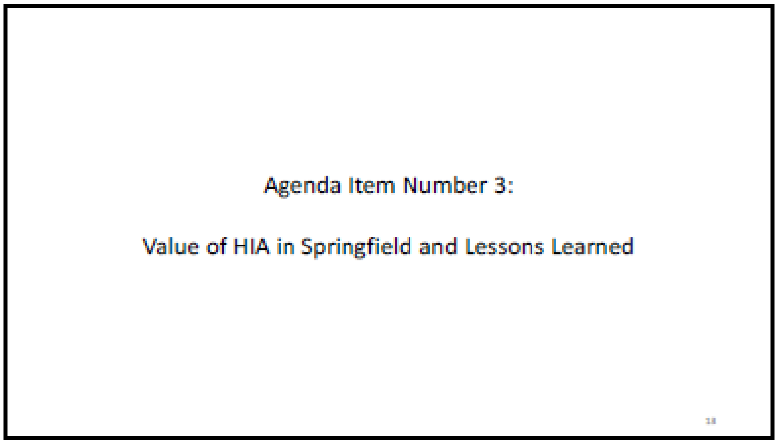
Appendix E. Documentation of HIA Communication Materials



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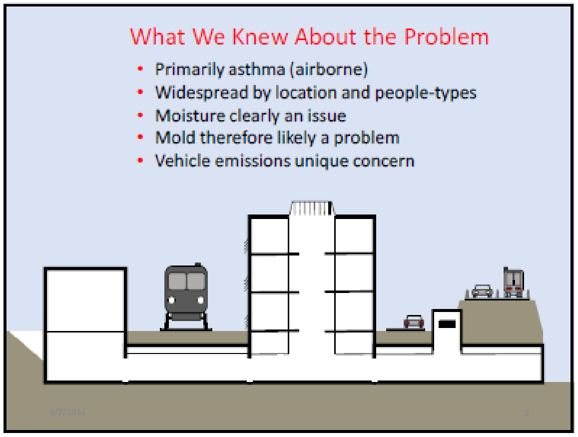

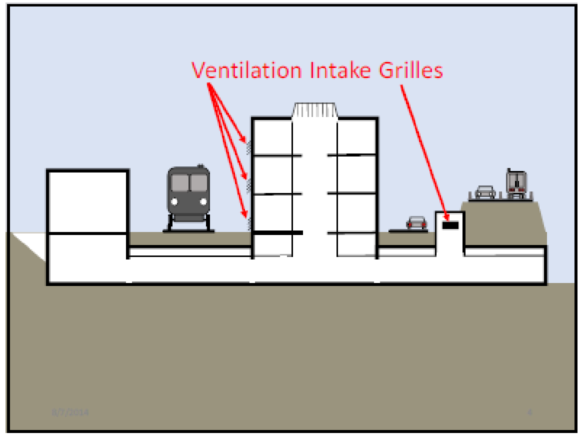

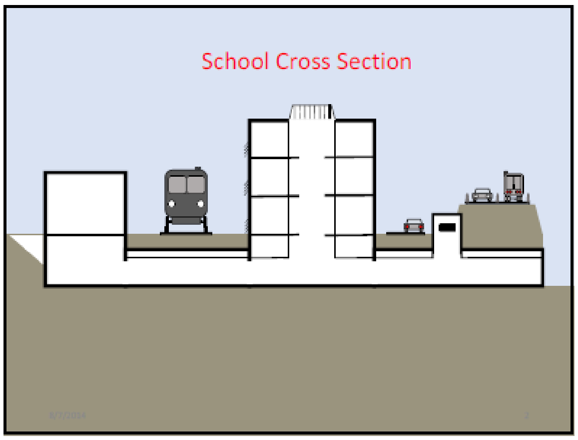

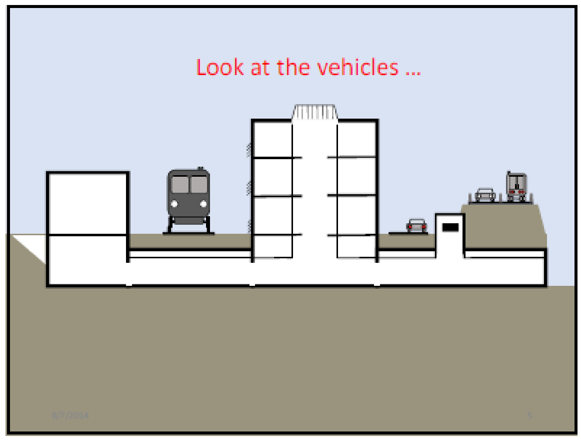

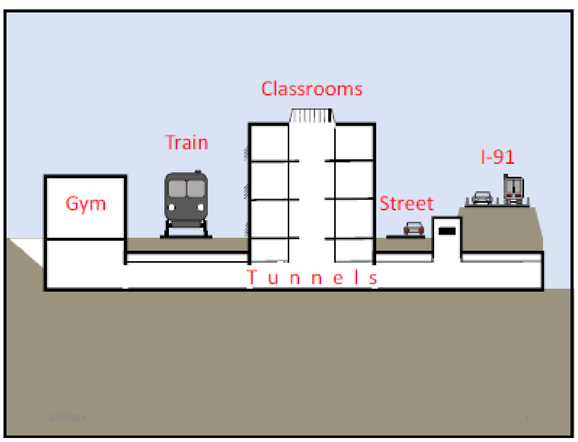

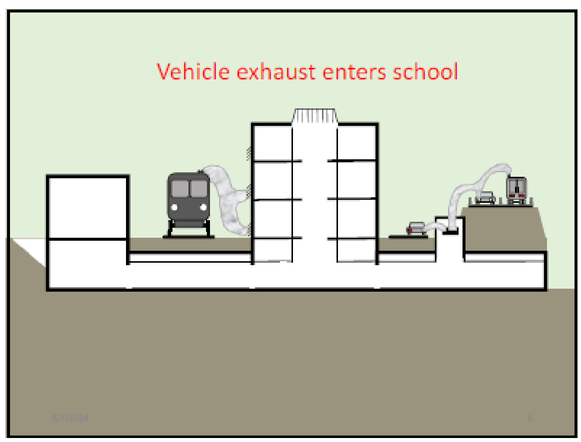

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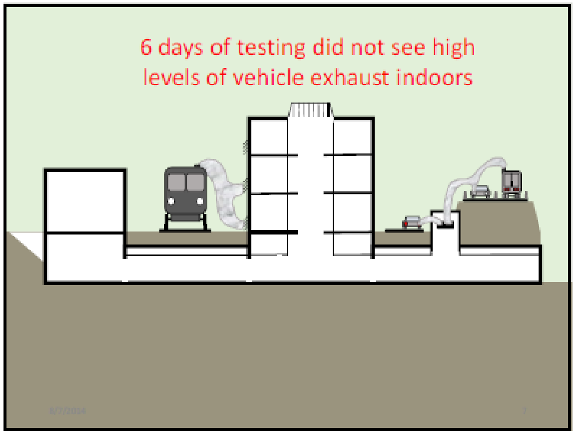

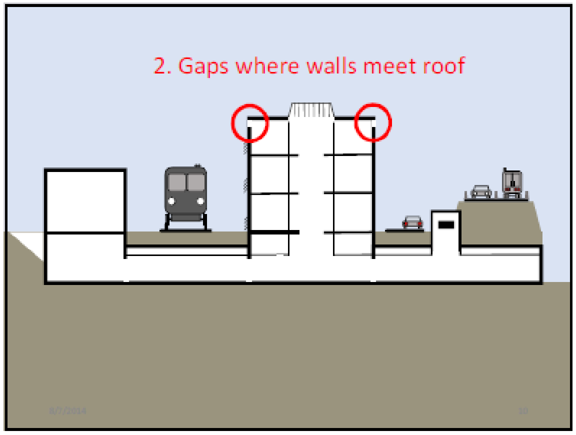

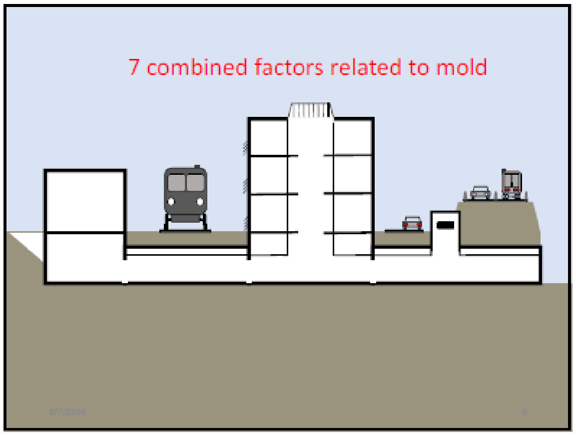

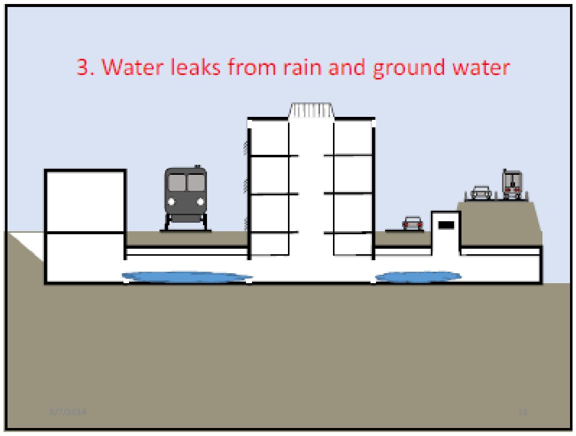

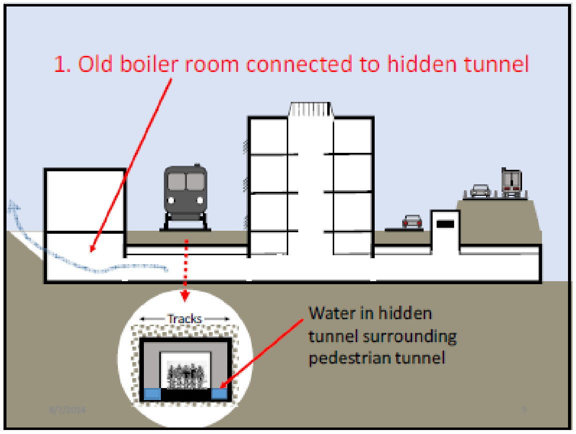

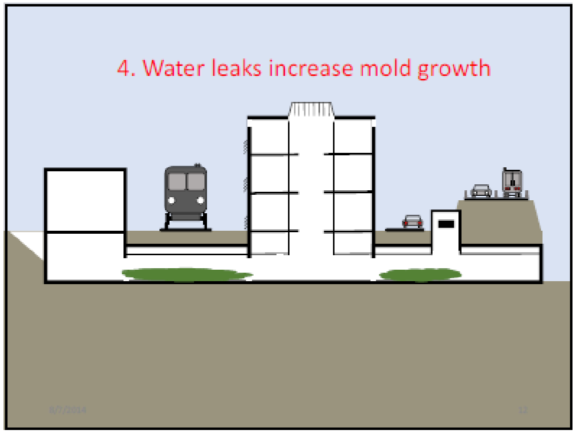

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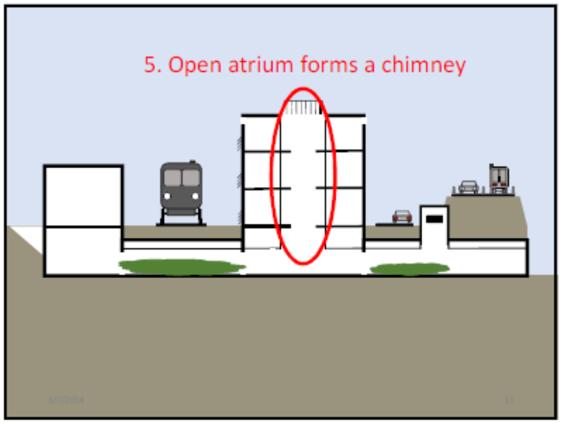

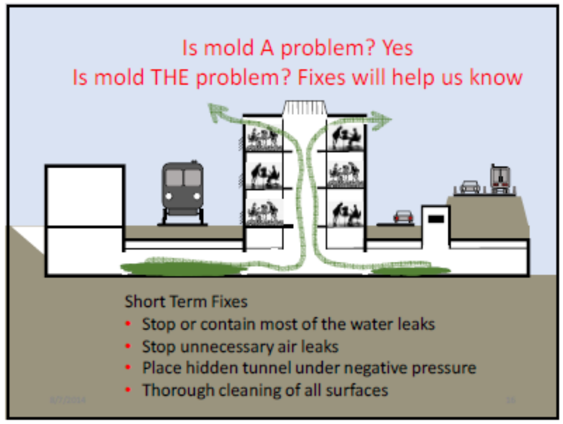

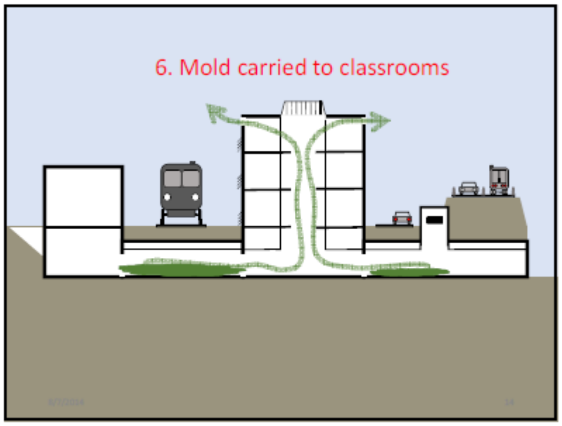

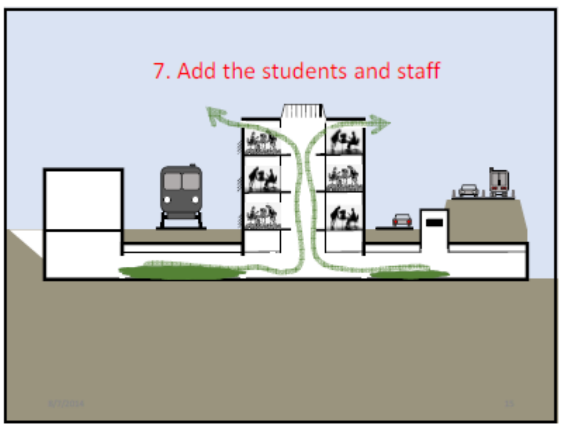

Appendix F. HIA Assessment Plan

HIA Assessment Plan for Baseline Analyses

Health Impact	Baseline Research Question	Assessment Method(s)	Indicators/Data	Data Source(s)
Indoor Air Quality	What are the levels of selected (key) air pollutants present in Gerena? • Are there areas in the building where there are higher levels of indoor air pollutants? • What are the primary health issues related to exposures to those indoor air pollutants?	• Forensic review of previous investigative reports • Quantitative mold contamination analysis • On-site diagnostics of HVAC system and building enclosure, which will include pressure mapping; enclosure air tightness, infrared imaging; HVAC operation, monitoring carbon dioxide, temperature, and relative humidity control, laser particle counting, visual inspection of HVAC equipment and maintenance plan • Continuous sampling of select air pollutants • Analyze reasons for visiting the school nurse	• Environmental Relative Moldiness Index (ERMI) values • Total Airflow (cubic feet per minute) • Pressure Gradient (Pascal's) • Carbon Dioxide (parts per million) • Carbon Monoxide (parts per million) • Black Carbon (nanograms per cubic meter) • Ultrafine Particles (particle count per cubic centimeter) • Nitrogen Oxides, Particulate Matter 2.5 (micrograms per cubic meter) • Relative Humidity (%) • Temperature (^{o}F) • Number of visits to school nurse by cause	• MA Department of Public Health; EPA testing and modeling • School nurse surveillance records

Appendix F. HIA Assessment Plan

Health Impact	Baseline Research Question	Assessment Method(s)	Indicators/Data	Data Source(s)
Classroom Noise	What are the current ambient noise levels in Gerena Community School classrooms? • What facility features contribute to ambient noise levels and/or the acoustic environment in the classrooms?	• On-site diagnostics of acoustic environment (if available) • Systematic literature review and synthesis • Qualitative analysis of input from building occupants	• Measured or estimated ambient noise levels ***Funding unavailable to perform on-site noise level measurements.**	• EPA testing (if available) • Peer-reviewed journal articles, grey literature, and/or agency reports
Community Perception	What are the current perceptions of Gerena Community School? • What conditions are influencing perceptions about Gerena among community members?	• Direct observation (if available) • Qualitative analysis of input from building occupants	• Observational and/or anecdotal evidence ***Observational data unobtainable without IRB approval**	• Local news and social media outlets (newspaper articles, news segments, radio, blogs, etc.)
Facility Use	What is the current capacity for facility use and does the current use meet capacity? • What demographic groups use the facility? • What types of activities are going on inside the building (e.g., physical activity programs, language learning, afterschool programs, etc.)?	• Direct observation (if available) • Qualitative analysis of input from building occupants	• Measured or estimated average number of users per day • Square footage and fire code occupancy maximum requirements for room occupancy • Ratio of student, local resident, visitor usage) ***Observational data unobtainable without IRB approval**	• Facility planning records

Appendix F. HIA Assessment Plan

Health Impact	Baseline Research Question	Assessment Method(s)	Indicators/Data	Data Source(s)
Asthma Symptoms	What is the prevalence of asthma among students and the community using Gerena Community School? • Are there differences in asthma prevalence among sub-groups in the population? • Are there agents in the school environment that contribute to asthma symptom exacerbation in children?	• Collection and risk analysis of reported data from school nurse and Massachusetts Department of Public Health • Systematic literature review and analysis	• Asthma prevalence among students • Asthma prevalence among North End residents (if available) by age, gender, race and ethnicity, educational attainment, and income	• School nurse surveillance records • Massachusetts Community Health Information Profile (MassCHIP) • Peer-reviewed journal articles, grey literature, and/or agency reports

Impact Assessment and Characterization

Health Impact	Impact Research Question	Assessment Method(s)	Indicators/Data	Data Source(s)
Indoor Air Quality	How can the proposed renovation options impact levels of key air pollutants?	• Qualitative review and analysis of evidence available	• Direction; Likelihood; Magnitude; Distribution	• Peer-reviewed journal articles, grey literature, and/or agency reports • Professional expertise
Classroom Noise	Will each of the proposed renovation options have the potential to change classroom noise levels and/or classroom acoustics?	• Qualitative review and analysis of evidence available	• Direction; Likelihood; Magnitude; Distribution	• Peer-reviewed journal articles, grey literature, and/or agency reports

Appendix F. HIA Assessment Plan

Health Impact	Impact Research Question	Assessment Method(s)	Indicators/Data	Data Source(s)
	• How can classroom noise and/or classroom acoustics affect health? • Are there sub-groups more vulnerable to impacts from noise?			• Professional expertise
Community Perceptions	Will each of the proposed renovation options have the potential to change community perceptions about Gerena Community School? • How can community perceptions affect health in the community and among facility users? • Are there sub-groups more susceptible to impacts from the perceived indoor environment?	• Qualitative review and analysis of evidence available	• Direction; Likelihood; Magnitude; Distribution	• Peer-reviewed journal articles, grey literature, and/or agency reports • Reviewed evidence and professional expertise
Facility Use	Will each of the proposed renovation options have the potential to change the amount of people who use of the facility or the activities performed inside? • How can using the facility affect health? • Will different groups who use the facility be impacted	• Qualitative review and analysis of evidence available	• Direction; Likelihood; Magnitude; Distribution *** Not enough information to perform the assessment. Evidence available links community perceptions to facility use. Thus, information was transferred to perceptions section.**	• Peer-reviewed journal articles, grey literature, and/or agency reports • Reviewed evidence and professional expertise

Appendix F. HIA Assessment Plan

Health Impact	Impact Research Question	Assessment Method(s)	Indicators/Data	Data Source(s)
	more from the predicted changes?			
Asthma	How can each of the proposed renovation options impact respiratory health for all users of Gerena Community School? ○ Will those with asthma be impacted more so than others?	• Qualitative review and analysis of evidence available	• Direction; Likelihood; Magnitude; Distribution	• Peer-reviewed journal articles, grey literature, and/or agency reports • Reviewed evidence and professional expertise

Appendix G. Details of Assessment Methods and Findings

Baseline Affected Population Analysis

Purpose

In public health practice, investigators establish a reference point (i.e., baseline) in which to compare potential health effects of the affected population. The baseline should include a characterization of the health status and/or health trends among the affected population and any socioeconomic and/or environmental variables known to influence health. Performing this analysis helps to understand the extent to which a proposed policy, program, project, or plan may affect health and identify any vulnerable populations.

Common socioeconomic variables included in a baseline analysis of the affected population may include, but are not limited to, socioeconomic status (a composite score of income educational attainment and occupation/employment), proportion of minority sub-groups, and primary language spoken at home. The ability to speak, read, and write in the common language can broaden or limit a person's access to social services and/or support. Since English is the common language in the United States, a low proficiency in the English language can become a disadvantage if the community's social system lacks the capacity to address this gap. The notes from stakeholder meetings documented that many residents use the afterschool language programs at Gerena Community School to learn English. Educational attainment is "used in studies of the relationship between education and mortality and provides and indicator of socioeconomic status, which is also closely associated with mortality" (Registry of Vital Records and Statistics (RVRS) Fact Book for Death Registration, Form R-301 Draft 10/05/2006). Formal education supplies additional opportunity to develop and strengthen cognitive, language, and emotional skills (Zimmerman & Woolf, 2014). These skills, coupled with strong social capital (i.e., the support and capability to address issues within a community), can influence a person's ability to maintain and improve individual health through many mediating pathways, such as self-efficacy (i.e., the ability to address one's own needs and challenges) and access to services. Hosuehold income can influence a person's financial access to healthcare, nutritious foods, and healthy home environments.

Methodology

The affected population included North End residents living in Census tracts 8006, 8007, 8006, and students enrolled at Gerena. The key indicators used to represent vulnerable impacted populations (VIPs) included young children under age 5 years, older adults over age 65 years, students with asthma, students with special needs, and households with low English proficiency (speak English less than "very well").

For resident information, investigators extrapolated data from the 2010 Census and American Community Survey 2008-2012 through American FactFinder (U.S. Census Bureau) for key socioeconomic indicators. Counts were aggregated and percentages computed using Excel. In early 2015, EPA's EJScreen was available for public use (http://www2.epa.gov/ejscreen). EJScreen is an environmental justice screening and mapping tool that utilizes standard and nationally consistent data to highlight places that may have higher environmental burdens and vulnerable populations. The mapping tool in EJScreen automatically aggregates 2008-2012 ACS estimate data at the block group level. Investigators used the mapping tool to draw a polygon around the three chosen Census tracts and generated summary reports for the area drawn.

For student information, researchers extrapolated data from the Massachusetts Department of Elementary and Secondary Education School/District Profiles portal (http://profiles.doe.mass.edu/).

Available health data for residents was limited to mortality counts. Massachusetts provides a state-wide health database available to the public, called the Massachusetts Community Health Information Profile (Mass CHIP; available at http://www.mass.gov/eohhs/researcher/community-health/masschip/). This database reports mortality (i.e., deaths) by cause at the neighborhood-level. Cause of death was reported using the IC-10 coding schedule.[12] Mortality counts were pulled for Brightwood/Memorial Square (North End component neighborhoods) for the years 2006 to 2010 (i.e., the most current data available). Causes selected included indicators of overall health, mental and behavioral health, and respiratory health. The population estimate (n = 8,484) was obtained from the American Community Survey data summary files for 2006 to2010 to match death years.

Cause-specific mortality rate is the number of deaths, by cause, among the total population at the midpoint of a time period. Crude cause-specific mortality rates were computed in Excel, except when the number of observed deaths was too few (i.e., less than five deaths), using Equation 1. Rates were reported per 1,000 people due to the small population size.

Equation 1. Equation used to Calculate Cause-specific Mortality Rates

[12] The International Classification of Disease (ICD) coding system is the method used to track patient diagnoses for surveillance and billing.

$$MR = \frac{Total\ Deaths\ Reported\ (Cause - Specific)_{2006-2010}}{Total\ Population\ Estimated\ (\sum_{2006-2010}^{CT8006-8008} x_{8006} + x_{8007} + x_{8008})} \times 1{,}000\ people$$

Where, MR = mortality rate, CT = census tract, and *x* = estimated total population

Cause-specific mortality rate is the rate in which a disease or condition may cause death, but does not describe the actual prevalence of disease among residents. Because of this, mortality rates are not optimal to indicate health status, but can be used to infer about common health issues.

The Massachusetts Department of Public Health (MA DPH) surveys asthma prevalence among residents across the state. MA DPH also collects school health records for the surveillance of asthma prevalence in school-age populations. There is a lot of confidence in both the community and school prevalence rates as reported in the pediatric asthma reports. The Pioneer Valley Asthma Coalition (PVAC), a local non-profit organization, has been working with school nurses on documenting visits to the school nurse related to asthma and respiratory health. This data has been used as a baseline to judge the success of community wide actions to improve the management of asthma symptoms. Counts and reasons for visits to the school nurse were collected for the dates August 27, 2011 to June 30, 2012 and August 27, 2012 to June 6, 2013. Data was reported by the school nurse at Gerena and verified by Springfield Public Schools. Counts were aggregated in Excel and graphed as a percentage of the total.

Findings

Demographic Indicators (Population Structure)

In 2010, there were 8,718 residents living in North End. There density of the population is 7,861 individuals per square mile. Young children under the age of 5 years represented 9.7% of the residents. Older adults over the age of 65 represented 7.7% of the population. Over one-third of the population (36.1%) was under 18 years old.

In October 2012, Gerena had 667 students enrolled, which was up 6% from the previous year. The five-year average enrollment was 694.4 students. With the exception of the 2013 year, total enrollment has been declining in the past five years. Gerena had a student to teacher ratio of 10.3 to 1. Of the students enrolled, 129 were pre-kindergarten.

Socioeconomic Indicators

In 2010, most (87%) residents living in North End were of Hispanic or Latino ethnicity; African Americans made up 14% of the population. White, alone and non-hispanic represented 5.2% of the population. Most households (estimated 77.0%) were low-income, living on an income below twice the federal poverty level. Table 1 compares the socioeconomic conditions in the study area (Census tracts 8006, 8007, and 8008) with Springfield, MA.

Table 1. Key Socioeconomic Indicators for Study Area and Springfield, MA

Socioeconomic Indicators	**Study Area***	**Springfield, MA**†
Total Population	8,625	153,276
Minority Population†	96.0%	48.5%
Low Income Population‡	77.0%	51.0%
Linguistically Isolated Households§	36.0%	15.4%
Population with Less Than High School Education	50.0%	23.9%

* Source: EPA EJScreen 2015, user-specified polygon location, margin of error not included
† Source: U.S. Census Bureau, 2008-2012 American Community Survey, margin of error not included
‡ Minority population includes all people other than non-Hispanic, white-alone individuals
‡ Percentage of population at or below twice the federal poverty level
§ Percentage of people in household in which all member's over age 14 years speak English less than "very well"

Most of the students at Gerena were reported as "high needs" (93%), which is based on the percentage of students that are English Language Learners (ELL), students with disabilities, and/or are from low-income families (i.e., enrolled in the state lunch assistance program). Of the 667 students enrolled in 2013, 13.5% were students with disabilities, 28.0% were ELL, and 90.1% were from low-income families. Over one-third (37.2) of students spoke English as a second language. The special education students are taught on the second level of Building B (Rooms 208 and 209), instead of in the open-floor pods on the third level. Students were also predominantly (81.3%) Hispanic or Latino ethnicity.

Health Indicators

The average mortality rate for the study area was 31.2 per 1,000 people over five years. Cancer (all types) was the leading cause of death in the study area, followed by coronary heart disease. Approximately one in a thousand people die from lung cancer or diabetes mellitus. Table 2 provides the total deaths reported in MassCHIP and the calculated mortality rates by cause.

Table 2. Cause-specific Mortality Rates in the Study Area

Cause of Death	Total Deaths*	Percentage of Total Deaths	$\frac{Total\ Deaths}{Total\ Population\ Estimated}$	Mortality Rate
All Causes	265	100%	0.0312	31.2
Cancer, All Types	61	23.0%	0.00719	7.2
Cancer, Lung	13	4.9%	0.00153	1.5
Circulatory, Cerebrovascular Disease	18	6.8%	0.00212	2.1
Circulatory, Coronary Heart Disease	29	10.9%	0.00342	3.4
Circulatory, Hypertension	3	1.1%	Too Few Observations	Too Few Observations
Endocrine, Diabetes Mellitus	12	4.5%	0.00141	1.4
Digestive, Chronic Liver Disease	6	2.3%	0.000707	0.7
Injuries, Homicide	2	0.8%	Too Few Observations	Too Few Observations
Injuries, Suicide	3	1.1%	Too Few Observations	Too Few Observations
Mental Disorders, All	9	3.4%	0.00106	1.1
Respiratory, Asthma	3	1.1%	Too Few Observations	Too Few Observations
Respiratory, Bronchitis/Chronic/ Unspecified	0	0%	Too Few Observations	Too Few Observations
Respiratory, CLRD	8	3.0%	0.000943	0.9

* Source: MassCHIP, Cause-specific deaths in Brightwood/Memorial Square, 2006-2010

† Source: U.S. Census Bureau, 2006-2010 ACS

The prevalence of asthma is considerably high in Springfield, MA compared to other parts of the state. Springfield, MA has a significantly higher prevalence of lifetime asthma at 18.1% (95% confidence= 16.6% to 19.5%), compared to the state's prevalence of 14.7% (95% confidence = 14.3% to 15.1%) (MA DPH, 2013b). The prevalence of asthma is higher among residents of Hispanic ethnicity, compared to non-Hispanics, and females, compared to males (MA DPH, 2013b). Socioeconomic factors appear to be related to asthma prevalence. Asthma prevalence is greater among low-income households (i.e., total household income less than $50,000 per year) at 13.7%, compared to only 7.9% prevalence among those with income greater than $50,000 a year (MA DPH, 2013b). Individuals with more formal education have a lower prevalence of asthma than those with less formal education. Table 3 lists the percentage of persons living in Springfield, MA, by educational attainment, who also have asthma.

Table 3. Asthma Prevalence in Springfield, MA by Educational Attainment

Educational Attainment (population over 25 years)	Estimated Prevalence of Asthma*	95% Confidence Interval
High School or Less	14.3%	12.6% to 16.0%
Some College	11.8%	9.6% to 14.0%
College or More	9.6%	7.2% to 12.0%

* Source: MA DPH, Mass CHIP 2003-2008 Springfield, MA

The prevalence of asthma among students at Gerena has continuously been higher than at the state, with an average of one in four students having physician-diagnosed asthma. Table 4 lists asthma prevalence by year at Gerena compared to the state.

Table 4. Asthma Prevalence among School-aged children at the School and State Level

School Year	School Asthma Prevalence*	State Asthma Prevalence*
2003-2004	21.2 %	9.5%
2004-2005	20.9 %	10.0%
2005-2006	42.6 %	10.6%
2006-2007	20.7 %	10.8%
2007-2008	21.3 %	10.8%
2008-2009	24.7 %	10.9%
2009-2010	24.0 %†	Not Available
2010-2011	20.0 %†	Not Available
2011-2012	19.0 %†	Not Available

* Source: MA DPH Pediatric Asthma Surveillance Metadata

† Source: Values reported by Springfield Public Schools, but not yet verified by MA DPH

Recently, there has been an improvement in both student attendance and the reduction in asthma prevalence. Figure 1 graphs the asthma rate, student attendance (and teacher attendance) over time. The data suggests that as asthma prevalence declined from 2009 to 2012, student and teacher attendance improved. It is important to note that the cause for the very dramatic prevalence of 42.6 %, during the 2005-2006 school year, is unknown; but may have been the result of a reporting error.

Appendix G. Details of Assessment Methods and Findings

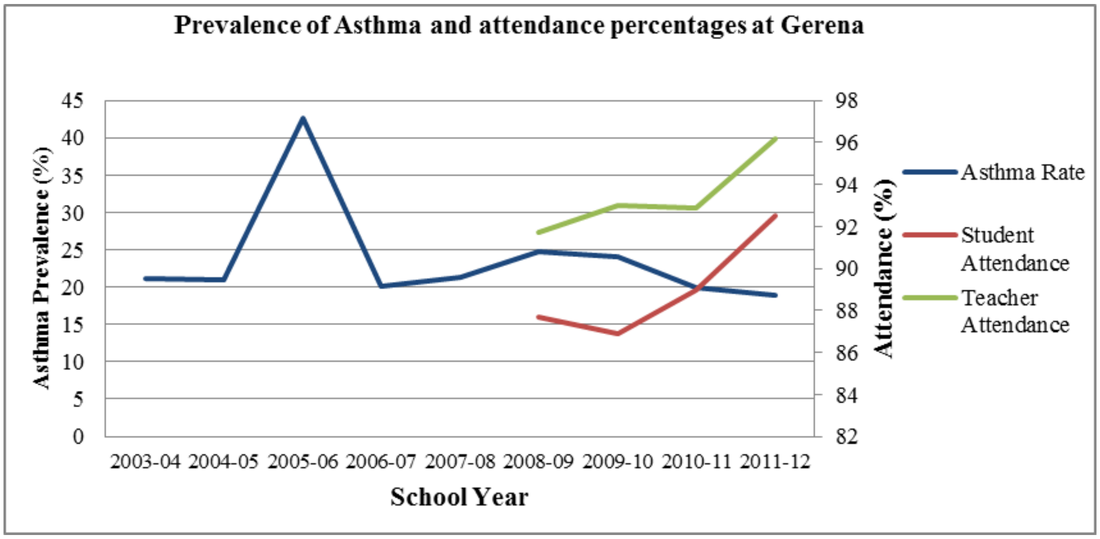

Figure 1. Asthma and attendance at Gerena

Over two years (2011 to 2013), there were 7,343 visits to the school nurse, 1,512 of which were related to asthma, respiratory health, and/or other exposures. Of those visits, 6.3% were directly related to asthma, 0.7% were related to difficulty breathing, 1.2% were related to chest pain and/or tightness, 5.2% were related to headaches, and 3.8% were related to neurological concerns. Figure 2 breaks down the composite visits to the school nurse by reason, in relation to asthma and/or respiratory symptoms and symptoms related to mold exposure. Both PVAC and the school nurses have focused on increasing the number of student asthma management plans filed with the school and increasing asthma awareness events.

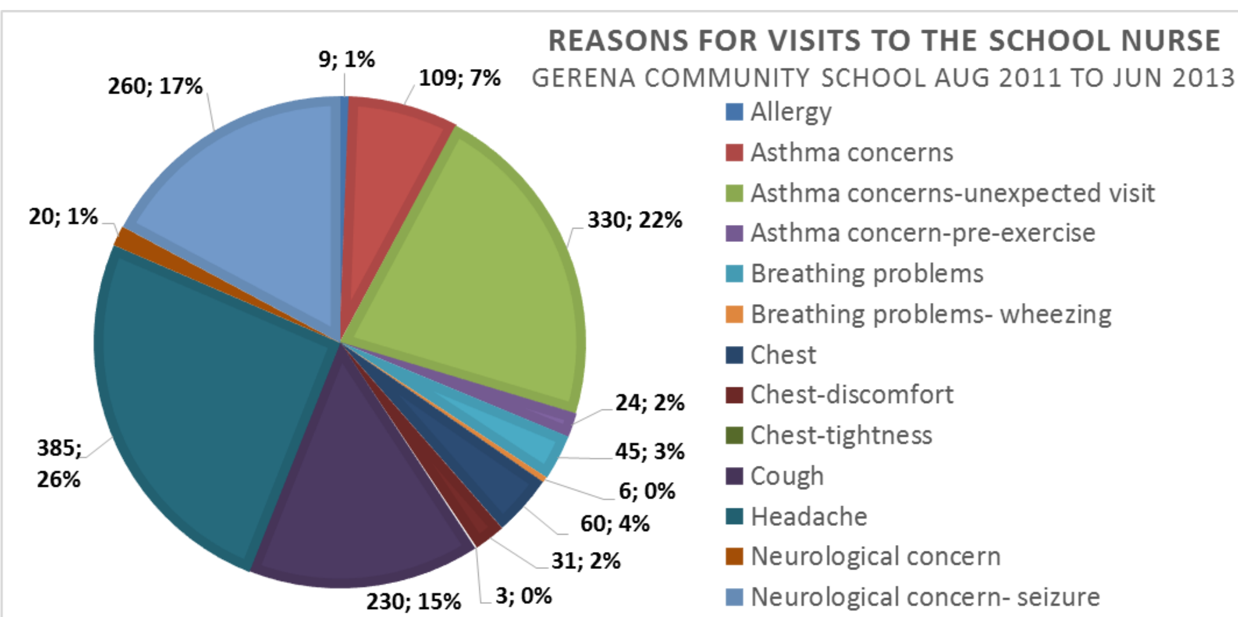

Figure 2. Visits to the school nurse by reason (related to asthma and mold exposure symptoms).

Mold Contamination Analysis

Purpose

From the start of the HIA (i.e., the Screening step), stakeholders from community representatives stated clearly that the presence of mold and/or the general "moldy" odor in the school has been an ongoing concern among Gerena users. Previous investigations already applied the traditional methods of visual inspection, via a walk-through survey, for identifying the presence of mold in Gerena. What is unknown is how much (or to what extent) mold contamination in a building becomes a health hazard.

It is important to note that there is no standard method for measuring the extent of mold contamination in buildings; nor is there a consistent method for assessing the health impact of mold exposure among building users.[1] The traditional method for identifying mold in a home involves visual inspection of microbial growth in or on building materials and/or checking for odor.[2] Visual inspection typically occurs as part of a walk-through survey. Although this method is useful for identifying areas where mold is growing, it is highly subjective and fails to determine the extent of mold contamination in the building and the species of mold (or other microbes) present. Different indoor environments can grow different types of mold. Scientific methods have evolved to identify the mold species that indicate water-damage and/or are associated with specific health outcomes. Therefore, identifying the species and extent of mold contamination in the school may help inform the potential risk to health for its occupants. For this reason, the HIA Project Leads planned to perform a mold contamination analysis as a subpart of the HIA. The purpose of the mold contamination analysis (as described in the RESES proposal) was to identify and quantify the long-term mold contamination in Gerena.

Methodology

EPA used internal contracts to fund and perform the mold contamination analysis. Dr. Steve Vesper, from the Office of Research and Development, National Exposure Research Laboratory (NERL) traveled to the site and collected mold samples in the presence of Lynn Rose, from PBRM, and Dr. Marybeth Smuts, from EPA Region 1 Office of Environmental Protection and HIA Project co-Lead. Samples were taken by using one Swiffer Duster™ and wiping settled dust at locations excluded from the routine cleaning schedule (e.g., on tops of light fixtures, bookcases, doorframes, railings, etc.) to capture historic mold exposures. The objective of capturing historic exposure was one reason, in addition to other limitations of methods prescribing visual inspection and/or air sampling, that the settled dust sampling method was used.[3]

Sampling occurred on October 16, 2012. One sample was taken per location, which included nine (9) locations in the tunnels, ten (10) locations from the second floor of the Main Building, and eleven (11) locations from the third floor of the Main Building (i.e., classroom Pod areas). The thirty (30) total samples were taken to the NERL in Cincinnati, Ohio, to perform the analysis. Researchers used an EPA-patented DNA-based technology method called Mold Specific Quantitative PCR (MSQPCR; U.S. patent number 6387652.B1) to identify and quantify the concentration of thirty-six (36) indicator mold species. The mold species included in the analysis consisted of twenty-six (26) species indicative of water-damage (i.e., Group 1 molds) and ten (10) species that did not indicate water-damage (i.e., Group 2 molds; reference molds).

For each sample, researchers computed the mold burden by taking the sum of log-transformed Group 1 mold species concentrations (s_1) minus the sum of log-transformed Group 2 mold species concentrations (s_2), as outlined in Equation 2. The resulting value represents a point on the environmental relative moldiness index (ERMI), a simple numeric estimate of the long-term mold burden. The ERMI scale, in which most values range from approximately -10 to 20 (lowest to highest), was developed and vetted among homes across the U.S. The standard deviation of an ERMI value is +/- 3.[4]

Equation 2. Calculating ERMI $ERMI = \sum_{i=1}^{26} \log_{10}(s_{1i}) - \sum_{j=1}^{10} \log_{10}(s_{2j})$

Note: EPA has no regulatory authority over mold exposures and therefore the use of the ERMI in this assessment was not required or sanctioned by EPA for non-research purposes.

Statistical analysis used to calculate average ERMI value, standard error and confidence intervals was performed using STATA IC-12.1 (College Station, TX).

<u>Findings</u>

The average ERMI value across the thirty (30) samples was 15.51 (95% confidence interval of 13.77 to 17.26). Table 5 lists the locations of each sample and the computed concentration and ERMI value, which ranged from 6.78 (Building C, Room 5) to 26.64 (Building B, Pod 7). The higher the ERMI value, the greater extent of long-term mold contamination.

Table 5. Computed Sum-logs and ERMI Value for Each Sample

Sample ID	Sum log of Group 1 molds (indicate water-damage)	Sum log of Group 2 molds (commonly found)	ERMI value
Tunnels (i.e., Building A, First Floor of Building B, and Building C)	[Blank]	[Blank]	[Blank]
BLDG C- Room 3, Recreation Department office	30.44	15.72	14.72
BLDG C- Suite B, (empty) office	25.44	14.07	11.37
BLDG C- Room 5, (empty) office	19.40	12.62	6.78
BLDG C- Community room	28.35	16.84	11.51
BLDG A- NEON office (empty), before bump out	32.34	15.97	16.37
BLDG A- Dust from window ledge outside daycare	39.98	25.94	14.04
BLDG B- Community/After-school program room	53.16	26.86	26.30
BLDG B- Cafeteria	28.13	21.32	6.81
BLDG B- Dust from near door going up stairs from Gallery (planned new playground area)	25.13	14.51	10.62
Building B, Second Floor	[Blank]	[Blank]	[Blank]
BLDG B- Dust from railing of Library/Media Room (opens to Gallery, below)	37.23	21.32	15.91
BLDG B- Library/Media Room dust from ledge near mechanical room	36.57	21.07	15.50
BLDG B- School Administrative office	42.66	22.43	20.23
BLDG B- Planetarium Language Room	42.70	24.54	18.16
BLDG B- Science Lab	39.59	23.00	16.59
BLDG B- Conference Room	27.22	15.74	11.48
BLDG B- Counselor’s Suite, middle room	37.89	19.94	17.95
BLDG B- Developmental, Pre-K room (208-209)	27.76	15.32	12.44
BLDG B- Music Room/Math Lab	28.37	18.19	10.18
BLDG B- Room B-207	36.19	19.41	16.78
Building B, Third Floor (i.e., classroom Pod area)	[Blank]	[Blank]	[Blank]
BLDG B- Pod 1	41.58	22.98	18.60
BLDG B- Mini-Pod 2	43.96	23.16	20.80

Appendix G. Details of Assessment Methods and Findings

Sample ID	Sum log of Group 1 molds (indicate water-damage)	Sum log of Group 2 molds (commonly found)	ERMI value
BLDG B- Pod 2	44.71	25.66	19.05
BLDG B- Pod 3	40.51	24.47	16.04
BLDG B- Pod 4 (Academic support room)	44.74	26.04	18.70
BLDG B- Pod 5	38.49	24.61	13.88
BLDG B- Pod 7	53.31	26.67	26.64
BLDG B- Pod 8	39.88	23.06	16.82
BLDG B- Pod 9	38.87	25.61	13.26
BLDG B- Pod 10	43.28	26.61	16.67
BLDG B- Teacher's Lounge	34.06	22.82	11.24

Figure 3 demonstrates that the average ERMI value appeared to increase with increasing building floor level. The nine samples collected in the tunnels (i.e., level 1) had an average ERMI value of 13.17 (95% confidence interval of 9.14 to 17.2.0). The ten (10) samples collected on the second level of Building B had an average ERMI value of 15.52 (95% confidence interval of 13.45 to 17.59). The eleven (11) samples collected on the third level of Building B had an average ERMI value of 17.42 (95% confidence interval of 14.86 to 19.99).

```
Mean estimation                   Number of obs    =      30

        Over         Mean   Std. Err.     [95% Conf. Interval]

ERMI
           1     13.16889   1.970533      9.138696    17.19908
           2       15.522   1.012517      13.45117    17.59283
           3     17.42727   1.253999      14.86256    19.99199
```

Figure 3. Average ERMI Value by Building Level.

References:

[1] Santilli, John. 2002. "Health effects of mold exposure in public schools." *Current Allergy and Asthma Reports. Bridgeport, CT* 2:460-467.
[2] ASTM International. Practice for Evaluating Residential Indoor Air Quality Concerns, D 7297-06. *ASTM International.* West Conshohocken, PA 11.01:1-28.
[3] Vesper, S., *et al*. 2007. "Development of an environmental relative moldiness index for U.S. homes." *Journal of Occupational and Environmental Medicine.* 49: 829-833.
[4] Haugland, R.A., Brinkman, N.E., Vesper, S.J. 2002. "Evaluation of rapid DNA extraction methods for the quantitative detection of fungal cells using real time PCR analysis. *Journal of Microbiological Methods* 50: 198-2010.

Appendix G. Details of Assessment Methods and Findings

Moisture Control Analysis

Purpose

Since mold requires water to grow, the control of moisture in buildings is important for controlling mold growth, in addition to occupant comfort. As stated in the EPA's Indoor Air Quality Tools for Schools guide, "Humid weather in generally cold climates, like the Northeastern U.S., can cause condensation on un-insulated ground contact floor slabs or basement walls," which can lead to mold growth (U.S. EPA, 2012d). EPA recommends a relative humidity of 60% (or below), and the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) recommends a temperature remaining between 68-74 ^{0}F during winter and 72.5 to 78 ^{0}F during summer (ASHRAE Standard 55- 1992, Thermal Conditions for Human Occupancy).

Historically, Gerena faced on-going issues with water infiltration and moisture. In June 2012, PBRM's contractors found evidence of water-damage to the floor tiles in Building C and some minor water staining on carpeting and floor tiles of Pod 10 (level 3 of Building B); but reported that the majority of the remaining school classrooms, offices, and other occupied areas were clean, dry, and showed no visible evidence of water infiltration (O'Reilly, Talbot & Okun Engineering Associates, 2012). As part of a more comprehensive assessment, EPA included temperature and relative humidity monitoring to evaluate the school system's ability to control moisture.

Methods

In March 2013, EPA performed a 48-hour recording of temperature and moisture (relative humidity) in real-time to determine the HVAC systems' ability to control moisture. EPA used GE Telair Model 7001 CO_2/Temperature/Humidity sensors to record temperature and relative humidity. The sensors continuously recorded for 48 hours during normal school conditions. The sites where recording took place included the main office and science lab (second level of Building B), Mini Pod 6 and Pod 6 (third level of Building B).

To help determine the variability in building conditions across campus, temperature and relative humidity measurements were taken twice daily at a number of indoor locations throughout the facility. In June 2013, EPA recorded the twice-daily temperature and relative humidity measurements for six days. Figure 4 maps the locations where temperature and relative humidity measurements took place in the tunnels and Building D. Figure 5 maps the locations where temperature and relative humidity measurements took place on the second level of Building B. Figure 6 maps the locations where temperature and relative humidity measurements took place on the third level of Building B. Recording took place on June 5, 6, 7, 10, 11, and 12 using the Vaisala Barometric Pressure Transfer Standard PTB330TS with optional temperature/RH probe HMP155.

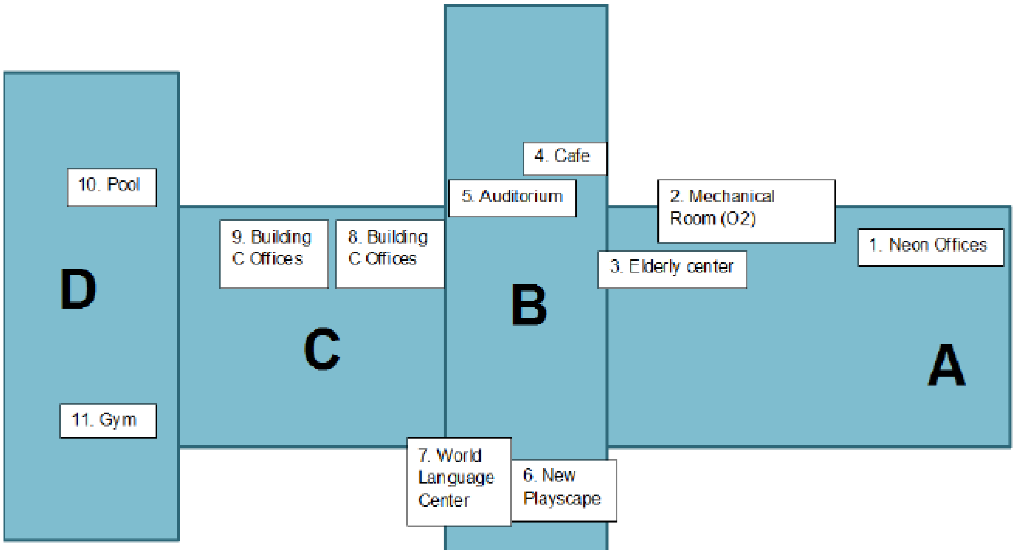

Figure 4. Recording sites for relative humidity and temperature in the tunnels and Building D.

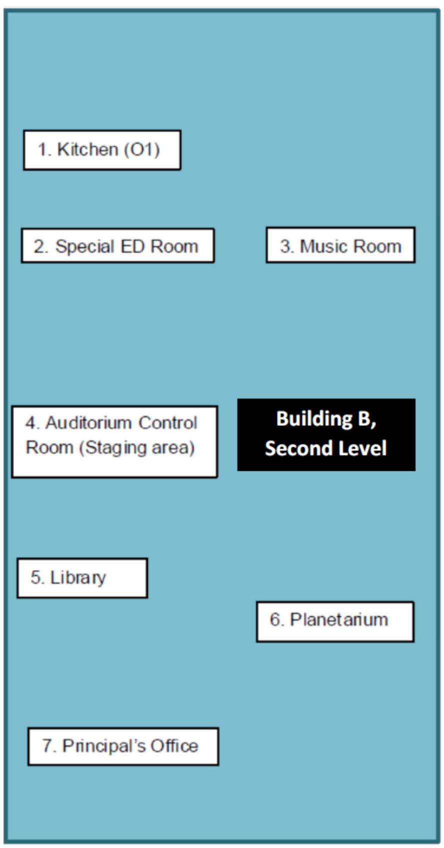

Figure 5. Recording sites for relative humidity and temperature on the second level of Building B.

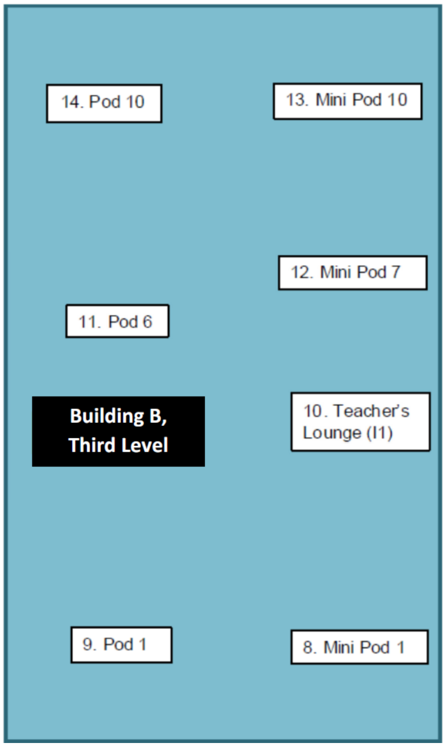

Figure 6. Recording sites for relative humidity and temperature on the third level of Building B.

Findings

A review of the March 2013 results of the real-time recordings indicated that the current building HVAC system, in conjunction with building infiltration, appears to be providing an appropriate temperature control in the areas where the continuous recording took place. A review of the June 2013 results of temperature and relative humidity recordings indicated that the average temperature and relative humidity values were generally stable and within published guidelines by the Occupational Safety and Health Administration and ASHRAE. Table 6 lists the sites in Gerena where EPA recorded the temperature and relative humidity twice a day for six days and the average measurements and standard deviations for each location.

Table 6. Average Temperature and Relative Humidity in Gerena

Location Recorded	Temperature (°F)	Standard Deviation	Relative Humidity (%)	Standard Deviation
NEON offices	71.3	1.3	59.3	9.3
Mechanical room	71	0.9	60.9	8.3
Elderly Center	72.3	2.2	58.4	8.9
Cafeteria	70.5	1.6	57.6	5.3
Auditorium	68.8	3.3	59.9	2.4
New playscape	71.2	0.9	59.2	6.6

Location Recorded	Temperature (^oF)	Standard Deviation	Relative Humidity (%)	Standard Deviation
World language center	71.2	0.9	59.8	7.4
Building C offices	72.3	0.7	58.7	5.4
Building C offices	72.6	0.6	59.3	4.5
Pool	74.1	0.7	57.6	4.9
Gym	73.7	1	61.9	4.9
Kitchen	71.3	1.8	56.6	5
Music room	72.4	0.8	58.1	4.4
Special education room	70.4	0.9	60.9	6.3
Storage room	68.4	1.4	57.9	2.5
Planetarium	71.1	1.2	58.1	4.7
Library	70.1	0.6	60.7	4.5
Principal's Office	70.3	1	62.2	6.3
Pod 1	71.8	2.1	59.2	6.4
Minipod 1	71.5	1.9	58.9	5.9
Teachers' lounge	71.8	1.7	56.2	3.7
Pod 6	71.7	0.7	54.5	1.9
Minipod 7	71	0.7	57.2	2.7
Minipod 10	71.6	0.8	55.3	3.5
Pod 10	71.3	1.1	55.4	3.3

Overall, the HVAC systems seemed to be adequately controlling the temperature (between 70-78^{0}F) and relative humidity (50-65%) in the spaces where sensors were recording. With the active and historical water issues, it may be advantageous to control the humidity at a lower level. There were five locations with an average relative humidity slightly above 60%, which is considered the upper threshold based on ASHRAE guidance, that included the mechanical room in Building A (tunnel), the gym in Building D, and the special education room, library, and Principal's office on the second level of Building B.

It is unlikely the mechanical room was actively conditioned and some windows were found open during this study. Based on nearby outdoor temperature readings (at the Springfield Airport), the HVAC systems was likely operating in both heating and cooling modes during this study.

Indoor Air Pressure and Movement Analysis

Purpose

The HVAC systems bring outside air into the building (via air intakes), then circulates the air using a series of supply, return ducts, and air handling units. An ideal air pressure means there is an equal balance between the amount of air coming into a space and the amount of air leaving a space. A neutral balance between the air supplied and the air returned can prove very difficult, especially during changes in climate. A negative pressure will develop in a space where more air is removed than supplied. This causes the building space to draw air in from other places or (unplanned) pathways to make up the loss of air pressure. A slight negative pressure can be advantageous in colder climates to keep moisture (relative humidity) lower. A positive pressure develops in a space when more air is supplied than removed, leading to air being pushed out of the space to other places or through (unplanned) pathways, such as gaps in the building enclosure. A slight positive pressure can also be advantageous in warmer climates to control moisture. Measuring air pressure can help identify the movement of air in a building at the rate at which air is escaping the building enclosure. Infrared imaging was conducted in order to obtain an initial understanding of where was leaking from the building enclosure. Air leakage from a building can make it difficult to control air movement and maintain air pressure in a building space.

Supplying an adequate amount of outdoor air is important to the comfort and breathing ease for building occupants. When a space is occupied, there must be enough fresh, outside air provided so that occupants can breathe easily and carbon dioxide (CO_2) levels remain low. Monitoring carbon dioxide levels helps determine if the HVAC systems are providing enough outdoor air into a space.

Methods

Air Pressure and Mapping

EPA contractors performed air pressure testing and mapped the direction of air movement throughout the facility. Tests were performed at all readily identifiable and accessible doorways and exit doors to see where air comes from and goes throughout the school. While on-site, EPA contractors documented air movement directions at all readily identifiable firewall doorways and at exit doors to see from where air comes and goes throughout the facility. Contractors determined airflow by measuring air pressure differentials across identifiable partitions and accessible zone partitions. An Energy Conservatory DG2 TEC Digital Micromanometer was used with the aid of smoke pencils to help identify air movement.

Appendix G. Details of Assessment Methods and Findings

Enclosure Air Tightness

Contractors used blower door measurements, specifically the Minneapolis Model 3 Blower Doors and Energy Conservatory DG700 Micromanometer blower door fans, to determine the current air leakage rate of the facility and the likely feasibility of making the enclosure more airtight to better gain control over the air quality inside the building. EPA followed the Standard Operating Procedure for Blower Door Measurements, which is closely aligned with the American Society for Testing and Materials (ASTM) 779-10 Standard Test Method for Determining Air Leakage Rate by Fan Pressurization. Testing was performed under normal operating conditions.

Data collected with respect to building leakage and building and fan pressure data, was analyzed using linear regression methods in accordance with ASTM E779. Collected data was plotted with fan pressure versus building pressure (including conversion of fan pressures to flow units).

Infrared Imaging for Air Leaks

EPA contractors also used infrared imaging equipment (FLIR Model B360 Infrared Camera) to identify specific areas of the facility where energy was being lost and if there were current wet areas along walls, ceilings, or floors that were not readily visible. Infrared imaging occurred in March 2013. Based on the time year, areas where air escaped from the building enclosure would be warmer than surrounding areas (i.e., emitting "hot spots"), allowing investigators to identify sites of air leaks. Areas of significant temperature differences, in which significance was determined as greater than 5 ^{o}C, indicated areas of air leakage or non-visible wetness damage. EPA followed the ASTM E1186-03 (2009) Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems.

Ventilation Rate Measurements

In March 2013, EPA contractors performed continuous recording of Carbon Dioxide (CO_2) in using a GAsTech Model 411 in selected occupied spaces to assess if existing ventilation rates are likely to meet current ASHRAE Standard 62 guidelines. CO_2 was measured under normal conditions to help evaluate the current ventilation rate provided by individual air handling units. In addition, EPA contractors placed CO_2 monitors (GE Telaire Model 7001 CO_2/Temperature/Relative Humidity sensors were placed at four locations in the school to perform continuous sampling for 48 hours.

<u>Findings</u>

Air Pressure and Mapping

A review of the results from the pressure mapping indicate that the current HVAC systems affect the movement of air within the facility. Some of the air-handling units no longer introduce outdoor air, either because they were closed or not function properly. In areas where the air-handing unit is not drawing in outside air (e.g., air conditioning units in the Main Office and Media Center), a low pressure gradient causes air to be drawn in from other areas, which overburdens the units serving those spaces.

Additionally, some of the building design features, including the atrium and the series of stair towers that connect the lower level of Building B to the upper levels, affect building pressures and transport pathways resulting in air movement from the street into the building. The atrium draws air from the lower levels (tunnels) and delivers it to the second level and third levels of Building B simulating a "chimney" effect. This finding helps explain why the average concentration of mold spores found on the third level of Building B was the highest of the three building levels when the suspected sources of mold growth came from the tunnels. Figure 7 maps the direction of air movement through the tunnels. Figure 8 maps the direction of air movement on the second level of Building B. Figure 9 maps the direction of air movement on the third level of Building B.

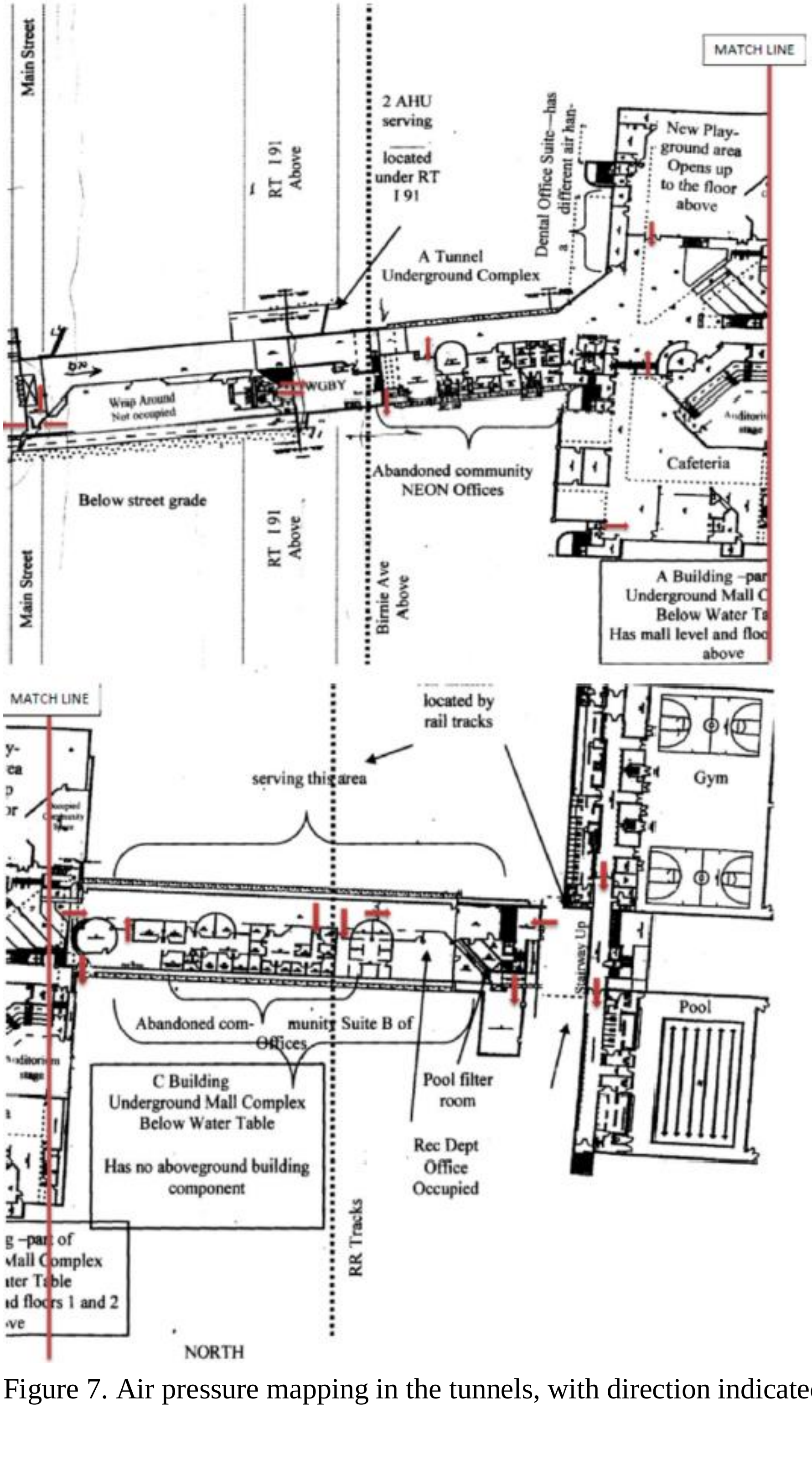

Figure 7. Air pressure mapping in the tunnels, with direction indicated by red arrows.

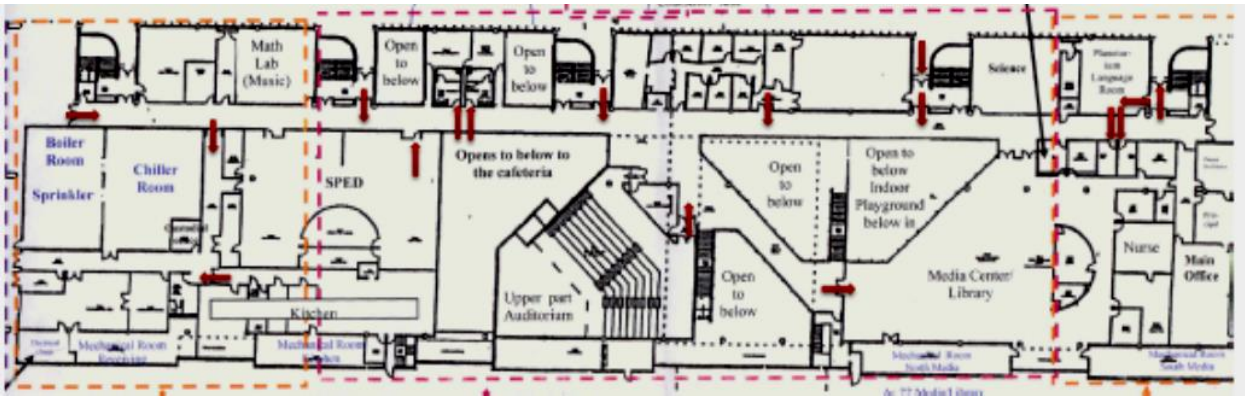

Figure 8. Air pressure mapping on second level of Building B, with direction indicated by red arrows.

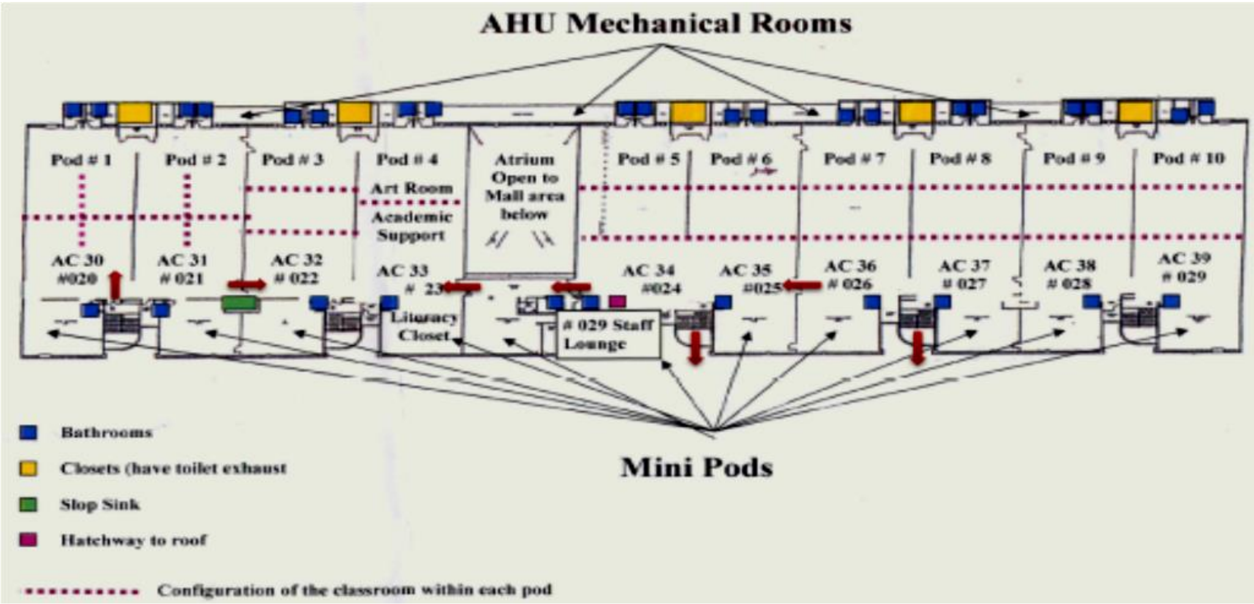

Figure 9. Air pressure mapping on third level of Building B, with direction indicated by red arrows.

Enclosure Air Tightness

EPA found that the building has a high air leakage rate (1,238.6 cubic feet per minute; CFM) compared to any modern standard now in existence for building construction. In its current condition, the building would require approximately 25,000 to 30,000 CFM of make-up air simply to keep the building at neutral pressure. Such a high amount of make-up air undoubtable uses a large amount of energy. Figure 10 graphs the total airflow and pressure difference measured at Gerena to get the air leakage rate. As air pressure increases, air leakage also increases.

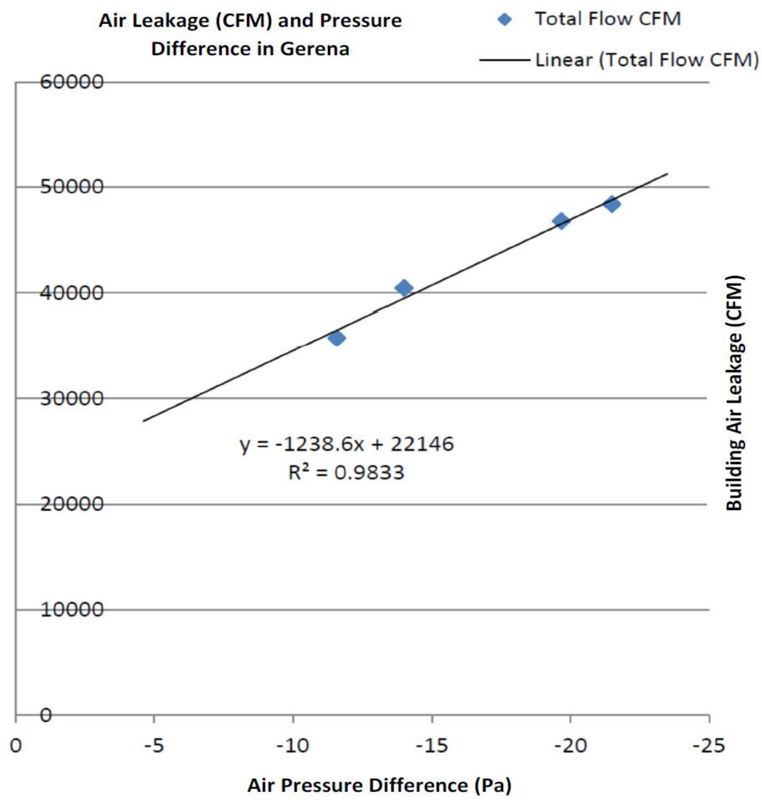

Figure 10. Measured airflow graphed by pressure difference to give air leakage rate.

Infrared Imaging for Air Leaks

The infrared imaging identified air leakage sites at the wall-roof junction and the floor-wall junctions of Building B (where the third level overhangs the second level). Other areas of air leakage include some sites along the structural beams and where the structural columns and walls join. Figure 9 identifies some of the air leakage sites found using infrared imaging that are not readily identified. Air leak sites, such as the one found at the end of Building C (tunnel) near Building B, allow for indoor air to escape out of the building and untreated outdoor air to enter the building. The lost air does not get recycled through the HVAC system, which leads to the system working harder and using more energy to heat or cool the air.

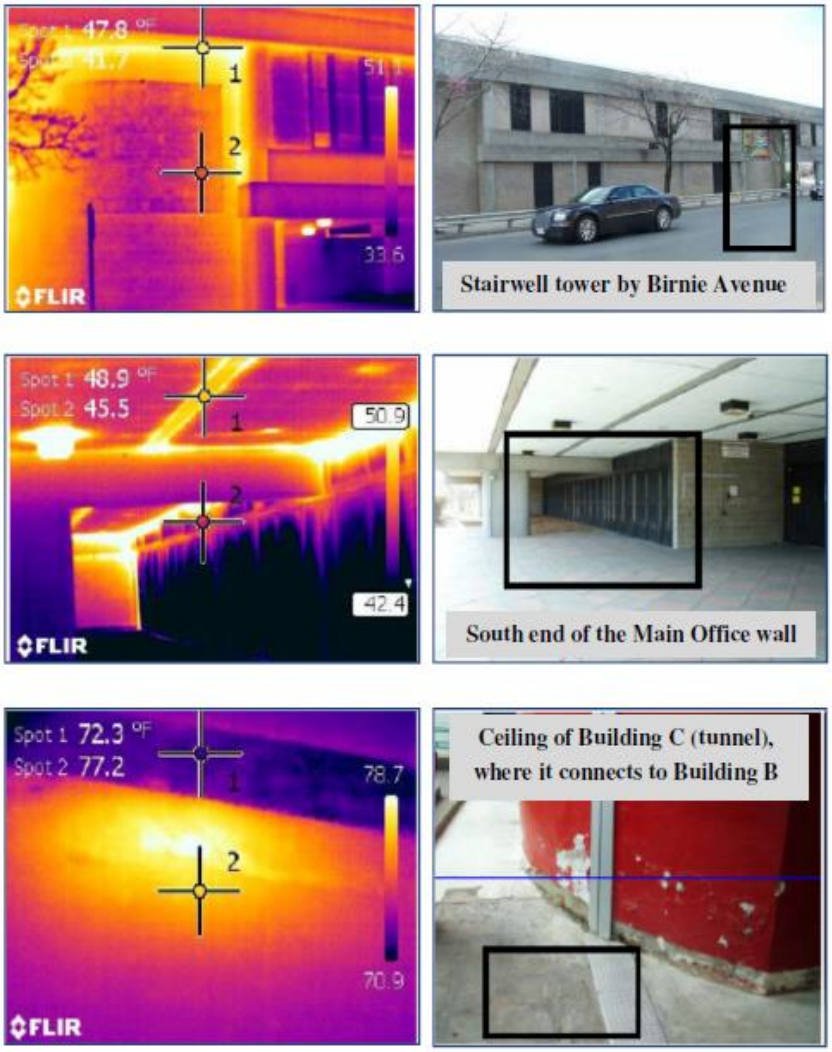

Figure 11. Infrared images of identified air leakage sites, next to non-infrared images of same location.

Ventilation Rate Measurements

Based on the results from the March 2013 testing, the current HVAC systems, in conjunction with building infiltration, appears to be providing an adequate supply of outdoor air, where monitoring was performed. The air handling units serving Pod 6, Mini Pod 6 and the Science Lab were providing an adequate amount of outdoor air to keep carbon dioxide levels low. However, the Main Office, which is connected to the Media Center through a short corridor and door, had higher levels of CO_2 that those found elsewhere (maximum recorded slightly above 1,000 parts per million). The air handing units (units 23 and 234) serving the Media Center were not supplying outdoor air and had closed dampers. The lack of incoming air was causing a negative pressure resulting in air pulled from the Main Office and other spaces. The ability for the Main Office to draw air from other areas likely kept the CO_2 levels below a level of concern.

HVAC Operation Analysis

Purpose

The technical portion of the building conditions and systems assessment requires an inter-disciplinary approach that includes evaluation of previously performed work and existing operations and maintenance. This approach helps prevent the duplication of work, improves the design of (new) data collection and analysis, and helps provide a more comprehensive perspective of the issues facing the operations and management of the facility.

Methods

EPA and contractors gathered information on the operation and maintenance of the HVAC systems from the building maintenance staff and the company contracted to perform maintenance on the systems to determine the current control logic for the HVAC air supply and exhaust fans. In addition, EPA and its contractors performed a forensic review of documents prepared by PBRM's contractors from previous investigations at the school related to the HVAC systems. In March 2013, EPA and its contractors performed a visual survey the current conditions for some of the air handlers that were accessible. The interiors of four air-handling units were observed, including units 12, 12, 22, and 36.

Findings

Based on the on-site observations, EPA and its contractors verified that the information gathered from the review of historic reports appeared reasonable regarding the status of the various systems and actions planned to address building and occupant needs. Estimated costs (based on 2012 costing) associated with the proposed renovations ranged from $525,000 to $875,000. PBRM has been working closely with the school maintenance staff and hired new positions to help meet maintenance requirements. The occupied run-time for the HVAC systems was 3:00 AM to 11:00 PM. Areas served by overburdened air handling units combined with the high air leakage rate are likely contributing to the high-energy use for the facility.

Some of the air handling units were found to be closed or operating with major malfunctions, broken equipment, and poorly maintained drain pans (units 12, 23, 24, 33, and 36). The access doors to the interior of some air handing units were malfunctioning making it difficult to gain access to provide routine maintenance (e.g., cleaning coil faces and drip pans). Visible microbial growth was found in the drain pans and coil faces of the observed units (units 12, 23, 33, and 36). In addition, several units were overdue for replacement. The condition of the four units observed suggest that the remaining (unobserved) units are likely in the same condition.

Indoor Air Quality Analysis

Purpose

The purpose of analyzing the indoor air was to address stakeholders' perceived concerns related to indoor air quality in Gerena. Many factors, including the design of the building and the efficiency of the HVAC system to treat incoming air influence indoor air quality. Air coming into the building through the air intakes contains particles and molecules. When the HVAC system runs efficiently, it typically filters some pollutants from the incoming air, but not all, and provides sufficient fresh air and exhausts used air. The indoor air quality analysis was intended to provide information related to the HVAC systems performance at Gerena, specifically whether or not eh HVAC system is effectively controlling traffic emissions from the nearby interstate, frontage road (Birnie Avenue), and railroad. This analysis was not meant to perform a comprehensive assessment of indoor air quality, since it only evaluated select combustion-source pollutants.

The key air pollutants chosen for indicating indoor air quality were Nitrogen Oxides (NO_X), Carbon Monoxide (CO), ultrafine particles (particulate matter less than 100 nanometers in diameter), Black Carbon (BC), and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$). Nitrogen oxides (NO_X), which includes compounds like nitrogen dioxide (NO_2) and nitric oxide (NO), are very reactive gases emitted from combustion reactions, such as from automobile engines and power plants. Carbon monoxide (CO) is an odorless, clear gas emitted from incomplete combustion reactions, commonly from automobile exhaust. Particulate matter is a complex mixture of liquid droplets and extremely small particles made up of many components, including acids (nitrates and sulfates), organic chemicals, metals, and soil or dust particles. Ultrafine particles are emitted directly from combustion reactions or indirectly from gases from reacting in the ambient air. Black carbon (BC) is a component of ultrafine particulate matter emitted from incomplete combustion of fossil fuels, biofuels, and biomass.

Methods

In March 2013, EPA contractors performed a short-term (48-hour) recording of particulate matter (PM; sized 0.5, 1.0, 2.5, 5.0, and 10 microns) concentration to determine if further study of possible indoor intrusion of combustion-source byproducts was warranted. Contractors used Graywolf PC-3016A (light-scattering) Particle Counter sensors to record data. EPA contractors performed continuous sampling of particulate matter for 48 hours in the "wrap-around" and library. Gerena is a smoke-free zone and no tobacco odors were detected during this study. This initial test indicated that some combustion-sized particles were present in the indoor air, with spikes indicating morning and afternoon rush hour traffic, warranting further study.

Appendix G. Details of Assessment Methods and Findings

In June 2013, EPA contractors performed the data collection for the air quality analysis. Air sampling was limited to 8-hour continuous recording (not 24-hour), due to security and building access limitations, and monitors recorded for a total of six days. Air sampling occurred on June 5 through 7 (Wednesday through Friday) on June 10 through 12 (Monday through Wednesday) during normal operations (i.e., school and buses in operation). Equipment included continuous $PM_{2.5}$ aerosol monitors (RTI MicroPEMs), continuous NO_2/NO_X air monitors (2B Technologies 400 series), continuous black carbon (BC) air monitors (Aethlabs AE 51), continuous relative humidity and temperature monitors (HOBO U series), continuous particle count monitors (P-Traks), CO_2 monitors (Gas Tech model 411, calibrated for zero, 325ppm, 180ppm, and +/-25ppm), and particle counter (Graywolf PC-3016A). There was no railroad traffic observed during sampling, but EPA contractors reported high road traffic on both Birnie Avenue and I-91.

Monitors recorded for a total of six days. The BC sensor was initially located with MADEP's PM monitor on the roof of Building B, but had to be moved inside the air intake duct for protection from the elements. The CO monitors recorded in the Principal's Offices, in Pod 10, and at both indoor locations. The outdoor monitors were placed in the fresh air intakes, to prevent damage from the elements and to monitor the air going directly into the building. The indoor air monitors spent the first three days in the classrooms on the third level of Building B and the last three days of the study in Building A (tunnel). Figure 12 identifies the locations of air sampling.

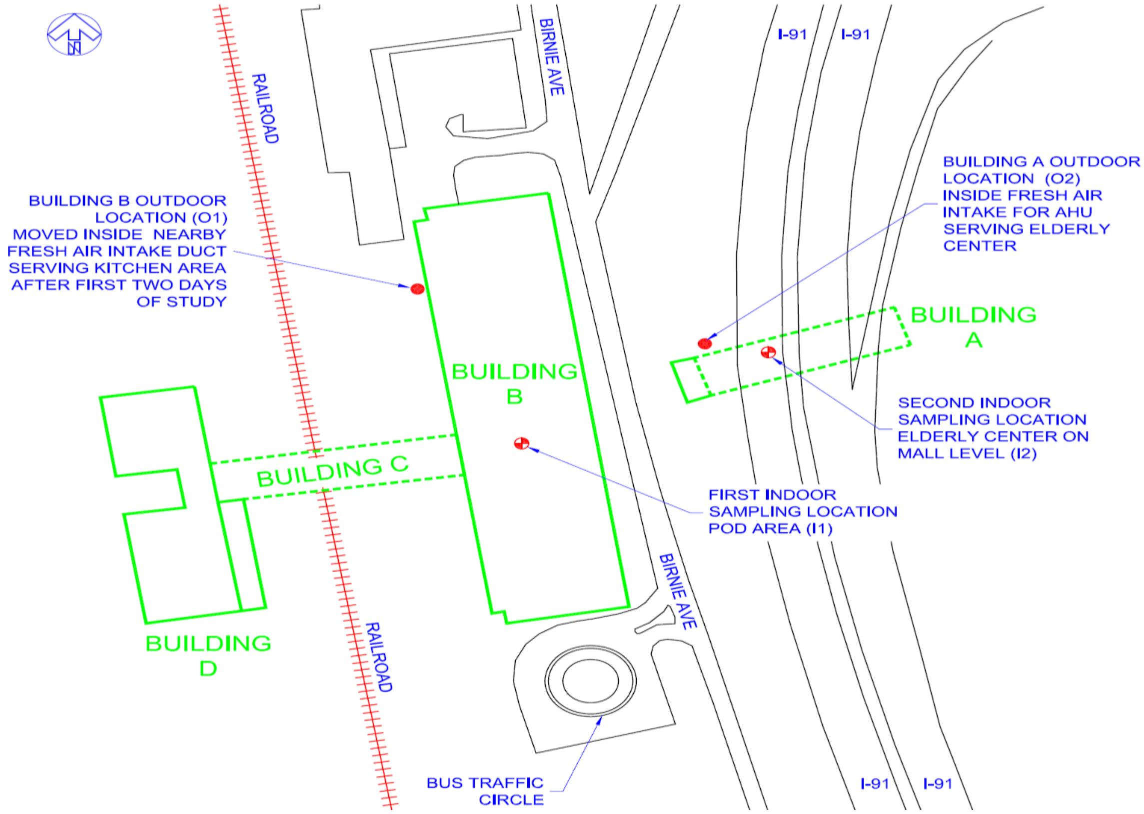

Figure 12. Locations of continuous monitoring for both indoor and outdoor air.

Samples from the outdoor air intakes were taken for comparison with indoor levels to measure the filtration efficiency. Values were also compared with regulatory and industry standards, from the National Ambient Air Quality Standards (NAAQS), Occupational Safety and Health Administration (OSHA), and the American Society of Heating and Air-conditioning Engineers (ASHAE). Meteorological conditions (wind speed and direction) were also monitored from the roof of Building B for the duration of the study using a RM Young 3D Sonic Anemometer. EPA obtained additional data during non-normal operating conditions (every night, when instruments were left running overnight, and over the weekend).

Findings

NO_X Measurements

Daily NO_X average values for both indoor and outdoor measurements were typically below the published NAAQS (100 ppb per hour or an average of 53 ppb per year). The one exception for this occurred on June 7, 2013, when monitors recorded an average 66 parts per billion (ppb) and winds were out of the north, drawing air from I91. The reduction in NO_X concentrations moving from outdoor to indoor spaces was easily observed. Indoor readings each day were approximately half that of the corresponding outdoor readings. However, the influence of mobile sources at the Building A air intakes and inside the tunnel was also readily observed.

The NO_X values sampled from the air intake for Tunnel A (site O2) were typically higher than measured from the air intake for Building B (site O1), likely due to the proximity to road traffic and "upwind" location of Building A. According to the NAAQS, outdoor NO_2 values should not reach above an average of. In addition, the NO_X values inside Building A (site I2) were higher than inside the Pods (site I1), with respective averages of 4ppb and 14ppb. Figure 13 plots the average values for NO_X over the six-day study period.

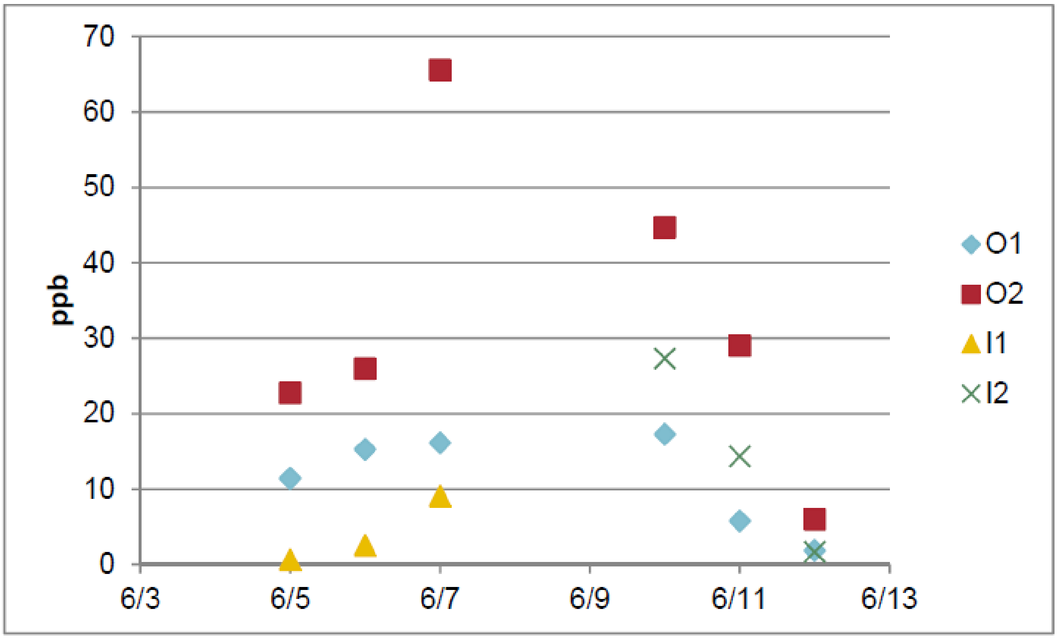

Figure 13. Average NO_X concentration values, by sample location, for the six-day study.

CO Measurements

A 3-point calibration check (at 0ppm, 1ppm, and 15ppm) was performed on the Lascar data loggers prior to deployment of the CO sensors. Indoor CO values, which were 3ppm or less, were almost always below the detection ability of the instruments used (range is 0 to 1,000ppm). The NAAQS threshold for outdoor ambient CO is 9 ppm for an 8-hour period.

Ultrafine Particulate Matter Measurements

Daily average counts for ultrafine particles were consistently the highest at the air intake for Building A for all six days of the study. This may be due to the close proximity of Building A to traffic on the interstate and Birnie Avenue. The reduction in ultrafine particle counts moving from outdoor to indoor spaces was easily observed. Indoor readings each day were approximately half that of the corresponding outdoor readings. Figure 14 plots the average values for ultrafine particulate matter over the six-day study period.

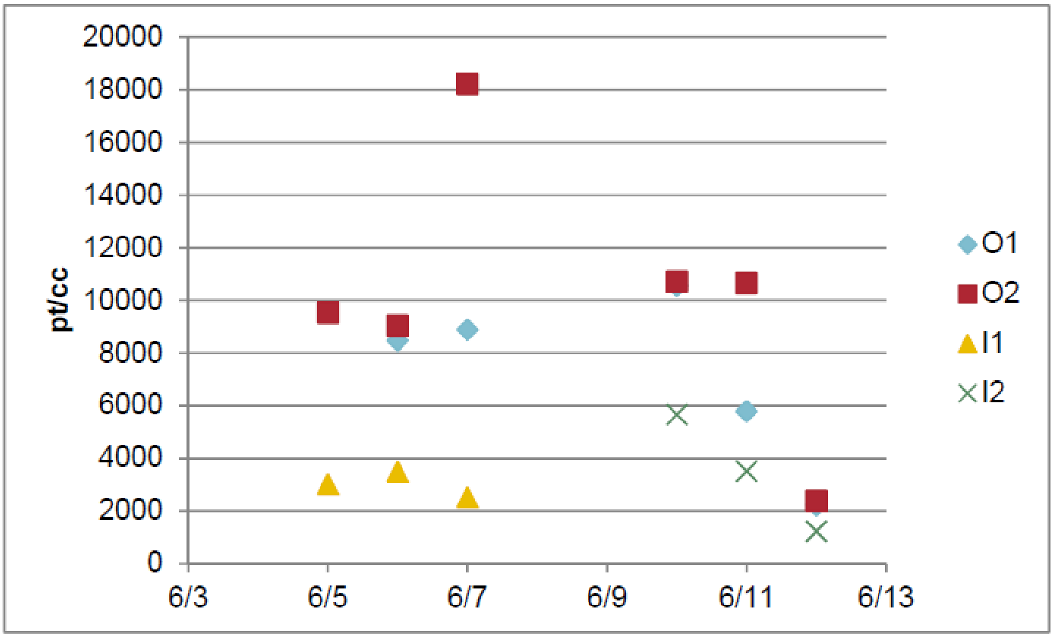

Figure 14. Average ultrafine particulate matter counts (in pt/cc), by sample location, for the six-day study.

There was an occurrence of higher than normal ultrafine particles that occurred in the Pods around 1:00PM on June 6, 2013, likely attributed to the new flooring installation occurring in Building A (tunnel) and/or the increased lunch time activity. There was also some tile and carpet work occurring near the intersection of Buildings B and C (tunnel) that may have influenced the indoor particulate levels, but neither indoor sampling sites were near this work. Meals for the students were catered, reducing the risk of influence on the data from cooking activities.

BC Measurements

The air intake for Building A (tunnel) had the highest BC average values for all six days of the study. This is likely due to the close proximity of the interstate and Birnie Avenue traffic to the sampling location. There was a sharp fall in BC concentration outside Building A from June 10 to 12, 2013, most likely due to the change in wind direction from north to northwest. Figure 15 shows the daily averages of BC monitoring during the six-day study.

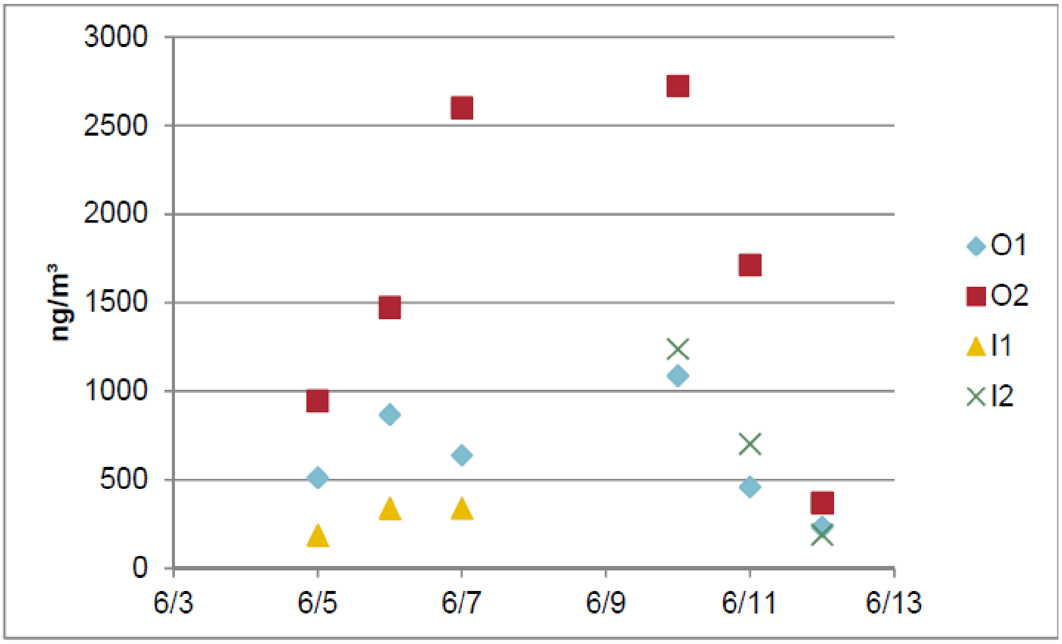

Figure 15. Average BC particulates (in ng/m^3), by sample location, for the six-day study.

Although the typical 50% reduction in particulates from outdoor to indoor air measurements was observed, BC measurements in the school also showed an influence of outdoor combustion sources inside Building A. When traffic volumes were highest, BC levels in Building A (tunnel) were also high. Increases in indoor concentrations of BC usually followed increases in outdoor levels. The permissible exposure limit for BC is 3.5ng/m^3, based on OSHA standards. The highest study average at all locations was less than half the OSHA PEL (at 1.6 ng/m^3).

$PM_{2.5}$ Measurements

Typical indoor $PM_{2.5}$ levels in the presence of human activity (for residences) is above 20µg/m^3. In general, indoor monitors revealed average $PM_{2.5}$ levels below 20µg/m^3, with the exception of a few isolated high levels for a short duration of time (i.e., "spikes"). There were no definitive time patterns observed over the course of the study to attribute the spikes in $PM_{2.5}$ to any one source or explanation. The outdoor sampling locations did show increased $PM_{2.5}$ levels with respect to the indoor concentration averages. Based on the data (normalized for worst-case scenario), there appeared to be some process where $PM_{2.5}$ were removed (scrubbed) from the indoor environment, either through physical filtration mechanisms and/or deposition (in the ductwork itself). Average indoor $PM_{2.5}$ concentrations were often well below half of the outdoor concentrations, with the exception of data from day five of recording that had an average $PM_{2.5}$ concentration of 40µg/m^3. It is important to note that HVAC operation may influence $PM_{2.5}$ levels, especially if operating in an economizer mode in which large volumes of outdoor air is introduced to indoor spaces to save energy costs for cooling.

Appendix G. Details of Assessment Methods and Findings

Literature Review on Pediatric Asthma and Symptom Exacerbation

A student researcher (Neal Jawadekar), supervised by Marybeth Smuts (EPA Region 1), performed a systematic literature review of 103 studies related to pediatric asthma and exposures suspected of exacerbating asthma symptoms. Articles were retrieved using Medline (an online search engine) with the following parameters: sample size at or above 100 children, asthma and/or asthma indicator (e.g., wheezing) as outcome of interest, publish date between 1989 and 2012. There were too few school-based studies, so the environmental exposure parameter was expanded to include in-home and other settings. The exposures investigated in the reviewed literature included the presence of formaldehyde, ozone, $PM_{2.5}$, PM_{10}, NO_2. SO_2, CO, proximity to major roads/traffic pollution, dust mite (in-home), cat (in-home), dog (in-home), mold (in-home), dampness (in-home), mold and/or dampness (unspecified), water damage, cockroach droppings, breast-feeding, and carpeting.

The student researcher extracted the odds ratio and 95% confidence interval observed for each exposure (variable) investigated and inputted them into forest plots (www.stattools.net/ForestPlot_Pgm.php) to visualize the array of odds ratios. The odds ratio represents the probability of cases (those with asthma) among persons exposed (to the variable) compared to the odds of those with asthma among persons not exposed. An odds ratio above 1.0 indicates the exposure may be a risk factor, at 1.0 suggests that the exposure does not affect the outcome of interest, and below 1.0 indicates the exposure may be a protective factor. The following series of images are the resulting forest plots for each variable from each study.

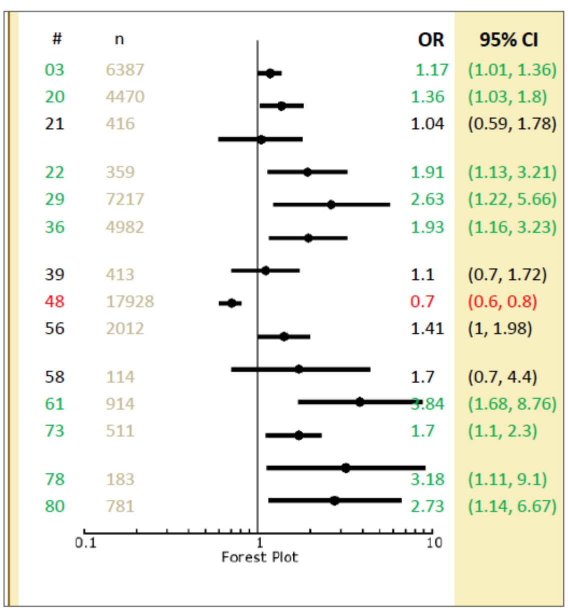

Figure 16. Forest plot graph of odds ratios and confidence intervals for asthma symptoms and exposure to formaldehyde.

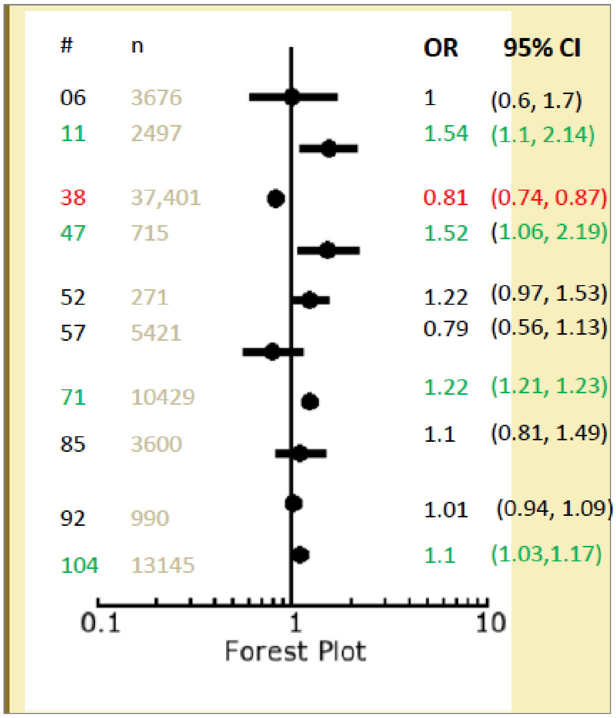

Figure 17. Forest plot graph of odds ratios and confidence intervals for asthma symptoms and exposure to ozone.

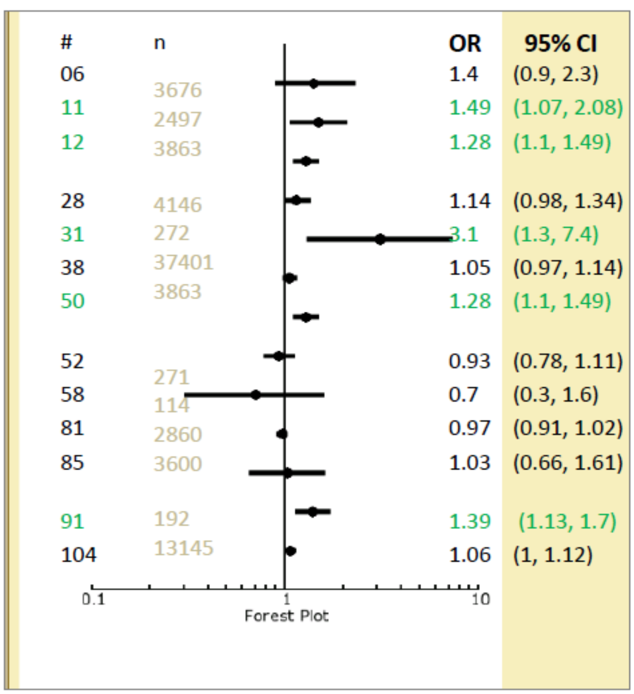

Figure 18. Forest plot graph of odds ratios and confidence intervals for asthma symptoms and exposure to particulate matter with diameter less than 2.5 microns.

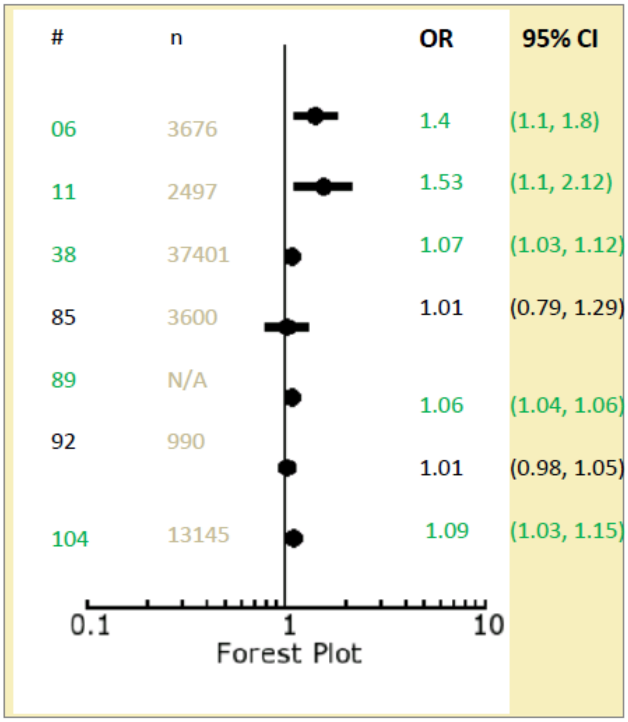

Figure 19. Forest plot graph of odds ratios and confidence intervals for asthma symptoms and exposure to particulate matter with diameter between 2.5 and 10 microns.

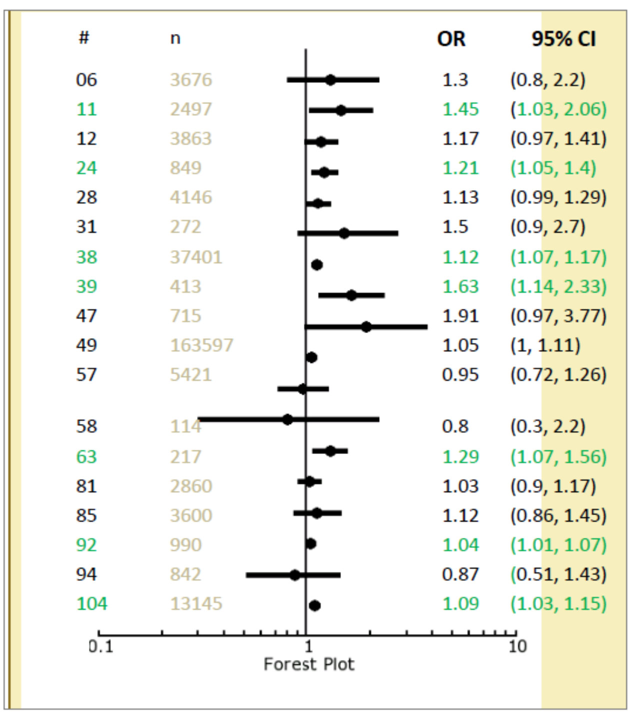

Figure 20. Forest plot graph of odds ratios and confidence intervals for asthma symptoms and exposure to nitrogen dioxide.

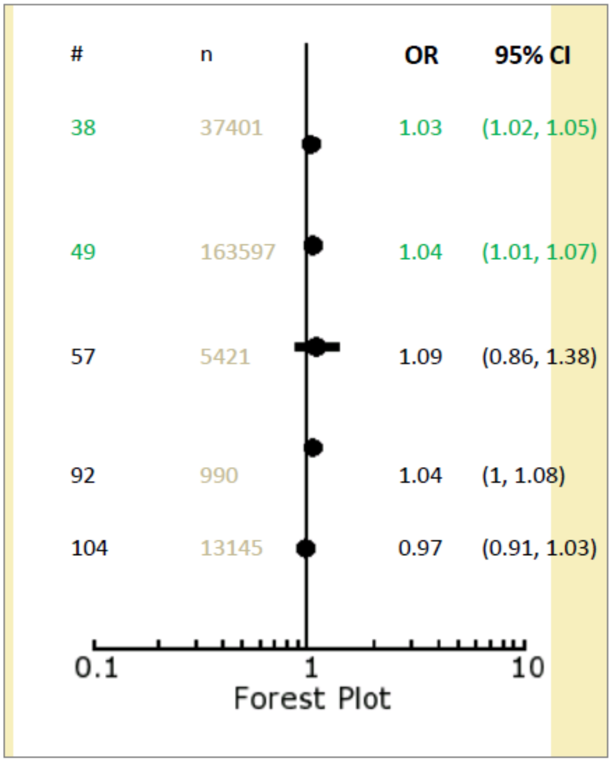

Figure 21. Forest plot graph of odds ratios and confidence intervals for asthma symptoms and exposure to sulfur dioxide.

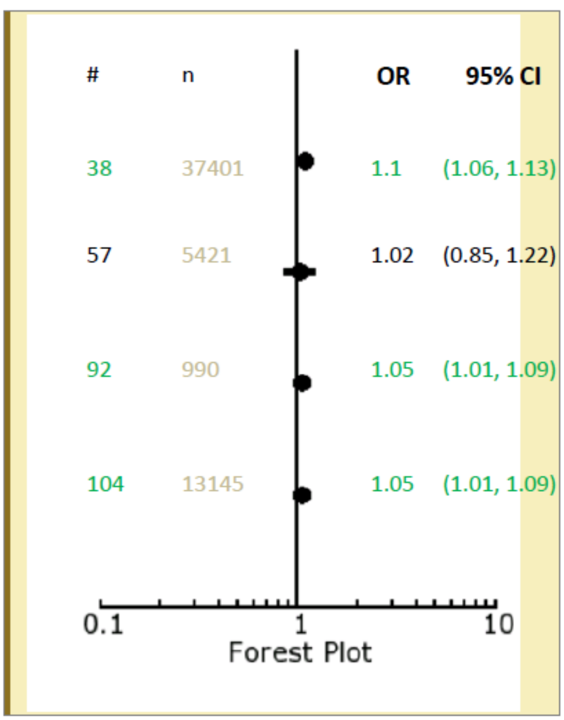

Figure 22. Forest plot graph of odds ratios and confidence intervals for asthma symptoms and exposure to carbon monoxide.

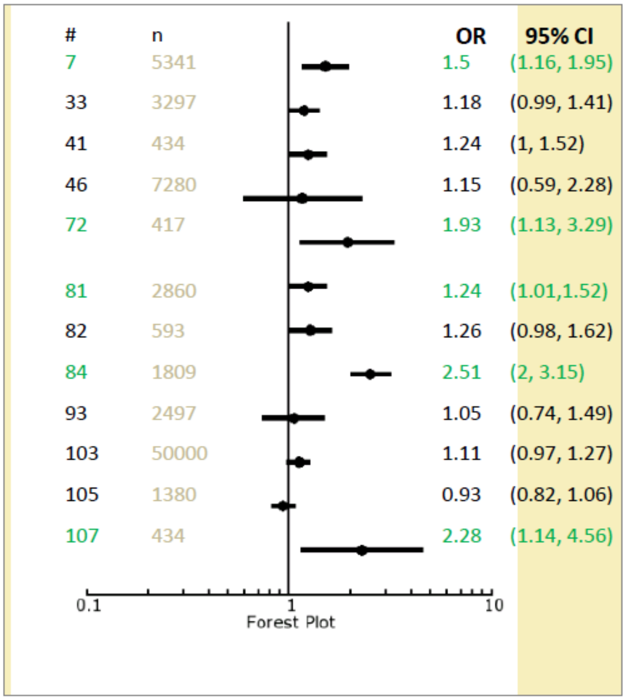

Figure 23. Forest plot graph of odds ratios and confidence intervals for asthma symptoms and exposure to proximity to major roads/traffic pollution.

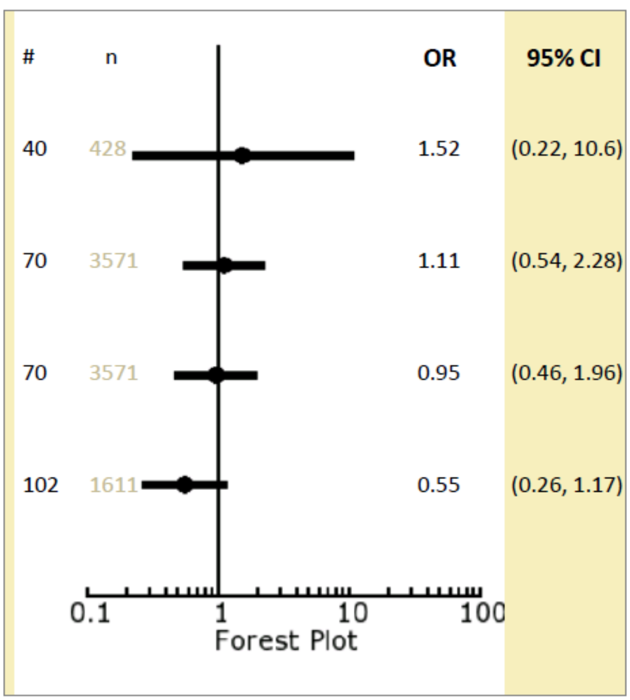

Figure 24. Forest plot graph of odds ratios and confidence intervals for asthma symptoms and exposure to dust mite (in-home).

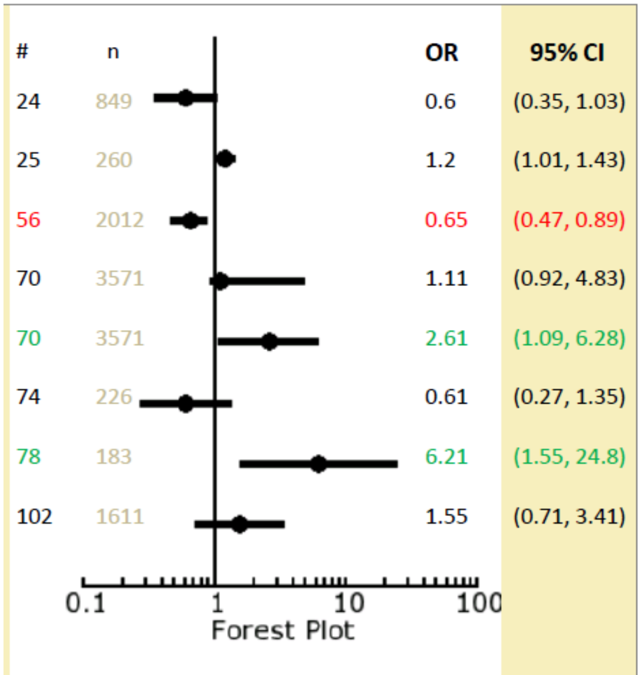

Figure 25. Forest plot graph of odds ratios and confidence intervals for asthma symptoms and exposure to cat (in-home).

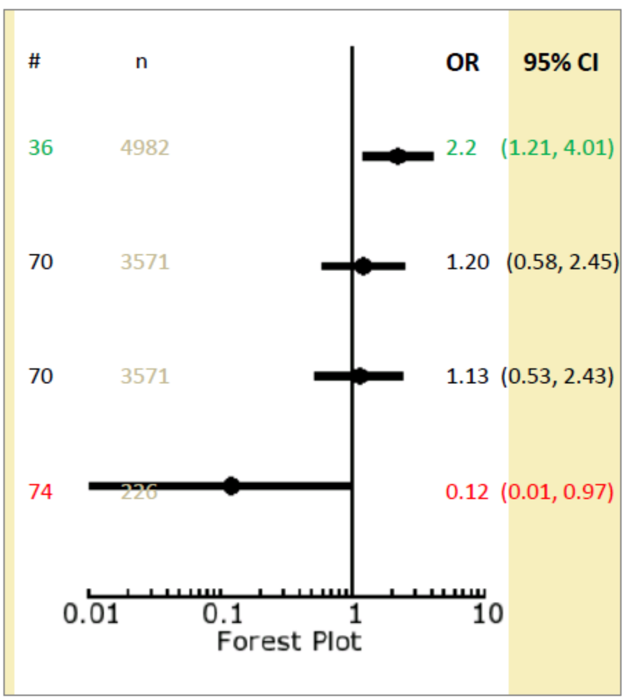

Figure 26. Forest plot graph of odds ratios and confidence intervals for asthma symptoms and exposure to dog (in-home).

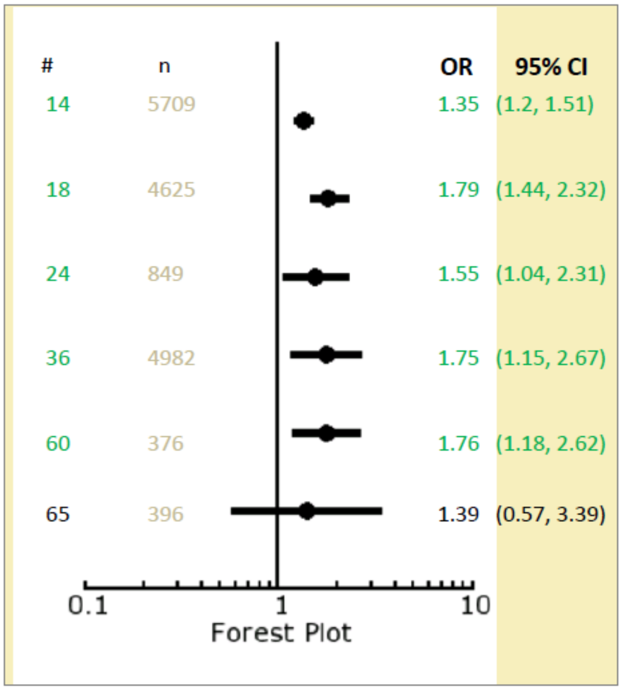

Figure 27. Forest plot graph of odds ratios and confidence intervals for asthma symptoms and exposure to mold (in-home).

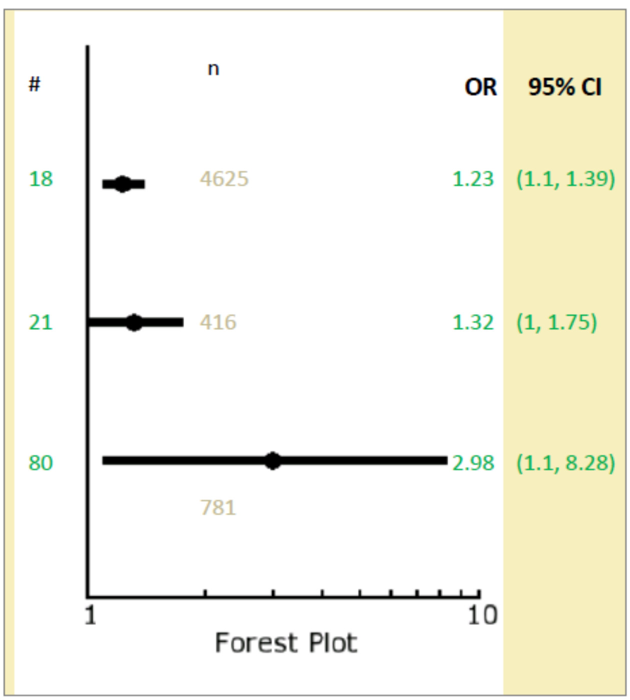

Figure 28. Forest plot graph of odds ratios and confidence intervals for asthma symptoms and exposure to dampness (in-home).

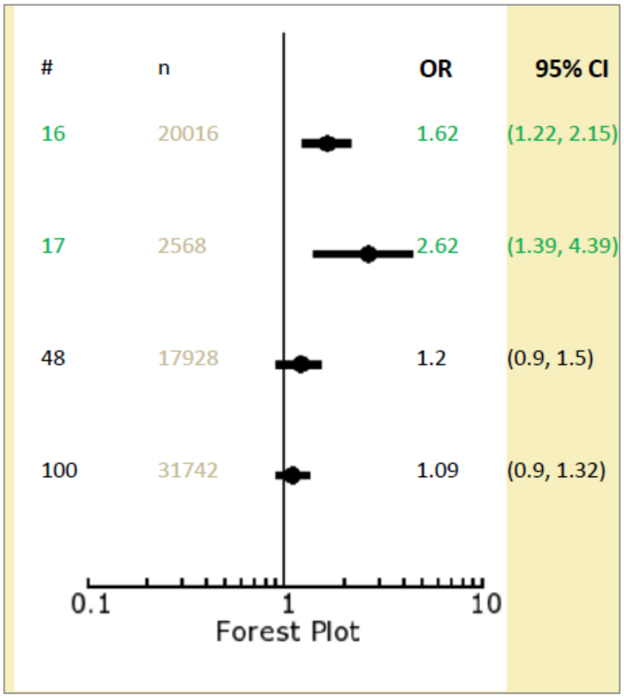

Figure 29. Forest plot graph of odds ratios and confidence intervals for asthma symptoms and exposure to mold and/or dampness (unspecified).

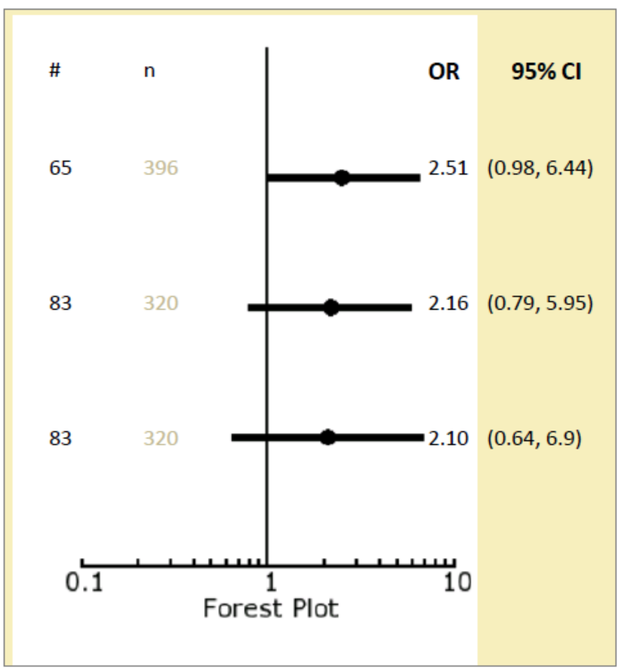

Figure 30. Forest plot graph of odds ratios and confidence intervals for asthma symptoms and exposure to water damage.

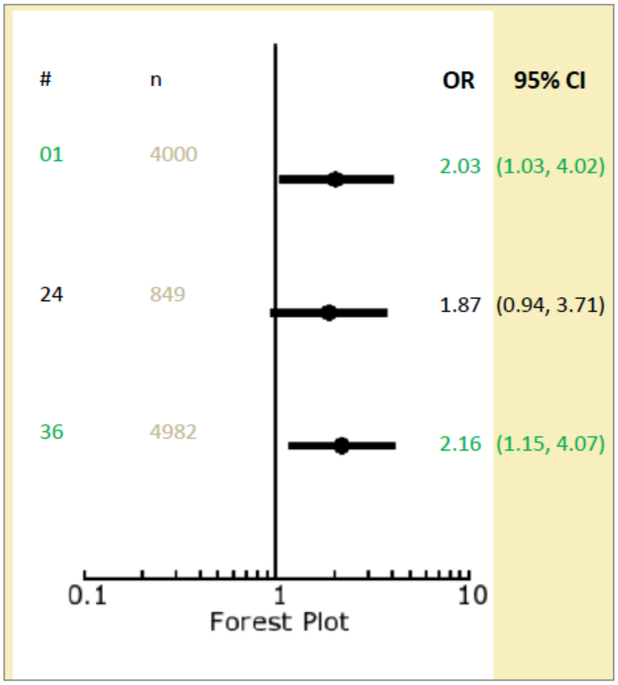

Figure 31. Forest plot graph of odds ratios and confidence intervals for asthma symptoms and exposure to cockroaches.

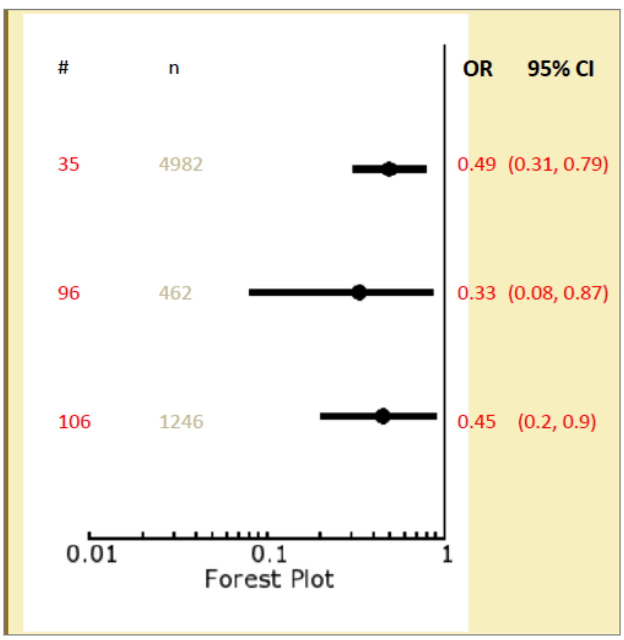

Figure 32. Forest plot graph of odds ratios and confidence intervals for asthma symptoms and exposure to breastfeeding.

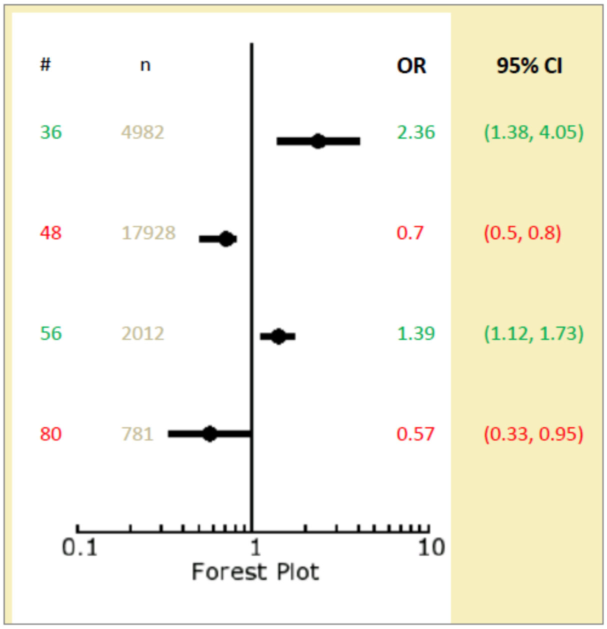

Figure 33. Forest plot graph of odds ratios and confidence intervals for asthma symptoms and exposure to carpeting.

The ranking of odd ratios was performed using standard epidemiological approaches, including weighting by sample size and excluding odds ratios at or below 1.0 (i.e., only potential risk factors were ranked). Although exposure categories are broad, there is enough distinguishing information to identify the fifteen most common exposures (potential risk factors) with confidence (1 = most common, 15 = least common):

1. Dampness (in-home)
2. Mold (in-home)
3. PM_{10}
4. Cockroaches
5. SO_2
6. CO
7. Formaldehyde
8. Dog (dander and hair)
9. Ozone (O_3)
10. Cat (dander and hair)
11. Carpeting
12. NO_2
13. Proximity to major roads/traffic pollution
14. $PM_{2.5}$
15. Dust mites

Literature Review of Health Impacts from Classroom Noise and the Acoustic Learning Environment

An empirical literature review was conducted on classroom noise as a health determinant. Meta-analyses and peer-reviewed literature were considered high priority literature to review based on their immediate access to summarized information and decreased risk of study bias. Databases used to extract the literature included GoogleScholar.com, APHAPublications.org, U.S. Environmental Protection Agency (EPA), Noise Pollution Clearinghouse (NPC), World Health Organization (WHO), Acoustical Society of America (ASA), and the National Clearinghouse for Educational Facilities. Anecdotal evidence regarding noise in the classrooms was gathered from informal surveys taken of the building by investigators, school staff, and the community and documented in the meeting notes. The following keywords were used as the search criteria:

Noise, Noise Levels, noise pollution, health outcomes, health determinants, children, students, schools, review

Literature Review of Health Impacts from Perceived Environment

A systematic review of empirical literature was conducted in regards to the perceived environment as a determinant to health. The review examined pathways between community perception and health impacts. Anecdotal information was gathered via community engagement meetings, news articles, televised interviews, and interactions with stakeholders. The information was documented in meeting notes. References for the news articles and televised interviews are provided at the end of this report. Peer-reviewed journal articles and grey literature were reviewed using search engines: Google Scholar, Taylor and Francis Online, SAGE Journals, PubMed, and ProQuest. Keywords used included:

Community perception, health determinants, social capital, neighborhood, neighborhood design, social interaction, condition of neighborhood, health, community interaction

Appendix H. PBRM's Addendum to HIA Report

City of Springfield, Massachusetts Department of Parks, Buildings and Recreation Management

Addendum to EPA HIA Report for German Gerena Community School

August 2015

Table of Contents

HIA Addendum - PBRM Documentation of Work Completed at Gerena School

Introduction

This report summarizes the majority of routine, non-routine and capital project work completed at German Gerena Community School (Gerena) by the current administration of the Springfield Department of Parks, Buildings and Recreation Management (PBRM). The timeframe spans from FY 2008 through the end of FY 2015.

It is important to understand that the building presents both typical and atypical maintenance issues due to its design and location. As illustrated by the included summary of completed work orders, contracted services and capital projects, PBRM has been effectively addressing the typical routine building maintenance requirements of the above ground portions of this building complex to a large degree. It must be noted that the building's complexity and location make even typical maintenance more difficult, costly and time consuming than the average building.

The portions of the building located underground in the tunnel system and mall area present atypical, large scale and expensive maintenance, repairs and replacement issues due to the buildings location and design, as outlined in the list below.

1. The school building's location below street level, in the water table, and under the I91 interstate highway and railroad tracks.
    a. The building requires numerous pumping stations and drainage systems that are costly to operate, maintain and replace. They are not typically found in the average facility, but are located in Gerena to address:
        - Continuous and unplanned infiltration of storm and ground water.
        - Planned influx of stormwater as the building's storm water management systems also serve an adjacent school parking lot. The stormwater drains into the building and must be pumped out into the City's stormwater system.
        - Ejection of sewage up to street level, which is due to the location of the building below street level.
        - Vulnerability to flooding when the city stormwater structures have exceeded their capacity. This is due to the fact that the entrance location to Tunnel A building on Main Street is built below street level.
    b. There are numerous abandoned utility conduits under the building that serve as pathways of uncontrolled water intrusion. Their presence is due to:
        - Abandonment of Thomas Ave and the utility structures underlying it. Thomas Ave was abandoned to enable Gerena to be built at that location, but some of those underground utilities were never removed.
        - Abandoned utilities under the Interstate 91 bridge overpass over Bridge Tunnel A.
        - Excess pressure from an elevated water table which caused the floor in Bridge-Tunnel C to rise in excess of 4" thereby damaging the in-

floor slab utility network (electrical, fire alarm, phone and intercom conduits), which had to then be abandoned. The final settlement of the floor slab is now roughly 1-1/4" above its original grade level.

2. The building's size, underground location, and numerous levels make multiple air handling units a necessity.
    a. The building is approximately ½ mile long in east west direction, approximately ¼ mile long in the north-south direction, and roughly 50 feet in height, of which only 35 feet is visible above the ground. The building size is 227,500 square feet.
    b. The building has 36 air handling units (AHU) to service the extensive underground tunnel system and mall area, as well as two aboveground structures.
    c. The design also incorporates a huge open atrium to bring in natural light from the roof to the lowest level of the building to the third floor in the mall area. This large volume of air must be conditioned.
    d. The energy use per square foot is one of the highest of the City's buildings, due in part to the multiple AHUs, the water and sewage pumping stations, and the large open atrium and tunnel spaces in the building.
3. The age of the facility (40 years) and its location relative to other manmade structures and conditions.
    a. The increased traffic on the roadways overhead and adjacent (Interstate 91 highway and Birnie Avenue) to the building has increased the amount of vibration on Bridge- Tunnel A, affecting the building's structure.
    b. Over time, construction and maintenance projects at nearby roads and at Birnie Avenue have compromised the waterproofing membrane on the exterior of Bridge- Tunnel A. Please note that Birnie Avenue is directly above Tunnel A.
    c. The building's expansion joints have been exposed to conditions beyond their original design, allowing water and uncontrolled air to enter and leave the building.
    d. Usage and frequency of use of the federally-maintained railroad tracks located over Bridge Tunnel C, has changed over the last 40 years, from passenger to freight, with changes in amount of weight being carried.
4. The age of the facility (40 years) and its relationship to its internal systems and components.
    a. At the time of construction, the facility's energy management system (EMS) was only the second such system installed in the City.
    b. State-of-the-art systems, such as the EMS, were dependent upon equipment and technology that is currently no longer in use, available, or both.
    c. Design criteria for many of the building's internal systems has changed and evolved. Thus, many of the building's systems are not adequate for today's operations.

d. The material at the juncture of the upper walls and the roof has deteriorated to the point where the exterior is clearly visible. It may have been caused by both the age of the building material in the juncture and/or movement of the building. These expanded openings allow leakage of the indoor air, and cause the atrium to act like a chimney. This increases the loss of conditioned air and increases energy costs.

e. The deterioration of the building's various waterproofing systems, which require complete replacement and extensive renovations to surrounding areas to complete, including excavation of the soil around the underground tunnels. Work on A Bridge- Tunnel requires excavating Birnie Avenue.

f. Many of the internal systems have reached the end of their operational life cycle and require major capital outlays to replace. HVAC maintenance issues are encountered on a regular basis due to the fact that some of the parts cannot be purchased off the shelf and must be fabricated; some the old pneumatic controls have air leaks, while some have rusted and do not work effectively due to exposure to water-laden air, and were never made to be installed in that type of moist environment.

HIA Addendum - PBRM Documentation of Work Completed at Gerena School

Work Summary and Funds Expended

Table 1. Purchase Orders and Capital Expenditures

SYSTEM WORK	CAPITAL PROJECTS & REPAIRS	NON-ROUTINE MAINTENANCE	ROUTINE MAINTENANCE	TOTAL EXPENDITURE PER SYSTEM
Architecture and Engineering Services	203,780.00	[Blank]	[Blank]	203,780.00
Carpentry, Masonry, Painting and Ceiling Tiles	[Blank]	27,563.00	51,784.00	79,347.00
Communications	65,471.37	[Blank]	[Blank]	65,471.37
Custodial	3,185.87	4,351.00	71,890.95	79,427.82
Electrical	51,195.11	46,003.00	11,320.63	108,518.74
Elevator	[Blank]	21,115.50	[Blank]	21,115.50
Environmental	18,000.00	36,402.56	11,655.24	66,057.80
FF&E	[Blank]	5,333.96	25,540.00	30,873.96
Flooring	15,870.00	16,759.37	17,945.70	50,575.07
Generator	[Blank]	17,543.05	[Blank]	17,543.05
HVAC	337,157.00	117,371.24	30,634.60	485,162.84
Interior Playscape	86,656.25	[Blank]	[Blank]	86,656.25
Lighting	87,694.73	16,975.00	27,650.23	132,319.96
Miscellaneous	[Blank]	14,211.25	[Blank]	14,211.25
Moisture Mitigation and Damage Repairs	229,987.00	127,821.19	27,579.00	385,387.19
Plumbing	14,750.00	7,903.10	992.51	23,645.61
Pool/Gym/Lockers	183,118.60	2,432.74	22,110.00	227,661.34
Pumps	101,968.00	31,814.69	[Blank]	133,782.69
Roofing (Garage)	12,850.00	[Blank]	[Blank]	12,850.00
Safety and Security	116,500.00	22,147.43	49,639.00	188,286.43
Water Treatment	[Blank]	2,000.00	[Blank]	2,000.00
Atrium Skylight & Building B Roof	1,474,794.00	[Blank]	[Blank]	1,474,794.00
Replacement & Upgrade of Heating Boilers	478,213.00	[Blank]	[Blank]	478,213.00
SUMMARY	**$3,481,190.93**	**$537,748.08**	**$348,741.86**	**$4,367,680.87**

HIA Addendum - PBRM Documentation of Work Completed at Gerena School

Table 2. Work Orders Completed – the following costs are categorized using the same categories as listed in the chart above.

WORK ORDERS	TOTAL COST
Architecture. and Energy Services	3,000.00
Carpentry, Masonry, Painting & Ceilings	113,543.16
Communications	727.58
Custodial	14,999.62
Electrical	22,623.27
Elevator	9,090.19
Environmental	5,783.87
FF&E	12,701.50
Flooring	0.00
Generator	376.44
HVAC	105,374.40
Interior Playscape	29.17
Lighting	6,943.56
Miscellaneous	8,604.34
Moisture Mitigation & Damage Repairs	21,689.72
Plumbing	45,537.61
Pool/Gym/Lockers	7,547.79
Pumps	41,770.44
Roof	20,078.18
Safety & Security	41,106.91
Water Treatment	0.00
Vandalism	327.89
TOTAL	**$481,855.64**

HIA Addendum - PBRM Documentation of Work Completed at Gerena School

Highlights of Completed Work

Reports, Studies, and Assessments performed at the request of PBRM:

- Caolo and Bieniek Associates, Inc. – interior security and atrium floor waterproofing
- Gale Architects, Inc. – reroofing and atrium skylight replacement
- Timothy Murphy Architects – roof, wall, and floor leak investigations
- Cardno ATC – environmental, and indoor air quality assessments
- O'Reilly, Talbot & Okun, Geoenvironmental Engineering – indoor air quality assessment
- Lindgren and Sharples – mechanical inspections and redesigns
- RDK Engineers – mechanical system assessment
- Siemens Engineering – mechanical inspections and redesigns, energy conservation for building envelope, transformers, additional interior lighting, etc.
- Harry Grodsky and Company – mechanical equipment survey, inspections, maintenance and repairs
- TJ Conway Co. – mechanical equipment inspections, maintenance and repairs
- Rise Engineering and WMECO – mechanical and electrical energy audits
- Universal Electric – electrical inspections, repairs and audits
- GZA Geotechnical, Inc. – subsurface investigations and evaluations, Facility Condition Assessment
- Simpson Gumpertz and Heger – subsurface investigations and evaluations

Upgrades & Repairs to Mechanical Systems (Air):

- Replaced the cooling tower
- Separated domestic hot water for handwashing and pool heating by installing 2 new domestic hot water boilers (Energy project)
- Replaced original boilers for building heat with 3 new hot water boilers (Energy project)
- Upgraded pool heating (see above) (Energy project)
- Upgraded the Energy Management System to a hybrid pneumatic-electric system which allows it to be controlled remotely (Energy project)
- Performed maintenance and various repairs on all 36 AHUs
- Repaired or replaced vandalized air handling equipment for A tunnel and D building and installed additional preventative measures against vandalism occurring to AHUs and building envelope

    - Relocated Tunnel A air handling units from the roof to inside the building to protect it from damage from the highway and vandalism (prior to 2008).
    - Fenced Tunnel A roof under I 91 off-ramp.
    - Fenced AHUs located on roof of Building D.
    - Fenced off the area between the railroad tracks and B Building to prevent vandalism to the building envelope, and air intakes and returns.
- Management of Nuisance Vegetation
    - Removed all vegetation and debris in the cooling tower. The area was sprayed with a natural product to prevent re-growth.
    - Removed interior garden of shrubs and trees in the mall area of the tunnel system to prevent moisture and mold from the vegetation from being emitted into the building.
    - Periodic removal of vegetation in in 2011 and 2015 the area between the railroad tracks and B Building to prevent pollen and debris from entering the air intakes and to ensure adequate air flow into the air intakes.

Prevented and/or Reduced Water Intrusion, and Mitigated Water Damage:

- Resurfaced and waterproofed 25,000 square feet of atrium floor in the interior pedestrian walk-way in the tunnel mall area.
- Recaulked and repointed the exterior north and south brick walls on Building B to eliminate water intrusion. Also replaced all carpeting in adjacent learning areas due to water damage from exterior walls.
- Replacement and ongoing maintenance of eight pump stations (with 2 pumps at each station) handling stormwater, groundwater and sewage. The two largest stations handle stormwater and groundwater. The pumping stations that handle the sewage are needed because the building is below street level and the sewage must be ejected up to City sewage and wastewater lines in the streets. Typical buildings do not have any of the pumping stations. These pump stations have flooded in the past, and to prevent flooding they require monitoring and maintenance:
    - Pump Station Replacement

      Large pump station # 8 - $124,000 (both pumps)

      Small pump station # 1 - $22,000 (both pumps)

    - Pump Inspection, Monitoring and Maintenance:

Installation of alarms and monitoring devices on the four critical pump stations for pump failures by an outside security company at $1,000/year

Requirements for special preventative maintenance, and inspections, at $4,000/year

HIA Addendum - PBRM Documentation of Work Completed at Gerena School

Improved Safety and Security:

- Upgraded Security and Safety Systems
  - Installed additional surveillance equipment throughout building complex
  - Installed additional lock-down door hardware throughout the building
  - Upgraded the building fire alarm system
  - Upgraded the building intercom system
- Restricted unauthorized access to the school
  - Installed two additional security vestibules at the interior public pedestrian walkway to prevent unauthorized access to the school.
  - Isolated the cafeteria from unauthorized access from the interior public pedestrian walkway.
- Upgraded Interior and Exterior Lighting
  - Upgrade the exterior lighting to LED fixtures and bulbs
  - Upgraded lighting in the A and C tunnel portions of the interior pedestrian walkway.
- Installed Additional Security Fencing (already detailed)

Improved the Learning Environment:

- Lighting – retrofitted interior lighting in Pods 1 thru 5
- Playscape – installed an interior playscape, which is handicapped accessible. The PBRM design was recognized and published in a national magazine.

HIA Addendum - PBRM Documentation of Work Completed at Gerena School

Funding Sources to Conduct Repairs, Upgrades and Capital Projects

- Massachusetts School Building Authority – PBRM has applied to MSBA for funding the HVAC upgrades
- Massachusetts Department of Transportation (MA DOT) – PBRM had Tunnel A recognized as a bridge. This status as a bridge makes it eligible for other forms of state and federal funding. Its status as a bridge now requires the MA DOT to perform inspections. PBRM worked with a previous State Representative to have three million dollars requested as a budget line item in the state's Highway Transportation Budget.
- PBRM has actively sought energy grants through State and Federal funding, and has bonded for a number of energy improvements at Gerena.

Highlights of Proposed and/or Scheduled Work

Note that the work listed is in addition to HIA recommendations under consideration, PBRM is seeking funding for the proposed work that includes, but is not limited to the following:

- Mitigate water intrusion at entrance to A Tunnel from Linda Park and Main Street
- Mitigate water intrusion and damage in Bridge Tunnel A, especially at Birnie Avenue
- Resurface the tunnel floors. PBRM has obtained quotes for this work, which will commence in FY 2016 if funding can be secured:
    - Tunnel A – resurface the aggregate floor
    - Tunnel C – grind down existing flooring and resurface the aggregate
- Increase the air exchange in Tunnel C
- Continuing to correct an electrical grounding problem which has accelerated the plumbing pipes to corrode and leak. All compromised piping and water damaged materials will be replaced. PBRM has estimates for this work and is seeking funding to complete this work in FY 16. Note that plumbing pipes have been replaced in approximately 2/3 of the areas damaged.
- Continuing replacement of the old or original pumps in the pumping stations:
    - Small pump station #3 – on order at $27,000 (both pumps)
    - It is anticipated that the additional 5 pump stations will need to be replaced in the near future
- Seal the building envelope and implement other energy saving measures.
- Upgrade and continue to maintain HVAC systems
- Hire a dedicated HVAC technician to service all of the mechanical systems in the building

End.

Appendix I. Results of the HIA External Peer-Review

Table 1. Responses and Comment Resolution to HIA Process Charge Questions

Peer-Review Charge Questions	**Reviewer 1**	**Reviewer 2**	**Reviewer 3**	**Comment Resolution from Authors/HIA Core Group**
1. Context of HIA.				
1a. Was the HIA undertaken to inform a proposed decision (e.g., policy, program, plan, or project) and conducted in advance of that decision being made?	The HIA was undertaken to inform the pending decisions about renovations to the Gerena school. Of particular importance was helping to set priorities among a number of proposed renovations. The timeliness of the HIA was adequate but not ideal – some budget decisions and renovations apparently were being made while the HIA was underway, and completion of the HIA was delayed for a number of reasons documented in the report.	Yes. Decision timelines were clearly outlined. The decision to conduct the HIA was comprehensive and included the value added, decision points, timelines, and funding sources.	No comment.	The authors acknowledge that the timing for this HIA was not ideal- in that the HIA was performed as a concurrent HIA, not prospective HIA- and recognized that this limitation was not made more clear in the beginning of the report. The authors resolved to address this issue by making the timing of the HIA more explicit and reflecting the language above in the evaluation of the report.
1b. Were the need for and value and feasibility of performing the HIA assessed and clearly documented?	The need, value, and feasibility of the HIA were assessed and well documented.	No comment provided.	No comment.	No response needed.
1c. Do the authors acknowledge sponsors and/or funding sources for the HIA?	The sponsors and funding sources are appropriately acknowledged.	Yes	No comment.	No response needed.
1d. Is the screening process clearly documented in the report?	The screening process is appropriately documented in the report.	Yes. The report acknowledges that the timeline of the HIA exceeded the original screening and scoping timeframe. This self-reporting of limitations is a hallmark of transparency.	No comment.	No response needed.
2. Scope of HIA.				

Appendix I. Results of the External Peer-Review

Peer-Review Charge Questions	**Reviewer 1**	**Reviewer 2**	**Reviewer 3**	**Comment Resolution from Authors/HIA Core Group**
2a. Are the goals and/or objectives of the HIA clearly defined?	The goals of the HIA are defined in Section 3.1 on page 18. But these goals are somewhat different than the goals in the Executive Summary on Page B-32. Specifically, on page 18 it refers to a goal of examining health and environmental impacts of the proposed school renovations, which is appropriate as an HIA goal. But on Page B-32, the first goal is to improve air quality and asthma, which is too narrow as an overall goal for an HIA. The HIA goals in these two sections should be more consistent.	Yes.	Yes, 2.3.1. discusses some of the advantages of doing an HIA. In 3.1., pp. 18-19, specific goals are explicitly described.	The goals documented in the HIA report are the original goals outlined at the beginning of the HIA (i.e., in the Screening step). As the HIA progressed, these goals were modified in Scoping to reflect more appropriate/reasonable goals for the resources available. The authors resolved to note this process in Chapter 2: Screening and update the HIA goals for consistency.
2b. Is the scope of the HIA clearly defined (i.e., decision to be studied and its alternatives; potential impacts of the decision on health, social, environmental, economic, and other health determinants and their pathways; populations and vulnerable groups likely to be affected by the decision; demographic, geographic, and temporal scope of analysis; health impacts and research questions selected for examination in the HIA and why)?	The scope of the HIA is clearly defined. The HIA core team considered a good range of possible topics with input from stakeholders in the scoping process and appropriately focused on a smaller number for the full assessment. The issue of safety and security of school users (both students and community members) could have received more attention in the HIA assessment and recommendations.	Data availability and data gaps are covered in the report which is very transparent. The vulnerable population is identified in the report. The report also details the method (discussion/consensus) that was used to select the final health determinants to be studied, and in detail is the notion that the stakeholders and community lead the selection of final health determinants and their pathways. It is clear that the HIA team did utilize community knowledge and experiences by holding community meetings. At these meetings, the concerns of the community were acknowledged. The knowledge of the condition of tunnel areas, and the student attendance came from the community meetings. The perceptions of the community regarding deteriorating environmental conditions in	It is not completely clear in the Scoping section what "the decision to be studied" is. It seems to be the selection and sequencing of the renovation options to pursue, of the ones listed in Table 1 on pp 10-11, choosing those that would be of the greatest benefit, and the least detriment, to health. The initial investigations by PBRM, by contractors in 2012, seemed appropriate, and provided substantial evidence, and a set of proposed renovations (Table 1, pp. 10-11) for the HIA to use, and these recommendations did not change during the HIA process. [in regards to potential impacts of the decision on health...] This question on scope seems to be on whether the breadth of potential impacts to be considered is clear? If so, yes, clear. [in regards to populations and vulnerable groups] This is clear. [in regards to demographic, geographic, and temporal scope] The demographic and geographic scope seems clear. The temporal scope is not so clear. At the beginning of Chap 2, it provides that for an HIA to be appropriate,	The topics related to facility use and safety and security are brought up in the Scoping chapter and later discussed in the Assessment chapter, under community perceptions. The HIA minimum elements and practice standards require establishing baseline and impact research questions that drive the assessment. These questions are documented in the HIA report, regardless of whether they were answered to the full intended extent. Documenting this piece of the process helps to inform the process evaluation, which answers whether the HIA was implemented as planned and identifies lessons learned and/or best practices for future HIA implementation. The authors resolved to clarify the discussion regarding the research questions to better reflect their purpose. The HIA Core Group missed an opportunity to further investigate issues related to facility use and safety and security at Gerena, due to limited resources and other restrictions. The authors resolved to discuss this missed opportunity in the evaluation section of the report. The reviewer was correct in discerning that the "decision to be studied" includes the selection and sequencing of renovation options listed in Table 1 on page 10-11. The authors will revisit that section and make improvements for clarity, where

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		the school is described in the assessment section.	there should be enough time for the recommendations to be considered before the decision is made. This apparently seemed feasible at the time, although ultimately it was not the case. The temporal scope of the decisions becomes somewhat clearer towards the end of the document, when it considers solutions that can be implemented immediately, in the mid-term, or in the long-term, and also considers the possibility that any solutions to the current buildings will be temporary while a replacement facility is built. [in regards to health impacts and research questions] These seem clear, as they were developed from input at the stakeholder meetings. In Table 6, the difference between and the different roles of baseline condition research questions and impact research questions are not so clear within the Scoping section. Later this is explained in Chap 4 on Assessment.	possible. In regards to the temporal scope of the HIA, the authors agreed to include the HIA timeline, broken down by step, at the beginning of each chapter (excluding the introduction chapter)believing this change would help provide more context regarding when HIA activities occurred.
2c. Is the scoping process clearly documented in the report?	The scoping process is well documented in the report, including minutes from community meetings in the Appendix.	Yes. The goals of the HIA, the roles of HIA team members and the plan to execute are clearly defined in the report.	Yes, the process is clearly explained.	No response needed.
2d. Are the participants in the HIA and their roles clearly identified?	The participants in the HIA and their roles are appropriately identified.	No comment provided.	Yes.	No response needed.
3. Stakeholder Engagement.				
3a. Are stakeholder groups, including decision-makers and vulnerable population groups, clearly identified?	The stakeholder groups are appropriately identified and invited to participate in the process. One concern is that only 7 of the 27 stakeholder groups invited to participate (page 21) chose to participate. Of these 7 groups, 3 represent government, so only 4 participating groups actually represent voices from the community. It would be helpful to clarify which viewpoints were absent that may have been	Yes	No comment.	The HIA Core Group acknowledge that very few people that were invited to participate attended the scoping meetings. However, it should be noted that those who did participate may have represented more than one group, but listed only their primary organization. The authors resolved to make this notation in the report and highlight this shortcoming in the "lesson learned."

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	different from the viewpoints that were present.			
3b. Is a stakeholder engagement and participation approach, including plans for stakeholder communications, clearly described in the report?	Stakeholder engagement and communications are well described in the report. Announcements of and minutes from stakeholder meetings are included in the Appendix.	Yes	No comment.	No response needed.
3c. If so, was input from stakeholders solicited and utilized as planned in the HIA process?	Input from stakeholders appears to have been used in the HIA process. In particular, the inclusion in the HIA of noise levels and community perceptions of the school appear to have originated with community input and may not have been on the list of issues initially considered by the HIA Core Group.	Yes. The core group used various strategies (e.g. flyers, pamphlets, personal phone calls etc.) to ensure the participation of stakeholders. Additionally, due to lack of English language proficiency of community members, the information was translated in Spanish language as well.	No comment.	No response needed.
3d. Did the HIA utilize community knowledge and experiences as evidence and in what ways?	The HIA Core Group received community knowledge in the stakeholder meetings in 2012 as documented in the minutes of those meetings. The value of the school as a community asset came across clearly and served as a major reason to not consider demolishing the school and rebuilding it elsewhere.	Yes. The community knowledge and experiences served as the backbone of this study. Major concerns of the community included factors that involved respiratory health (e.g. asthma and mold), noise in class rooms that impacted learning environment and the security of the buildings etc.	No comment.	No response needed.
3e. Where stakeholders given the opportunity to review and comment on the findings of the HIA?	The Draft Communications Plan in Appendix A indicates that opportunities for review and comment by the city, external stakeholders and the general public were to occur in 2014. On pages 110-112, Table 21 documents meetings with the city's PBRM office for review and comment, but does not document any meetings for review and comment with other stakeholders or with the general public in 2014 as the HIA was nearing completion.	Majority of stakeholders who were invited for participation did not respond. The report indicates that the core group tried every possible way to convince them to participate, but did not succeed. The situation put the decision-making responsibilities mostly in the hands of the core group. Comments provided by the community members (Community Knowledge) provided essential pieces of information regarding safety, student absenteeism, air quality, mold, health condition and the	No comment.	The authors acknowledge that stakeholders- other than PBRM- were not engaged after the Scoping step of the HIA. The HIA Core Group planned to re-engage the community and other stakeholders during the Recommendations and Reporting steps, but failed to accomplish this objective. This shortcoming was further documented in the evaluation section of the report.

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		community's socio-economic concerns. This information proved valuable to establish the priority list and scope pathway diagram. All stakeholders were encouraged to review and provide comments on the findings of the HIA.		
4. Evidence and Analysis.				
4a. Are the methods for evidence gathering and analysis clearly described and justified?	The methods for evidence gathering and analysis are well described. No noise monitoring was done so it is difficult to assess subsequent improvements in noise in the absence of baseline measurements.	Yes	The search for and decisions about data sources seem generally reasonable. The approach used to decide what air pollutants to assess was appropriate. The prior site investigations identified were appropriately used to characterize problems with the facility. The exception is the method used to assess moisture and mold-related risks. The topic of measurement of indoor air quality and mold did not seem to include a literature review, but just somehow decided to use internal EPA quantification of mold. This is not the decision that likely would have been made from a thorough literature review on health effects of indoor dampness and mold. The method of investigating perceptions among community residents seems reasonable.	The authors noted in the report that no measurements of noise levels were taken in the school. Because the initial funding proposal did not include allocation for noise measurements, and funding was already limited, no noise measurements could be taken at that time. The HIA Core Group acknowledged that the choice of using ERMI to quantify the extent of mold contamination was not based on literature review, albeit there is a plethora of scientific literature on ERMI methodology used in homes. This decision was made, during the development of the RESES proposal, based on the knowledge that the traditional methods of identifying and/or assessing mold contamination (e.g., visual survey) had already been performed at Gerena and further information was needed. EPA recognized the opportunity to apply an established quantification method to a new setting, which would add scientific value. The authors drew from language in the RESES proposal to help add context for why the ERMI method was chosen.
4b. Was evidence selection and gathering reasonable and complete (i.e., was the best available evidence obtained)?	Figure 34 on page E-20 indicates that air sampling was done at only 4 locations which seems like a relatively small number of sampling locations. An air quality expert would be in the best position to judge whether this constitutes a sufficient number of air samples.	Yes	The method of investigating perceptions among community residents seems reasonable. One conclusion was: "residents and students continuously reported a heavy dampness and "musty" odor throughout the school." Note that this is the single factor most strongly associated with both new asthma and allergic rhinitis in available health studies (Quansah et al. 2012;	In regards to the number of air sampling sites, the indoor air and building systems expert reviewer commented that the sampling of indoor air was appropriate. The authors will incorporate the added notation and references provided by the reviewer in the report.

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			Jaakkola et al. 2013). It thus merits consideration in assessing dampness/mold-related health risks in this facility, both before and after renovations, along with other assessments of visible dampness or mold.	
4c. Are the existing conditions (e.g., demographics, socio-economic conditions, health determinants and health outcomes, presence of vulnerable groups, etc.) clearly described?	The existing conditions are well described to the extent that data are available. Census data provide a good picture of local demographics and socio-economic conditions. Health outcomes are less well described because mortality data as not a particularly sensitive measure of health status, especially for asthma and other respiratory diseases that have a high morbidity but a relatively low mortality. Some of the data in Table 11 and in Figures 11-15 are based on small numbers so trends may not be meaningful. It would help if the numbers in that table and those figures were compared with statewide data.	Yes. Information related to demographics, health determinants and health conditions are described under appropriate headings. The evidence selection and their analysis is describe very well along with the reasoning from the core group why the available evidences were selected from the three selected tracts for the HIA completion.	Yes. The demographic, economic, and other community-level health data were appropriately obtained, as feasible; individual level data on facility use or health status was not feasible to obtain within the HIA. The cause-specific mortality rates in Table 11, some of the only health-related data readily available, would not be of much use in decisions about renovations, and are also unlikely to be useful in evaluating benefits or adverse effects of the renovations performed at the school. The asthma prevalence rates by family education level in Springfield, along with the baseline profile of students, and the asthma prevalence among Gerena students (Table 13) are useful in documenting the unusually high asthma prevalence, and would help in estimating study size needed to do a before and after health study among the students. Data from school nurses would also be useful for this.	The HIA Minimum Elements and Practice Standards prescribe that the HIA Report should include a characterization/profile of the status of health in the community. The authors acknowledged in the report that health status data for the study area was limited to mortality data (provided by MA DPH) and student asthma prevalence (provided by Springfield School Nurse Department). The HIA Core Group acknowledged that mortality rates are not the optimal indicators of health status, but that reported cause-specific mortality was the only public health data available at the neighborhood level. The authors noted in the report that mortality does not provide sufficient insight as to the prevalence of disease in the study area, but can be used to infer which health outcomes may be of issue. The authors resolved to clarify this section in the report and minimize it (move the figures and explanations to Appendix) to make the section more understandable for readers.
4d. Is the profile of existing conditions appropriate as a baseline against which to assess the impacts of the proposed decision?	The profile of the existing conditions related to asthma is adequate but not ideal as a baseline for subsequent comparison of impacts. The available data include Table 13 with reported asthma prevalence at the school and Figure 17 related to school nurse visits for illness, asthma, and breathing problems, but do not include any standardized clinical measurement of asthma. No baseline data on noise is provided so there is only anecdotal	Yes. The core group spent a lot of time to profile the existing baseline conditions. This seems important since the other participants did not seem to possess either the technical knowledge or the expertise for this task.	Yes, although as the report states, it will be difficult to accurately assess the impacts actually caused by any renovations performed. One potential opportunity to assess impacts of the renovations is to monitor the student asthma prevalence over time after specific renovations, using a surveillance system already in place for nurses: "The Pioneer Valley Asthma Coalition (PVAC), a local non-profit organization, has been working with the school nurses on documenting visits to the school nurse related to asthma and	The authors resolved to note that asthma prevalence reported was clarified as "physical-diagnosed asthma." The school nurses report prevalence and symptoms for those students already diagnosed by their physicians. The HIA Core Group was unable to obtain more ideal health data, such as direct observations of students and/or medical records. Thus, the best available data was used. Refer to the response to item 4a. regarding the missing noise data. The HIA Core Group investigated, to the best extent possible, potential confounding factors for asthma (e.g., exposures in-home and in ambient air). However, further investigation

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	information against which changes in noise level can be compared.		respiratory health. This data has been used as a baseline to judge the success of community wide actions to improve the management of asthma symptoms." While other factors than just the school environment will influence these outcomes, it may still be worth analyzing these data, and possibly collecting additional demographic or health data to help analyses be more accurate.	was limited by the scope of the HIA. The overall goal of the HIA was to provide timely guidance to City officials regarding renovations at Gerena. Because of this, a long-term follow-up plan is recommended, with PVAC identified as a potential partner, but was not feasible within the HIA timeline.
4e. Are the potential health impacts of the proposed decision identified?	The potential health impacts for asthma, noise, and community perceptions are appropriately identified in Tables 14, 17 and 18.	Yes.	Yes.	No response needed.
4f. If so, is the characterization of impacts reasonable and complete (e.g., direction, magnitude, likelihood, distribution, and permanence of impacts addressed; affected populations clearly identified; etc.)?	The characterizations of impacts seem reasonable, although as documented in Appendix D, some of the characterizations are based on professional expertise where not otherwise addressed in the literature.	Yes. The characterization of impacts are transparent and reasonably supported by evidences e.g., exposure impact to mold and moisture on respiratory health. Predicted impacts of proposed renovations are explained in an easy to understand language – a nice feature of communication with people of different educational and English proficiency levels.	Specification of the potential health impacts of the recommended renovations was reasonable in terms of direction and rough likelihood, although it is not possible to characterize magnitude, distribution, or even the permanence of the impacts (Table 19). Concerning noise, in 4.3 there is a good thorough review. Aside from the unclear method for determining values in Table 17, which summarizes the predicted impacts each renovation option will have on noise, another issue is that the table seems to mix short-term noise increases from renovation activities with long-term effects? The issue of HVAC systems and noise was not mentioned. This is often especially an issue in portable classrooms, but this may not be relevant in this school facility.	The HIA Core Group acknowledged the limitation of this HIA to report quantified predictions in health outcomes. The qualitative characterization of health impacts were developed based on the professional experts in indoor environments and health at EPA. The predicted impacts to health were derived from the Delphi method, which is inherently qualitative. The authors resolved to provide further explanation in the report on how the predicted health impacts were determined.
4g. Are the methodologies, data sources, assumptions, limitations, and uncertainties of the assessment clearly identified?	The methods and data sources are well documented in the text and in the Appendices. The assumptions, limitations and uncertainties could be presented in more detail.	Yes. The usage of ERMI for mold detection is a smart and convenient choice. It is a relatively newer technology that is known for reliable qualitative and quantitative information.	Yes.	The HIA Core Group agreed with the reviewer about the lack of detail in limitations, assumptions, and uncertainties throughout the assessment. The authors resolved to provide more notations in the report where limitations and uncertainties could be noted (e.g., data was missing and/or incomplete, assumptions were made, etc.). In addition the authors will revisit the discussions in the Appendix to see if the

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				methodology of analyses could be further explained or clarified.
4h. Are the conclusions of the analysis based on a transparent and context-specific synthesis of evidence (i.e., are the conclusions reasonable and supported by the evidence)?	The conclusions are reasonable and based on the evidence including recommendations from engineering and environmental experts. The school needs many renovations, some simple and some complex and costly. Including health as one of the components of priority setting is a major reason this HIA was conducted.	Yes. The conclusion of the analyses are transparent and supported by evidences (e.g., exposure impact to mold and moisture on respiratory health). Predicted impacts of proposed renovation are explained in an easy to understand language – a nice feature of communication with people of different educational and English proficiency levels.	The process on which the conclusions are based is fairly clear, and seems appropriately context-specific. The conclusions seam generally reasonable and supported by the evidence, although the actual decision-making is not fully transparent. One conclusion was: "residents and students continuously reported a heavy dampness and "musty" odor throughout the school." Note that this is the single factor most strongly associated with both new asthma and allergic rhinitis in available health studies (Quansah et al. 2012; Jaakkola et al. 2013). It thus merits consideration in assessing dampness/mold-related health risks in this facility, both before and after renovations, along with other assessments of visible dampness or mold. The report concluded that the specific renovations chosen that improved tunnel environments and maintained accessibility, and did not involve further study, would have a positive effect on community perceptions, and on health. These conclusions in Table 18, while requiring assumptions, seemed reasonable. The evaluation of outdoor air pollutants by census tract concludes that the three included tracts had substantially elevated levels of respiratory hazard, above 4. The report concludes "The limit of using this tool is that estimates are generated for a broad area (i.e., census tract, county, state) and may be overestimated." In fact, given the role of vehicular emissions in the measured pollutants, and the location of the school adjacent to t highway, these estimates are more likely to underestimate the risks of time spent	The HIA Core Group agreed that the used of ERMI for quantifying the extent of mold contamination would help bring new information regarding the conditions in the school, beyond what has already been done at the school. However, the HIA Core Group would also like to acknowledge that there exists some debate in the appropriate application of ERMI-based findings and relevance to asthma prevalence.

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			at the school. This would seem to support the importance of considering indoor exposures to outdoor air pollutants at the school, and the importance of filtering the air, while movement of HVAC air intakes farther from the freeway or replacement of the school elsewhere are investigated over years. Page. 106- This is the first mention that "PBRM" may have to consider replacing the school, but leaving the tunnel for the community." This had not been included in the discussion, even though some of the options for renovating the existing school tunnels would offer continued benefits in retained tunnels, even if the buildings were no longer used. This issue may need greater consideration in decisions.	
5. Recommendations.				
5a. Are recommendations, mitigations, and/or alternatives identified that would protect and/or promote health?	The recommendations mostly focus on repairs and renovations to improve air, water and mold issues and would contribute to improving health.	Yes. Recommendations presented in the report are evidence-based, actionable, and enforceable. Since they are science-based, therefore, in all likelihood, protect and/or support the health and well-being of the community.	Yes (to both). The specific mechanism for selecting these recommendations was explained in Section 5.1, but was not fully clear. For instance, the 2 criteria mentioned did not include community perception, although that seemed to be considered in the selection? It is not clear why item 7, removal of water-damaged porous materials, is not to be done immediately, as this may be responsible for much of current dampness/mold exposures to occupants. It is recommended that this should be done, and the items replaced, only after all water intrusion is stopped. While perhaps logical economically, this is not a health-protective decision, and a delay of years for this action seems inadvisable. Some alternative but feasible approach should be developed if possible.	The authors resolved to provide more clarity in the report discerning the development of recommendations and the prioritization process. The HIA Core Group agreed that water-damaged materials should be removed immediately. However, the sources of incoming water will never be completely resolved, due in large part to the building's design. The group also acknowledged, based on information from PBRM, that these materials are replaced on a on-going basis. Given the persistent water issues, the HIA recommends that materials be replaced once the source of incoming water is better controlled, so that the replacement materials are not further damaged and/or contaminated.

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5b. Are these recommendations reasonable and supported by the evidence?	The recommendations seem reasonable. The presentation of the recommendations could be improved by adding a table that explicitly links each recommendation to the assessment finding(s) that support it. The absence of documenting these links between assessments and recommendations were noted by PBRM on page 113.	Yes.	Yes.	There were several iterations between the interim-recommendations (from the on-site investigations) and the final HIA recommendations, which were developed from the comprehensive perspective of reviewing all of the analysis findings. The HIA Core Group had decided to not present the initial recommendations from the interim-HIA reports that related to specific findings and instead provide the final table of proposed action items to prevent confusion among readers. The authors resolved to provide language in the report regarding this decision and further explanation for how the recommendations were developed.
5c. If prioritization of recommendations took place, was the method of priority-setting documented, reasonable, and appropriate?	Prioritization is one of the most important parts of this HIA because many repairs and renovations are needed and not all can be done. The report does a good job in separating the immediate, short term, and long term recommendations in a way that is helpful to decision makers. Appendix B on pages B-26 to B-29 provides an excellent table for setting priorities that includes health value, costs, maintenance, durability and other factors. But the right hand columns of this table are not filled in, so it is difficult to tell which renovations would receive the highest priority.	The prioritized recommendations have placed high stress on mold contamination assessment, building assessment and the assessment of indoor air quality. Timing for implementation and the predicted health values are based on relevant scientific literature reviews and professional expertise. The method of priority setting is reasonable and appropriate.	The method of priority setting was explained, and the decisions seemed reasonable, but the actual decision making was not very transparent. The HIA team also provided specific information on the practicality of each recommended action to the PBRM. 4.6 page 105 – first mention of possible filtration of outdoor air intake for Tunnel A without waiting for further testing or measurements: an excellent idea. PBRM, "could increase filtration to reduce the influence of roadway combustion-source pollutants on the indoor air for Tunnel A." Still, this did not seem to be included in the high priority renovations ultimately listed, for some reason.	In regards to the cost and feasibility values, the authors resolved to add the table filled in by PBRM to the notes from the stakeholder meeting. In regards to upgrading air filtration, there was not enough evidence to support that increased filtration was needed. The data indicated that there was some influence of outdoor-source combustion particles and wind, but there was already appropriate filtering (unidentified) occurring that rendered the average indoor levels of pollutants below of a level of concern.
5d. Is an implementation plan identified for the developed recommendations (e.g., responsible party for implementation, timeline, link to indicators that can be monitored, etc.)?	Table 22 on page 119-123 provides a good proposed outcome monitoring plan including a responsible party, timeframe, and indicators to monitor. The table could be improved by adding a column indicating baseline levels against which each of the indicators could be compared. Appendix E indicates which earlier recommendations are already	Yes. The implementation plan identifies the timeline, responsible party to implement and the link to the indicators. The timeline list of action items for completion within one year, within 2-3 years and after three years is appropriate and reasonable approach.	The timeline is identified, and the responsible parties and funding sources. Possible methods and timing of impact evaluation are discussed, keyed to the recommended time frame of the proposed actions.	The report provides benchmarks for classroom acoustics and a baseline of indoor air measurements for comparison with later assessments. However, the baseline for community perceptions would have to be inferred since no direct surveys were performed to gather that baseline information.

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	underway and the responsible party.			
6. Documentation.				
6a. Is the layout and format of the report clear and logical, with information clearly organized in sections that are easy to follow?	The layout and format is clear and logical and the table of contents is helpful. A short executive summary at the beginning of the report would add substantial value to the report, even though there is a lengthy executive summary buried in an appendix.	Yes.	The report is generally well-organized and clear.	The authors resolved to move the Executive Summary to the beginning of the report and revisit the length of the report and eliminate superfluous details that are already provided in the appendices, as appropriate.
6b. Is the writing style such that the report is easily read and understood (e.g., clearly written, complex or unfamiliar terms described, examples and graphics used to illustrate text, etc.)?	The writing style is easy to read, abbreviations are explained in a table, and tables and figures are appropriate. While the report contains a small number of photos, it would be helpful to include more photos of various places in the school to help the reader visualize the setting and the problems discussed in the report. Some typos and wording errors were noticed in the report; a careful review by a copy editor would be helpful before the report is finalized.	The language of the report is very readable and all the important aspects of HIA practice have been highlighted well. The section on cautions, acronyms and caveats inclusion is novel and should help readers with various educational levels to understand the report. Further, notations and public meeting symbols are novel and very helpful.	The report is clear in these ways, although it is a long and complicated document that winds around in a convoluted way and is somewhat challenging to read and digest.	The authors will re-visit the figures in the report and find areas where the text would benefit from a visual aid. In addition, the HIA Report will undergo technical editing and 508 compliance tasks, prior to publication.
6c. Is documentation of the overall HIA process transparent (i.e., are the processes, methodologies, sources of data, assumptions, strengths and limitations of evidence, uncertainties, findings, etc. of the HIA clearly documented)?	The documentation of the overall HIA process is well done especially on processes, methods, and data sources. More could have been included on study limitations and uncertainties.	The HIA report can serve as a guide for HIA practitioners. The overall HIA process is transparent and the various aspects of the report indicate the hardship in getting scientific data, cooperation from some stakeholders and financial constrains etc. These are the real world problems that HIA practitioners face in their line of work. Authors of this report	This is all done reasonably well, with some issues discussed in these comments.	The authors will revisit the discussion of the limitations and uncertainties in the assessment, as described in the response to 4g.

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		have done great job in writing this report. The core group successfully resolved the problems created due to data gaps (e.g. non-existent, non-publically available data or not relevant data etc.).		
6d. Does the report identify any other methods to be used for documenting and disseminating the HIA and its findings (e.g., briefings, presentations, factsheets, flyers, newspaper or journal articles, etc.)?	The report describes a number of methods of dissemination of the HIA at various stages of the process in Table 21 (pages 110-112) and in Appendix A (Draft communication plan). The plans for dissemination of the final report are less specific.	Yes. The reporting of HIA progress has been an on-going process since the start of the HIA studies. It has used various methods (formats) of communication, described in Table 21 of the report. The core group utilized all available means of communication (e.g. flyers, personal phone calls, e-mails etc.) to involve stakeholders. A Spanish translator was hired to patch the communication gap with the users of the facility.	Yes, it discusses various approaches to do this.	The HIA Core Group acknowledged that the communications portion was a weakness of this HIA. There were missed opportunities for more community participation and more frequent communications among the different stakeholder groups. The authors resolved to revisit the discussion regarding dissemination of communication materials and identify areas where further explanation can be provided and make notations in the lessons learned.
7. Monitoring and Evaluation.				
7a. Was an evaluation of the HIA process conducted (e.g., who was involved, strengths and weaknesses of the HIA, successes and challenges, how effective the HIA was in meeting stated objectives, engagement and communication with stakeholders, lessons learned, etc.)?	The report has a substantial monitoring and evaluation section which is more detailed than that found in most HIA reports. On Page 114, it states that a process evaluation is "whether the methods used to predict impacts to health were appropriate," which is not a good definition of process evaluation. Rather, process evaluation is whether the HIA followed the intended steps, such as those found in various guidelines to conducting HIAs. The challenges identified on Pages 140-145 are a valuable part of the process evaluation in that they recognize what did and did not go well during the HIA and can assist in improving future HIAs. The external peer review now underway is also a valuable	Yes. The evaluation of the HIA process was conducted by involving the decision makers, the HIA core group, PBRM, the City's office of Management and Budget. The Core group also recommended the stakeholders involvement to do a more formal and regular evaluation of the HIA to determine that all recommended implementations are addressed. Also, this would help the decision makers to take appropriate immediate counter action if negative impacts were observed. An Impact Evaluation Form was also developed by the core group to help monitor the	No comment.	No response needed.

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	part of the process evaluation in that it provides an independent review of how well the HIA process worked.	implementation timeline along with relevant supporting evidences. It is admirable that this HIA successfully completed the tasks while facing many challenges that started from the scoping phase of the HIA when only seven out of 27 stakeholders attended the stakeholders meeting. Another challenge that was faced by the core group involved data gaps (e.g. non-existent, non-publically available data or not relevant data etc.). The HIA successfully met the stated objectives and successfully engaged the stakeholders. The HIA made a positive impact on PBRM who supported it and made few changes in the document mainly for financial reasons.		
7b. Was a plan proposed for monitoring implementation of the decision and the effect the HIA had on the decision-making process (i.e., impact evaluation)?	A form for impact evaluation is provided in Appendix F. This form is discussed on Page 117 which it states this form could be filled out by any person including the HIA core group or various stakeholders. While the form is relatively simple, obtaining the information to complete the form requires cooperation from those with sufficient knowledge to know what school renovations were done (such as replacing/repairing HVAC components) and how well the changes match the recommended renovations. It is not clear exactly who would take responsibility for such monitoring.	Yes. Recommended action items may take several years for implementation to occur. Therefore, impact evaluations were planned to be performed at a minimum of 12 months and 48 months.	No Comment.	The HIA Core Group agreed that the simplicity of the form does not reflect the expertise and/or resources needed to complete it. Prior to the finalization of the HIA Report, PBRM provided a document that detailed the final decision and future renovation plans at the school. The HIA Core Group used this information to inform the impact evaluation, rendering the previous form unnecessary. However, the authors notated that stakeholders should continue to monitor the renovations to ensure they are implemented as planned.

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7c. Was a plan proposed for monitoring the impact of the decision?	The plan includes a proposed outcome evaluation on page 124-126 that includes following over time the number of visits to the school nurse for respiratory and asthma related symptoms. As noted in the limitations on page 126, this is not ideal but is a reasonable approach because the data can be easily obtained.	Yes. A detailed, thorough monitoring plan was proposed for identified health determinants (Table 22). The plan includes the time frame for the responsible agency to monitor each indicator, the funding source and the health impact parameters.	Yes, although as the report states, it will be difficult to accurately assess the impacts actually caused by any renovations performed. Monitoring of specific renovation outcomes and of health outcomes is discussed extensively, using a variety of different approaches (Table 22). One potential opportunity to assess impacts of the renovations is to monitor the student asthma prevalence over time after specific renovations, using a surveillance system already in place for nurses: "The Pioneer Valley Asthma Coalition (PVAC), a local non-profit organization, has been working with the school nurses on documenting visits to the school nurse related to asthma and respiratory health. This data has been used as a baseline to judge the success of community wide actions to improve the management of asthma symptoms." While other factors than just the school environment will influence these outcomes, it may still be worth analyzing these data, and possibly collecting additional demographic or health data to help analyses be more accurate. This reviewer would not suggest performing ERMI evaluations over time to assess environmental conditions, but would suggest instead use of better studied, more subjective evaluations of dampness and mold. It is not clear what "SCGIH/ASHRAE evaluations of IAQ" are. If they involve CO2, T and RH, that would seem reasonable. If health were to be monitored in Gerena students to assess benefits from renovations, one relatively good approach, although with limitations, would be, as is suggested on page 126 and Table 23. This should involve	At this point in time, the entities that could perform the monitoring are unknown. Only potential entities that should be involved in the monitoring was provided in the report, but there is no mechanism (contract, funding etc.) as part of the HIA. The HIA Core Group did not agree with the recommendation for using more subjective measures for follow-up. Using objective measures, where possible, helps to eliminate potential bias inherent with subjective methods. EPA offered to perform post-assessment ERMI sampling at no cost to PBRM to provide a comparison to baseline results. For more responses related to the use of ERMI, refer item 4a and 4h, above.

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			data collected the same way before and after the renovations, and would be strengthened if school nurses could also collect data on asthma inhaler use at school, as well as data to adjust for differences in demographics and initial diagnosed asthma prevalence, year to year. Again, for schools and if any home data can be obtained, I would suggest careful data collection on dampness and mold indicators, instead of ERMI.	
8. Overall HIA Process.				
8a. Are the methods and procedures used in the HIA appropriate?	The overall methods and procedures used in the HIA are appropriate and efforts to incorporate stakeholder engagement were well done. The report could provide more information on limitations of the methods used.	Yes.	The identification of the health problems that defined the research questions to be addressed in the HIA (Table 6 and then section 3.5.3) seems to have included only those perceived by community stakeholders. The community may not know about risks that are chronic health effects rather than acute. Other relevant health effects, including chronic, may include other less obvious impacts that might be identified by public health or technical experts; e.g., greater likelihood of developing incident asthma with dampness/mold exposures, chronic effects of spending each day in and outside buildings adjacent to a major freeway, etc. The HIA process is obviously very complex and challenging. The history of this particular HIA suggests that ensuring timeliness will be a key challenge, and may require difficult trade-offs between completeness/thoroughness and speed. Developing a way to produce preliminary results when needed would be good, even if complete results take longer.	The HIA Core Group decided to focus on the issues more important to (or identified by) the community stakeholders, within the context of the decision appraised. The HIA Core Group performed literature reviews to verify the impact pathways of interest. However, as with most HIAs, the resources available to perform in-depth analyses and further investigations limited the scope of the HIA. Not all issues that were identified could be investigated in the assessment. Inclusion of chronic health data would have increased the expense and the time required to complete the assessment, which was already behind schedule. Furthermore, investigating other sources of asthma symptom exacerbation outside the school would have been outside the scope of the decision and inherently the HIA.

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8b. What aspects of the HIA process appeared to be implemented effectively or successfully and what aspects of the HIA process could have been strengthened or improved?	The overall process was well done for each of the steps of the HIA. Some areas that could have been improved include better timeliness of the recommendations related to the decision making processes (acknowledging there are factors beyond the control of the HIA Core Team), obtaining baseline measurements of noise levels before trying to improve noise levels, and tying each recommendation more specifically to the assessments.	Public perception and the visibility implemented changes/processes was given priority status. A list (Table 18) was prepared to summarize the predicted impacts of proposed renovations on community perception. Most proposed renovation items are expected to result in positive promotion of citizen's health.	No comment.	For more discussion, refer to responses for items 1a, 4a, and 5b.
8c. To what extent were the goals and/or objectives of the HIA achieved?	As documented on pages 139-140, the goals and objectives of the HIA were generally met including providing a full HIA with recommendations and lessons learned for future HIAs in which EPA may be involved. The goal of providing asthma-related educational materials of the community appears to be incomplete as of the date of the report.	This HIA has achieved most of the goals/objectives that were set in the scoping section (page 17-18) of the document. This includes: (a) Information for stakeholders how built environment could impact health and wellness at the project site. (b) Decisions that will be made to maximize health benefits and avoiding potentially harmful health impacts. (c) Present scientific evidences, professional expertise and the community input regarding the problems at Gerena. (d) Use the assessment information to develop comprehensive recommendations addressing the environmental problems to promote health and wellness of the building users. (d) Make recommendations for consideration in decision making that will help maximize health benefits and avoiding potentially harmful health impacts. Additional goals that EPA indicates, include the development of HIA that will provide science-	Other than the extended time required, the HIA seems to have achieved its primary goals. It will not be fully clear till later the extent to which the HIA recommendations were practical/ feasible enough to provide actual benefits to the Gerena renovation process.	The opportunity to provide asthma-related educational materials was missed in this HIA, but there are other entities that provide these materials. EPA's Indoor Air Quality Tools for Schools Initiative offers several handouts and reference materials related to asthma in school. Handouts in both English and Spanish are needed to ensure the information available is accessibility to this community.

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		based and context-based educational material and tools, lessons learned and other tools that could be used by other federal agencies in the future.		
9. General Comments.	Overall the report is well done. Its usability would be increased if a concise executive summary were to be added to the beginning of the report. It would also be valuable to add a section that more explicitly identifies the limitations of the study.	The title of the HIA does not lend itself to internet search for topics such as relocation, renovation, demolition degraded tunnels, mold remediation/control, water infusion, schools, students, school staff, community health etc. The title of the HIA does not give any detail as to what are the main concerns of the HIA that a potential reader should know. Consideration should be given to include an Abstract for quick overview and understanding of the most important findings and results. This HIA has all the qualities to serve as a mini-training booklet in HIA process and HIA related materials and forms. If the authors' goal was to provide an HIA that would inform and educate future HIA practitioners about the subject, then they have achieved that goal with this HIA. The reader of this report has to work hard to understand if: (a) the tunnels also serve as a building space with offices, community rooms, and classrooms, and (b) are the tunnels open to anyone or just for the school staff and students. It would be easier to understand the situation of problem in the tunnel area if these items were explicitly stated.	Regarding "monitoring for indoor air quality" as an outcome: using this terminology might lead to less than optimal follow-up for the following reason. In evaluating indoor dampness and mold in the buildings, the current most scientifically supported evaluation would be to assess visible moisture, visible water damage, visible mold, and mold odor, and not to measure anything in the indoor air, and probably not anything in the dust for now. The phrase "indoor environmental quality" might be more appropriate for this reason (as well as because it would include noise as well).The issue of the location of the school adjacent to a highway, and resulting high indoor and outdoor exposure to OAPs, is not emphasized sufficiently in this evaluation. Multiple studies have shown high pollutant exposures and increased health risks for such locations. The need to ensure adequate outdoor air ventilation at the school, but the downside of bringing indoors more outdoor air pollutants while doing this, suggests a need to assess the feasibility of outdoor air cleaning in the school HVAC system. This is especially true if any decisions about moving some air intakes farther from the roadway might take years to make, might still introduce unhealthy levels of outdoor pollutants indoors, and might not be done at all. "During events of heavy rainfall, the pits fill too quickly and overpower the pumps causing system failures and damage." An issue not specifically addressed in the report is that of the capacity of the	The authors resolved to make the proposed changes for moving the Executive Summary to precede the report and making the title more searchable. The authors added "key terms" under the proposed citation to improve visibility of the report. In regards to the monitoring plan for indoor air quality, the HIA Core Group disagreed that the follow-up activities should not include considerations for mold and moisture, as discussed in the responses above. The water pumps that control the groundwater around the school were not further investigated, since they were replaced with backup pumps at the main stations. The authors resolved to provide more information about the water pumps in the report. The HIA Core Group does agree with the reviewer's comment about lessons learned in future school siting.

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			water control systems for the tunnels. In standard urban decision making, drainage systems can be designed as adequate for all but the unusual flooding, and when the 100-year storm occurs, the streets flood. However, when a building for children and a community is located within a tunnel that can flood, and the building will become a major health hazard and require extensive remediation or demolition after flooding, the cost/benefit balance needs to shift. If this is not possible, then this provides evidence that a school and community center should not be located in these tunnels in the first place. The wisdom of siting major building uses underground in tunnels where water incursions would be likely, and in fact have been ongoing, is questionable. Obviously this must be balanced against feasible alternatives in this community.	
			The references in the comments above are: Jaakkola MS, Quansah R, Hugg TT, Heikkinen SA, Jaakkola JJ. 2013. Association of indoor dampness and molds with rhinitis risk: a systematic review and meta-analysis. J Allergy Clin Immunol 132(5): 1099-1110 e1018. Kangchongkittiphon W, Mendell MJ, Gaffin JM, Wang G, Phipatanakul W. 2015. Indoor Environmental Exposures and Asthma Exacerbation: An Update to the 2000 Review by the Institute of Medicine Environmental Health Perspectives; doi: DOI:10.1289/ehp.1307922. Mendell MJ, Mirer AG, Cheung K, Tong M, Douwes J. 2011. Respiratory and allergic health effects of dampness, mold, and dampness-related agents: a review of the epidemiologic evidence. Environ	

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			Health Perspect 119(6): 748-756. Quansah R, Jaakkola MS, Hugg TT, Heikkinen SAM, Jaakkola JJK. 2012. Residential dampness and molds and the risk of developing asthma: a systematic review and meta-analysis. PloS one 7(11): e47526. WHO. 2009. World Health Organization (WHO) Guidelines for Indoor Air Quality: Dampness and Mould. (WHO Guidelines for Indoor Air Quality). Bonn, Germany.	

Table 2. Responses and Comment Resolution for Technical Charge Questions

Additional Questions for IAQ and Building Systems Expert	Technical Reviewer	Comment Resolution from Authors/HIA Core Group
a) Were the series of investigative studies conducted at the school and used as evidence in this HIA (see below) designed and conducted in an appropriate manner?	In general, (a)-(e) were good for all factors of interest, with some exceptions described below. The assessments and data interpretation for temperature and relative humidity, HVAC systems and operation, air movement/pressure, combustion pollutants, and ultrafine and fine particles seem (p. 74) reasonable, based on the evidence collected and the literature review.	Responses provided below.
b) Are there any uncertainties in the assumptions, parameters, and/or methodologies used in these studies?	No comment.	No response needed.
c) Were the claims reported by these studies reasonable and consistent with indoor air and building system principles?	No comment.	No response needed.
d) Were the results of these studies and the findings of the literature review used appropriately to describe the current conditions at the school as they relate to indoor air and building systems?	No comment.	No response needed.

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e) Were the results of these studies and the findings of the literature review used appropriately to characterize the potential health impacts of the indoor air and building system-related renovation options?	One general exception is for item (e) above: Table 7 p. 36, in metrics used to characterize health impacts, considers magnitude of health impact to include only the number of people effected. The magnitude does not include the likelihood/probability of effect per person (as a multiple of baseline health risk or an excess health risk, such as a 50% or a 150% increase in risk for individuals in a population with a specified exposure, as estimated in an odds ratio, risk ratio, or relative risk), an important dimension that may be available from prior health studies for specific health risks, such as indoor dampness or mold, and possibly for indoor exposures to outdoor air pollutants at school. For (e), on p. 73: the ranking of exposures in what seems to be an un-numbered figure. "Exposures were then grouped and ranked according to how frequent each was found to be a significant risk factor for triggering asthma symptoms." It is not clear what this means (perhaps, in how many studies, or how many review articles, the exposure was deemed a risk factor for asthma exacerbation?) It is also not clear that this is a good way to rank the importance of exposures. For (e), conclusions about predicted impacts of proposed renovations on IAQ, on pp 74-76: the method for determining values in this table is not clear, and the process is not transparent. "Each renovation option was evaluated, based on the ranking of factors that trigger asthma and the potential to impact respiratory health for those without asthma. Table 14 summarizes the predicted impacts of each of the proposed renovations on respiratory health and asthma." Also, while the conclusions still seem generally reasonable, there is one omission – relocating outdoor air intakes seems advisable, but no mention of possible additional air cleaning for air brought in, immediately, or for even future improved intake locations if still near a major road.	As noted in previous responses, magnitude for this HIA was characterized (qualitatively) as a separate criteria than likelihood. The authors resolved to provide more explanation in the report on how the predicted impacts were determined. In regards to the process for raking of asthma exposures, the authors resolved to provide more explanation in the appendix and clarify the language in the report. In regards to upgrading air filtration, there was not enough evidence to support that increased filtration was needed. The data indicated that there was some influence of outdoor-source combustion particles and wind, but there was already appropriate filtering (unidentified) occurring that rendered the average indoor levels of pollutants below of a level of concern.
Speak to:		

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• *Settled dust sampling to test mold contamination;*	Note that there is no specific investigation category listed here for the issue of moisture incursion as a critical element that requires assessment as to presence, severity, location, and required remediation strategies. In fact this was appropriately investigated in 2012 by PBRM contracts with architects, industrial hygienists, and building engineers. For now, the most well-documented assessments of indoor environment for evaluating dampness/mold-related health risks are the assessments of visible dampness, visible water damage, visible mold, and mold odor ,(WHO 2009; Mendell et al. 2011), which have been causally associated with asthma exacerbation (Kangchongkittiphon et al. 2015). No measurement of mold or other microbiologic measurements has currently been found to have this well-documented a relationship with asthma exacerbation. ERMI might, within the EPA and at some commercial laboratories offering ERMI-related services, be considered a recognized and validated assessment for moisture-indicating mold. However, it is not considered such in the broader scientific communities working in indoor air, microbiology, and health. There is nowhere near the amount of scientific substantiation needed to justify the use that ERMI is put to in this HIA. The exclusive use of ERMI-based assessments, and not evaluation of dampness/mold indicators, is a major limitation of this HIA evaluation. For instance, on page 74, the report says "Mold remediation/clean-up efforts should be focused in the areas where high levels of mold spores were found – classroom pods, afterschool room (Lower Level of Building B), and Administration Office. Even if these areas do not have active or readily identifiable sites of mold growth, settled dust sampling showed high levels of mold spore contamination, which increases the risk for these areas to develop mold growth." Current evidenced suggests that evident dampness or mold would be more appropriate indicators of a need for remediation. Issues with the decision to use ERMI to assess indoor health risks include: o The basis for assuming that the specific sampling approach used in ERMI is adequate(e.g., one dust sample is sufficiently representative of a specific home or building) has not been demonstrated, to my knowledge, even if this approach has been used in many publications on studies with ERMI. No studies seem to have included validation of this approach. o The specific ERMI formula for selecting and combining concentrations of 36 specific fungal species, and the interpretation, were developed in a manner that has never been well-scrutinized by outside researchers for success in identifying buildings with water damage, or with unhealthy levels of mold growth. To this reviewer, the basis of the construction of the ERMI scale has never been clearly explained or justified, even though each article in which ERMI is used cites prior articles as if they contain such justification. o Prior ERMI data, on which interpretation in this HIA rest, have been mostly from homes, not schools. o QPCR-based assays of fungi in dust hold great promise for assessing indoor fungal growth for use in determining health risks. However, some of the specific "primers" used in the set of 36 QPCR assays are considered by some mycologists to be erroneously derived and thus incorrect. o Overall, while the use of fungal QPCR shows promise, use of fungal QPCR in dust, and ERMI in particular, is currently only justifiable as a research tool, and not as a validated assessment for dampness-related fungi (and thus a proxy for health risks) in all kinds of buildings, including homes. Especially inappropriate would be to interpret an ERMI score with some accompanying "threshold" level to trigger action or justify non-action. It is not clear that the ERMI, despite its quantitative nature, provides more information about health risk than subjective indicators of indicators dampness or mold. Such an advantage has not been clearly demonstrated. o In this HIA, Figures 18-20 do not provide actual ERMI levels for each location that could be compared to levels (~13.8 – 19.1) found in the one school and one school gym studied in the two cited studies (Thomas et al. and Li et al.).	It is important to note that all epidemiological studies of asthma come with limitations. The WHO 2009 report is a review of pre-2009 studies and recommended that mold exposure should be "minimized." The ERMI was not created until 2007 to help quantify the extent of mold exposure. It should also be noted that that the WHO report was highly supportive of the development of molecular-based methods of mold analysis because of the many limitations of traditional mold analysis methods. HUD in its testimony before Congress also noted the many limitations of traditional mold analysis. These quotations and references can all be found at: Vesper S. Traditional Mould Analysis Compared to a DNA-based Method of Mould Analysis. Critical Reviews in Microbiology. 2011. 37:15-24. (A pdf of this publication can be made available upon request.)

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• Air pressure mapping throughout the facility;	An important assessment to make, often not performed. This would be very important in correcting the overall indoor air problems in the school, considering the identified moisture incursion, mold, and outdoor pollutant issues. The report says mixed things about air pressure relationships. For instance, on page 74, it says: "Continuing to evaluate and adjust the HVAC system control logic may help to improve air flow in the building simply by reducing pressure gradients between spaces." This seems simplistic – the desired pressure differentials and air flows depend on where the air is flowing, and some pressure differences are desirable. Elimination of all differences is not necessarily ideal. For instance, see paragraph below re desired positive pressure in the inner tunnel in Tunnel C.	The HIA Core Group agreed that the air pressure mapping analysis was critical to the assessment. The authors resolved to revisit the section describing the analysis and its findings and provide more clarity of its intent.
• Building enclosure air tightness testing and infrared imaging;	Useful and appropriate	No response needed.
• A visual survey of HVAC equipment and maintenance plan;	This was a critical inspection to conduct, apparently not done recently or ever before this, and it turned up multiple problems needing remediation.	No response needed.
• 3-day continuous recording of indoor carbon dioxide, temperature, relative humidity, and laser particle counting in selected areas; and	In Appendix E, the report says "Carbon dioxide (CO_2) levels were elevated above 800 ppm in 5 out of 23 areas surveyed, indicating a ventilation problem in some areas of the school." One caveat here is that these measurements would only be valid if they were taken in an occupied space after a substantial period of occupancy during the day, not in, for instance, a classroom early in the morning, or an assembly room or classroom with no occupants. Also, since 800 ppm, with a likely outdoor CO_2 of at least 400 ppm, is a pretty conservative threshold for indicating ventilation problems, and this was only found in 5 of 23 locations, this does not suggest a widespread problem of inadequate ventilation. However, it does seem that this approach enabled investigators to identify units with closed dampers, so it was helpful.	The authors resolved to make notifications about the carbon dioxide monitoring in the occupied spaces, as indicated by the Building Conditions and Systems Analyses interim report.
• 6-day recording of indoor temperature, relative humidity, and select combustion source pollutants (particles and gases)	The report says on p. 54 "Investigators measured the levels of combustion source air pollutants coming into the building through air intakes and in two locations inside the school." On page 64, it says: "Continuous monitoring equipment was used to sample nitrogen oxides (NOX), carbon monoxide (CO), particulate matter ($PM_{2.5}$), ultrafine particulate matter ($PM<1.0$), and black carbon (BC). Monitors were placed at two different indoor locations, which sampled the air for three days at each location; and in two fresh air intakes, which sampled the air for six days." These measurements seem appropriate, and this showed high levels of several outdoor pollutants from mobile sources at the intake for Tunnel A. The report contains some odd language about CO_2: "When a space is occupied, there must be enough fresh, outside air provided so that occupants can breathe easily and carbon dioxide (CO_2) levels remain low." Outside air does not help occupants breathe easily. CO_2 is generally not considered to be an indoor pollutant per se, but just an indicator of whether the ventilation systems is effectively keeping down the concentrations of indoor-produced pollutants, especially occupant-produced pollutants. That sentence doesn't make this clear.	The authors resolved to revisit this section with the HIA Core Group and verify/clarify the language for better understanding.

End.