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THE RELATIONSHIP BETWEEN CHEMICALS PRESENT IN THE SCHOOL ENVIRONMENT AND STUDENT HEALTH AND STUDENT ACADEMIC ACHIEVEMENT

Submitted by

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A Dissertation Presented in Partial Fulfillment
Of the Requirements for the Degree
Doctorate of Education

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Abstract

The purpose of this study is to examine the relationship between environmental chemical exposures in the school environment and student health and achievement. There is ample medical evidence that chemical exposures, at certain levels, can cause acute reactions in children. There is also medical research that indicates long-term, low-level exposures to certain chemicals can have negative health impacts long-term. What has not yet been determined is to what extent there is any short-term impact on health when exposure is at levels currently considered safe. Moreover, research on short-term student health impact, and that relationship to student achievement, did not previously exist.

Table of Contents

List of Figures

List of Tables

Chapter 1: Introduction

There are many petrochemicals in the physical school environment to which students are exposed. Petrochemicals are contained in both pesticides and cleaning products. "Although insecticides were most frequently associated with pesticide-related illnesses (n = 895, 35%), we found that exposure to disinfectants at schools might also be a cause for concern" (Alarcon et al., 2005, p. 463). The danger of persistent low-level exposure to both pesticides and disinfectants at schools is an issue, which needs to be quantified. Pesticides can be tracked into buildings, and disinfectants are used regularly, which keeps students and school employees constantly exposed to these potentially dangerous toxins. As stated by Frumkin, Geller, Rubin, and Nodvin (2006), "a safe and healthy school environment does more than benefit student health; it also improves academic performance and morale. It does more than protect students; it also safeguards teachers and staff" (p. 7). The implication is that there is a correlation between student health and student achievement.

The impact of a safe school environment can potentially impact students and teachers by means both quantifiable and non-quantifiable. The quantifiable component will be examined in this study via a review of test scores over a range of years. A district, which follows a green program, that employs comprehensive policies and procedures for conducting operations and maintenance of the school environment, will be contrasted against neighboring districts, which use traditional, primarily non-bio-based/non-green, policies and procedures. The non-quantifiable perception of safety will not be directly observed or reviewed, but warrants review in future research. This study explored any correlation between chemical environmental factors and student health and achievement, but there is potentially a correlation between teacher

perceptions of a safe environment and instruction, which may influence student achievement factors.

There are many products present in the physical school environment in which students and teachers spend their school day. Petrochemicals, which are contained in both pesticides and cleaning products, are one aspect of the environment to which students are exposed; these products are used in high quantities in a traditional building maintenance program. Pesticides and disinfectants are both used regularly, which impacts student exposure to these recognized contaminants. "There is a large body of literature associating short-term changes in air pollution with short-term changes in pulmonary health of children, often focused on individuals with asthma" (Schwartz, 2004, p. 1039). The potential danger regarding persistent low-level exposure to traditional cleaning products at schools, and the volatile organic compounds (VOCs) they release into the built environment, is an issue which needs to be understood by educators and parents. Health hazards associated with exposure to volatile organic compounds are stated on product the Safety Data Sheets required for all chemicals used in the school environment.

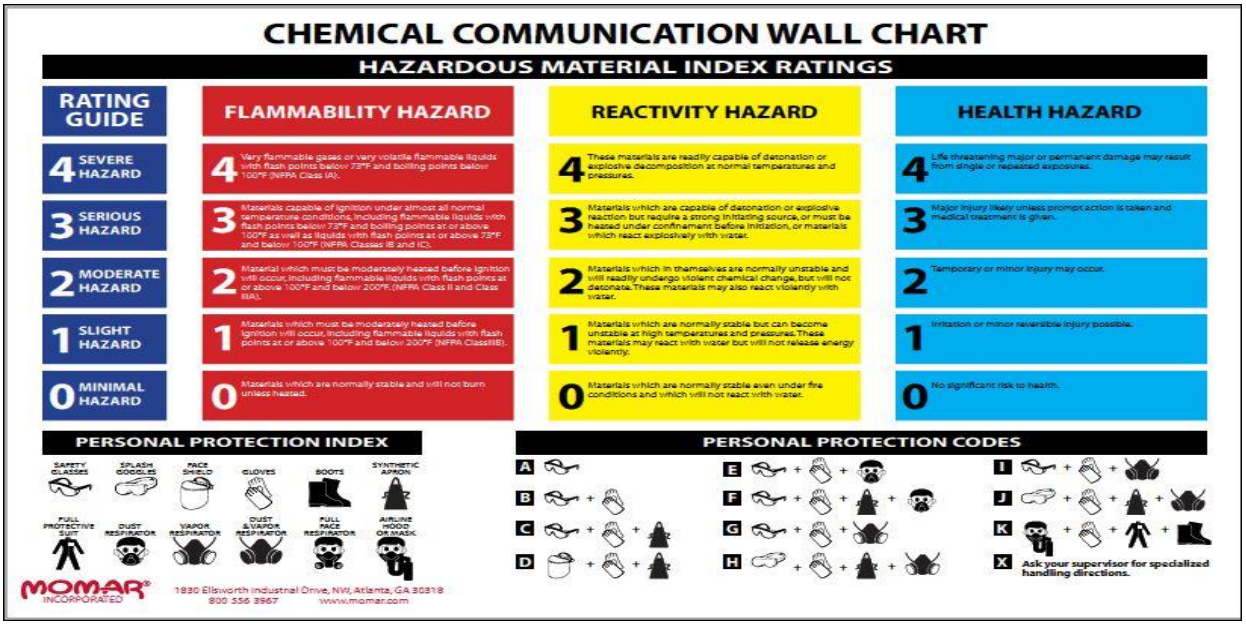
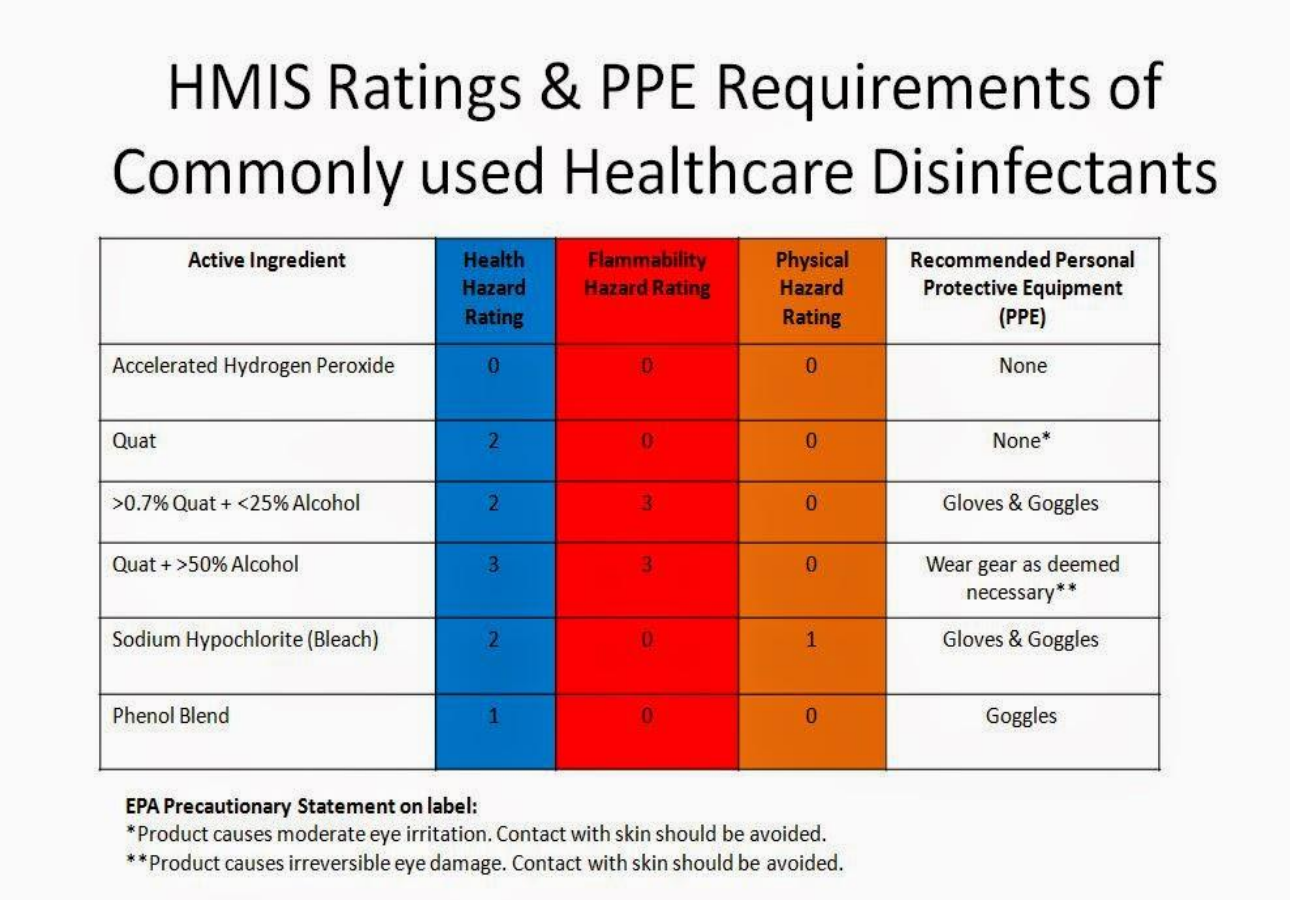


Figure 1. – Chemical Communications Chart



HMIS Ratings & PPE Requirements of Commonly used Healthcare Disinfectants

Active Ingredient	Health Hazard Rating	Flammability Hazard Rating	Physical Hazard Rating	Recommended Personal Protective Equipment (PPE)
Accelerated Hydrogen Peroxide	0	0	0	None
Quat	2	0	0	None*
>0.7% Quat + <25% Alcohol	2	3	0	Gloves & Goggles
Quat + >50% Alcohol	3	3	0	Wear gear as deemed necessary**
Sodium Hypochlorite (Bleach)	2	0	1	Gloves & Goggles
Phenol Blend	1	0	0	Goggles

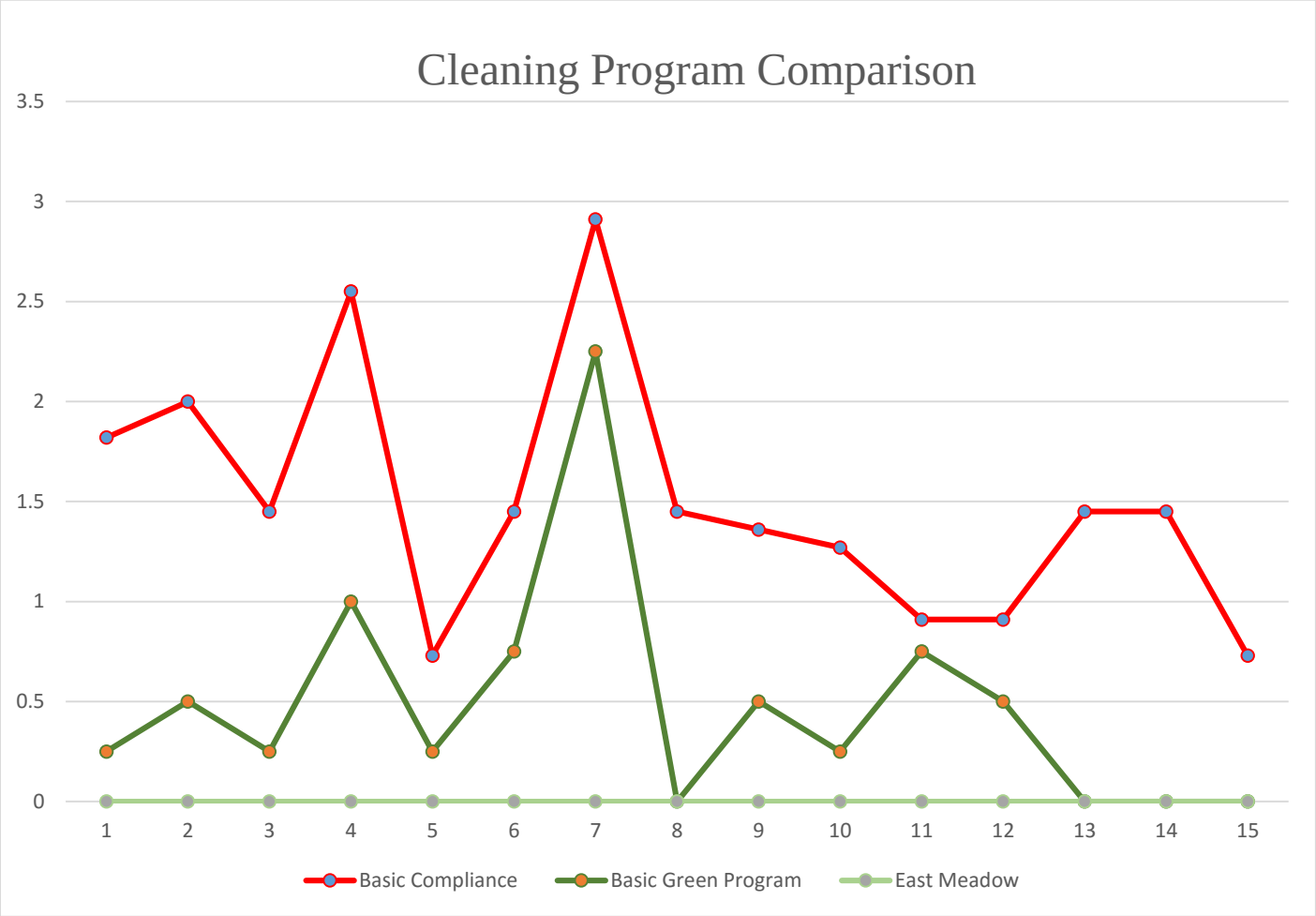
EPA Precautionary Statement on label:
*Product causes moderate eye irritation. Contact with skin should be avoided.
**Product causes irreversible eye damage. Contact with skin should be avoided.

Figure 2. – HMIS Ratings and PPE Requirements of Healthcare Disinfectants

Several types of chemicals are used for disinfecting. Chemicals listed on this chart exhibit the range of impacts that these chemicals have on the health of students and building occupants. The only chemical on the chart used regularly in a bio-based green environment is Hydrogen Peroxide, which off-gases only oxygen. All other chemicals listed cause a range of issues, from irritation to more substantial impacts on health, even when used as directed according to the Environmental Protection Agency (EPA) notation on label.

Table 1. – Cleaning Comparison Chart

Hazardous Materials Identification System (HMIS) - For Health



	Cleaning	Bathrooms	Glass	Disinfecting	Air Freshener	Wax	Stripper	Carpets	Grout	Graffiti	Polish	Paint	Polyurathane	Microfiber	Theoretical Approach
Basic Compliance	1.82	2	1.45	2.55	0.73	1.45	2.91	1.45	1.36	1.27	0.91	0.91	1.45	1.45	0.73
Basic Green Program	0.25	0.5	0.25	1	0.25	0.75	2.25	0	0.5	0.25	0.75	0.5	0	0	0
East Meadow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Background of the Study

Many functions, both internal and external to the classroom, potentially have an effect on student achievement. The goal of this research is to quantify any impact of environmental factors on student health and achievement and provide a resource to support the primary function of student education. The multiple issues, which have been investigated, indicate several possible correlations. The literature indicates that (a) there are many substances which potentially adversely affect health in children, (b) children may have greater absence rates when exposed to these substances, and (c) there may be a correlation between student health and student achievement as measured by data on student testing. Health impacts attributable to chemical exposures are known, through mandated testing, to comply with Safety Data Sheet regulations. Long-term, low-level impact of chemicals used in a school environment on student health/achievement are inconclusive. An analysis was completed using a *t*-test and an ANOVA model has been utilized to evaluate any correlation between chemicals in a school environment and student health/achievement impacts.

The intent of this inquiry was to examine through examination of standardized test scores, a possible link between the scientifically established health concerns listed in the literature and student health as related to student academic achievement. Research on the effect of low-level long-term exposure to petrochemicals is available, but any link to student achievement has not previously been explored. There are deficiencies in the research regarding volatile organic compounds produced by petrochemicals, and this limitation may require additional research (Chin et al., 2013, p. 412).

The concerns related to petrochemicals are now medically known, as stated in the literature review. Safety Data Sheets state the potential threats of traditional chemicals- both

acute and long-term. What has not been stated is the low-level short-term impact of traditional chemicals on student health, which may then affect student academic achievement. Safety Data Sheets offer guidance on how, if used properly, traditional chemicals will not have any short-term acute (asthma attacks) or long-term (various cancers) effects on students in our schools. However, chemicals are not always used as directed, and some accumulate in the environment-both of these issues relate to greater than expected exposures for children. Further, even when these products are used as directed, products are evaluated on the potential impact on healthy adults, not children. Synergistic effects of multiple chemicals, used concurrently in the school environment, have not been examined. Children not feeling well, or worse not in attendance and missing instructional time, may be affected by short-term exposures to chemicals.

Purpose Statement

The purpose of this study is to evaluate to what extent there is a correlation between the physical environment and student health and achievement. This has been evaluated through comparison of historic scoring data from previous non-bio-based environments in the East Meadow School District to contemporary scoring and attendance data in the same district, which now maintains a green environment. Participants in this study were elementary school students at all 5 locations in the district; schools included in this inquiry are (a) Barnum Woods Elementary, (b) Bowling Green Elementary, (c) George McVey Elementary, (d) Meadowbrook Elementary, and (e) Parkway Elementary. There are a multitude of factors present in the school environment which cannot be controlled as part of this study, including (a) changes in testing, (b) variations in socio-economic conditions (both internal and external to East Meadow Schools), (c) changes in teacher training and evaluation, and (d) changes in technology available to both teachers and parents. Due to this limitation, data from 17 other districts in Nassau County was

used, over the period examined, to control for these other factors, which have an impact on student achievement.

Research Questions

What is the relationship between chemicals present in the school environment and health/student performance?

1) To what extent are chemicals present in the school environment, such as petrochemicals used in non-green cleaning chemicals, correlated with the achievement of students in East Meadow elementary schools, where use of these chemicals has been reduced?
2) To what extent is attendance, as measured by evaluation of student attendance data, in an environment practicing a green maintenance program, correlated with the change to bio-based green cleaning program? What is the correlation as the program is implemented in a more comprehensive manner?

Significance of the Study

What is the relationship between student health and the physical environment? The impacts of (1) pesticides, (2) traditional cleaning products, and (3) poor indoor air quality (IAQ) on student achievement have been identified as potential points for concern, but have not been conclusively proven or quantified. Lack of existing data confirming a link between the physical environment and factors such as achievement and attendance is a challenge. As stated by Mendell (2007), "The primary goal of this review was to summarize available knowledge relevant to the effects of indoor school environments and the performance and attendance of children. Little direct scientific evidence of high quality was available" (p. 25). Research indicates cause for concern; however, to date, studies on the effect of these green issues are limited.

East Meadow Schools, through a district-wide green committee, have implemented a comprehensive green approach, which has been well received and widely chronicled; however,

wide acceptance of the importance of these initiatives is not universal. An approach, from the perspective of local stakeholders, may explore possible implications of actions taken by an organization. As stated by Xia, Stone, Hoffman, and Klappa (2016), "Academic researchers and community representatives jointly plan a project and develop objectives in light of a mutually negotiated mission and equal decision-making powers that incorporate community assets, knowledge, priorities, and customs" (p. 412). This inquiry is a quantitative, quasi-experimental inquiry to evaluate any correlation between chemicals used in the built school environment and student achievement. Salient research on environmental toxins to which children are exposed was identified and evaluated. Research of childhood illness related to low-level, long-term exposure to petrochemical products would be an effective method of gathering secondary source material. Historic data and current findings would need to be compared to determine if a variance could be identified.

Effective control of physical environmental factors by administrators may positively influence teacher efficacy; through improved teacher efficacy student success may be enhanced and encouraged. Various functions, both internal and external to the classroom, impact student achievement; research regarding the impact of the physical environment on instruction is incomplete. Research on the effect of low-level long-term exposure to petrochemicals is available, but the link to any correlation to teacher efficacy or student health and achievement is also deficient. As stated by Creswell (2008), "deficiencies in the research may require a need to extend the research, replicate a study, explore a topic, lift the voices of marginalized people, or add to practice" (p. 79). A survey of 17 participating districts was completed to address this deficiency and confirm the theory of cleaning programs differing in districts contained in this geographic area.

Practical concepts that are rapidly being accepted in the facilities industry must be quantified to be implemented nationally. Long-term, low-level exposure to petrochemicals and environmental toxins may lead to developmental problems such as (a) childhood obesity, (b) diabetes, (c) asthma, (d) cognitive developmental issues, and (e) acute illness which must be quantified through further research. This study evaluated if environmental factors, which may impact on student health and achievement, can be controlled prior to the student's entrance to the classroom through an existing green maintenance program. Advances of our society, through the use of petrochemicals, etc., may be an impediment to our success in a global community through reduced health of children in the built school environment. The potential for a change in the environment having an impact on students warrants further study.

Conceptual Framework

In the East Meadow School District, there are five elementary schools, two middle schools, and two high schools. East Meadow, and a portion of Westbury included in the school district, serves an area consisting of approximately 50,000 people. The majority of the people in the community are Caucasian, but an expanding minority population has increased diversity, which is consistent with many districts in Nassau County. Income levels range from lower to upper middle class; the average household income is $81,392. East Meadow and Westbury are located on Long Island, New York in the northeast part of the United States. Green cleaning in East Meadow Schools was not effectively, or widely, applied prior to 2008.

The focus of the study was on all five elementary schools, as any potential impact from environmental factors is more prevalent on younger children. As stated by Cooper et al. (2000):

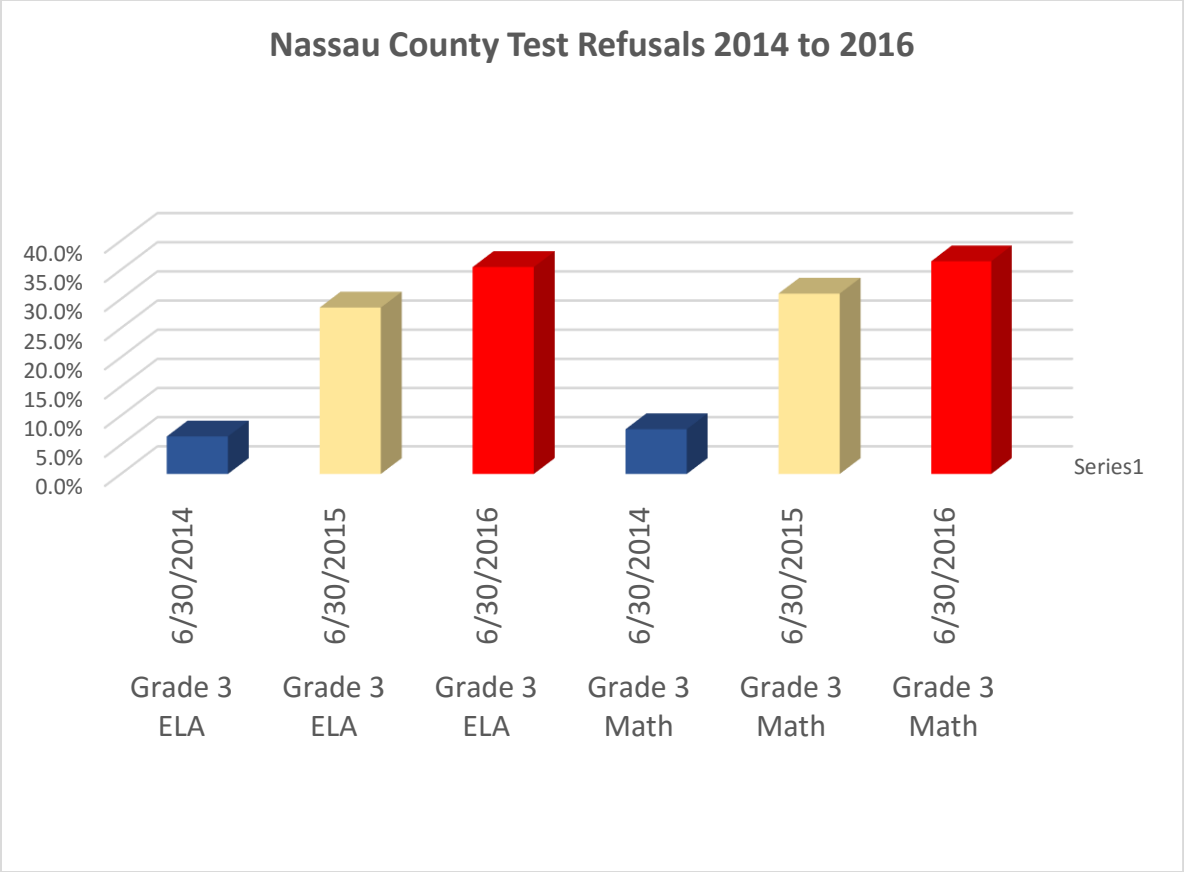
> Underdeveloped, immature organ systems (especially the lungs, skin and gastrointestinal tract) allow greater absorption of chemical contaminants via inhalation, absorption and

> ingestion. As well, the smaller size of the child means that they have relatively greater intake of substances via breathing, ingestion and skin contact by comparison to their body weight. (p. 38)

The biological factors associated with younger children allow the potential for this age group to exhibit the greatest potential impact on health/achievement.

Nature of the Research Design

The quantitative quasi-experimental based inquiry consisted of a study of all 3rd Grade classrooms in all five of the elementary schools in East Meadow; the focus was on elementary schools, as students at this level are believed to be at the greatest risk (Schwartz, 2004, p. 1037). Records of the school year of 2008-2009, through the school year of 2014-2015, for student achievement on all 3rd Grade ELA and Math exams was evaluated. Comparing records to findings after a comprehensive green program was initiated will provide objective data to analyze the effect of an environmentally conscientious cleaning program. The school year of 2014-2015 was chosen, as this was the final year prior to the wide-scale opt-out movement of the Common Core Tests in New York, which would make a consistent analysis impossible. From 2016 forward, the percentages of opt-outs in Nassau County have exceeded 40% for both English and Math. Data on findings for any correlation possibly associated with areas now bereft of pesticides was examined. The possibility was explored that as green cleaning was implemented, to include all aspects of the school environment, was any student achievement trend accelerated.



Test	School Year	Nassau County%
Grade 3 ELA	6/30/2014	6.4%
Grade 3 ELA	6/30/2015	28.5%
Grade 3 ELA	6/30/2016	35.5%
Grade 3 Math	6/30/2014	7.7%
Grade 3 Math	6/30/2015	30.9%
Grade 3 Math	6/30/2016	36.5%

Figure 3. – Nassau County Refusal Chart

To identify a correlation between the changes to the environment and the scores in East Meadow Schools the average test scores of all other surveyed schools in Nassau County, not using a bio-based/green program during the period analyzed, were compared against East Meadow Schools through a *t*-test. This method should minimize any variation attributable to

changes in test that may cause spikes downward across the entire county in first year of change. The first year evaluated, 2008-2009, is the initial base-line year for the evaluation, as East Meadow Schools was in the initial stages of its bio-based program that year.

Definition of Terms

Disinfectants: Antimicrobial agents that are applied to non-living objects to destroy microorganisms that are living on the objects.

Green Environment: The use of cleaning methods and products with environmentally friendly ingredients and procedures which are designed to preserve human health and environmental quality.

Indoor Air Quality: The quality of the air inside buildings as represented by concentrations of pollutants and thermal conditions that affect the health, comfort, and performance of occupants.

Indoor Environmental Quality: The quality of a building's environment in relation to the health and wellbeing of those who occupy space within it. IEQ is determined by many factors, including lighting, air quality, and damp conditions.

Insecticides: Chemicals used specifically to kill or control the growth of insects. Certain insecticides have been banned because of their adverse effects on animals or humans.

Organic Lawn Treatments: The process of using natural products, in conjunction with proper lawn care techniques, to establish and maintain a lawn that is free of weed and disease.

Pesticides: Chemical or biological substance designed to kill or retard the growth of pests that damage or interfere with the growth of crops, shrubs, trees, timber and other vegetation desired by humans. Practically all chemical pesticides, however, are poisons and pose long-term danger to the environment and humans through their persistence in nature and body tissue.

Petrochemicals: Chemicals produced synthetically from petroleum or petroleum distillates used in traditional cleaning chemicals and traditional lawn fertilizers.

Assumptions

1. Purpose of study has been disclosed to all administrators and teachers evaluated by this study. All testing information for the buildings and periods examined were included.
2. The researcher will be impartial in collecting and analyzing the data collected.

Limitations

1. Findings of this study are based only on the data collected from the participating schools identified in this study. Factors outside of the change in scoring cannot be controlled.
2. Data collected on student attendance records are only from the timeframes specified. Data was used from 5 elementary schools in the district identified.

Delimitations

1. Only elementary schools were used from the district selected as younger children are believed to be more susceptible to chemical exposures.
2. It is impossible to identify and isolate all factors which impact on student health and student achievement. This could result in error variance and less significant correlation in the identified variables.
3. Correlations do not necessarily represent a causal relationship.

Summary and Organization of the Remainder of the Study

This dissertation will consist of five chapters organized in the following manner: (a) Chapter 1, Introduction to the Study, (b) Chapter 2, Literature Review, (c) Chapter 3, Methodology, (d) Chapter 4, Analysis of Data, and (e) Chapter 5, Summary of Results.

Chapter 2: Review of Related Literature

Chapter 2 examines literature on student health impacts related to petrochemicals. Petrochemicals are found in many applications in a school setting: (a) cleaning products, (b) floor treatments (wax, gym floor finish, and wax stripper), (c) furniture (off-gassing of volatile organic compounds), (d) air fresheners, (e) pesticides used for lawn care, and (f) artificial turf. These substances have been shown, at concentrations greater than recommended, to have short-term acute affects. "Effects, or potential effects from contaminants vary according to the type of and nature of the chemical exposure, frequency and duration of exposure and exposure dose" (Children's Health Project, 2000, p. 50). Many of these products contain substances which are known carcinogens, but again, risk is linked to exceeding the recommended exposure.

"Environmental health researchers increasingly recognize that a variety of health problems may be attributable in part on exposures to environmental toxins" (Cooper et al., 2000, p. 72). Medical research can now be found on low-level, long-term impacts of pollutants. As stated by Schwartz (2004), "recent evidence has implicated pollution exposure with the development of chronic disease or impairments" (p. 1039- 1040). This is potentially a problem as petrochemicals and airborne contaminants are intertwined into our environment; some level of exposure is unavoidable. With greater understanding of the mechanisms of toxicity of certain classes of chemicals, the notion of 'inherent toxicity' has arisen (Cooper et al., 2000, p. 115). Through an analysis of student test scores by use of a *t*-test, any effects on students can be measured through control of the environment in which children are educated.

Where the issue of short-term, low-level impact relates to student achievement is that symptoms of olfactory discomfort, and an increase in student absence, may distract or impede student achievement. As stated by the City of Toronto, Public Health Environmental Protection

Office (1998), "children are generally more susceptible to the toxic effects of pesticides because of their immature stage of development" (p. 54). This increased vulnerability could lead to symptoms at lower levels than necessary to impact on a healthy adult. This increased risk, combined with the repeated exposures in a relatively congested area (classrooms), is now the subject of research in the area of schools. "Compared with office buildings, schools house about 4 times the occupants" (Jones, Smith, Wheeler, & McManis, 2010, p. 281). Decision makers have tried, mostly beginning in the 1990's, to formulate and implement policies aimed at systematically preventing or reducing environmental risks for children (Landrigan et al., 1999, p. 431). While there is conjecture on the impacts of petrochemicals below acceptable exposure levels, as currently established under green cleaning legislation, there is a possible benefit to a change to lower allowable levels, or to eliminate the use of some substances completely. "Lead is one example of where the threshold for adverse effects has been progressively lowered and for certain health effects there is probably no safe level of lead for children" (Cooper et al., 2000, p. 115). This established science regarding lead opens the potential for there to be a correlation between other, now commonly used, substances to health and achievement.

Long-term, low-level impact on health later in life cannot be accurately quantified based on current information available, due to the relatively short duration of the widespread use of petrochemicals. The known carcinogens in petrochemicals has a possible connection to the handling of another substance, asbestos. "Regardless of a historical progression towards lower and lower levels of asbestos exposure, occupationally exposed individuals consistently experience excess rates of cancer" (Epstein, 1998, p. 54-68). While this area is not the primary focus, short-term impacts may be carried into adulthood and therefore should be acknowledged. According to the United States General Accounting Office (1999), "Information on long-term

illnesses from the use of pesticides in schools, and in general, is even more limited than the information on short-term illness" (p.7).

This literature review will be examined from the perspective of (a) children and teacher health, (b) relevant medical research, (c) exposures via Indoor Air Quality, (d) contact exposures.

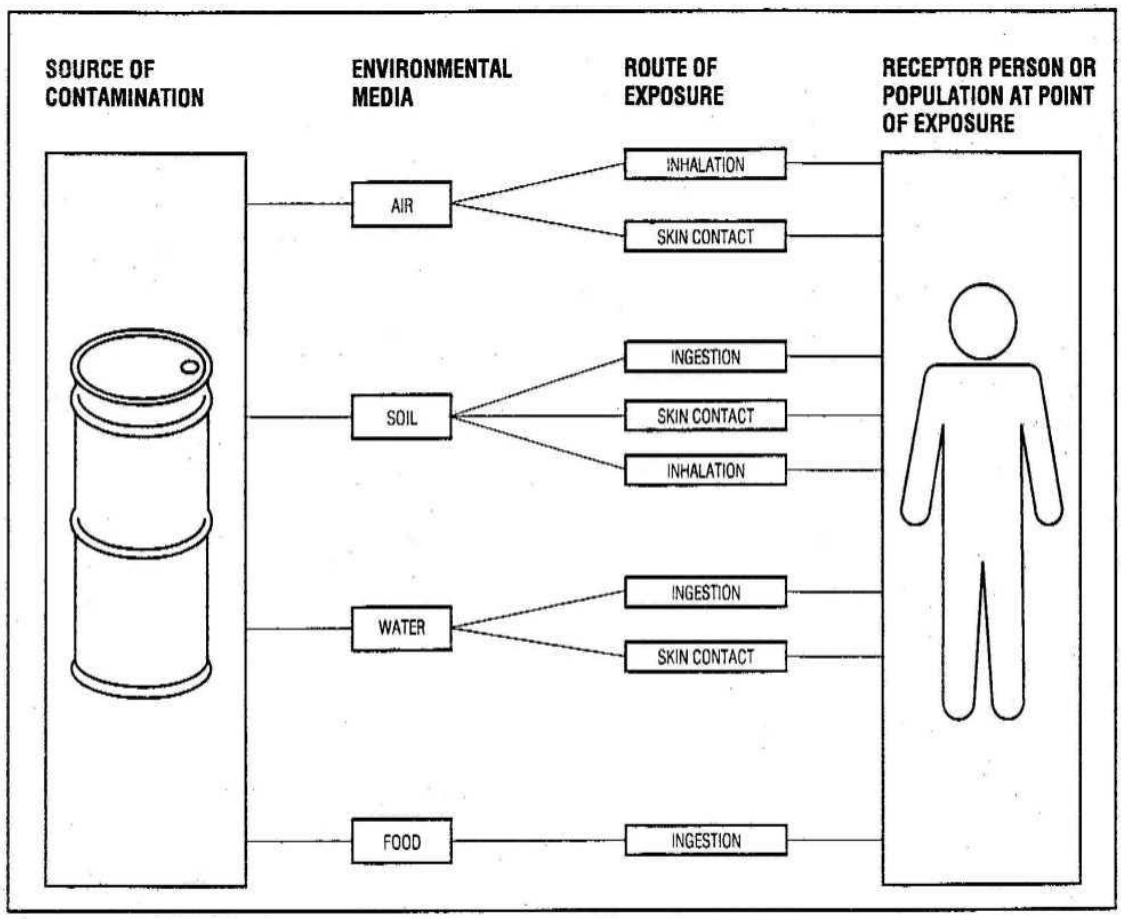


Figure 2.1. The pathways of human exposure to environmental contaminants.
(Source: Health Canada, 1995a, *op.cit.*)

Figure 4. – The Pathways of Human Exposure to Environmental Contaminants

Student Health

Children are potentially at the greatest risk of experiencing an adverse effect attributable to various toxic substances. According to the U.S. Environmental Protection Agency (2016):

> Pound for pound of body weight, children breathe more air, drink more water, and eat more food than adults…their behavior patterns, such as play close to the ground and hand-to-mouth activities, can increase their exposure to potential risks in the environment…the systems of a child's body are still developing making children less able to metabolize, detoxify, and excrete some toxins than adults. (p. 8)

Factors associated with the biology of children exhibit the need for greater caution when maintaining an environment occupied by children. Long-term, low-level exposure to pesticides may be problematic in terms of both children's health and establishing causation. "Chronic illnesses…such as exposures to community residents, schoolchildren, and sensitive subpopulations, will be more difficult to solve than was true for serious acute illness and injuries brought about as a consequence of pesticide application and handling" (Ames, 2002, p. 401).

Practical concepts that have gained acceptance by green advocates, both internal and external, in the facilities industry require further study to become common practice. Long-term, low-level exposure to petrochemicals, and other environmental toxins, may lead to health and developmental problems which require further study to establish cause and effect. "Exposure to ambient levels of criteria air pollutants has been associated with several acute and chronic adverse respiratory health effects in both asthmatic (18) and nonasthmatic (19) children" (Buka, Koranteng, & Osornio-Vargas, 2006, p. 515). More subtle aspects of the physical environment may affect student health and achievement as well. Air quality may adversely affect achievement though decreased focus while in the classroom or increased absence. As stated by

Young, Green, Roehrich-Patrick, Joseph, and Gibson (2000), "When students do not feel well when they are in school, or miss school due to air quality problems, learning is adversely affected" (p. 19). As stated by Mendell and Health (2005), "Reduced attendance may impair learning by decreasing class time for direct verbal and visual transfer of information from the teacher or by causing student to fall behind on their work" (p. 28). Impact on health/achievement may occur through either reduced direct teacher to student instructional time or olfactory discomfort.

Teacher Environmental Health Perspective

Instructing Right-To-Know classes for the faculty and staff district-wide has led to an insight on the perspective of educators with regard to safety. There appears to be a link between safety and a safety need as defined by Abraham Maslow. As stated by Prescott and Simpson (2004), "Maslow's argument was that once the lower level needs, such as physiological and safety needs, are met other higher needs emerge" (p. 353). Higher-level motivation cannot be achieved without safety needs being adequately addressed, which applies to both teachers and students. This concept was also identified by Hertzberg who claimed issues such as safety were "hygiene" factors, "some factors cause dissatisfaction when they are not present, but do not motivate" (as cited in Kroth, 2007, p. 8). While these theories are not explicitly linked to exposure to petrochemicals, or indoor air quality, environmental issues are a tangible component of the school environment; safety concerns, while tangential to many of the educational staff, are relevant.

As stated by Buckley, Schneider, and Shang (2004), "most teaching takes place in a specific physical location (a school building) and the quality of that location can affect the ability of teachers to teach, teacher morale, and the very health and safety of teachers" (p. 3).

Disruptions attributable to problems in the physical environment can adversely affect classroom instruction and time in the classroom. As stated by Mendell and Health (2005),

> IEQ factors in turn could influence health outcomes of students (or teachers), which could influence students' performance directly or through effects on attendance (or through impaired teaching). IEQ factors might also influence performance through discomfort or distraction, or through thermal, visual, acoustic, or olfactory effects that reduce performance. (p. 5)

Teachers, while not as vulnerable as children, may be affected by the physical environment. "Since current student-focused asthma studies show that students lose considerable school time because of the poor conditions of schools, it is not surprising to find that poor IAQ also affects teachers' health" (Buckley, Schneider, & Shang, 2004, p. 3). Teacher absence and teacher respiratory irritation impact on both instructional time and the quality of instructional time.

Medical Research on Health

Research has shown that people react differently to the numerous chemical compounds in pesticides and other common products such as cleaning solvents and detergents (Sterling & Browning, 1999, p. 9). As stated by Cooper et al. (2000):

> There are other chemical exposures that affect the child's brain in this period of rapid and critical development. Less is known of them than lead. There are concerns with regard to mercury, organochlorines, pesticides, and manganese, which has recently been readmitted into Canadian gasoline. The gaps in knowledge should not restrict us in our efforts to protect the potential that is our children. (p. 78)

Children are at a greater risk, as a child's metabolic system is also unable to break down and excrete many toxic substances, increasing the possibility of immune system impairment,

neurological problems and cancer (Environment Prevention Health Center of Atlanta, 1997, p. 2). Children, when exposed to chemicals, have more adverse reactions, at lower exposure levels. This is due to their developing immune systems being unable to effectively deal with chemical exposures. The adverse reactions that children may suffer are both short-term and long-term. Short-term exposures may impact on student focus and student attendance; long-term may impact student health and achievement through life-altering illness (childhood cancers) and cognitive impairment.

A child's environmental health and well-being can be thought of as occurring at the intersection of three causal domains. Individually and in combination, these domains are the primary determinants of (a) exposure, or contact with a hazardous environmental chemical(s), (b) susceptibility, or personal vulnerability to the adverse health outcomes related to those exposures, and (c) effects, or health consequences that are caused or exacerbated by exposures (Needham & Sexton, 2000, p. 612-613). Potential exposures present in the physical environment include chemicals used to clean and maintain schools. Points of entry for these potential contaminants include the surfaces children contact as well as the air they breathe. Younger children are at greater risk for expose due to hand-to-mouth behaviors and additional contact with surfaces through crawling and rolling on floors.

Asthma

A remarkably strong association was observed between nasal symptoms and physician-diagnosed asthma, in particular the use of QAC's (Quaternary Ammonium Compounds), which are being used for disinfection (Heederik, 2014, p. 472). As stated by Miller, Wayne and Garry B. Hill, "New Statistics Canada research estimates that in 1994/95, asthma prevalence among those aged 0 to 14 years, was at 11.2% (affecting about 672,000 children). In 1978/79 there was

only a 2.5% asthma prevalence rate which indicates that there has been more than a fourfold increase in numbers of children afflicted with asthma in under two decades" (1998, p. 9-21). Since the 1950's the use of petrochemicals both inside and outside of the built environment has increased substantially. Petrochemical-based products have been introduced to both cleaning and lawn treatment programs, increasing the chemicals, and volatile organic compounds (VOCs) off-gassed into the air, that student and teachers breathe. Poor indoor air quality (IAQ) has many sources, including emissions from pesticides, cleaning products, office equipment, art supplies, new furnishings and finishes (VOCs), and contaminants that stem from heating, ventilation, and air-conditioning systems (Jones, Smith, Wheeler, & McManis, 2010, p. 281). Petrochemicals have several routes of possible exposure in a school environment.

Recent attention has focused on the ability of preventative maintenance to potentiate the effects of common allergens, promoting IgE (antibody that plays a major role in allergic asthma) production (Karol, 2002). Fine particles have been shown to decrease the forced expiratory volume in asthmatic schoolchildren (Delfino et al., 2004). Changes to the built school environment can be accomplished by use of a comprehensive sustainable program, such as the program utilized in East Meadow Schools, which mitigates particles entering the school building through use of effective matting. Further, additional measures include effective preventative maintenance to heating and ventilation equipment which has a positive impact on indoor air quality.

Multiple Chemical Sensitivity

Multiple Chemical Sensitivity is an occurrence where individuals exhibit a collection of symptoms, at very low levels of exposure to chemicals, such as, (a) headache, (b) breathing difficulties, (c) fatigue, (d) muscle aches and (e) inability to think and function; individuals often link the onset of this condition to an earlier over-exposure of a chemical, or chemicals. Petrochemicals generate free radicals, which can damage energy metabolism, causing fatigue (Robinson, 1996, p. 852). "Individuals frequently report symptoms after exposure to what would normally be low levels of chemicals (triggers) and they sometimes recall that their illness began after a distinct episode of over-exposure to some chemical (an initiating event)" (Kipen, Fielder, & Lehrer, 1997, p. 76-84). Further, even low-level exposure to volatile organic compounds can cause changes in brain function (Ziem, 1999, p. 402). Changes in brain function include chronic systems, including (a) headache, (b) fatigue, (c) weakness, (d) balance disturbance impaired coordination, (e) reduced memory, (f) reduced attention span, and (g) concentration changes (Edling et al., 1990, p. 75).

Indoor Air Quality

Children and adults who are exposed to poor IAQ can experience (a) nausea, (b) dizziness, (c) headaches, (d) sleepiness, (e) fatigue, (f) upper respiratory infections, (g) irritated eyes, nose, and throat, among susceptible children and adults; poor IAQ can trigger asthma episodes (Schneider, 2002, p. 1-24). There are many sources of air pollution in the built school environment ranging from furnishings to cleaning products. Effective maintenance and cleaning can mitigate many of these issues, but when budgets are constrained maintenance is often the first item reduced in a school budget. The link between student/teacher attendance and comfort is often either not a priority or not a consideration. Volatile organic compounds impact on indoor

air quality and then may impact on student's ability to achieve to their full capabilities. As stated by The Environmental Protection Agency (2010):

> Volatile organic compounds (VOCs) are emitted as gases from certain solids or liquids. VOCs include a variety of chemicals, some of which may have short- and long-term adverse health effects. Concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoors. VOCs are emitted by a wide array of products numbering in the thousands.

All aspects of the physical school environment may be linked back to student health and achievement. Indoor Air Quality is affected by poor maintenance; effective maintenance is a component of a properly implemented green program.

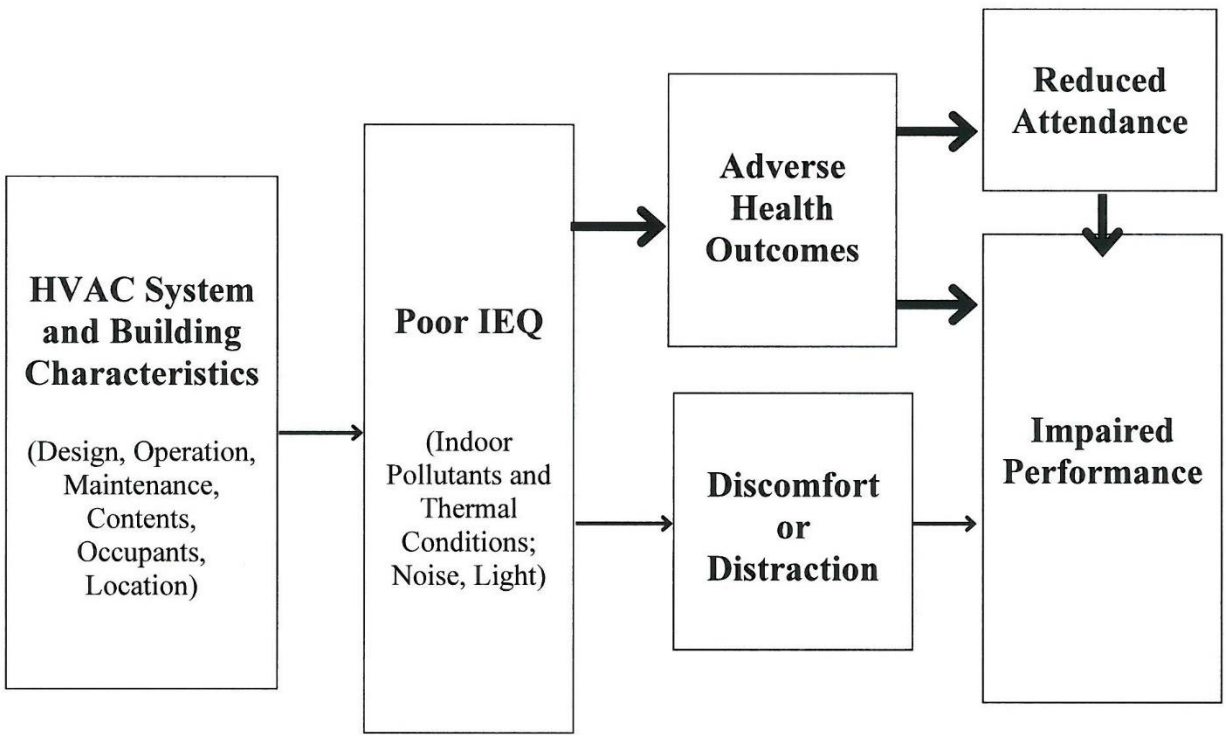


Figure 5. – Impaired Performance

Pesticides

The risks associated with the use of pesticides on school grounds, and their impact on students, is now well documented. According to a study by Alarcon et al. (2005), "findings indicate that pesticide exposures at schools continue to produce acute illnesses among school employees and students in the United States albeit mainly of low severity and with relatively low incidence rates" (p. 461-462). Low-level impact was not quantified as part of the Alarcon et al. (2005) study, but questions regarding pesticides, both low-level and acute, have contributed to additional legislation. As stated by Ames (2002), "Federal EPA is recommending that schools adopt Integrated Pest Management (IPM), an approach that has among its goals reducing pesticides" (p. 401). Several states, including New York, now have regulations which strictly restrict the ability of a school district to apply pesticides both in schools and to school grounds. This change is based on concerns regarding significant exposure for children and staff via spraying of chemicals or exposure to volatile organic compounds from the break-down of these chemical compounds. Students can be exposed to pesticides at school when pest control chemicals are applied, a practice which is particularly problematic when schools apply these chemicals as part of a routine regardless of need (American Academy of Pediatrics Committee on Environmental Health, 2003, 459- 476).

There are several compounds found in pesticides, which could potentially cause impact on health. Compounds, mixed in small concentrations in pesticides, often do not require notification (Landrigan et al., 1999, p. 435). Three common chemicals used which have been identified as a risk are (a) Chlorpyrifos, (b) Glysophate (Round Up), and (c) Diazinon. Chlorpyrifos, also known as Dursban, has been known to cause headaches, dizziness, vomiting, and birth defects (Small, 1997, p. 2). Glysophate has been linked to skin irritation, vomiting, and

diarrhea and this substance can drift far beyond the application site (p. 2). Diazinon has been linked to long-term impacts, including pulmonary edema and muscle weakness, as well as the death of many birds (p. 2). Both diazinon and chlorpyrifos have both been found in samples of air, rain, and snow in excess of 25 miles from the application site (Ames, 2010, p. 398).

Persistent organic pollutants are a class of petrochemicals, which includes some pesticides, which do not degrade easily and often remain in the environment a long time (Children's Health Project, 2000, p. 50). There is evidence of pesticides being conveyed to the built school environment after application. As stated by Alarcon et al., (2005), "pesticide residues on the school grounds might be tracked into school buildings by students and school employees" (p. 462). Further, several pesticides are not water soluble, but are soluble in fat, which will lead to accumulation in an organism when digested; bioaccumulation increases as this substance works up the food chain (p. 50). Both hand-to-mouth behaviors and normal play activities of children contribute to the increased exposure which children encounter.

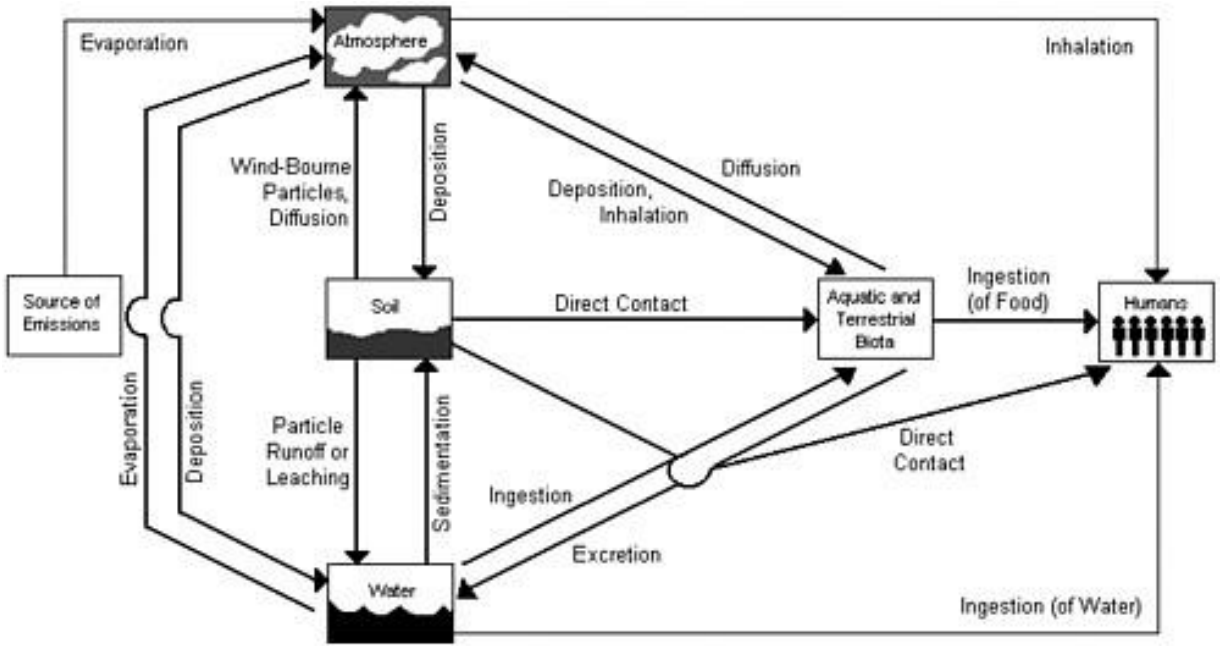


Figure 6. – Possible Pathways from Emission of Substances to Human Exposure

Styrene

Short-term impact of styrene includes headaches, nausea, eye and throat irritation (Grassroots Educational Education); styrene may contribute to asthma symptoms (Hayes, Lambourn, Hopkirk, Durham, & Taylor, 1991, p. 396-397). Long-term, this chemical is potentially a carcinogen. "Styrene is reasonably anticipated to be a human carcinogen" (Department of Health and Human Services, 2011). The United States Environmental Protection Agency (2000) states:

> Acute (short-term) exposure to styrene in humans results in mucous membrane and eye irritation, and gastrointestinal effects. Chronic (long-term) exposure to styrene in humans results in effects on the central nervous system (CNS), such as headache, fatigue, weakness, and depression, CNS dysfunction, hearing loss, and peripheral

neuropathy. Human studies are inconclusive on the reproductive and developmental effects of styrene.

Indoor air is the principal route of styrene exposure for the general population. Average indoor air levels of styrene are in the range of 1 to 9 μg/m^3, attributable to emissions from building materials, consumer products, and tobacco smoke (Agency for Toxic Substances and Disease Registry, 1992). "Aside from food-related intake, children's exposure to styrene may differ from exposures to adults, especially during school, home, or play activities that may expose the children to styrene sources" (United States Public Health Service, 2010, p. 188). A retrospective cohort study in China reported lower birth weight among nonsmoking women occupationally exposed to aromatic solvents including (a) benzene, (b) toluene, (c) styrene, and (d) xylene (adjusted for gestation length, compared to unexposed women, birth weight difference –79.0 g, 95% CI –156.0 to –1.9) (Ha, et al., 2002).

Diesel Fuel

"Diesel exhaust contains 20 times more particles than gasoline exhaust does. Some of the main toxic gases in diesel exhaust are nitrogen oxides, sulfur oxides, and carbon monoxide" (California Department of Health Services, 2002, p. 1). Exposure to diesel exhaust is a known cause of both asthma and lung cancer, and can exacerbate respiratory diseases through inflammation and irritation of the airways. There is variation between schools which effectively monitor bus idling, and have an understanding of the health implications of student exposure to diesel exhaust, and schools which do not take precautions. Children are exposed to diesel fumes through riding a bus fueled by diesel (most buses are still fueled by diesel) or through fumes pulled into their classroom by idling buses. "Exposure of students to school bus diesel emissions

is receiving increased attention because of emerging information regarding the associated health risk" (Jones, Axelrad, & Wattingney, 2007, p. 546). As stated by Wargo and Brown, (2002):

> A vast majority of U.S. school buses are powered by diesel fuel. Diesel exhaust is comprised of very fine particles of carbon and a mixture of toxic gases. Federal agencies have classified diesel exhaust as a probable human carcinogen. Benzene, an important component of the fuel and exhaust, is designated to be a known human carcinogen. Components of diesel exhaust are genotoxic, mutagenic, and can produce symptoms of allergy, including inflammation and irritation of airways. There is no known safe level of exposure to diesel exhaust for children, especially those with respiratory illness. (p. 2)

Currently, the primary fuel used by buses is diesel, but precautions to limit exposure are an important component of any well planned green program.

Contact Exposures

Children can be exposed to chemicals via direct contact through (a) absorption of cleaning chemical residue on hard surfaces, (b) use of anti-bacterial/anti-microbial products during hand-washing, (c) direct contact with petrochemicals used in the manufacture of artificial turf fields, (d) and through ingestion. Safety Data Sheets are required for virtually all chemical containing products by the Occupational Safety and Health Administration (OSHA), and these documents clearly state the dangers of many of these chemical compounds. Chemicals listed in the Safety Data Sheets often bioaccumulate and are therefore often at a more concentrated level in practice than manufacturers recommend. Children are more vulnerable to these chemicals than adults, but Safety Data Sheets are based on the impact of a chemical on a healthy adult male, not a child. As stated by the Occupational Safety and Health Administration (2015), "Industrial experience, new developments in technology, and scientific data clearly indicate that

in many instances these adopted limits are not sufficiently protective of worker health" (p. 1). As stated by the agency mandating safety data sheets these standards, designed in 1970, were instituted to protect workers and not designed for the needs of children.

Cleaning Products

Many of the traditional products used to clean schools contain toxic chemicals that can be harmful to the health of students, including (a) solvents, (b) surfactants, (c) fragrances, (d) chemical disinfectants, and (e) hand-sanitizers. These chemicals are known to cause short-term, low-level eye, skin and throat irritation as well as more serious chronic long-term complications such as respiratory and neurological diseases and some cancers. Acute health effects from exposure to disinfectants usually involve inflammation, edema, and burns (Reigart & Roberts, 1999). Over the last 10 years, advances in the cleaning chemical market have produced products that replace these harmful chemicals with products evaluated to be safer. Research and development has also lead to a reduction, and sometimes elimination, of cleaning chemicals in several applications, without a reduction in cleaning efficacy.

Cleaning involves the use of both surfactants and solvents to remove soil and bacteria from surfaces. The best solutions to cleaning involve limiting or reducing chemicals through change in process. Instead of focusing on the proof of harm, a focus would be on designing products and activities such that the threat of harm would be avoided. Examples of such measures in this context would include recognition of inherent toxicity as the basis for phasing out of dangerous substances, the establishing of pollution prevention standards, the development and encouragement of clean technologies, and methodologies to promote alternatives (Castrilli, 1999, p. 11). Effective procedures can reduce or eliminate chemicals commonly used, including (a) 2 butoxyethoxy ethanol (a degreaser), (b) sodium hydroxide and monoethanolamine (used to

remove floor wax), (c) Ethoxylated Linear Alcohol (cleaner), and (d) sodium lauryl sulfate and sodium lauryl ether sulfate (foaming agents in soap).

The fragrances contained in air fresheners actually mask, but do not remove, malodors. The masking agents in air fresheners are petrochemical compounds, including (a) butane, (b) ethane, and (c) 1-difluoro which are known carcinogens according to their mandated Safety Data Sheets. There are also often short-term, low-level impacts which can result in headaches or allergic reactions. Better solutions, which avoids the use of these masking agents, are proper cleaning procedures and natural products that eliminate odors on the molecular level.

Products used for disinfecting which were a health concern and are already banned in many states for schools include, (a) sodium hypochlorite (bleach), (b) ammonium hydroxide (ammonia), and (c) phenol. Products that have replaced traditional disinfectants and have problems as well, but are not yet banned, include quaternary ammonium compounds (as known as Quats or QAC). "The main sensitizers contained in cleaning products are disinfectants such as quaternary ammonium compounds" (Gonzalez et al., 2013, p. 394). There are alternatives for all of these strong chemical options which have been used in the past and present, including (a) steam cleaning, (b) silver ions, and (c) thymol.

Hand sanitizers contain several different chemicals which are designed to kill germs. Active ingredients commonly include the following petrochemical compounds (a) triclosan, (a) isopropanol, or (c) ethanol. "Over the last 20 years its use has grown rapidly in personal care products including, soap, hand sanitizer, cosmetics, and toothpaste…" (Cooney, 2010, p. 242). Triclosan is considered a potential endocrine-disrupting compound (United States Environmental Protection Agency, 2010), although there is no clear evidence that triclosan in antibacterial soaps provides any extra health benefit over regular soap and water (United States Food and Drug

Administration, 2010). The best solution for cleaning hands is soap and water; any surfactant which breaks surface tension will remove germs to be rinsed away. Hand sanitizers kill germs on the surface, but allow germs which are below particles not removed to survive and multiply.

Poisoning from isopropanol is reported frequently, although primarily through ingestion (Stremski & Hennes, 2000, p. 238- 240). Isopropanol can also be absorbed through inhalation or dermal absorption, although exposure needs to be of greater duration (Martinez, Jaeger, deCastro, Thomson, & Hamilton, 1986, p. 233- 236). Children, with hand to mouth behaviors, are more susceptible to multiple paths of ingestion, including contact with treated surfaces resulting in residue on hands ingested during meals. Hand sanitizers are often over-used in school environments and many have Health and Safety ratings above zero. Schools which adhere to a bio-based program use products which only contain a surfactant, not any anti-bacterial/anti-microbial chemicals.

Table 2. –Hand Sanitizer Comparison Chart

Hand Sanitizer Comparison Chart

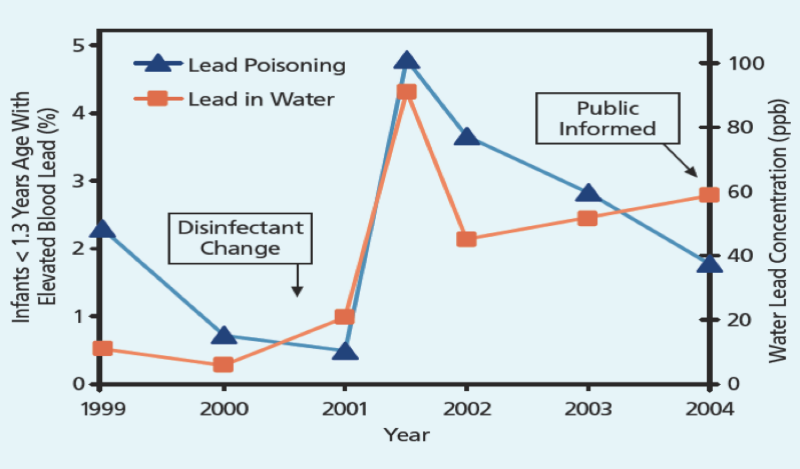
Product	Hand Sanitizer	Antibacterial Soap	Quat-Based Hand Cleansers	Bio-Based Sanitizer
Example of Product	Purell, etc.	Most brands found in retail stores claiming to be antibacterial and not containing alcohol	Triple S, Hands2Go, Soapopular, Safer4Kids	Avant, CleanWell, Benefect, EO
How Applied	Waterless/ or with Water	With Water	Waterless/ or with Water	Waterless/ or with Water
Reason Antibacterial	**Ethyl Alcohol** (Grain Alcohol) **Isopropyl Alcohol** (Petrochemical)	**Triclosan** (Petrochemical)	**Quaternary Ammonium Compounds** (Benzalkonium chloride, Benzethonium Chloride)	**Oils, Thyme** (Thymol)
Problem Associated with Contents	Drying of skin, intoxication, fire, eye irritation	Eye irritation, accumulates in environment, endocrine disrupting, cause resistant to antibiotics, increased incidence of allergies, aquatic risks	Asthma, Chronic Dermatitis	None
Source of Information	http://www.cdc.gov/niosh/ipcsneng/neng0044.html http://www.cdc.gov/ncidod/eid/vol7no3_supp/pdf/levy.pdf http://www.oem.msu.edu/userfiles/file/News/v20n1.pdf	http://www.cdc.gov/ncidod/eid/vol7no3_supp/levy.htm http://www.epa.gov/oppsrrd1/REDs/factsheets/triclosan_fs.htm http://www.health-report.co.uk/triclosan.html http://jama.ama-assn.org/content/303/20/2022.1extract?maxtoshow=&hits=10&RESULTFORMAT=&fulltext=triclosan&searchid=1&FIRSTINDEX=0&resourcetype=HWCIT	http://www.cdc.gov/niosh/ipcsneng/neng1584.html http://www.state.nj.us/health/eoh/survweb/wra/documents/asthmagens.pdf	http://www.cleanwelltoday.com/wp-content/uploads/MSDS-allhandsanitizers_06032011.pdf
Average HMIS Health Rating	1	1	1	0
Average HMIS Flammability Rating	2	0	0	0
Research Indicates	*Worst Option as Currently Understood for Schools*	*Likely Worst Option, After Triclosan is Adequately Quantified, for Schools*	*Best of the Worst Three Options for Schools*	*Promising, But Efficacy Not Yet Conclusively Quantified*
CDC Recommendation:				
Hand washing is the single most important prevention step for reducing disease transmission.(http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5605a4.htm)				

Lead

Lead is a neurotoxic metal that can trigger health effects such as (a) reduced cognitive function, (b) decreased growth, (c) hyperactivity, (d) impaired hearing, (e) damage to the brain and kidneys (Wigle, 2003, p. 396). The most common exposure for children from lead is paint, but most school now mandate strict regulations regarding identification and remediation of this exposure source; use of lead paint has been banned since the 1970's. Common sources for lead that can now be found in schools include drinking water that has been contaminated by plumbing materials, including lead solder (American Academy of Pediatric Committee on Environmental Health, 2003, 459- 476). Other possible sources for lead include shredded tires used as cushioning material on synthetic turf fields. As stated by the Center for Disease Control and Prevention (2013):

> As the (synthetic) turf ages and weathers, lead is released in dust that could then be ingested or inhaled, and the risk for harmful exposure increases. If exposures do occur, CDC currently does not know how much lead the body will absorb; however, if enough lead is absorbed, it can cause neurological development symptoms (e.g., deficits in IQ).

Table 3. – Elevated Blood Lead in Young Children



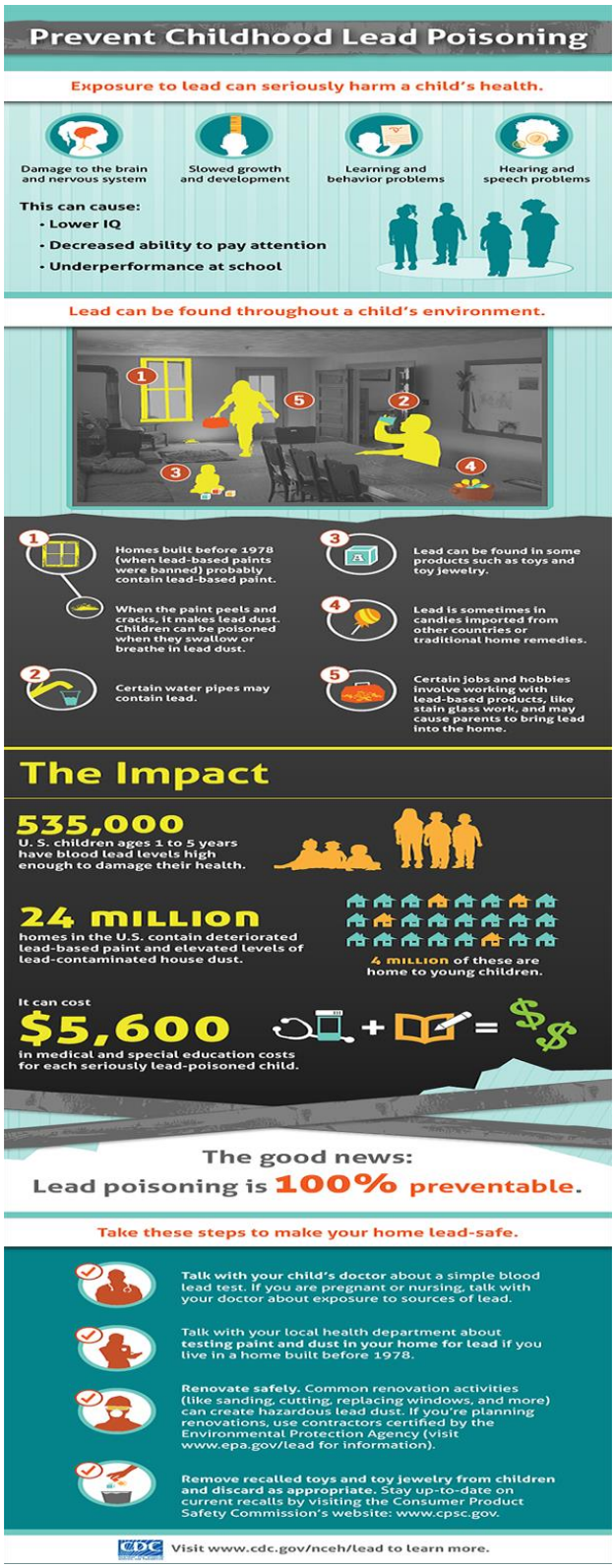


Figure 7. – Exposure Pathways for Lead Poisioning

Synthetic Turf

Synthetic turf fields are typically cushioned by up to ten tons of ground-up truck and automobile tires; this recycled rubber contains high levels of know toxic substances. Chemical toxins that have been identified in synthetic turf included the metals (a) arsenic, (b) cadmium, (c) chromium, (d) cobalt, (e) lead and (f) zinc. Chemicals present on these fields are the chemicals (a) acetone, (b) ethylbenzene, (c) tetrachloroethene, (d) toluene, (e) xylene, and (f) phthalates. These metals and chemicals are either known, or suspected, carcinogens according to mandated Safety Data Sheets. Additional hazards identified on Safety Data Sheets are extensive and range from short-term acute concerns to long-term severe ailments.

The potential long-term health effects of exposure to the chemicals present on synthetic turf fields include (a) endocrine disruption, (b) neurological impairment, and (c) cancer. Exposure levels for children who are in frequent bodily contact with the turf may be greater, due to the additional transfer of the cushioning material to their bodies and clothing. Athletic team goal tenders, from soccer and field hockey, can be exposed to chrome rubber used as surface cushioning on modern synthetic turf fields. This substance can stain exposed skin and get trapped in clothing, continuing exposure beyond the actual activity. Chemicals transported off field can be brought in to the built environment, including both schools and the child's home. Runoff from synthetic turf fields will also lead to toxins eventually working their way into the aquifer, causing residual impacts. Other short-term impact includes the additional heat on the playing surface, which can add 10 to 20 degrees.

The maintenance of synthetic turf adds to the many concerns regarding student exposure to chemicals, while eliminating the benefits of an outdoor recreational activities. Cleaning synthetic turf requires chemical disinfectants, as the natural process of biological elimination of

bodily fluids is impeded by abandoning natural turf. These chemical exposures are similar to the problems with disinfectants in the built school environment. Adding synthetic turf eliminates a green space, while adding an additional area of chemical exposure for children. "Evidence of the wide-ranging benefits of a green school grounds are mounting. These benefits extend to student learning, environmental awareness and teacher motivation, social behavior and relationships, safety and health" (Bell & Dyment, 2008, p. 77).

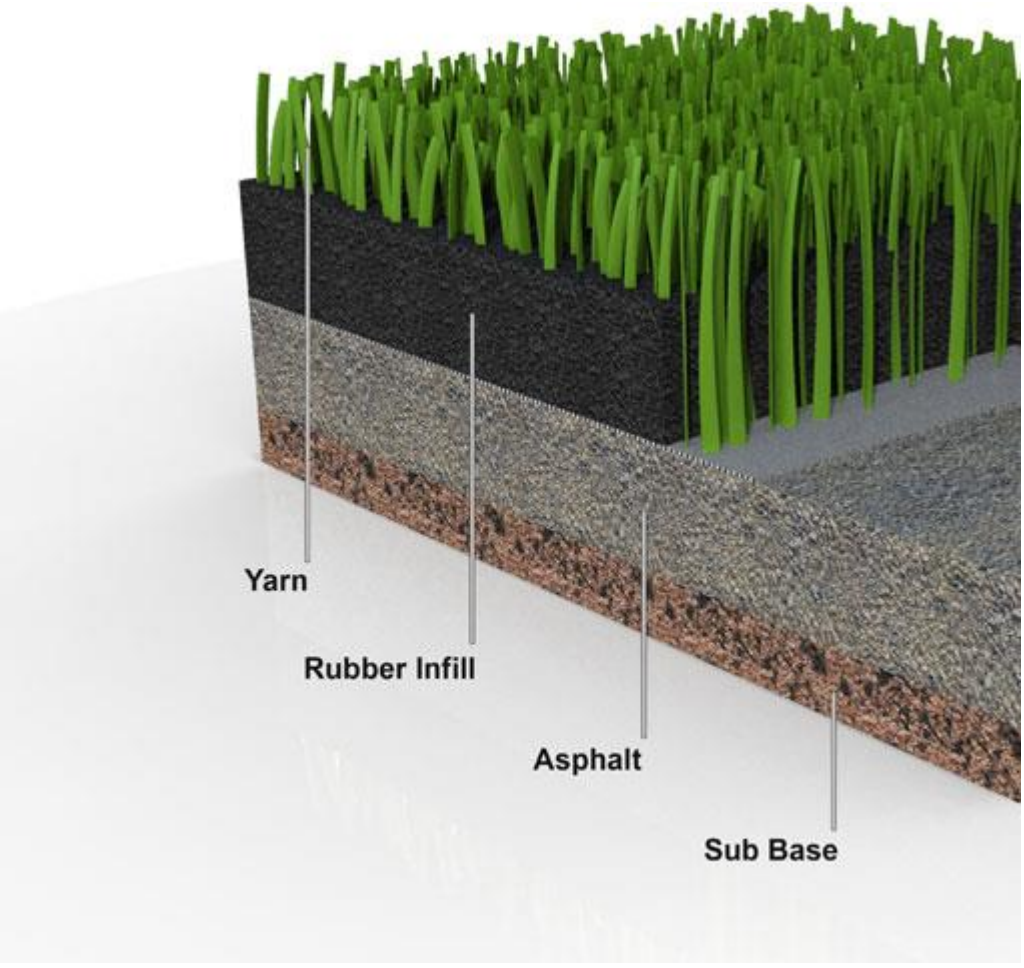


Figure 8. – Diagram of Synthetic Turf Field Components

Summary

Children have greater vulnerability to toxic exposures due to a number of dynamics. The immature organs and developing bodies of children make it more difficult for them to detoxify or eliminate certain toxins. Due to the size of children, relative to a mature adult, they receive proportionally greater doses of chemical contaminants found in (a) air, (b) water and (c) food. Small exposures, occurring during a critical window of a child's development, may result in long-term adverse health outcomes. Children, because of their play habits and typical hand-to-mouth behavior, have a greater risk. They live in their school environments in ways different from working adults. Square foot per person is less in the built school environment than in the built work environment of most adults. In addition, children play outdoors on the grass where pesticides may have been applied, or on synthetic turf, encountering risks not normally experienced by adults. The play methods of children include greater contact with flooring where chemical contaminants accumulate in a traditional school environment. Schools that practice a green approach control, to the best extent currently possible, the multitude of environmental factors that potentially effect children.

Chapter 3: Methodology

Research for the two questions entailed utilizing the average of all district information for East Meadow Elementary Schools, (a) Barnum Woods, (b) Bowling Green, (c) Meadowbrook, (d) McVey, and (e) Parkway, against the average of all schools in Nassau County not using a green program during the period analyzed; the data was then evaluated for the school year 2009/10 through the school year of 2014/15. The green program in East Meadow was initiated over the summer of 2008 and was well established by the summer of 2009, immediately following the first year to be analyzed. The program has improved each year after the initial period to be evaluated.

Statement of Problem

While various environmental exposures, both internal and external to the classroom, may impact on student health and achievement, research regarding the physical environment is deficient. Impact of the physical environment on students may have a direct impact on student learning as the students' ability to process information may be impaired. Effective control of physical environment factors may positively influence teacher efficacy; through teacher efficacy student success may be enhanced and encouraged (Mendell & Health, 2005, p. 5).

Research Questions

The analysis of the first question utilized 3rd Grade test results on both the ELA and Math exams for all years in the period examined. The delta between the two averages was used to determine whether there was a trend correlated to the reduction in the use of petrochemicals. Any opt-out issue was mitigated by the size of the sample, and the number of opt-outs was consistently below 5% for districts throughout New York State until 2011/12. The independent variable was the change in products from a traditional petrochemical program to a bio-based

green chemical program. The dependent variable was the average change in scores on standardized tests. There was a slight correlation between the environment and the short-term academic achievement related to irritation and olfactory discomfort related to known warnings provided on the safety data sheets provided with traditional cleaning products.

The second question was approached by analyzing student attendance, again using the same method as used for question one, to determine if there is a delta between the two groups over the period examined. The short-term impact of traditional chemicals was correlated to a higher/increasing, absence rate which was correlated to the chemicals in the environments evaluated. The independent variable was the change in the chemicals used in the environment and a dependent variable was any change in attendance.

Research Methodology

Student Achievement

Historical records for test scores, both past and near past, were evaluated to determine if a trend could be identified. Comparing historical records to findings after a comprehensive green program was initiated provided objective data to analyze the effect of an environmentally conscientious cleaning program. Data on findings for any impact possibly associated with areas now bereft of pesticides was also examined. The possibility was explored that, as green cleaning became more comprehensive, to include all aspects of the school environment, student achievement trends may have become accelerated. The analysis of the green cleaning program compared the net change of East Meadow Schools to group one (Basic Green Programs) through a *t*-test. Then, the analysis of the green cleaning program compared the net change of East Meadow Schools to group two (Basic Compliance Programs) through a *t*-test.

Student Attendance

Attendance records determined if there is any correlation between the change in chemicals used attributable to increased absence through an ANOVA design for East Meadow Schools. To determine if there is a difference in the mean absence rate between 2009, 2010, and 2011, an analysis of variance test was used. Data was obtained from attendance records for a three-year period from the start of the bio-based green cleaning program in East Meadow Schools until the program was fully established. As absence is decreased student-teacher contact time is increased, which is a vital aspect of student achievement.

Research Design

Data collected included historic data from elementary classrooms impacted by the new environmentally friendly products and techniques used in East Meadow, against all districts in Nassau County with non-green programs. Data was examined via quantitative analysis of three groups over a range of time. Data was then considered to contain significance if a *P*-value of < .05 was attained. Data needed for this study is available for East Meadow, and other districts in Nassau County (53 total), through the BOCES Data Warehouse. Information for East Meadow schools is collected through use of a program called eSchool Data and then provided to the BOCES Data Warehouse. Reliable information is available for the first two questions, according to the Director of Technology in East Meadow Schools.

In East Meadow Schools, extensive research has been done with regard to cleaning for health, which includes change in process to minimize any chemicals used during the cleaning process. These changes have led to a reduction in product/labor cost, which is quantified; however, any correlation to student health and academic achievement is currently inconclusive.

The design of this inquiry is a quasi-experimental, but from the perspective of an Action Research approach to problem solving within an organization.

Population of Selection Sample

The quantitative inquiry consisted of a study of five schools throughout the East Meadow School District compared to all districts surveyed not employing these strategies in Nassau County; the focus was on elementary schools, as students at this level are believed to be at the greatest risk (Schwartz, 2004). Historical records for student attendance were evaluated for the 1st Grade through 7th Grade. Test scores were evaluated to determine whether a trend can be identified over the sample period. Comparing historical records of these two sample groups to data after a comprehensive green program was initiated provided objective data to analyze any correlation of an environmentally conscientious cleaning program to student health and academic achievement.

Measures and Variables

"A variable is a characteristic or attribute of an individual or an organization that (a) researchers can measure or observe and (b) varies among individuals or organizations studied" (Creswell, 2008, p. 123). There are three types of variables: (a) dependent, (b) independent, and (c) intervening; independent variables consist of four types: (a) measured, (b) control, (c) treatment, and (d) moderating. The following chart will convey what criteria was used to examine the concepts.

Table 4. – Measure of Variables

Dependent Variables:	Independent Variables:	Type of independent variable:
Student achievement/ scores	Change in Products	Measured, Continuous

Data Warehouse

Information pertaining to testing data was obtained via access to the Nassau County Data Warehouse. According to Nassau County BOCES (2016):

> The Nassau BOCES Instructional Data Warehouse (IDW) is a repository for student data collected from multiple sources and organized for analysis and reporting. Those who take advantage of the IDW can access data on multiple criteria without affecting the original source data and enrich district professional learning and instruction. The data available for district analysis expands as it accumulates from year to year. The IDW provides a wide variety of reports for all New York State assessments to be used for curriculum analysis. It also yields reports regarding diploma type and college tracking of graduates. Data can be downloaded for further disaggregation, and all reports can be saved and/or printed as needed.

Data Collection Procedures

Data collected has entailed the evaluation of historic W data. Data on findings for any impact correlated with areas now bereft of pesticides was also examined. Data used was compiled by use of eSchool Data. According to Nassau BOCES (2016): eSchoolData delivers an intelligent data framework that is completely web based. The system includes your basic components: registration, period by period attendance, reports, report cards, transcripts and scheduling.

To verify validity of assumptions on status of cleaning programs in the other 55 school districts in Nassau County, a survey of Directors of Facilities was conducted to confirm the products and protocols established in their districts during the timeframe examined. Three different categories were established from findings: (a) basic compliance, (b) basic green

programs, and (c) East Meadow Schools bio-based program, which exceeds green certification levels.

Attendance data is available for the period of 2009/10 through 2011/12 and was obtained through use of eSchool. Three years of data were evaluated to determine any trend of student absence as the green cleaning program progressed in East Meadow Schools.

Survey Protocol Development

Survey questions were determined in advance and were appropriate for the education/maturity level of the people surveyed. The researcher used a survey document to guide the interviewees through the questions. Questions were fill in the blank and two option multiple choice. Survey questions were designed to verify that primarily non-green, or moderately green, programs were used by the 55 districts in Nassau County during the period investigated. Results obtained were converted to a number scale, consisting of 0, 1, 2, 3, and 4, from the Health and Safety category from the Safety Data Sheets. The score of 0 is the lowest impact on health; a score of 4 is the highest impact on health. The product manufacturers of every chemical-containing substance used in commercial applications are required to provide safety information via a standard Safety Data Sheet.

Participant Selection Process

Directors of Facilities were identified from the Nassau County area of Long Island, a primarily suburban area, located east of New York City, New York. Each district has a Director of Facilities, or a person in a similar title performing that function. Directors of Facilities are responsible for the following responsibilities in a Nassau County school district: (a) supervising custodial staff, (b) supervising grounds staff, (c) supervising trades people, (d) purchasing products to perform cleaning, and (e) developing cleaning protocols district-wide.

In total there are 56 school districts in this area, consisting of varied socio-economic levels. Variation in socio-economic levels was mitigated by use of an averaging of information complied each year of a multi-year period. During the school year 2012/2013, scores state-wide dropped dramatically, as testing methodology, and cut scores, were changed substantially from the prior year. The district to district comparison mitigated the impact of the drop in scoring for all districts on the resulting data. From year to year, districts identified in each category were consistently applied for each year examined. The only district to have a program consistently improving on their green initiatives over the range of time identified is suspected to be the East Meadow School District.

Written permission was sought from each Director of Facilities in Nassau County during a monthly meeting of their professional organization. It was anticipated that approximately 25 to 30 Directors of Facilities would be available and willing to participate. The Director of Facilities' willingness to participate and being able to obtain consent to participate in the interviews will, unfortunately, be a factor. Each selected Director of Facilities was required to sign an informed consent form to participate in the research study.

Data Analysis

Questions were structured as fill in the blank and two-option multiple choice. A point scale is assigned to each response to quantify responses and provide an index of the variable measured (Giraud & Hannon, 2011; Sirkin, 2005). Answers provided on the fill in the blank section were matched to the Health and Safety rating, contained on the Safety Data Sheet which is provided with the purchase of the product identified, on a scale of 0 to 4. Two-option multiple choice questions were coded in the following manner: 2 for non-green option and 0 for green option. All choices scored were totaled and then divided by the number of questions to provide a

score. Data collected was from the timeframe specified for the period evaluated; most districts rarely modify programs once a program is established. The lower the score, the closer the program being rated is to providing a healthy environment for the students and staff.

The value of this format is the quantifiable approach attributable to using the Health and Safety rating, which is a component of Safety Data Sheets. Safety Data Sheets are required to be provided with all maintenance products and are regulated under the United States Department of Labor (Standard Number 1910.1200 App D). While variation in programs from school to school within a district cannot be eliminated, there is a consistency in the products available to end-users at the building-level; purchasing is centralized at the district-level. Custodians in the buildings have access only to products purchased and provided by the district, as this is a direct system from the district-level to the building-level.

Proposed Data Analysis

Data obtained from survey produced a weighted average which was then delimitated into three groups, (a) East Meadow Bio-based Green Program, (b) Basic Green Programs, and (c) Basic Compliance Programs. An evaluation was then made to determine if there was any correlation between the presumed quality of the cleaning program and student achievement. Student achievement has been identified from standardized testing results between 2009/10 and 2014/15 for 3rd Grade Students in Nassau County, New York. All attendance data for Grades 1 through 7, for East Meadow Schools only, was evaluated to determine if there is any correlation between the changes implemented and student attendance.

Table 5. – Survey Document

	Survey Questions: Cleaning Products			
				Health Score: Safety Data Sheets (0 to 4)
	Please fill in brand name of product commonly used (from 2009 to 2015):			
1	What is the cleaning product that your staff uses for basic cleaning?			
2	What is the cleaning product that your staff uses for bathroom cleaning?			
3	What is the cleaning product that your staff uses for cleaning glass?			
4	What is the cleaning product that your staff uses for disinfecting?			
5	What is the product that your staff uses as an air-freshener?			
6	What is the product that your staff uses for floor finish (wax)?			
7	What is the product that your staff uses to remove wax (stripper)?			
8	What is the product that your staff uses to deep clean carpets?			
9	What is the product that your staff uses to clean grout?			
10	What is the product that your staff uses to remove graffiti?			
11	What is the product that your staff uses to clean/polish metals?			
	Please circle one option for the option commonly used (2009 to 2015):	Score= 2	Score= 0	
12	What type of finish does your staff use for painting?	**Standard**	**No-VOC only**	
13	What type of finish does your staff use for wood polyurethane floors?	**Oil-Based**	**Water-Based**	
14	Does your staff always use microfiber products for both rags and dust mops?	**No**	**Yes**	
15	Can a product that contains petrochemicals still be considered green?	**Yes**	**No**	
				Total Score
				Average
	** Thank you for completing survey*			

Limitations

This study was designed to measure any correlation between several environmental factors and student health and achievement. There are many factors that cannot be excluded as a related impact to any correlation identified. When evaluating cleaning programs, there are limitations attributable are many different choices of cleaning products and procedures. Details of both the chemicals used and the procedures implemented will also vary from district-to-district. Even districts using a consistent set of products across their district, may still encounter a variation from building to building. Variation between buildings in a district can be caused by varied levels of training and/or understanding of the proper method to use a product provided by administration. General categories for exposure levels can be established based on common practice for a group of districts, but no two programs will ever be identical.

Summary

There is a growing public concern regarding chemicals present in our environment and children spend the majority of their waking hours in the school environment, which contains many different chemicals. Regardless of any correlations identified, or not identified, in this inquiry further research is needed to determine any impact of the school environment on children. The acute impacts associated with certain chemicals above recommended exposure levels have been quantified by Safety Data Sheets and numerous medical articles. Low-term, low-level impact warrants further study.

Chapter 4: Presentation and Analysis of Data

This chapter provides descriptions and a possible correlation of bio-based cleaning methods, present in one school district in Nassau County, New York, to improved achievement and attendance. Any correlation to these changes in approach may indicate the possible need to change accepted protocols and procedures commonly used in schools both in Nassau County and nationwide.

Study Population and Parameters

Surveys and Consent Forms were provided, and explained, to all districts participating in a cooperative bid meeting on February 2nd in 2017. Only 17 districts chose to participate, although the survey and consent form were provided to all 53 districts in Nassau County. From the feedback received there was no resistance to filling out survey, but it was not a priority to most. The low number of surveys received was attributable to apathy toward the topic, opposed to any concern regarding any adverse impact attributable to participation. Most of the district leaders were unaware, and unconcerned, about the products in use in their districts. All participants required the input of their subordinates to accumulate the information requested.

Descriptive Statistical Analysis

Data on cleaning programs was obtained by taking products disclosed by participating districts and converting them into a number (0 to 4) based on the Health rating from the Hazardous Materials Identification System (HMIS codes) found on the products' Safety Data Sheets (SDS). The score indicating the least impact on human health is 0; highest impact on human health is reflected in a score of 4. The higher the score the greater the impact on student/occupant health. All districts included have signed consent form, and survey, and are fully aware that individual scores are only to be included in documents related to study

evaluation, but individual scores will not be used in final report. Safety Data Sheets are required for all chemicals used in a school building, and all products used in schools are required to be disclosed under Right-To-Know laws.

All school districts evaluated have appropriate cleaning and maintenance programs, which meet the current standards required by NYS Legislation. The assertion of East Meadow Schools is that a focus on bio-based green products, used in compliance with manufacturers recommendations, are the preferred method of maintaining schools. Further, opportunities to minimize chemicals in the school environment are preferred, when possible, through use of mechanical means and procedural changes. The current green cleaning requirement does not mandate bio-based products and does not regulate the misuse and overuse of chemicals. My intent was to compare compliant programs with a bio-based program which far exceeds standards. There is no assertion in this study that any program is in any way operating outside of currently accepted best practices.

Inferential Statistical Analysis

The hypothesis is that the data derived from testing data is correlated with the implementation of a stringent green cleaning and maintenance program in a group of schools as compared with other less stringent green programs. The intent is to determine if there is any correlation, and if so to what extent. All data is grouped into three segments, (a) East Meadow Schools, (b) basic green programs, and (c) basic compliance programs.

Table 6. – Survey of Directors of Facilities

Survey Results

Survey Questions: Cleaning Products

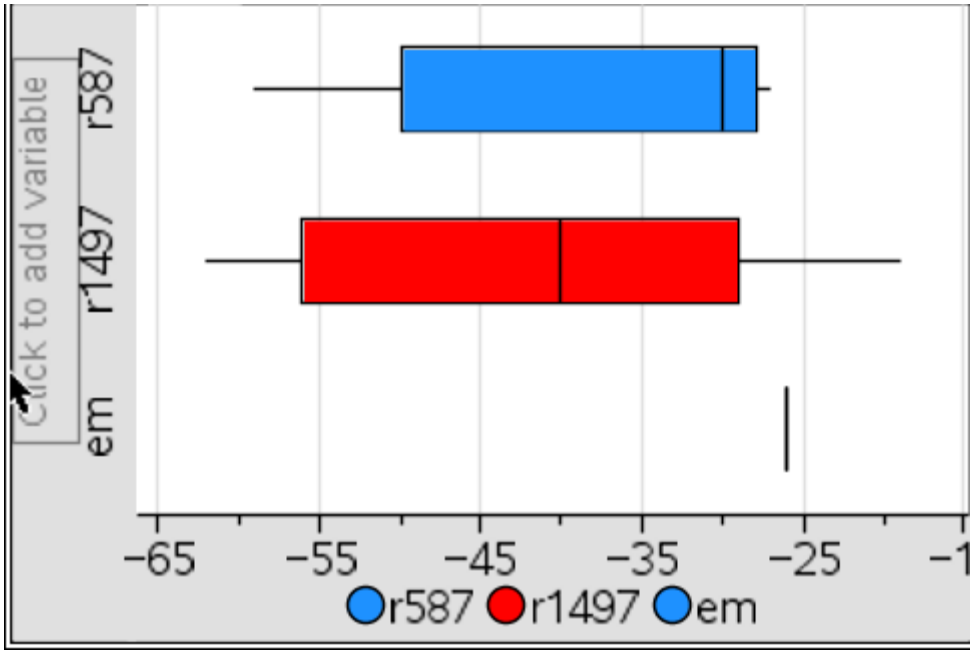
	1	2	3	4	5	6		7	8	9	10	11	12	13	14	15	16	17	
	East Meadow	District 2	District 3	District 4	District 5	District 6	Average	District 7	District 8	District 9	District 10	District 11	District 12	District 13	District 14	District 15	District 16	District 17	Average
1	0	0	0	1	0	1	0.4	0	1	0	1	3	3	2	3	2	3	2	1.82
2	0	0	0	1	1	1	0.6	0	1	1	2	3	3	1	3	2	3	3	2
3	0	0	0	1	0	1	0.4	1	1	1	1	2	0	3	2	2	2	1	1.45
4	0	0	0	1	3	2	1.2	1	3	1	2	3	3	3	3	3	3	3	2.55
5	0	0	1	0	0	1	0.4	1	0	0	0	2	1	0	0	2	1	1	0.73
6	0	0	1	1	1	1	0.8	2	1	1	3	0	1	3	1	1	1	2	1.45
7	0	1	3	2	3	4	2.6	3	3	3	3	3	3	3	3	3	2	3	2.91
8	0	0	0	0	0	1	0.2	2	2	2	2	0	1	2	2	1	1	1	1.45
9	0	0	0	1	1	1	0.6	2	1	1	1	2	0	0	1	3	3	1	1.36
10	0	0	0	1	0	0	0.2	1	1	0	0	1	0	2	3	2	1	3	1.27
11	0	0	0	0	3	0	0.6	0	1	1	0	1	1	1	1	1	2	1	0.91
12	0	0	0	0	2	0	0.4	0	2	2	0	0	2	0	0	2	0	2	0.91
13	0	0	0	0	0	2	0.4	2	2	2	0	0	2	2	0	2	2	2	1.45
14	0	0	0	0	0	0	0	2	0	2	2	2	2	2	2	0	2	0	1.45
15	0	0	0	0	0	0	0	0	0	2	2	0	2	0	0	0	0	2	0.73
	0	**1**	**5**	**9**	**14**	**15**	**8.8**	**17**	**19**	**19**	**19**	**22**	**24**	**24**	**24**	**26**	**26**	**27**	**22.5**
	0.000	**0.067**	**0.333**	**0.600**	**0.933**	**1.000**	**0.587**	**1.133**	**1.267**	**1.267**	**1.267**	**1.467**	**1.600**	**1.600**	**1.600**	**1.733**	**1.733**	**1.800**	**1.497**
	East Meadow 0.000	Green Programs 0.587						Basic Compliance Programs 1.497											

Table 7. – Percentage of Students Scoring at Level 3 and 4- All Surveyed Districts

Achievement Data

				Percentage of Student Scoring at Level 3 and 4																				
Current Rank- Surveyed	Rank 2009/10- Surveyed	Change +/-		2009/2010			2010/2011			2011/2012			2012/2013			2013/2014			2014/2015			Total	Net	Average Score	Program Rating
			District	ELA	Math		ELA	Math	+/-	ELA	Math	+/-	ELA	Math	+/-	ELA	Math	+/-	ELA	Math	+/-	+/-	+/-		
1	10	9	**District 2**	68	77	145	76	81	12	81	81	5	51	49	-62	47	60	7	60	66	19	-19	164.96	56.93	1.497
2	9	7	**District 3**	69	78	147	71	71	-5	84	88	30	50	55	-67	48	64	7	56	67	11	-24	159.96	57.21	1.497
3	7	4	East Meadow	71	81	152	77	82	7	80	86	7	46	62	-58	53	72	17	55	71	1	-26	157.96	59.71	0.000
4	3	-1	**District 4**	86	83	169	80	88	-1	82	86	0	55	58	-55	51	80	18	62	80	11	-27	156.96	63.64	0.587
5	5	0	**District 5**	73	85	158	80	79	1	74	78	-7	58	46	-48	56	56	8	56	73	17	-29	154.96	58.14	0.587
6	8	2	**District 6**	70	80	150	73	81	4	80	88	14	51	53	-64	50	61	7	57	64	10	-29	154.96	57.71	1.497
7	1	-6	**District 7**	84	88	172	79	86	-7	83	87	5	63	69	-38	66	71	5	65	77	5	-30	153.96	65.57	0.587
8	4	-4	**District 8**	75	84	159	75	88	4	85	88	10	65	71	-37	62	74	0	55	71	-10	-33	150.96	63.79	1.497
9	2	-7	**District 9**	82	89	171	82	86	-3	87	89	8	61	64	-51	51	75	1	59	78	11	-34	149.96	64.50	1.497
10	6	-4	**District 10**	76	82	158	75	86	3	83	86	8	50	54	-65	42	66	4	51	67	10	-40	143.96	58.43	1.497
11	12	1	**District 11**	69	70	139	72	80	13	61	73	-18	44	43	-47	44	60	17	40	58	-6	-41	142.96	51.00	0.587
12	17	5	**District 12**	34	41	75	29	41	-5	34	39	3	11	14	-48	10	18	3	9	20	1	-46	137.96	21.43	1.497
13	14	1	**District 13**	64	69	133	65	74	6	67	65	-7	43	40	-49	33	50	0	29	50	-4	-54	129.96	46.36	1.497
14	16	2	**District 14**	62	64	126	61	51	-14	43	46	-23	36	21	-32	36	32	11	37	33	2	-56	127.96	37.29	1.497
15	11	-4	**District 15**	66	76	142	76	78	12	70	74	-10	36	37	-71	43	56	26	40	43	-16	-59	124.96	49.64	0.587
16	15	-1	**District 16**	58	75	133	64	73	4	59	67	-11	43	46	-37	45	50	6	35	38	-22	-60	123.96	46.64	1.497
17	13	-4	**District 17**	69	68	137	77	85	25	77	81	-4	43	46	-69	44	59	14	35	40	-28	-62	121.96	51.71	1.497
			Average Score (Per Year)	**68.74**	**75.02**	**143.75**	**71.85**	**76.28**	**4.38**	**73.06**	**77.11**	**2.04**	**47.11**	**48.47**	**-54.58**	**45.53**	**56.55**	**6.49**	**45.47**	**58.08**	**1.47**	**-40.21**		**61.94**	

Table 8. – Comparison Net Change Year-To-Year: Three Groups



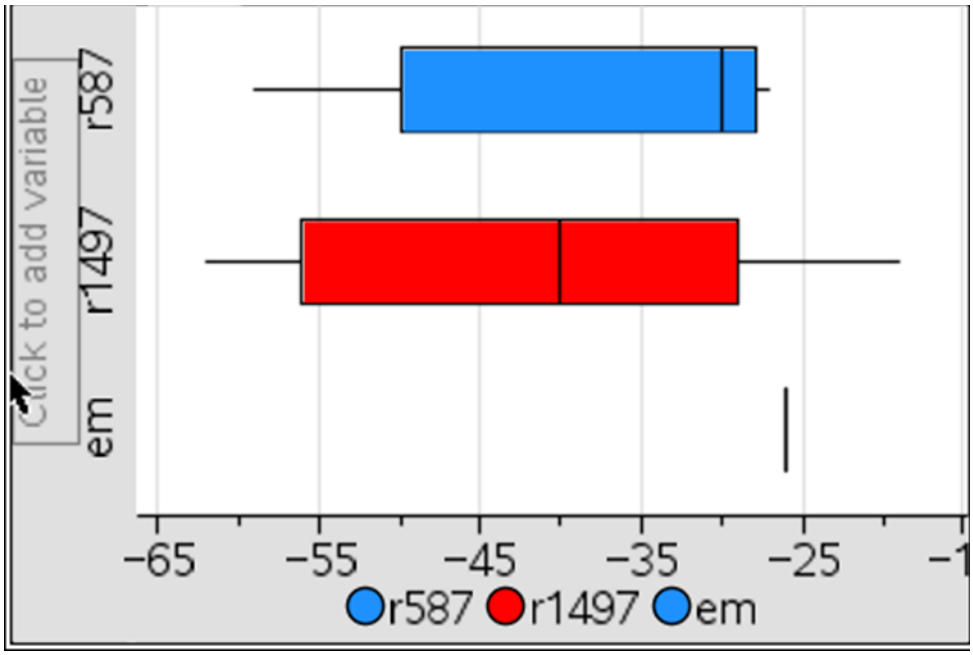
Comparison of the total difference between East Meadow and groups classed with .587 and 1.497 rating

	R0.587	R1.497
Min	-59	-62
Q1	-50	-56
Q2	-30	-40
Q3	-28	-29
Max	-27	-19
mean	-37.2	-41.5
Std dev	13.35	15.00
n	5	11

EM vs R0.587
$H_o: \mu = -26$
$H_o: \mu =< 26$
T= -1.88
P-value: 0.066

EM vs R1.587
T= -3.44
P-value: 0.003

Table 9. – Overall Score Change: Three Groups



Comparison of the total difference between East Meadow and groups classed with .587 and 1.497 rating

	R0.587	R1.497
Min	124.96	121.96
Q1	133.96	127.96
Q2	153.96	143.96
Q3	155.96	154.96
Max	156.96	164.96
mean	146.76	142.74
Std dev	13.35	15.00
n	5	11

EM vs R0.587
$H_o: \mu = 157.96$
$H_o: \mu < 157.96$
T= -1.88
P-value: 0.066

EM vs R1.587
$H_o: \mu = 157.96$
$H_o: \mu < 157.96$
T= -3.44
P-value: 0.003

Research Question 1

Research Question one focused on the extent of the impact the use of chemicals has upon student achievement. The comparison of the performance of the Basic Compliance Program (Group 2) and East Meadow Schools showed that mean net difference is significantly less than East Meadow School District (*P*-value = 0.003) at a significance level of .05. The comparison of the performance of the Basic Green Program (Group 1) and East Meadow Schools did not show significance (*P*-value = 0.066).

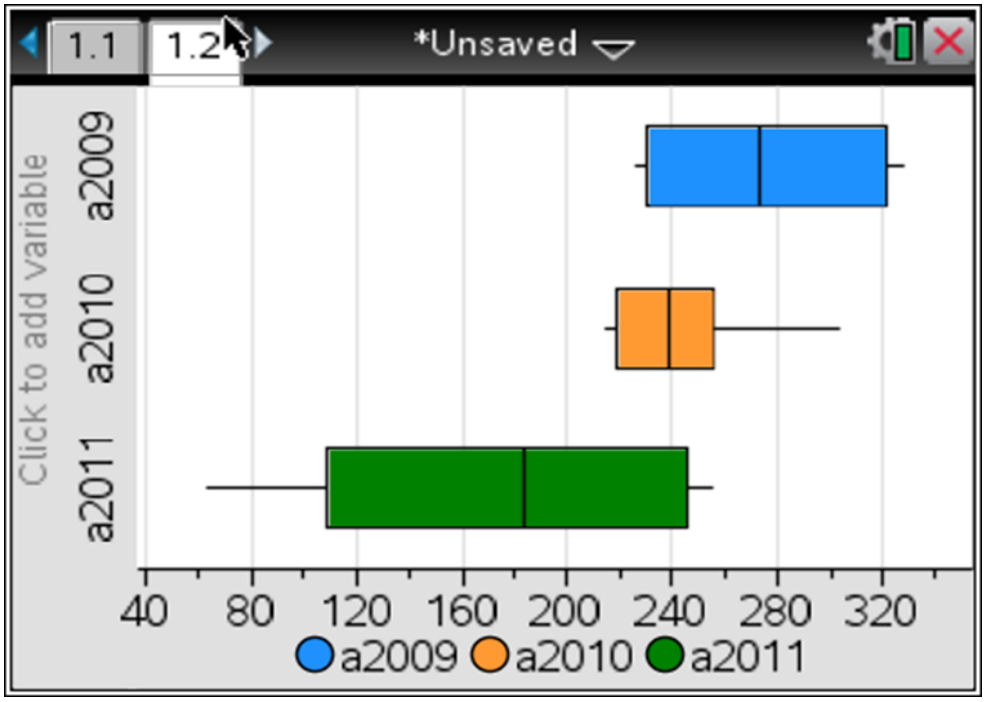
Table 10. – Absence Chart: East Meadow Schools

Student Absence Data

	Enrollment District-wide	2009/10 District-Wide Absence	Enrollment District-wide	District-Wide +/- Enrollment	2010/11 District-Wide Absence	Absence +/-	Enrollment District-wide	District-Wide +/- Enrollment	2011/12 District-Wide Absence	Absence +/-
Grade 1	522	**328**	520	-2	**256**	-72	555	35	**256**	0
Grade 2	524	**281**	481	-43	**234**	-47	494	13	**246**	12
Grade 3	507	**273**	554	47	**238**	-35	518	-36	**183**	-55
Grade 4	562	**321**	529	-33	**304**	-17	552	23	**219**	-85
Grade 5	561	**236**	588	27	**238**	2	526	-62	**153**	-85
Grade 6	600	**230**	583	-17	**215**	-15	605	22	**109**	-106
Grade 7	604	**226**	605	1	**219**	-7	582	-23	**63**	-156

Table 11. – East Meadow Absence Rate: 2009 to 2011

Range of Data for Each of the Years Evaluated



Range of Data for Each of the Years Evaluated

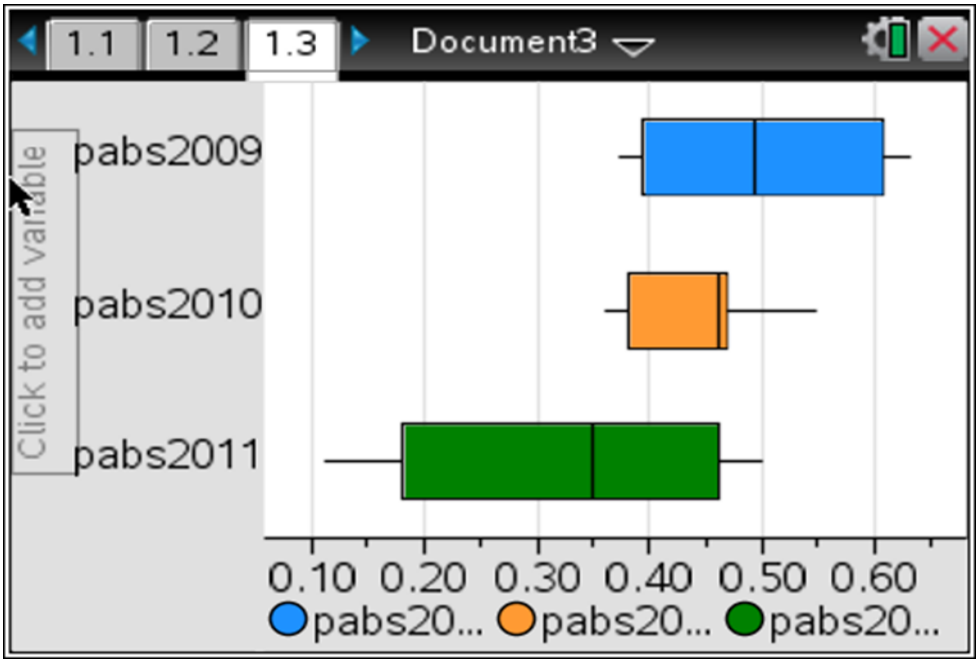


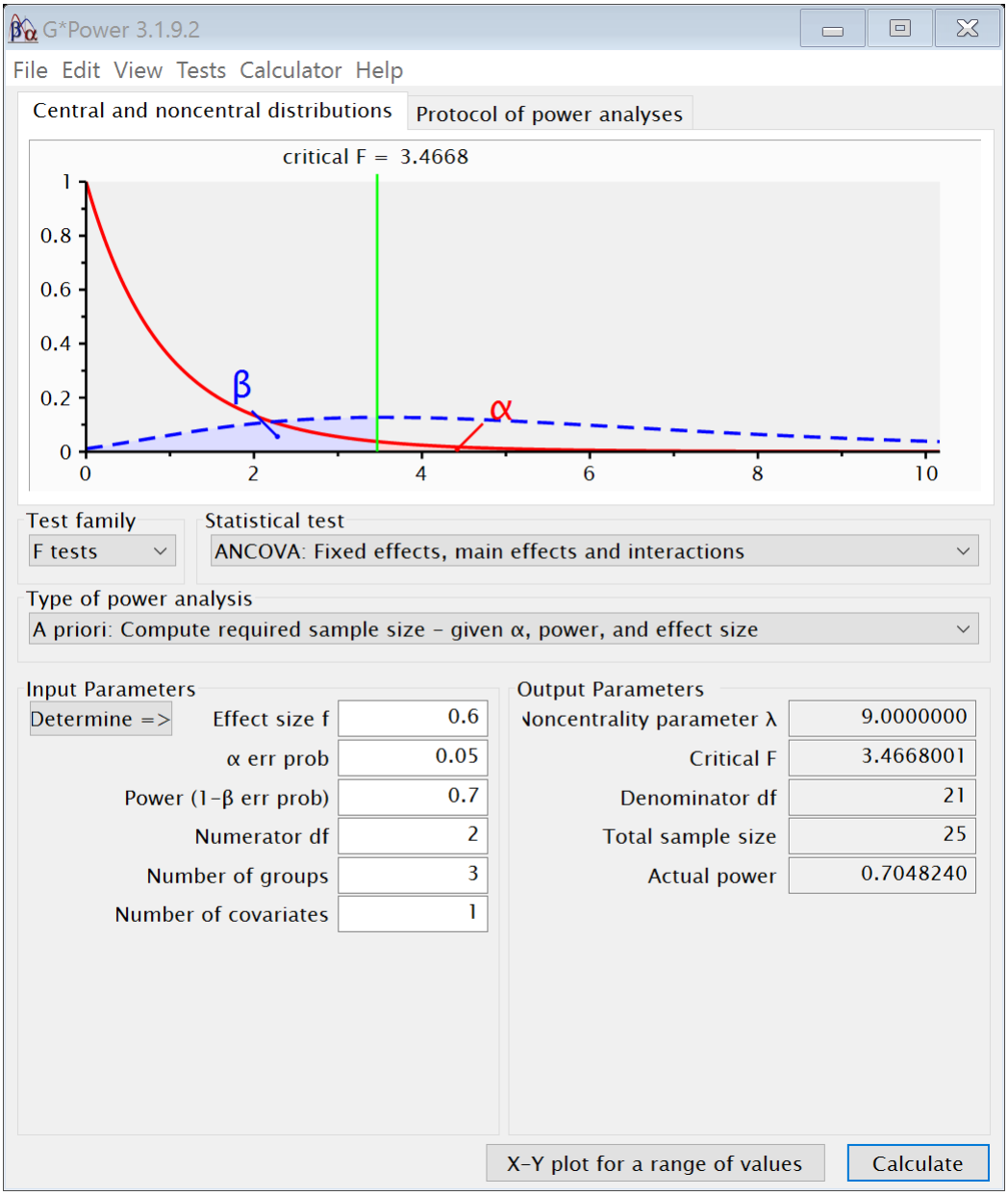
Table 12. – ANOVA Chart

ANOVA	
Analysis	Value
F	4.404
P-Value	0.027
df	2.00
SS	0.107
MS	0.054
df Error	18.00
SS Error	0.220
MS Error	0.012

Research Question 2

Research Question 2 focused on any impact chemicals used in the school environment has on student attendance. While the sample size is small, there is a significant difference between the three years evaluated (*P*-value 0.0277) at a significance level of .05.

Table 13. – G*Power Chart



Chapter 5: Summary

This study was conducted to determine if there is any correlation between chemicals used in a school environment and student health/achievement. The study focused on 17 school districts in Nassau County, New York, for which survey data was available; there are 53 districts in total in Nassau County. Related literature indicated a need for further review of chemical impacts on students, which resulted in the model used to determine any correlation between three separate approaches to school cleaning and maintenance. The results of this study indicate a need to review concerns related to the impact of chemicals on student health/achievement.

Analysis of Findings

The comparison of the total difference between East Meadow Schools and two other groups presented two different results: one had significance and the other did not. Three groups were analyzed on the net change, from year to year, from 2009/10 to 2014/15. The three groups were further analyzed to determine if there was any significance in the total change, from year to year, from 2009/10 to 2014/15. Analysis of student absence was evaluated for East Meadow Schools only for the years of 2009/10 to 2011/12, for grade 1 through grade 7.

Analysis of Net Year-To-Year Change

The net year-to-year change between East Meadow Schools and the green cleaning group, which has the most attributes in common with East Meadow Schools, resulted in *P*-value of 0.066 which was not significant ($P > .05$). The second group, which was the group which only met basic compliance with New York State Green Cleaning Regulations, resulted in a *P*-value of 0.003 which is of significance ($P < .05$).

Analysis of Total Cumulative Change

The total cumulative change between East Meadow Schools and the green cleaning group, which has the most attributes in common with East Meadow Schools, resulted in *P*-value of 0.066 which was not significant ($P > .05$). The second group, which was the group which only met basic compliance with New York State Green Cleaning Regulations, resulted in a *P*-value of 0.003 which is of significance ($P < .05$).

Analysis of East Meadow Student Attendance

The analysis of data for absence in East Meadow Schools only for 2009 to 2011 resulted in a *P*-value of .03 which was significant ($P < .05$). Data from years after 2011 were excluded due to the start of the "Opt Out" movement in Nassau County. After the "Opt Out" movement began absence rate increased drastically throughout the schools in Nassau County from 2012 until the present year.

Limitations

While there is a correlation between student health/student achievement and the three different methods of providing cleaning maintenance to the school buildings as analyzed, there are many other factors which could not be controlled. There are (a) socio-economic differences between the school districts analyzed, (b) different district priorities in regard to standardized testing, (c) different priorities among parents regarding the importance of standardized testing, (d) variations in presentation of material from a curriculum standpoint, and (e) varying levels of resources available from district to district. Limitations require that any findings should be considered a correlation and not cause and effect directly related to the changes in cleaning and maintenance programs between district.

Conclusion

The analysis of data does indicate significance in several areas examined. Data does indicate some correlation between cleaning and maintenance products used and student health/achievement. Data on increased student attendance indicates a possible correlation between the absence of chemically caused irritation and discomfort possibly leading to greater attendance. Higher attendance results in more instructional hours and greater student-teacher contact. While there may be some correlation between olfactory discomfort and achievement, the main factor is maximization of available instructional time due to increased attendance.

Recommendations for Future Studies

Due to the correlations between types of chemicals used in cleaning and maintenance in school buildings and student health/achievement further study is warranted. Future quantitative studies could be initiated at the beginning of a new program to better analyze changes introduced and better control other factors which impact on student health/achievement. A possible approach could be a multi-elementary school district, with consistent socio-economic factors across their buildings, evaluating the impact of a pilot cleaning and maintenance program conducted in one building against all other buildings using their traditional approach. Districts will often pilot cleaning product changes first, as a mechanism to evaluate efficacy of the new cleaning program, without anticipating any other impacts on students or staff; this traditional approach, after evaluation of data presented in this study, may be incomplete.

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Appendix A

Consent to Participate in a Research Study, Which is Part of the Dissertation Study of Patrick Pizzo at Concordia University Chicago

Title: "The Relationship Between Chemicals Present in the Environment and Student Health and Student Academic Achievement"

Voluntary Participation/Withdrawal: Participation in this research is voluntary. You may withdraw at any time without any consequences. Declining consent will not affect my current or future relationship with Concordia University. I can contact Dr. Beth Venzke, Committee Chair, at beth.venzke@cuchicago.edu with any questions related to this study. If you have any questions about the rights of research participants, please feel free to contact the Institutional Review Board or IRB at: IRB@CUChicago.edu

Purpose: You are being asked to give your permission to take part in a research study that examines the impact of petrochemicals on the school environment. The purpose of the study is to ascertain the levels of the use of petrochemicals in your school environment; approximately 30 Directors of Facilities have been asked to participate in this study.

Procedures:

- If you consent to participation in this study, you will complete a survey about products used to maintain your buildings.
- The principal investigator will administer the questionnaire.
- If you consent to participate in this study, your name and district will not be identified.
- I understand this survey will take approximately 10 minutes to complete.

Right to Ask Questions: Do not hesitate to ask questions about the study before participating or during the study. I would be happy to share the findings with you after the research is completed.

Confidentiality: I understand that my responses will be strictly confidential and that my name will not be mentioned in any reports of the research. The record of this study will be kept private. No identifiers linking me, or my district, to the study will be included in any sort of report that might be published. Research records will be stored securely and only Patrick Pizzo will have access to the records. The survey documents administered will be destroyed after 12 months.

Risks/Discomforts: There are no foreseeable risks from the participation in this study.

Benefits: The expected benefits associated with your participation are the information about the safety of the physical environment as related to students, teachers and staff.

Please sign this consent form. You are signing it with full knowledge of the nature and purpose of the procedures. A copy of this form will be given to you to keep.

Signature:_____ Date: _____

Patrick Pizzo, Assistant Superintendent for Business and Finance East Meadow Public Schools
(516)478-5737 pizzop@cuchicago.edu

Table 14. – East Meadow Green Cleaning Program

East Meadow Schools Green Cleaning- Products/ Process

Task	Product/ System.	EPA Cert. (DFE)	Additional Certification	Details of Certification	Green Info	Health	Flammability	Reactivity	Personal Protection	Details of Product
				General Cleaning Program						
Step 1										
Glass Cleaner,sanitizer	Activeion			OGS approved sanitizer	Ionized water only	0	0	0	N/A	All green solution
Step 2										
General cleaning	H2 Orange (Envirox 117)		GS	Green Certified (GS-37)	Dispensing system	0	0	0	N/A	Green Solution- mild concentration/ general surface use
Step 3										
General cleaning	H2 Orange (Envirox 117)		GS	Green Certified (GS-37)	Dispensing system	0	0	0	N/A	Red Solution- strong concentration/ bathrooms use
Step 4										
Disinfecting	PureGreen24			EPA Registered	Bio-based	0	0	0	N/A	Disinfectant; **not for use on blood spills**
Step 5										
Disinfecting (Periodic)	Steam cleaner	-	-	-	No chemicals used	-	-	-	-	Disinfectant for bathrooms, detail cleaning; all green solution
Disinfecting (Periodic)	Fogger				Uses PureGreen	-	-	-	-	Disinfecting for lockerrooms pilot to begin in 2011; to be completed every 2 wee
Step 6										
Disinfecting	Spray 9				N/A	1	0	0	B	**Exempt product for blood spills only**
				Bathroom Cleaning Program						
Bathroom Cleaner	MSC parts cleaner	DFE		Eco Friendly	Biodegradable	0	0	0	N/A	Breaks down compounds
	Clingin Citric	DFE		Eco Friendly	Biodegradable	0	0	0	N/A	Natural ingredients; non-toxic
	A-Ben-Aqui		CFP	Non-toxic	Green Seal	0	0	0	N/A	Can be used to clean white boards as well; very low VOC
	Parsley Cleaner	DFE		Natural ingredients	Bio-based	0	0	0	N/A	Environ. friendly; biodegradable; made from parsley; for general cleaning also
	H2 Orange(Envirox 117)		GS	Green Certified (GS-37)	Dispensing system	0	0	0	N/A	Red Solution- strong concentration/ bathrooms use (part of base program)
	Hillyard AFRC					1	0	0	N/A	minimal health impact
Tile/ Grout/ Porcelain	Magic Erasers					0	1	0	N/A	http://householdproducts.nlm.nih.gov/cgi-bin/household/brands?tbl=brands&id=16003386
										Products do contain formaldehyde, not appropriate for non-staff use; use gloves.
	Magical Erasers					0	0	0	N/A	
	Pumice Stones				All Natural	0	0	0	N/A	
	Grout Smart		GS			1	0	0	N/A	

East Meadow Schools Green Cleaning- Products/ Process

Task	Product/ System.	EPA Cert. (DFE)	Additional Certification	Details of Certification	Green Info	Health	Flammability	Reactivity	Personal Protection	Details of Product
				Floor Maintenance Program						
Terrazzo floors	3M Diamond pads	-	-	-	No Chemicals Needed	-	-	-	N/A	Replaces wax, spray buff and need for stripper; all green solution
Auto Scrubber	Tan & White Pads				*No Chemicals Needed					*Auto Scrubbers at Elementaries use ionized water; recycled content
Tile floors- Wax	E-LEK-TRO		EC	Environmental Choice	Bio-based	0	0	0	N/A	* Can go 3 years before it needs to be completely stripped to the tile.
Stripping- tile floors	Square Pad Scrubber	-	-	Chemical-free	Stripper-free	-	-	-	N/A	Does not require stripper, just water/pad; Secondary Schools 2011 forward
Stripping- tile floors	Maroon Pad System	-	-	Chemical-free	Stripper-free	-	-	-	N/A	Does not require stripper, just water/ pad; recycled content
Buffing- tile floors	Hair Pad System			Chemical-free	Spray Buff Free	-	-	-	N/A	Does not require chemical free; recycled content
Floor Neutral Cleaner	E-LEK-TRO		EC	Environmental Choice	Bio-based	0	0	0	N/A	A component of wax application process
Floor maintenance	Ionized Scrubber					-	-	-	N/A	Uses ionized water/ no chemicals- in PK and CC/ all Elementary Sept. 2011
Tile Cleaning	Traditional Scrubbers		GS			0	0	0	N/A	Use H2 Orange as cleaning agent
Carpet Cleaning	HydroPro Carpet	DFE				0	0	0	N/A	Process completed with pad and standard floor machine
				Specialized Cleaning Products						
Odor Eliminator	Fresh Wave IAQ	DFE			Natural ingredients	0	0	0	N/A	Works through contact, absorption, & reaction
Glass Cleaning	Glass Smart	DFE		Green Seal	Natural ingredients	0	0	0	N/A	**Alternative to ionized water**, uses hydrogen peroxide
Rags	Microfiber	-	-		Chemical Free	-	-	-	N/A	Washable; more effective than cotton; color coded to monitor use; cost reduction due to re
Fabric Refresher	Eco Breeze	DFE		Natural ingredients	Bio-based	0	0	0	N/A	Environmentally friendly; biodegradable
Stainless Steel	Soy Shine			Natural ingredients	Bio-based	0	0	0	N/A	Environmentally friendly; biodegradable; made from soy
	Scotch Pad	-	-	No Chemicals		0	0	0	0	Attachment for grinder; eliminates use of chemicals for metal polishing
Degreaser	Power Safe	DFE		Green Seal	Natural ingredients	0	0	0	N/A	Contains hydrogen peroxide; alternative to harsh degreasers

East Meadow Schools Green Sustainable/ Conservation

Task	Product/ System.	Certified	Green Info	Health	Flammability	Reactivity	Personal Protection	Details
			Bathroom Supplies					
Paper towel dispensers	Bay West	-	Uses recycled paper					Self-feeding sheets, feeds one role to next to reduce waste
Toilet paper	Bay West	-	Uses recycled paper					Dispenser contains three rolls which are easily viewed/ advance- reduces product waste
Soap dispensers	Hands-free	Green Seal(R) and	Alcohol Free	1	0	0	N/A	Hands- free; prevents spread of germs by eliminating surface contact;
(Bathrooms)		EcoLogo (TM)						more washes than liquid (to be replaced when viable alternative is available 10/11?)
Soap dispensers	Hands-free		Botanical	0	0	0	N/A	Contains Thyme; hands- free; prevents spread of germs by eliminating surface contact;
(Computer/ Libraries)								more washes than liquid; *limited use **(does not contain alcohol, Quats, etc.)**
			Dust Control/ Product Applicators					
Wax stripping	Stripping pads		Recycled Material					Made from recycled plastic
Wax buffing	Buffing pads		Recycled Material					Made from recycled plastic (for prep of classrooms)
Dust Mops	Microfiber		Chemical free					Washable; chemical-free; does better job of removing dust, etc.; eliminates service vendor
Wax Application	Microfiber		Chemical Free					More durable; Evenly applies wax for better appearance/ reduced cost (reduces waste)
Wet Mops	Microfiber		Chemical Free					Pilot program to begin 6/2010; more durable; washable; more user friendly, ergonomic
Rags	Microfiber		Chemical Free					Washable; more effective than cotton; color coded to monitor use; cost reduction due to reuse
			Options for Microfiber Product Laundering					
Laundry Detergent	AllerSafe		Non-Chlorine	0	0	0	N/A	Pilot program to begin 9/1/10; for cleaning of microfiber products; uses oxygen to clean
	Ecos Laundry Detergent			0	0	0	N/A	Currently used by Head Custodians for microfiber products
	Green WashBall	Natural Ceramics		0	0	0	N/A	No chemicals used; friction causes pH level to increase releasing stains

East Meadow Schools Site Management

Task	Product/ System.	EPA Cert. (DFE)	Additional Certification	Details of Certification	Green Info	Health	Flammability	Reactivity	Personal Protection	Details of Product
Ice & Snow Melt					Environmentally Sensitive	0	0	0	N/A	Pilot Program to begin Winter 2011 @ CM ent.; no corrosive salts; chlorine-free
Graffiti Removal	Ultra Strip	DFE			Earth Friendly	0	0	0	N/A	Environmentally friendly; biodegradable
	Healthy Clean Buildings			Natural ingredients	Bio-based					Non-toxic, soy-based, biodegradable; very low VOC
Paint- interior/ exterior	Behr/ B. Moore				No VOC	1	0	0	N/A	
Gym Floor Finish	polyurethane				Low VOC	1	0	0	N/A	Water-based; low VOC
				Lawn Care/ Pest Control						
Lawn Treatments	Alternative Lawncare				Organic					Notification Exempt; compost tea, corn gluten, and change in process
Weed Control	-			-	-	-	-	-	-	Use weed-whackers to remove/ gas and battery operated units
Int. Pest Management	A & C Pest Manage.			-	Organic					Notification Exempt
				Green Waste Management/ Recycling						
Paper	Town of Hempstead				Recycle					All programs operating in every building 9/1/10; pilot programs prior
Bottles	Town of Hempstead				Recycle					All programs operating in every building 9/1/10; pilot programs prior
Bulbs	Bulb Eater				Recycle					Bulbs crushed, placed in 55 gallon drums and then recycled
Batteries	IBNYS				Recycle					All batteries are now green; recycled products used; no lead, mercury, cadium
Bags	IBNYS				Biodegradable					Pilot program for small bags
E-Waste	eWorks				Recycle					Container provided my eWorks; used for all e-waste at no cost to district
Metal	Two- Brothers, etc.				Recycle					Generates revenue, instead of cost for dumpsters

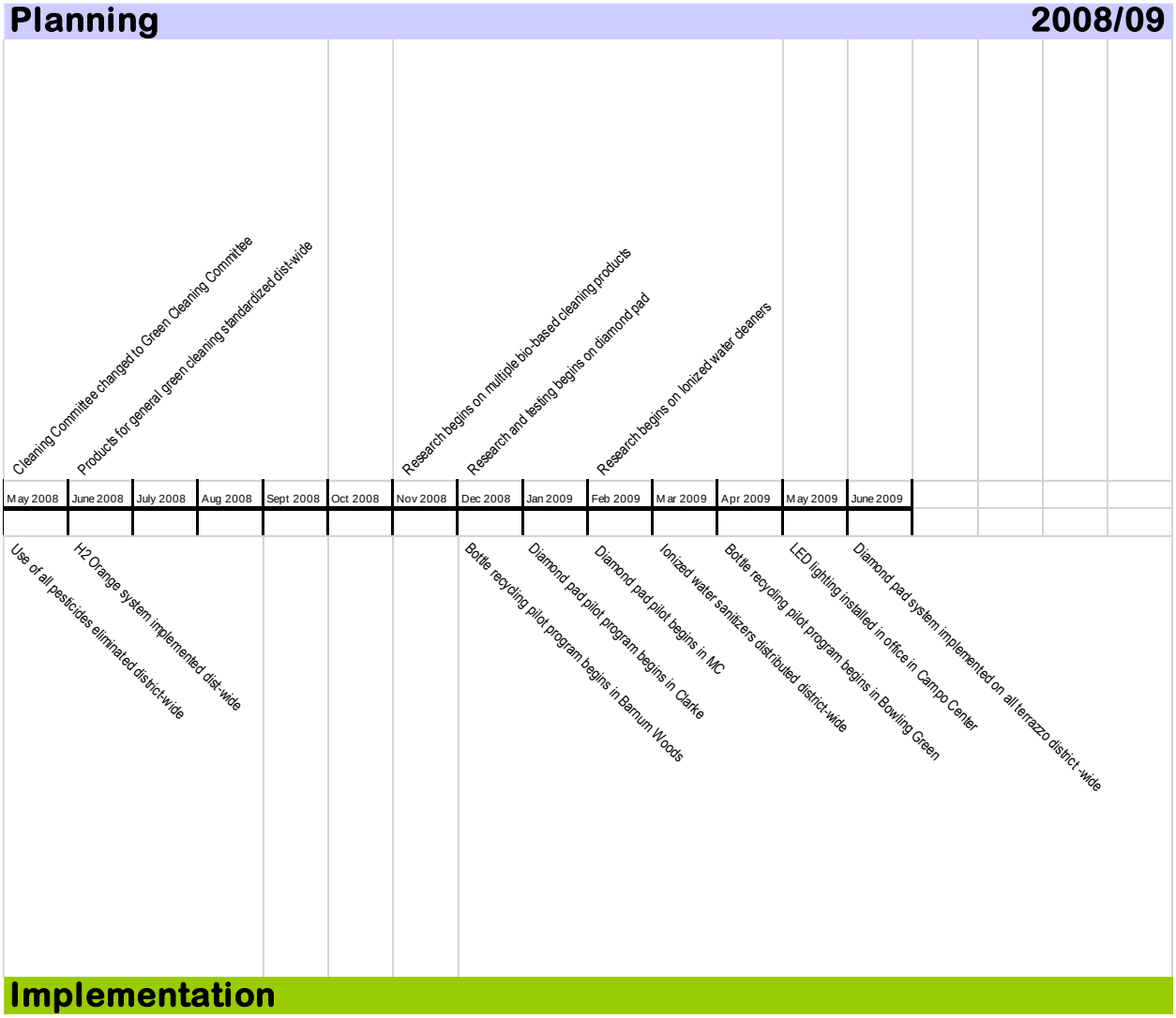
Table 15. – East Meadow Schools List of "Where to Buy Green"

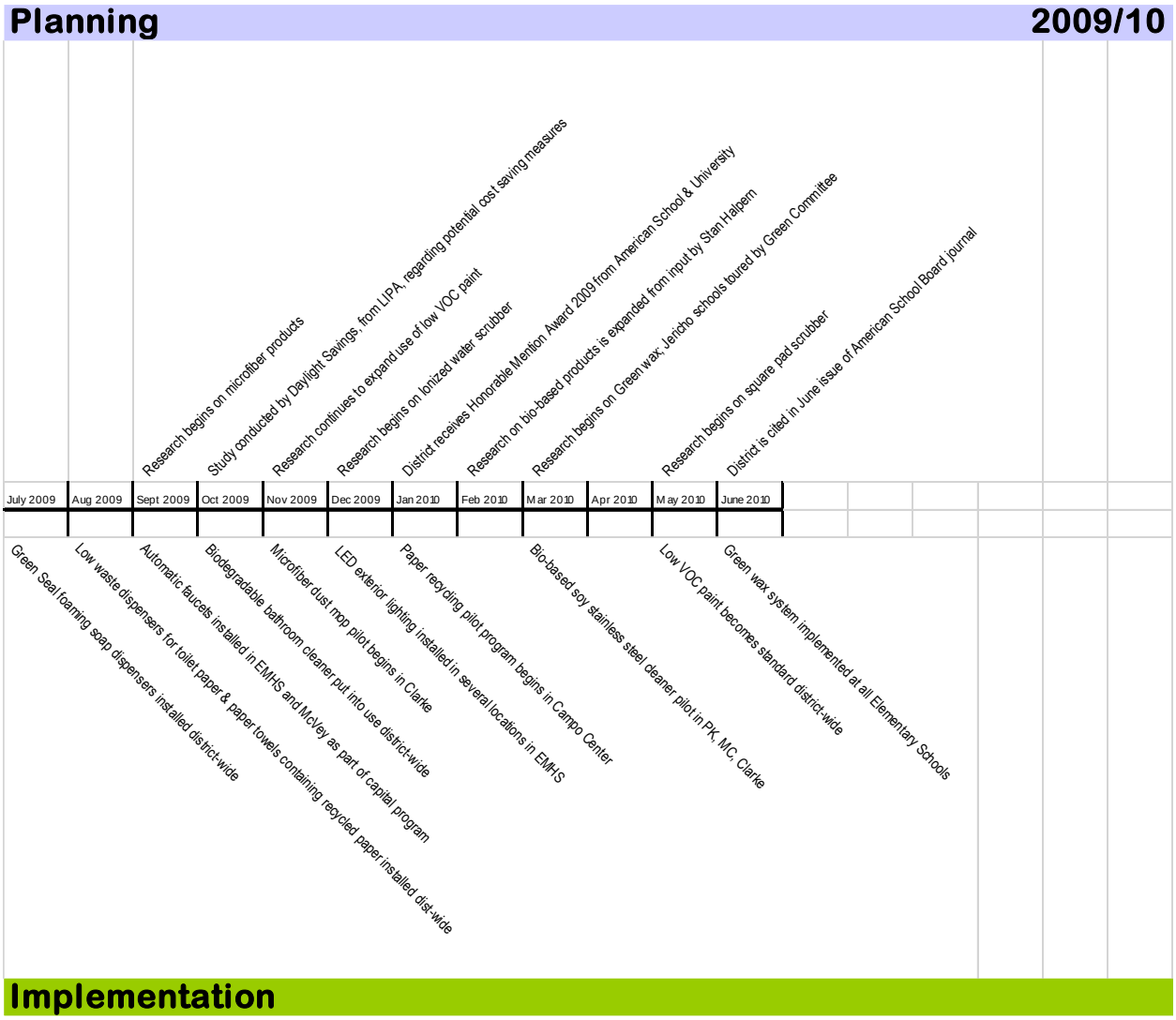
Where to Buy Green

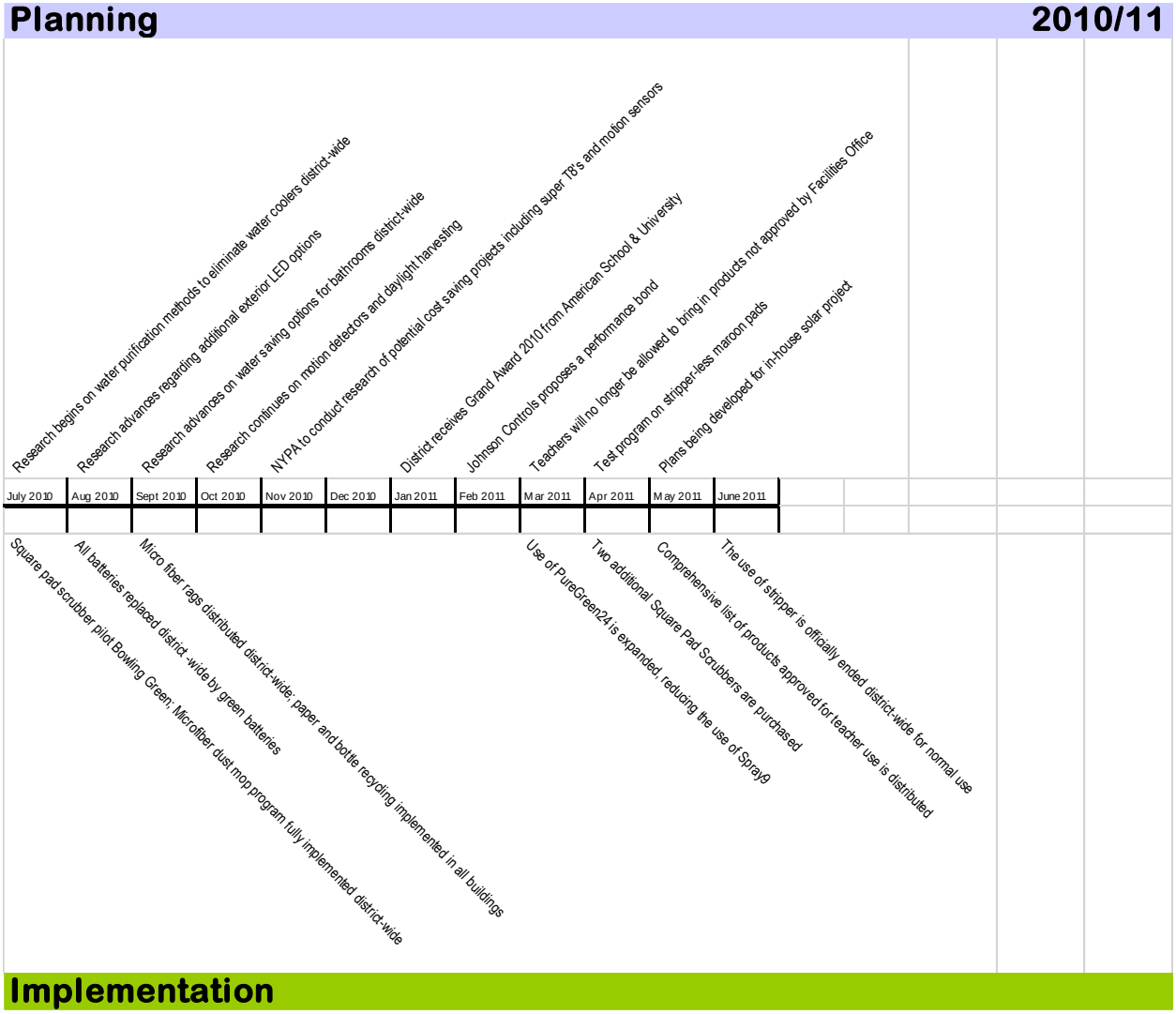
Green Companies:	Method	Seventh Generation	EO	Benefect	Aterra (Avant)	Core Products
Green Sanitizing Wipes, Containing Thyme or Other Natural Products:	**Method Antibac Wipes**	**Seventh Generation Disinfecting Wipes**	**All-Purpose Cleansing Wipes (Not Disinfecting)**	No	No	No
Email Address:	Available, But Not Listed on Website Yet	http://shop.seventhgeneration.com/disinfecting-wipes.html	http://eoproducts.com/Products/All-Purpose-Cleansing-Wipes---210-ct-			
Peroxide Based Wipes:	No	No	No	No	No	**HydrOxiPro**
Hand Sanitizer, Containing Thyme:	**Method Hand Sanitizer**	No	No	**Benefect Natural Hand Sanitizer**	**Aterra Antibacterial Foaming Hand Soap**	No
Email Address:	http://methodhome.com/shop/gel-hand-wash/			http://www.benefect.com/US_benefect/US_products_hand.php	https://www.b4brands.com/hand-sanitizer/green-certified-hand-	
Antibacterial Cleaner, Containing Thyme:	**Method Antibac Bathroom Cleaner**	**Seventh Generation Disinfecting Bathroom Cleaner**	No	**Benefect Botanical Disinfectant**	No	No
Email Address:	http://www.methodhome.com/product/antibacterial-bathroom-cleaner/?spearmint	https://shop.seventhgeneration.com/disinfecting-bathroom.html		http://www.benefect.com/US_benefect/US_products_disinfectants.php		
Where To Buy:	Waldbaums	Waldbaums	Whole Foods Market, Jericho	Aramsco, Brooklyn	Healthy Clean Buildings, www.cleaningpro.com	Healthy Clean Buildings, www.cleaningpro.com
	Bed Bath & Beyond	Walmart		Total Supply, Medford		
	Costco	Target	Fairway Market, Plainview	All Botanical Cleaning & Restoration, NJ		
	Harmon's Discount	Stop & Shop	Whole Foods Market, Manhasset			
	Babies R Us	Babies R Us		ECI- Environmental Coating, Inc, NJ		
			Wild By Nature, Huntington			
Link to Website:	http://www.methodhome.com/	http://www.seventhgeneration.com/	http://eoproducts.com/	http://www.benefect.com/US_benefect/US_products.php	https://www.b4brands.com/	http://coreproductsco.com/index.php/hydroxipro
Link to MSDS Sheets:	By Request, On File in Facilities Office	http://www.seventhgeneration.com/material-safety-data-sheets	http://eoproducts.com/search.aspx?keyword=msds	http://www.benefect.com/US_benefect/US_docs_prodsheet.php	https://www.b4brands.com/msds-hand-soap-sanitizer-lotion	http://www.kanderandson.com/msds/Hydroxi%20Pro%20Cleaning%20Wipes.pdf

** While all products listed are green, not all products carried by these manufacturers are green so always check ingredients, when evaluating products not on this list, to confirm triclosan and ethyl alcohol are not present**

Table 16. – Timeline of East Meadow Schools Sustainable Changes




Planning
2009/10
Research begins on microfiber products
Study conducted by Daylight Savings, from LIPA, regarding potential cost saving measures
Research continues to expand use of low VOC paint
Research begins on Ionized water scrubber
District receives Honorable Mention Award 2009 from American School & University
Research on bio-based products is expanded from input by Stan Halpern
Research begins on Green wax; Jericho schools toured by Green Committee
Research begins on square pad scrubber
District is cited in June issue of American School Board journal
July 2009
Aug 2009
Sept 2009
Oct 2009
Nov 2009
Dec 2009
Jan 2010
Feb 2010
Mar 2010
Apr 2010
May 2010
June 2010
Green Seal foaming soap dispensers installed district-wide
Low waste dispensers for toilet paper & paper towels containing recycled paper installed dist-wide
Automatic faucets installed in EMHS and McVey as part of capital program
Biodegradable bathroom cleaner put into use district-wide
Microfiber dust mop pilot begins in Clarke
LED exterior lighting installed in several locations in EMHS
Paper recycling pilot program begins in Campo Center
Bio-based soy stainless steel cleaner pilot in PK, MC, Clarke
Low VOC paint becomes standard district-wide
Green wax system implemented at all Elementary Schools
Implementation


Planning
2010/11
Research begins on water purification methods to eliminate water coolers district-wide
Research advances regarding additional exterior LED options
Research advances on water saving options for bathrooms district-wide
Research continues on motion detectors and daylight harvesting
NYPA to conduct research of potential cost saving projects including super T8's and motion sensors
District receives Grand Award 2010 from American School & University
Johnson Controls proposes a performance bond
Teachers will no longer be allowed to bring in products not approved by Facilities Office
Test program on stripper-less maroon pads
Plans being developed for in-house solar project
July 2010
Aug 2010
Sept 2010
Oct 2010
Nov 2010
Dec 2010
Jan 2011
Feb 2011
Mar 2011
Apr 2011
May 2011
June 2011
Square pad scrubber pilot Bowling Green; Microfiber dust mop program fully implemented district-wide
All batteries replaced district -wide by green batteries
Micro fiber rags distributed district-wide; paper and bottle recycling implemented in all buildings
Use of PureGreen24 is expanded, reducing the use of Spray9
Two additional Square Pad Scrubbers are purchased
Comprehensive list of products approved for teacher use is distributed
The use of stripper is officially ended district-wide for normal use
Implementation

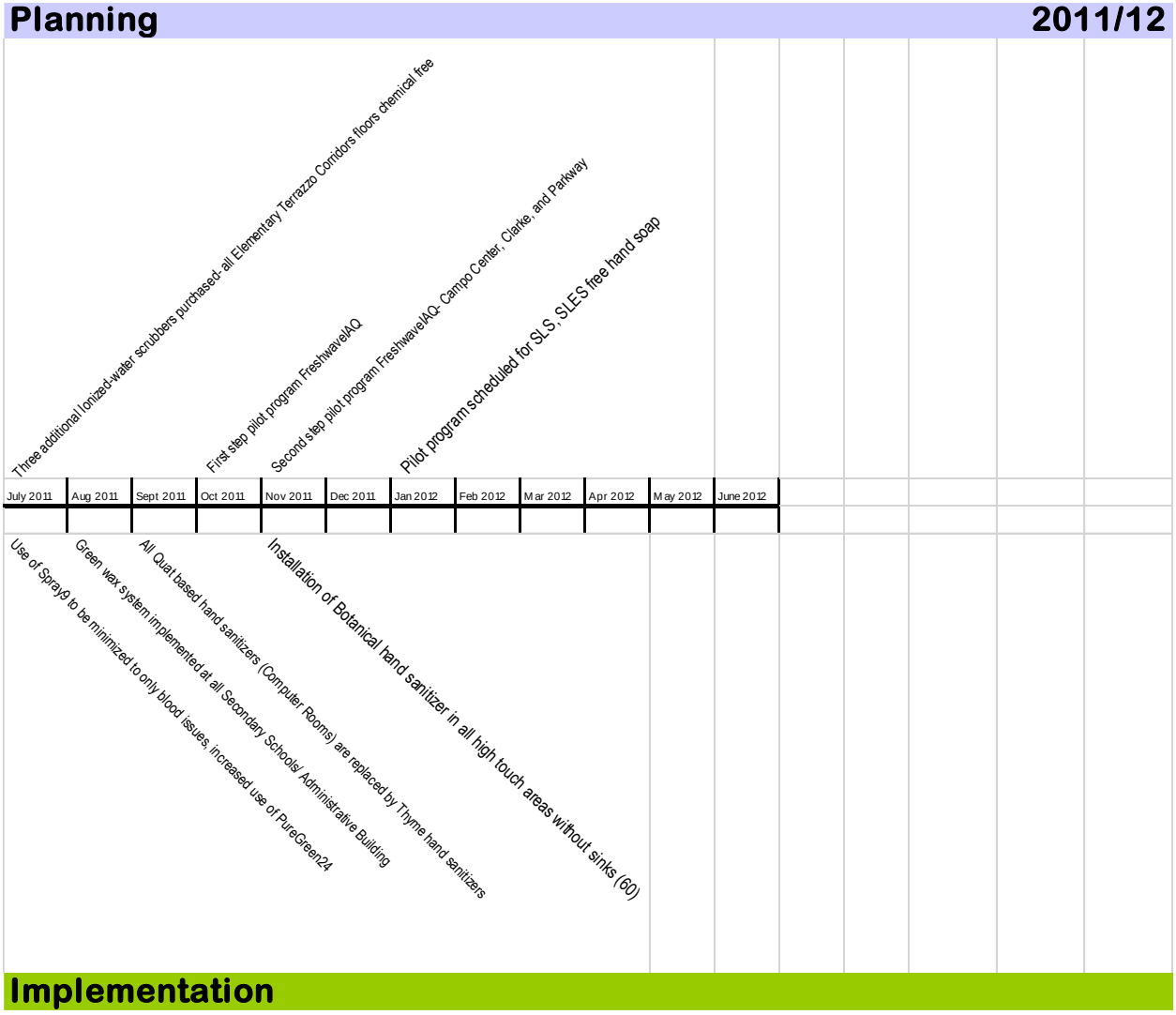

Planning
2011/12
Three additional Ionized-water scrubbers purchased- all Elementary Terrazzo Corridors floors chemical free
First step pilot program FreshwaveIAQ
Second step pilot program FreshwaveIAQ- Campo Center, Clarke, and Parkway
Pilot program scheduled for SLS, SLES free hand soap
July 2011
Aug 2011
Sept 2011
Oct 2011
Nov 2011
Dec 2011
Jan 2012
Feb 2012
Mar 2012
Apr 2012
May 2012
June 2012
Use of Spray9 to be minimized to only blood issues, increased use of PureGreen24
Green wax system implemented at all Secondary Schools/ Administrative Building
All Quat based hand sanitizers (Computer Rooms) are replaced by Thyme hand sanitizers
Installation of Botanical hand sanitizer in all high touch areas without sinks (60)
Implementation

Table 17. – East Meadow List of Disinfecting/Cleaning Products (EPA List Summary)

Active Ingredient in Institutional Disinfectant/ Sanitizer Products	Bleach- Sodium Hypochoride 5.25% (bleach concentrate)	Phenols	Quaternary Ammonium Compounds	Accelerated Hydogen Peroxide	Botanicals	Silver Dihydrogen Citrate	Electro-Chemical Activated (ECA) Water Technology	Ionized Water
Example of Commercial Product	Bleach	Some disinfectants, prior to law change	Spray9, Triple s hand sanitizer	H2Orange	Avant, Benefect, and EO hand sanitizers	PureGreen24	Orbito, GenEon, etc.	Activeion
CDC Disinfectant Level	Intermediate level	Some intermediate some low level- noted on label	Low level disinfectant	Product specific, Low or intermediate level disinfectant	Intermediate level disinfectant	Low level disinfectant	Sanitizer & Application Made to Register as a Disinfectant	Sanitizer only
EPA Toxicity	Category I	Category I or II	Category III	Category III or IV, product specific	Category IV	Category IV	*Category IV	*Category IV
Pre-Cleaning Needed	Surfaced must be pre-cleaned	Surfaced must be pre-cleaned	Product specific, some registered as a one-step disinfectant	Registered as a one-step disinfectant	Surfaced must be pre-cleaned	Surfaced must be pre-cleaned	None	None
Effectiveness	Effective against most bacteria and some viruses	Product specific	Effective against a broad spectrum of microbes	Effective against a broad spectrum of microbes	Effective against a broad spectrum of microbes	Effective against a broad spectrum of microbes	Effective Sanitizer/Disinfecting Properties	Effective Sanitizer
Health Effects	• Mixing with ammonia, ammonium quaternary compounds and other acidic products can create poisonous gas. • Corrosive to eyes and skin, and a respiratory irritant. • Suspected cardiovascular, gastrointestinal or liver, kidney, central nervous system, respiratory, and skin or sense organ toxicant.	• Phenols are recognized carcinogens (CA Prop. 65), suspected cardiovascular, developmental neurological, reproductive, respiratory, skin and sense organ toxicant. • Corrosive to eyes and skin • Absorbed through the skin and by inhalation	• Can cause contact dermatitis and nasal irritation. Ammonium quaternary compounds including benzalkonium chloride, dodecyl-dimenthyl-benzyl ammonium chloride and lauryl dimethyl benzyl ammonium chloride are respiratory sensitizers, and are associated with asthma	• Some products using this technology have been third-party certified by EcoLogo to meet environmental and human health criteria. (EPA does not allow eco labels on disinfectants.)	• No warning or first aid statements are required on the MSDS • The botanical oils in the product are either F.D.A approved as Food Additives or on the United States G.R.A.S. (Generally Recognized as Safe) list. • Third-party certified by EcoLogo to meet environmental and human health criteria.	• No warning or first aid state-ments are required on the label.	Studies Still Being Conducted. As there are multiple settings for cleaning and disinfecting there may be different advisements for different settings.	None

Table 18. – Environmental Protection Agency List of Registered Disinfectants

Active Ingredient in Institutional Disinfectant Products	Bleach- Sodium Hypochlorite 5.25% (bleach concentrate)	Phenols	Quaternary Ammonium Compounds	Accelerated Hydrogen Peroxide (hydrogen peroxide /anionic surfactants)	Botanicals Example- Benefect — Thymol	Silver Dihydrogen Citrate Example - PureGreen 24
Product Description	• EPA registered chlorine bleach at a 5.25% dilution. (Use only EPA registered products for disinfecting purposes.)	• Ready-to-use. • Usually an aerosol product. • Warning — not intended for use as an air freshener.	• Range of products that use "quats" as the active ingredients.	• Hydrogen peroxide in synergy with a blend of commonly used ingredients.	• Plant based products with natural disinfecting characteristics,	• Combination of citric acid and a minute amount of silver ions.
CDC Disinfection Level	• Intermediate Level Disinfectant	• Some are intermediate some are low level - noted on label.	• Low Level Disinfectant	• Product Specific • Low or Intermediate Level Disinfectant	• Intermediate Level Disinfectant	• Low Level Disinfectant
EPA Toxicity Category See Chart Below	• Category I	• Category I or II	• Category III	• Category III or IV, product specific.	• Category IV	• Category IV
Pre-cleaning Needed	• Surfaces must be pre-cleaned.' • Best practices advise pre-cleaning all surfaces before disinfecting.	• Surfaces must be pre-cleaned.' • Best practices advise pre-cleaning all surfaces before disinfecting.	• Product specific. Some products registered as one-step disinfectant • cleaners, Best practices advise pre-cleaning all surfaces before disinfecting.	• Registered as one-step disinfectant cleaners, • Best practices advise pre-cleaning all surfaces before disinfecting.	• Surfaces must be pre-cleaned according to label instructions, • Best practices advise pre-cleaning all surfaces before disinfecting.	• Surfaces must be pre-cleaned according to label instructions. • Best practices advise pre-cleaning all surfaces before disinfecting.

Active Ingredient in Institutional Disinfectant Products	**Bleach- Sodium Hypochlorite 5.25% (bleach concentrate)**	**Phenols**	**Quaternary Ammonium Compounds**	**Accelerated Hydrogen Peroxide (hydrogen peroxide /anionic surfactants)**	**Botanicals Example- Benefect — Thymol**	**Silver Dihydrogen Citrate Example - PureGreen 24**
Storage	• If used for disinfecting purposes, bleach should not be stored longer than 3 months. When mixed with water the solution is only effective as a disinfectant for 24 hours.[3]	• Stable in storage. • Flammable if in aerosol form.[4]	• Stable in storage.	• Stable in storage. 2 year shelf life.	• Stable in storage. 2 year shelf life.	• Stable in storage. No expiration date required.
Effectiveness	• Effective against most bacteria and some viruses and is registered as effective against HIV, HBV, H1NI (Influenza A), MRSA and TB.[5] • See notes below	• Read product label for effectiveness against specific microbes,	• Generally effective against a broad spectrum of microbes including MRSA and H1N1 (Influenza A), but typically not proven effective against spores. • Read product label for effectiveness against TB.	• Effective against a broad spectrum of microbes including H1N1 (Influenza A), norovirus and MRSA. • Read product label for specific claims including TB.	• Effective against a broad spectrum of microbes including H1N1 (Influenza A). TB and MRSA. • Read product label.	• Effective against a broad spectrum of microbes including MRSA, norovirus and H I N1 (Influenza A). Read product • label.
Dwell Time	• 5-10 minute dwell time. • (Read the label for specific	• Generally **10** minute dwell time. • (Read the label	• Generally 10 minute dwell time. • (Read the label	• 1 - 10 minute dwell time. • (Read the label for specific	• 10 minute dwell time. • (Read the label for specific	• 30 second to 10 minute dwell time. • (Read the label

Active Ingredient in Institutional Disinfectant Products	Bleach- Sodium Hypochlorite 5.25% (bleach concentrate)	Phenols	Quaternary Ammonium Compounds	Accelerated Hydrogen Peroxide (hydrogen peroxide /anionic surfactants)	Botanicals Example- Benefect — Thymol	Silver Dihydrogen Citrate Example - PureGreen 24
	recommended dwell times.)	for specific recommended dwell times.)	for specific recommended dwell times.)	recommended dwell times.)	recommended dwell times.)	for specific recommended dwell times.)
Health Effects	• Mixing with ammonia, ammonium quaternary compounds and other acidic products can create • poisonous gas.[6] Corrosive to eyes and skin, and a respiratory • irritant.[7] Suspected cardiovascular, gastrointestinal or liver, kidney, central nervous system, respiratory, and skin or sense organ toxicant.[8]	• Phenols are recognized carcinogens (CA Prop. 65), suspected cardiovascular, developmental neurological, reproductive, respiratory, skin and sense organ toxicant.[9] Corrosive to eyes and skin.[10] Absorbed through the skin and by • inhalation." •	• Can cause contact dermatitis and nasal irritation.[1,2] Ammonium quaternary compounds including benzalkonium chloride, dodecyl-dimenthyl- benzyl ammonium chloride and lauryl dimethyl benzyl ammonium chloride are respiratory sensitizers, and are associated with asthma.13	• Some products using this technology have been third-party certified by EcoLogo to meet environmental and human health criteria. (EPA does not allow eco labels on disinfectants.)	• No warning or first aid statements are required on the material safety data sheet. • The botanical oils in the product are either F.D.A (Food and Drug Administration) approved as Food Additives or on the United States G.R.A.S. (Generally Recognized as • Safe) list. Third-party certified by EcoLogo to meet environmental and human health criteria. (EPA does not allow eco labels on disinfectants.)	• No warning or first aid state-ments are required on the label.
Exposure	• Personal	• Requires	• Requires	• No special	• No special	• No special

Active Ingredient in Institutional Disinfectant Products	Bleach- Sodium Hypochlorite 5.25% (bleach concentrate)	Phenols	Quaternary Ammonium Compounds	Accelerated Hydrogen Peroxide (hydrogen peroxide /anionic surfactants)	Botanicals Example- Benefect — Thymol	Silver Dihydrogen Citrate Example - PureGreen 24
Controls	protection equipment and/or increased ventilation should be • used." See notes below.	personal protection equipment and increased • ventilation.[15] See notes below,	personal protection equipment and proper • ventilation. See notes below.	requirements. • Regular ventilation is adequate. • See notes below.	requirements. • Regular ventilation is adequate. • See notes below.	requirements. • Regular ventilation is adequate. • See notes below.
Environmental Issues Pros and Cons	• Toxic to aquatic organisms.[16]	• Toxic to aquatic organisms.[17] • Considered a persistent bio accumulative toxin by EPA.[18] • Disposal restrictions in some states. Check state and local regulations.	• Very toxic to aquatic life.[19] Also see Material Safety • Data Sheet. Associated with antimicrobial resistance.[20]	• Some products using this technology have been third-party certified by EcoLogo to meet environmental and human health criteria. (EPA does not allow eco labels on disinfectants.)	• Third-party certified by EcoLogo to meet environmental and human health criteria. (EPA does not allow eco labels on disinfectants.)	• Listed on the Grassroots Environmental Education's ChildSafe Products List. See http://www.thechildsafeschool.org/pdf/CSGrev308.pcif for inclusion criteria.
Additional Dis-advantages	• May damage floor finishes, carpets, clothing and other fibers when used in higher concentrations. • Has an	• Not for use on food or food utensils. 23 • May damage floor finishes and other surfaces. • Caution: Do	• Thorough rinsing required. See product label for specifics.	• Rinsing is required where direct skin or oral contact can occur (children's toys).	• Not yet widely available through vendors, may need to be ordered. • Strong odour.	• Not yet widely available through vendors, may need to be ordered.

Active Ingredient in Institutional Disinfectant Products	Bleach- Sodium Hypochlorite 5.25% (bleach concentrate)	Phenols	Quaternary Ammonium Compounds	Accelerated Hydrogen Peroxide (hydrogen peroxide /anionic surfactants)	Botanicals Example- Benefect — Thymol	Silver Dihydrogen Citrate Example - PureGreen 24
	• unpleasant odor. Must be stored separately from ammonia and • flammable products.[21] Rinsing is required in applications where direct skin or oral contact can occur (children's toys).[22]	not use around babies and small children.[24] • Generally leaves a residue so rinsing is required.				
Advantages	• Inexpensive. • Easy to purchase. • The same product can be used for routine and special event tasks, by changing the concentration.	• Readily available,	• Readily available.	• Readily available. Non- • corrosive in diluted form. No rinsing • required except as above. • Some products are odourless.	• Non-corrosive. • No rinsing or wiping required. • Approved by the Canadian Food Inspection Agency for use in • Food Processing. Suitable for use on children's toys.	• No rinsing required. • Non-corrosive. • Odourless. EPA • registered for • use on toys. 24 hour residual protection.

EPA Registered Hard Surface Disinfectants Comparison Chart

*Notes:

I. Pre-Cleaning - Except for disinfectant cleaners that are tested to disinfect in the presence of 5% of organic matter, all other disinfectants require pre-cleaning. Best practices recommend cleaning first and then disinfecting for optimal efficiency.

2.Dwell Time — is product specific. All disinfectants are tested and labeled for the specific amount of time they must be in contact with the surface to kill the microbes. The times listed here are approximate only.

3.Personal Protective Equipment - may be required for the concentrated form of some products, but not for the *Ready to Use* (pre-diluted form). Check the label and the Material Safety Data Sheet (MSDS).

4.pH. pH is a measure of how acidic or basic a product is. Look for products with a neutral pH of 7 or as close to this number as possible.

5.Information is from material safety data sheets, Scorecard at hltp:!/www.scorccard.org/cheniical-profiles/, Pesticide Action Network's Pesticide Database and product information sheets.

6.Costs - When comparing costs, life cycle costs must be considered. Although a product may be less expensive to buy, its negative impact on surface materials may require replacing hard surfaces more frequently, may increase worker's compensation claims and may cause environmental damage.

CDC Definition of 3 Levels of Disinfection - means the use of a chemical procedure that eliminates virtually all recognized pathogenic microorganisms but not necessarily all microbial forms (e.g., bacterial endospores) on inanimate objects:

I. *High-level disinfection* - kills all organisms, except high levels of bacterial spores, and is effected with a chemical germicide cleared for marketing as a sterilant by FDA. Typically not used for generalized disinfecting.

2. Intermediate-level disinfection - kills mycobacterium, most viruses, and bacteria with a chemical germicide registered as a "tuberculocide" by EPA.

3. Low-level disinfection - kills some viruses and bacteria with a chemical germicide registered as a hospital disinfectant by the EPA.

EPA Toxicity Categories Require These Warnings:

A. Culver, M. Feinberg et.al. Cleaning for Health Products and Practices for a Safer Indoor Environment. 2002. INFORM Inc. http://informinc.ore/cleanforhealth.php.

6

Signal Word	Category	Oral Lethal Dose
DANGER, POISON (skull and crossbones)	I Highly toxic	A few drops to a teaspoonful
WARNING	II Moderately toxic	Over a teaspoonful to one ounce
CAUTION	III Slightly toxic	Over one ounce to one pint
CAUTION	IV Relatively non-toxic	Over one pint to one pound

[1] Based on a 150-pound person.

[2] See specific product information sheet.

[3] University of Oklahoma Health Sciences Environmental Health and Safety Office Saf-T-Gram. Letter from the Clorox Company. http://www.ouhsc.edulehsolsaf-t-aramiSprin0 I .pclf.

[4] Material Safety Data Sheet. http://www.spartanchemical.com/sfailVISDSRep.ns170/ebe0e15bf7c02k2852.56ea000545 I t3!OpenDocument.

[5] EPA, Selected EPA Registered Disinfectants. http://www.epa.L'ov/oppad001/cliemretlindex.htm.

[6] Agency for Toxic Substances & Disease Registry (ATSDR) (2007). *Medical Management Guidelines for Calcium Hypochlorite and Sodium Hypochlorite.* hup://www.atsdr.ccie.gov/M1-1M_84.htrnl.

[7] Clorox Bleach Material Safety Data Sheet http://www.thecloroxcompany.coinfproducts/msdslbleach/cloroxregularbleach0505 .pdf.

Agency for Toxic Substances & Disease Registry (ATSDR) (2007). *Medical Management Guidelines for Calcium Hypochlorite and Sodium Hypochlorite.* http://www.atsdr.cde.gov/V11-1M1/mmq184.11tml.

Scorecard, Chemical Profiles. http://www.scorecard.org/chemical-profilesi.

[9] Scorecard, Chemical Profiles. http://www.scorecard.orgichemical-profilesi.

[f'] Material Safety Data Sheets.

[J] Material Safety Data Sheets.

[12] Guidelines for Protecting the Safety and Health of Health Care Workers. http:i/www.cdc.goviniosh/docs/88-119/chemical.html.

[13] AOEC List of Asthmagens. http://www.aoecdata.or2/ExpCocleLookup.asox.

[14] Guidelines for Protecting the Safety and Health of Health Care Workers. http://www.cdc.govinioshldoes/88-119/chemical.html.

[15] Guidelines for Protecting the Safety and Health of Health Care Workers. http://www.cdcAlovfnioshldocs/88-119/chemical.html

[16] Brite Bleach Material Safety Data Sheet. http://www.masseywholesale.comlnisds/britebleach.pd.

[17] NIOSH International Chemical Safety Card. Phenol- http://www.cdc.goviniosh/iocsnenglneng0070.htnil.

[18] Ohio EPA Pollution Prevention Fact Sheet. http://www.epa.state.oh.usiocappip2/mercurv pbtlact99.pdf.

[19] Pesticide Action Network Pesticide Database. http://www.pesticideinfo.on2/Detai I Productisp?REG NR=00087500081&DIST NR=000875.

[20] R.Ventullo, R. Larson (1986) *Adaptation of Aquatic Microbial Communities to Quaternary Ammonium Compounds.* Applied and Environmental Microbiology. Vol. 51, No. 2: 35.461. Feb 1986. http://aem.asm.orgicgilcontent/abstract/51/2.1356.

G. Sundheim, S. Langsrud, E. Heir and A. L. Holck. *International Biodeterioration & Biodemradation.* Volume 41. Issues 3-4, 1998, Pages 235-239. Irttp://www.sciencedireacomiscience? obs:ArtieleURI.& udi=B6VG6-3TN9PP1-B& user-¯·10& rdoe=l& orig=search& sort-¯-d& docanchor=&view=c& acct—0000050221& version—I & urIVersion-0& userid=10&md5-574a268bded54f837ce9cecad2519433.

[21] Brite Bleach Material Safety Data Sheet. hitp://www.masseywholesale.comlinsdsibritebleach.pd.

[22] Chlorox Health Center: SARS. Cleaning & Sanitation in Daycare Facilities, Schools and Universities. http://www.cloroxprofessional.comihealtheentertsars6.slitml.

[23] L. Crawford, Z.Yu, E. Keegan, T. Yu. *Infection Control Today.* A Comparison of Commonly Used Surface Disinfectants. http://www. i n feet ioneontroltodav.com/articles/Ob I feat2.html.

[24] Ohio EPA Pollution Prevention Fact Sheet. http://www.epa.state.oh.uslocappl p2lmercurv nbt/fact99.pdf.

Vita

Patrick Pizzo, A.B.D., M.B.A.

Assistant Superintendent for Business & Finance, East Meadow Public Schools
Instructor, Hofstra University School of Continuing Education

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Scientific Advisory Board, The ChildSafe School, Grassroots Environment Education

National Green Clean Schools Leadership Council, Healthy Schools Campaign

Editorial Advisory Board, Facilities Maintenance Decisions magazine

Chair, Hofstra Certificate Program, Nassau County School Facilities Organization

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Recognitions

- ***The ChildSafe School Recognition Program, Grassroots Environmental Education,*** East Meadow Public Schools**,** 2016
- ***East Meadow PTA Council Honoree****,* East Meadow Public Schools, 2016
- ***Maintenance Solutions Achievement Awards,*** *sponsored by Maintenance Solutions Magazine,*
  Achievement Award for Sustainability, East Meadow Schools, 2012
- ***Green Cleaning Award for Schools & Universities,*** *sponsored by American School & University magazine, The Green Cleaning Network, & Healthy Schools Campaign*
  Grand Award School Districts, East Meadow Public Schools, 2010
  Honorable Mention Award School Districts, East Meadow Public Schools, 2009

Public Presentations

- "Green Cleaning in Schools: Learning From the Leaders" ISSA Industry Forum in Chicago. (2016)
- Presenter on video for, "The ChildSafe School" (2015)
- "Green Clean Schools Leadership Summit" Healthy Schools Campaign Summit. (2015)
- "What Do Customers Care About" ISSA Industry Forum in Philadelphia. (2015)
- "Launch of National Clean Green Schools Leadership Council"- Press Conference in Orlando, Florida. (2014)
- "Financial Management: Helping Managers Create Bottom-Line Benefits" National Facilities Management & Technology Conference/Exposition (NFMT) in Baltimore. (2012)
- "Forum on Healthier, Cleaner, Greener Schools and Facilities" Cleveland Botanical Garden and Beyond Pesticides Ohio. (2012)

- ❖ Hofstra University, Director of Facilities Certificate Program program launch at the Hofstra University Club. (2012)
- ❖ "Action Steps for a Greener, Cleaner Learning Environment" Nassau Regional Parent-Teacher Association Winter Conference. (2011)

Juror and Evaluation Panels

- ❖ Green Cleaning Awards Juror, American School & University Magazine. (2012 to 2016)
- ❖ Sustainable Achievements Judge, Facilities Maintenance Decisions Magazine (2014 to 2016)
- ❖ Architect Portfolio, American School & University Magazine. (2012)

Webinar Presentations

- ❖ "Green Clean Schools: Floor Care in your Cleaning Program" Healthy Schools Campaign. (2015)
- ❖ "What Do Customers Care About" ISSA. (2015)
- ❖ "Making the Financial Case for Green Cleaning" Healthy Schools Campaign. (2012 to 2014)
- ❖ "Learn from the Leaders" Healthy Schools Campaign. (2011)

Patrick has written, contributed, or been cited in several facilities publications, academic journals, newspapers, and press releases for his work related to leadership, management, and sustainability:

- Pizzo, P. (2017). The science of green cleaning: How East Meadow School District mastered cleaning for health. *Facilities Cleaning Decisions, 3-4*. 24-26.
- Pizzo, P. (2016). Building a green team: Collaboration is key to the success of a green cleaning program. *Facilities Cleaning Decisions, 3-4*. 22-23.
- Wood, D. (2015). Is your child's school environment safe? *PTA Our Children Magazine, 3,* 4-5.
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- Ashkin, S. (2014). Green leaders: Introducing the green clean schools leadership council. *American School & University*, *12,* 18.
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- Lubach, D. (2013). Demand response: Delivering efficiency and savings. *Facilities Maintenance Decisions, 11,* 19-20.

- Hounsell, D. (2013). Green savings, from the grounds equipment up. *Maintenance Solutions, 5,* 26.
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- Healthy School Network. (2012). Three case studies in green cleaning. *State Education Standard, 2,* 33-35.
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- American School & University. (2009). Honorable mention 2009, *12,* 34.

Patrick holds a Master of Business Administration and an Advanced Certificate as a School District Business Leader from Long Island University. Patrick is currently preparing the final defense of his study for the Doctorate in Educational Leadership from Concordia University Chicago. His study evaluates the impact of chemical environmental factors on student health and achievement. Prior to working for East Meadow Schools, Patrick spent several years as a Deputy Regional Facilities Manager for the New York City Department of Education, supervising the cleaning and operation of 39 school buildings. Patrick is a New York City Licensed Stationary Engineer and Refrigeration Engineer.

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(516)306-3534 **East Meadow, New York 11554** PPizzo@emufsd.us

PROFESSIONAL SUMMARY

To continue to learn and grow as a school business leader through collaboration, team building and effective management philosophies.

PROFESSIONAL EXPERIENCE

East Meadow School District 2008 - Present
Assistant Superintendent for Business and Finance 2016 - Present

- Responsible for the development of the annual school district budget, long-term financial planning, and budget control as a member of the Superintendent's Cabinet
- Oversees financial operations including investing of funds, short-term borrowing, and bond sales; identifies and secures all revenue sources available to district
- Provides leadership, support, oversees and evaluated administration of assigned departments for the purpose of ensuring effective delivery of services to schools, departments, and the community
- Assists the Superintendent and staff to analyze financial and educational issues and develop solutions to problems to improve daily operations
- Assists the Superintendent in negotiations with professional and Civil Service bargaining units to provide fair solutions at a cost acceptable to district taxpayers
- Prepares budgetary presentations, under the guidance of the Superintendent, for the Board of Education, Parent Teacher Associations, local community groups, and the general public

Assistant to the Superintendent for Administration and Special Projects 2014 - 2016

- Build, defend, and implement annual facilities, operations, and capital budgets for review and approval of Superintendent and Board of Education
- From a Cabinet-level position, responsible for the efficient physical plant operation, environmental safety, and preventative maintenance of 10 buildings covering 1.34 million square feet of occupied space and 130 acres of grounds; direct operations departments staff totaling 117 regular employees
- Instruct Right-To-Know training for all classified and certified staffs
- Coordinate and direct completion of approved capital budget projects, including submission to State Education Department; research and implement sustainable in-house projects to produce cost savings
- Chair Parent Teacher Association Safety Committee and member of Community Security Council

Director of Facilities & Operations 2008 - 2014

Hicksville School District 2006 – 2008
Director of School Facilities and Operations

New York City Department of Education 1994 – 2006
Deputy Regional Manager 2004 – 2006

- Responsible for the overall physical plant operation and management of 39 schools

Custodian Engineer 1994 – 2004

INSTRUCTIONAL EXPERIENCE

Hofstra University 2012 – present

Continuing Education Lecturer (Part Time)

- As leader of a committee, developed and designed program, in partnership with Hofstra University
- Instructor of Savings Through Sustainability, Health Impact of Sustainability, and Management

ASA Institute of Business 2001 – 2002

Adjunct Instructor (Part Time)

- Illustrated and evaluated the organizational and ethical roles of management accountants

New York City Board of Education, P.S. 84 1992 – 1994

Teacher, Elementary Education

EDUCATION

Concordia University Chicago Present

Ed.D Candidate, Educational Leadership

- Dissertation: Sustainability as Correlated to the Learning Environment

Long Island University

P.D., School District Business Leader 2009

- 4.0 Grade Point Average in certification program

Master of Business Administration 2000

- Member of Delta Mu Delta, National Honor Society

Oneonta State University 1992

Bachelor of Science, Business Economics

PROFESSIONAL AFFILIATIONS & RECOGNITION

- **East Meadow PTA Council Honoree**, East Meadow Schools, 2016
- **Scientific Advisory Board**, The ChildSafe School, Grassroots Environment Education
- **National Green Clean Schools Leadership Council**, Healthy Schools Campaign
- **Editorial Advisory Board**, Facilities Maintenance Decisions magazine
- **Chair, Hofstra Certificate Program**, Nassau County School Facilities Organization
- **Kiwanis member,** Kiwanis Club of East Meadow

LICENSES & CERTIFICATES

- **New York City Stationary Engineer Licens**e/EPA Air Pollution License
- **New York City Refrigeration Engineer License**/Universal CFC Technician