Public Health Assessment

Evaluation of
Soil, Groundwater, Soil Gas and Indoor Air Data

Hamden Middle School
(aka Newhall Street Field)

Hamden, Connecticut

EPA Facility ID: CTD982544355

January 8, 2004

Prepared by
The Connecticut Department of Public Health
under cooperative agreement with
The Agency for Toxic Substances and Disease Registry

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The conclusions and recommendations in this public health assessment are based on the data and information made available to the Connecticut Department of Public Health and the Agency for Toxic Substances and Disease Registry. The Connecticut Department of Public Health and the Agency for Toxic Substances and Disease Registry will review additional information when received. The review of additional data could change the conclusions and recommendations listed in this document.

SUMMARY

The Hamden Middle School is a 55,000 square foot complex consisting of four interconnected building constructed in 1955. The school and grounds cover approximately 25 acres. During the 1940s and early 1950s (prior to construction of the school), the area now occupied by the school and school grounds was used for the disposal of domestic and industrial wastes.

The purpose of this public health assessment is to evaluate the environmental sampling data and current conditions at the Hamden Middle School to determine whether the school and school grounds present a public health hazard. The Connecticut Department of Public Health (CT DPH), under its cooperative agreement with the Agency for Toxic Substances and Disease Registry, previously has prepared health consultations for several areas immediately adjacent to the Hamden Middle School (athletic fields located behind the middle school, Newhall Street School, Rochford Field, Mill Rock Park). This public health assessment builds upon information contained in these previous consultations but the data analyzed in this public health assessment has not been evaluated previously.

Environmental investigations at the Hamden Middle School have focused on surface soil, subsurface soil, indoor air in the school and soil vapor. Investigations have shown elevated levels of metals, polycyclic aromatic hydrocarbons (PAHs) and petroleum hydrocarbons in soils at depth (to 16 feet below ground surface) on the school grounds. In surface soils, some areas with elevated PAHs, lead and arsenic were found. Those areas were capped in 2001 to eliminate potential contact with contaminants. Indoor air quality investigations showed that contaminants from the landfill waste constituents are not present in indoor air at the school. Soil vapor studies showed the presence of elevated methane below the floor in the boiler room of the school. A methane alarm was installed as a safety precaution.

To evaluate public health implications from contaminants at the Hamden Middle School, CT DPH first considered the available environmental data and how people might become exposed to contaminants. If there is no exposure, there is no threat to public health. In cases where exposure is possible, CT DPH compared maximum concentrations of contaminants with health-protective comparison values. This screening step rules out exposures that have little likelihood of causing adverse health impacts. When contaminant concentration exceeded comparison values, CT DPH further evaluated the exposures to determine the likelihood that such exposures would result in adverse health impacts.

The possible ways people could be exposed to landfill contaminants at the Hamden Middle School are through direct contact with contaminated soil (ingestion of soil, skin contact, inhaling

soil particles). Under current conditions, no exposure is occurring because soils with elevated levels of contaminants have been capped. In the past, students and staff could have been exposed while walking or running on the pathways across school grounds or while picnicking at outdoor tables near the cafeteria.

ATSDR has a categorization scheme whereby the level of public health hazard at a site is assigned to one of five conclusion categories. Based on a review of the available environmental data, CT DPH has determined that the Hamden Middle School presents "No Apparent Public Health Hazard." Although past exposures to contaminants in surface soils likely did occur, the exposures were not at levels that would result in health effects.

CT DPH did not evaluate health outcome data in this public health assessment. Based on its evaluation of the extensive environmental data, CT DPH concluded that the type, intensity and frequency of exposure to contaminants at the Hamden Middle School are not significant enough to have caused measurable adverse health effects.

CT DPH received community health concerns during numerous public and private meetings with school staff, parents and area residents. Their concerns have been identified and addressed in this public health assessment document.

Based on its evaluation of the environmental data, CT DPH's recommended actions include the following: digging into the soil on the Hamden Middle School grounds should be avoided; the soil cap and the methane alarm should be regularly inspected and maintained and followup testing of indoor air at the Middle School for the same parameters tested in 2000 should be performed.

CT DPH provided the public an opportunity to comment on this document from September 29, 2003 to December 1, 2003. CT DPH also held a public availability session in October 2003 to receive comments on this document. During the comment period, no comments were received from the public.

A. PURPOSE

The purpose of this public health assessment is to evaluate environmental sampling data and current site conditions to determine whether the Hamden Middle School and school grounds present a public health hazard. This public health assessment builds upon the results of health consultations previously prepared by ATSDR for the playing fields behind the Hamden Middle School and for the Newhall Street School, located next to the Hamden Middle School (these two health consultations are included in Attachment A). Environmental data from inside the Middle School buildings and from the Middle School grounds were not included in either of the previously prepared health consultations in provided in Attachment A**.**

This public health assessment evaluates the results of environmental investigations inside the Hamden Middle School and on the school grounds. Pathways by which people could be exposed to environmental contamination have been identified and evaluated. Community health concerns are also identified and addressed.

B. BACKGROUND

The Connecticut Department of Public Health (CT DPH) was asked by the Quinnipiack Valley Health District, the Town of Hamden and the CT Department of Environmental Protection (CT DEP) to evaluate the public health significance of environmental data that has been collected at the Hamden Middle School.

The Hamden Middle School is located at 560 Newhall Street in Hamden, Connecticut. The Middle School is a 55,000 square foot complex consisting of four interconnected buildings constructed in 1955 (FSS 2000, DEP 2000). The school was previously referred to as the Michael J. Whalen Junior High School. The school and adjacent grounds cover approximately 25 acres. The school grounds have parking areas, paved driveways and a grass athletic field approximately 10 acres in size. The athletic field is located behind the Middle School and consists of paved tennis courts, soccer fields, baseball fields and a small paved track area. The athletic field behind the Middle School was the subject of a health consultation completed in September 2001 by ATSDR (see Attachment A). Located next to the Middle School is the Newhall Street School, which houses community programs for children and youth, a day care and also has classrooms that are used by Hamden Middle School students. The Newhall Street School was also the subject of a past health consultation completed in April 2001. (See Attachment A). An aerial map of the school is included in Attachment B to this document (Figure 1).

Since the late 1970s, several environmental investigations have been conducted at the Middle School site. The earliest investigations focused on the athletic field, also known as the Newhall Street Field. During the 1940s and early 1950s (prior to construction of the Middle School in 1955), the Field was allegedly used by local residents for disposal of domestic waste and by the Winchester Repeating Arms Division for the disposal of old batteries (NUS 1991). As previously mentioned, an evaluation of environmental data collected from the athletic field is the subject of a separate health consultation, which is included in Attachment A.

In 1993, soil samples were collected adjacent to the south side of the school in an area being considered for an expansion to the school buildings. The results of the 1993 sampling event indicated that landfill waste materials are present beneath the school buildings, with results similar to the athletic field behind the school (FSS 2000). Expansion of the school was not initiated.

In 2000, the school again considered expanding its facility. A Phase I Environmental Site Assessment (ESA) was completed for the school in August 2000 and in November 2000, a Phase II ESA was completed. The Phase II field investigations included:

- 15 soil borings to depths 36 feet below grade around the school buildings and in the area of a fuel oil underground storage tank (UST);

- soil vapor samples from 23 locations beneath and adjacent to the school buildings to determine the presence of landfill-related and fuel oil UST-related gases; and

- surface soil samples (0-2 inches and 3-6 inches) in 13 locations near school buildings.

Results from the Phase II soil borings indicate that domestic and industrial wastes are present primarily at depth (greater than 2 feet below ground surface), beneath and adjacent to the school buildings. Elevated levels of metals, some polycyclic aromatic hydrocarbons (PAHs) and petroleum hydrocarbons were found associated with cinders and ash-containing fill materials. The highest petroleum hydrocarbon levels were found close to the fuel oil UST (FSS 2000). Results from the Phase II soil vapor survey showed that there are elevated concentrations of methane beneath the floor of the boiler room inside the school building. One of the levels measured was within the explosive range for methane (methane forms an explosive mixture with air at concentrations between 5 percent and 15 percent). No methane was detected in ambient air in the boiler room or in indoor air elsewhere in the school. The school has installed a methane alarm in the boiler room as a safety precaution. Phase II surface soil results showed the presence of elevated PAHs in several locations near school buildings.

In response to the Phase II soil results, CT DEP recommended that a consultant hired by the Middle School (Facility Support Service) sample the school grounds in a grid pattern to better understand whether accessible surface soils have been contaminated by landfill contaminants. In December 2000 , the consultant collected approximately 75 surface soil samples (0.2-0.5 feet below ground surface) from the school grounds. Although the focus of this sampling effort was surface soils, deeper soil samples (1-1.25 feet below ground surface) were collected at approximately 23 locations. The sampling effort revealed one small area with elevated lead, one small area with elevated arsenic and larger areas with high PAHs in surface soils. Several of these areas were not grassed and received frequent pedestrian traffic. As a temporary measure to reduce exposure to these elevated contaminant levels, another contractor hired by the school covered three areas immediately surrounding the school buildings with a multi-layer cap. The cap consisted of a geotextile layer, clean soil and mulch or grass seed. This work was performed in January 2001. In August 2001, a fourth area was capped. The capped areas are indicated in the map in Attachment B.

Separate from the Phase II activities, indoor air quality evaluations were performed at the school in November/December 2000 because of: (1) concerns expressed by staff and students regarding health symptoms they believed were related to indoor air quality; and (2) to further investigate the potential for infiltration of landfill gases into the school. Air sampling locations included basement and crawlspace areas as well as classrooms and offices where staff and students spend their time.

Typical indoor air quality parameters such as carbon dioxide, temperature and relative humidity were monitored at 26 locations inside the school. Metals and volatile organic compounds (VOCs) were sampled at 7 locations inside the school and 2 locations outside. Measurements were also taken at 58 locations for mercury, hydrogen sulfide, carbon monoxide and combustible gas. PAHs were sampled in indoor air in 11 rooms of the school, one location on the roof and one outside location. With the exception of elevated PAHs in the auditorium, results from the indoor air quality testing were unremarkable. PAH results will be evaluated in the Discussion Section. The results of the indoor air quality evaluation indicated that moisture incursion had occurred in several locations within the school. Also noted was that air handling units in the school may not be working properly and air supply and return ducts and plenums have not been regularly cleaned and maintained.

In January 2001, after the cap was installed over contaminated surface soils immediately surrounding the school buildings, the school hired a contractor to thoroughly clean the school, including the heating and ventilation system. In addition, certain changes were made to the ventilation system to improve the amount of fresh outside air brought inside the school. At a public meeting held after these activities were completed, several Middle School staff stated that they noticed an improvement in comfort and fewer health symptoms among students and other staff after the cleaning and maintenance was performed.

In January 2001, the town made a decision to find a new location for the middle school rather than expand in its current location. Until a new school is ready, the town has stated that it will continue to maintain the soil cap as needed to ensure its integrity and will continue a program of regular cleaning and maintenance of the school and the school's heating and ventilation systems.

Environmental investigations to further define the nature and extent of the former landfill have extended into an 11-block section of the residential neighborhood surrounding the Hamden Middle School and into two town parks (Rochford Field and Mill Rock Park). Environmental data from the 11-block residential area is currently being evaluated by CT DPH and a public health assessment is in progress. A health consultation focusing on one residential property was completed in July 2001(ATSDR 2001b). A health consultation has also been prepared for Rochford Field and Mill Rock Park (ATSDR 2003).

1. Demographics

Hamden Middle School has approximately 1000 students (aged 11-14) and approximately 100 staff.

2. Site Visits and Health Education/Community Involvement Activities

Since fall 2000, CT DPH, in conjunction with the Quinnipiack Valley Health District and CT DEP, have conducted community involvement and health education activities regarding the Hamden Middle School, the Newhall Street School (adjacent school facility and daycare center), and the surrounding neighborhood.

- In December 2000, a public meeting was held regarding contaminated soil around the school. Over 300 teachers and parents attended.

- A fact sheet was developed to address health concerns and distributed at the December meeting and subsequent meetings.

- In December 2000, a meeting of school and community leaders was held to develop a plan to educate the school community about school contamination issues.

- In January 2001, DPH, in conjunction with the Quinnipiack Valley Health District and CT DEP, conducted a special educational presentation for all middle school students about site contamination issues.

- A fact sheet (*Environmental Hazards at Hamden Middle School: Q & A for Students*) was developed for middle school students and distributed to all students.

- Two public availability sessions were held for school community and town residents, both followed by public meetings (1/11/01, 4/10/01).

- A public meeting was conducted in February 2001 by state and local agencies regarding preliminary neighborhood sampling data.

- In May and June 2001, home visits were conducted by CT DPH and EPA with over 60 residents to deliver sampling results and answer health concerns.

Fact sheets mentioned above are included in Attachment C.

C. DISCUSSION

1. Environmental Data

In this section, results from sampling at the Hamden Middle School are presented by environmental medium. Environmental data are presented along with relevant health-based comparison values. Comparison values are screening levels, below which, there is little likelihood of adverse health effects from exposure. Exposure pathways (i.e., way people could come into contact with contaminants) and the public health significance of the exposures are discussed in later Sections of this document.

Subsurface Soils

Approximately 54 subsurface soil samples have been collected from the grounds of the Hamden Middle School. As discussed previously, the Town's Phase II activities included 15 soil borings with subsurface soil samples analyzed from various depths. Field observations during sampling indicate that fill materials consisting of cinders, ash, brick, wood, glass, copper, brass, wire and metal parts were encountered at depths greater than 2 feet at almost all boring locations. In addition, Facility Support Services, contractor to the Middle School, collected approximately 23 samples from a depth of 1 to1.25 feet deep in many locations around the school. The presence of ash was noted at many sample locations.

Table 1 below summarizes maximum concentrations for only those contaminants found in subsurface soil at levels above health protective comparison values. Lead, arsenic, petroleum hydrocarbons (TPH), chromium and several PAHs were found at levels exceeding comparison values. TPH was found at very high levels (500 times greater than the comparison value) in one sampling location, 15-16 feet below ground. This sample location is very close to the fuel oil UST and is likely related to a current or former leak in the tank. Lead and arsenic were also found at elevated levels near the UST.

Table 1. Summary of Subsurface Soil Data, Hamden Middle School Grounds, samples collected in 2000 and 2001.

Contaminant	Sample Depth (feet)	Maximum Conc. (mg/kg)	Health-based Comparison Value (mg/kg)	Comparison Value Source	Number of samples exceeding Comparison Value
Lead	15-16	14,000	400^	CT DEP site-specific cleanup criteria^	18/54
Arsenic	15-16	57	10	CTRSR RESDEC#	8/54
Chromium	1-1.25	260	trivalent 3900 hexavalent 100	CTRSR RESDEC	1/54
TPH*	15-16	250,000	500	CTRSR RESDEC	12/18
PAHs					
Benzo(a)anthracene	1-1.25	180	1	CTRSR RESDEC	13/32
Benzo(b)fluoranthene	1-1.25	220	1	CTRSR RESDEC	16/32
Benzo(k)fluoranthene	1-1.25	93	1	CTRSR RESDEC	9/23
Benzo(a)pyrene	1-1.25	150	1	CTRSR RESDEC	14/32
Indeno(1,2,3-cd)pyrene	1-1.25	74	1	CTRSR RESDEC	10/32
Dibenz(a,h)anthracene	1-1.25	21	1	CTRSR RESDEC	1/23

#CTRSR RESDEC = CT Remediation Standard Regulations Residential Direct Exposure Criteria for soil. This soil standard is developed to be protective of young children and adults with frequent, intense contact with soil over the long term (CT Remediation Standard Regulations, 12/13/95).

*TPH = Total Petroleum Hydrocarbons.

[^]CT DEP site-specific cleanup criterion at the Hamden Landfill sites. This criterion will eventually become part of the CT Remediation Standard Regulations and will be used statewide.

Surface Soils

Approximately 100 surface soil samples have been collected from the Hamden Middle School grounds by the Town of Hamden and by CT DEP. Field observations during sampling noted the presence of coal-like slag material on the ground surface in an area just east of the tennis courts. This area has since been capped (see map in Attachment B). Also noted was ash material in surface soils in several locations on the school grounds that have also been capped (see map in Attachment B). Table 2 summarizes maximum concentrations for contaminants found in surface soil at levels above health protective comparison values.

Table 2. Summary of Surface Soil Data, Hamden Middle School Grounds, samples collected in 2000 and 2001.

Contaminant	Sample Depth (inches)	Maximum Conc. (mg/kg)	Health-based Comparison Value (mg/kg)	Comparison Value Source	Number of samples exceeding Comparison Value
Lead	3-6	1000	400[^]	CTRSR RESDEC[#]	1/102
Arsenic	0-3	44	10	CTRSR RESDEC	3/102
PAHs					
Benzo(a)anthracene	3-6	33	1	CTRSR RESDEC	30/86
Benzo(b)fluoranthene	3-6	40	1	CTRSR RESDEC	44/86
Benzo(k)fluoranthene	3-6	28	1	CTRSR RESDEC	25/86
Benzo(a)pyrene	3-6	30	1	CTRSR RESDEC	35/86
Indeno(1,2,3-cd)pyrene	3-6	13	1	CTRSR RESDEC	18/86
Dibenz(a,h)anthracene	3-6	3.3	1	CTRSR RESDEC	7/86

[#]CTRSR RESDEC = CT Remediation Standard Regulations Residential Direct Exposure Criteria for soil. This soil standard is developed to be protective of young children and adults with frequent, intense contact with soil over the long term.

[^]CT DEP site-specific cleanup criterion at the Hamden Landfill sites. This criterion will eventually become part of the CT Remediation Standard Regulations and will be used statewide.

Soil Vapor

As mentioned previously, a survey was conducted by the Town of Hamden in October 2000 to determine whether any vapors from the landfill or the fuel oil UST are impacting the soil beneath the school buildings or the soil near the school buildings. Soil vapor samples were collected from 2 to 3 feet below ground surface at four locations within school buildings and 10 locations on school property near school buildings. Samples were analyzed instantaneously in the field for methane, hydrogen sulfide, carbon dioxide, oxygen and hydrocarbon vapors. Samples were also analyzed in the laboratory for VOCs, methane and hydrogen sulfide. The only detection was a finding of methane at 4.2 percent in the sample taken from beneath the boiler room floor. Followup sampling from nine points beneath the boiler room floor in November 2000 indicated

the presence of methane at four locations at levels ranging from 2.3 percent to 5.4 percent. Landfill waste has not been conclusively shown to be the source of the methane, although it has not been ruled out as a possibility.

It is interesting to note that the boiler room is the only room in the school with concrete foundation. All other parts of the school have an asphalt-like surface in the crawl spaces. The asphalt surface in the crawl spaces has numerous cracks and would not be effective in trapping methane or other vapors and allowing them to build up beneath the foundation. On the other hand, the boiler room foundation appears to be intact and might be very effective trapping methane. This is a possible explanation for why methane was detected at elevated levels only beneath the boiler room floor.

Indoor Air

Indoor air samples in five of the 26 rooms tested indicated the presence of carbon dioxide at levels slightly above the recommended level set by the American Society of Heating, Ventilating, and Air Conditioning Engineers (ASHRAE) (ASHRAE 1999). ASHRAE recommends that indoor levels of carbon dioxide be kept below the combined total of 700 ppm plus the outdoor level. For Hamden Middle School, the recommended level is 1,125 ppm (based on outdoor measurements taken during the indoor air quality survey). Sample results for VOCs showed relatively low levels of toluene in five of the seven rooms tested. Concentrations ranged from 8 to102 ppb (30 to 380 ug/m3). One sample in one room was above the CT Residential Target Air Concentration (TAC) for toluene (56 ppb). Toluene is a common solvent used in cleaning products, inks, paints and adhesives and the findings are likely due to background sources not waste contamination.

Indoor air in eight rooms in the Middle School were also tested for PAHs. Two PAHs (naphthalene and phenanthrene) were detected in the auditorium of the Middle School. Table 3 presents the concentrations detected along with relevant health-protective comparison values. For the naphthalene sample, the laboratory reported breakthrough, meaning that the adsorption media in the sample collection tube failed to collect all of the naphthalene that was present in the air sample. However, according to the consultant who performed the sampling, the breakthrough was slight and the sample result should not reflect a significant underestimate of the actual naphthalene concentration in the air sample (Personal communication, December 27, 2000).

Table 3. Summary of PAH concentrations in Indoor Air, Auditorium, Hamden Middle School, 2000.

Contaminant	Concentration Detected (ug/m^3)	Health-based Comparison Value (ug/m^3)	Comparison Value Source
Naphthalene	2	3 10 1 50	EPA RfC[#] ATSDR chronic MRL[&] CT proposed chronic HLV[*] CT proposed acute HLV[*]
Phenanthrene	0.7	NA	-------

[#] EPA RfC = Environmental Protection Agency (EPA) Reference Concentration is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to humans (including sensitive subgroups) that is likely to be without an appreciable risk of adverse noncancer health effects during a lifetime.
[&] ATSDR chronic MRL = ATSDR chronic Minimal Risk Level is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects based on exposure duration of 365 days or longer (chronic).
[*] CT proposed HLVs = CT proposed Hazard Limit Values are limits for outdoor ambient air that are derived for use in permitting air pollution sources. Chronic values assume continuous exposure for 30 years and are protective of both cancer and noncancer effects. Acute value assumes short-term exposure (hours to several days) and are also protective of both cancer and noncancer effects.
NA = not established

Groundwater

Groundwater data collected from the Middle School indicate that groundwater has been impacted by landfill materials. Low levels of several volatile organic chemicals (VOCs) have been detected in groundwater on the Middle School grounds. However, groundwater is not used as a drinking water source and thus, there is no exposure to groundwater through ingestion. Despite this fact, staff and students at the Middle School expressed concerns about the quality of drinking water at the School. In response, the Regional Water Authority tested drinking water at the school in November 2000. With the exception of samples drawn from two, little-used water fountains, all samples were within established safe standards and guidelines. The samples from the water fountains were elevated with lead. Repeat testing after running the water in the fountain showed lead results well below the standard; thus, the source of lead was concluded to be from the plumbing.

With regard to the possibility of volatilization of VOCs from groundwater into indoor air, current data indicate that groundwater concentrations are below levels that could pose a risk to indoor air (i.e., CT Groundwater Volatilization Criteria).

2. Exposure Pathways

To evaluate potential exposures at the Hamden Middle School, CT DPH considered the available environmental data for the site and how people might come into contact with contaminants. In order to be exposed, there must be a source of hazardous contaminants, a way for people to come into direct contact with the contaminants and a way for the contaminants to enter the body. At

the Hamden Middle School, contaminants have been detected in surface soil, subsurface soil, soil vapor and, to a minor extent, indoor air. Contaminants have been detected in groundwater at the Middle School property, however, groundwater is not used for drinking water and there are no other ways people could be exposed to groundwater.
For surface soils at the school, possible ways people could be exposed is by ingestion (eating soil particles adhered to fingers or food items), dermal contact (skin contact with soil during activities such as walking on paths through the school ground) and inhalation (inhaling soil particles). At the Hamden Middle School, there are various paths and walkways across and around the school grounds. There is also a courtyard and picnic bench area. Most of these areas are not well-grassed and would provide the opportunity for students and staff to come into direct contact with surface soils. In January 2001, a cap was placed over three large areas on school grounds which have elevated levels of contaminants in surface soil. Included in this capped area was the courtyard and picnic bench area. In August 2001, a cap was placed over a smaller area on the school grounds (adjacent to the tennis courts) which has elevated contaminants in surface soils. Figure 1 in Attachment B shows these areas. The caps provide a barrier against exposure to surface soils. Thus, under current conditions, there is no exposure to contaminants in surface soils. Under past conditions (before the cap was installed), there was a potential for exposure to surface soils.

Although the athletic field behind the middle school is not evaluated in this Public Health Assessment, it warrants mentioning because the exposure scenario for the field is quite different from the paths and walkways on the school grounds. The potential for contact with surface soil on the field is much greater due to the sports activities that take place there (soccer, baseball and other recreational sports). It must be emphasized that existing surface soils which were added as part of capping of the field have been tested and are not contaminated[1]. The athletic field at the Hamden Middle School was evaluated previously in a health consultation (ATSDR 2001) and was found to present no public health threat, as long as digging through the soil cap did not occur.

Subsurface soils were also found to have elevated levels of contaminants. Possible ways people could be exposed to subsurface soils are the same as those discussed above (ingestion, dermal contact and inhalation). However, exposure to subsurface soils will not occur as long as excavation, digging or other activities that penetrate into deep soils does not occur.

Environmental data collected from Hamden Middle School indicate the presence of contaminants in indoor air and soil vapor in limited areas of the school. People could be exposed to contaminants in indoor air by inhalation. Methane was found in soil gas under the school but exposure would not occur unless there was infiltration into occupied spaces of the school buildings.

If there is no actual or potential for exposure to contaminants, then it can be concluded that there is no possibility of adverse health effects from the contaminants. If there is exposure or a

[1]The athletic field has a covering of clean soil which ranges in depth from approximately 2 feet to four feet.

potential for exposure, contaminant concentrations are then compared with health-protective comparison values. Comparison values are screening levels, below which, there is little likelihood of adverse health effects from exposure. When contaminant concentrations exceed comparison values, exposures are evaluated further. For the evaluation in this public health assessment, comparison values were taken from several sources. One source is the Connecticut DEP residential criteria for direct exposure to soil. These values assume that contact with soil occurs every day over the long term (30 years). For soil vapor, CT DPH used the Connecticut DEP residential volatilization criteria for soil vapor. These criteria are used to determine when concentrations of contaminants in soil gas are likely to result in indoor air levels which could potentially pose a health hazard. Soil gas concentrations below the volatilization criteria are not anticipated to pose a risk to people living in residential dwellings. For indoor air data, CT DPH used Connecticut's Target Air Concentrations (TACs). The TACs are part of CT DEP's remediation standard regulations and are levels that are not expected to pose a health threat, assuming a lifetime of continuous exposures. Under Connecticut's waste site cleanup regulations, at levels above the TACs, some form of remediation is required. For the evaluation of PAH data in indoor air, CT DPH also used comparison values developed by CT DEP, EPA and ATSDR. Comparison values are explained in Tables 2 and 3.

3. Health Outcome Data

If the evaluation of exposures indicates that people have or could have come into contact with contaminants at levels thought to cause adverse health effects, CT DPH evaluates health outcome data. Health outcome data are statistics that measure disease or death rates or characterize the health status of a defined group of people. Health outcome data include local and state disease registries such as cancer and birth defects registries but do not include individual medical data . CT DPH has evaluated the extensive environmental data that has been collected for the Hamden Middle School. The types and concentrations of environmental chemicals in and around the middle school and the likely exposure to those chemicals are extremely unlikely to pose a health hazard. To receive exposures large enough to cause measurable adverse health effects, people would need to have frequent and very intense contact (for example, gardening) with the highest concentrations of contaminants found in soil, every day for a lifetime. There is no evidence that this type of exposure has occurred in the past or will occur in the future. Therefore, CT DPH did not evaluate health outcome data in this public health assessment.

4. Evaluation of public health implications to adults and children

To evaluate public health implications to adults and children from contaminants at the Hamden Middle School, CT DPH considered the available environmental data and how people might become exposed to contaminants. If there is no potential for exposure, then it can be concluded that there is no threat to public health. In cases where exposure is possible, CT DPH compared maximum concentrations of contaminants with health-protective comparison values. This is a conservative (health protective) screening step to rule out exposures that have little likelihood of causing adverse health impacts. When contaminant concentrations exceeded comparison values, exposures were evaluated further to determine the likelihood that the exposures would be significant enough to cause health effects.

Subsurface Soils

As the data in Table 1 (page 8) show, subsurface soils have lead, arsenic, chromium, TPH and PAHs at concentrations greater than comparison values. However, exposures will not occur as long as digging, excavation or other soil disturbance does not occur. As long as such activities do not occur, there will be no exposure to contaminants in subsurface soils and no health threat.

Surface Soils - Current Conditions

With regard to surface soils, it is important to emphasize that *at the present time*, a multilayer soil cap exists in the areas around the school where elevated levels of contaminants were detected in surface soils. Part of the school grounds was capped in January 2001 and the remainder was capped in August 2001. Figure 1 in Attachment B illustrates the areas that have been capped. The cap prevents contact with contaminated surface soils. Therefore, under current conditions, there is no exposure to contaminated surface soils and thus no potential health threat.

Surface Soils - Past Conditions

Before the cap was installed, there was the potential for staff, students and children who live in the surrounding neighborhood to be exposed to contaminants in surface soil while walking or running on the paths across school grounds or picnicking at outdoor benches and tables near the cafeteria. Table 2 shows that lead, arsenic and six different PAHs are present at levels exceeding comparison values. For lead and arsenic, there were only a very few samples at the middle school that exceeded comparison values (up to 3 exceedances in 102 samples). Moreover, average[2] concentrations of lead and arsenic in surface soils at the middle school (161 mg/kg and 4.7 mg/kg, respectively) are well below comparison values and are similar to typical background levels in soil (ATSDR 1999, ATSDR 2000). An average concentration is a more realistic estimate than the maximum for what people are likely to be exposed to over time. Given that average concentrations of lead and arsenic are below health comparison values, CT DPH concludes that past exposures to lead and arsenic in surface soils at the middle school are very unlikely to pose a health threat.

Table 2 also shows that PAHs were detected in surface soils more frequently and at much higher concentrations than lead and arsenic, relative to comparison values. In some cases, PAHs are as much as 30 to 40 times above comparison values. Roughly one-half of surface soil samples had at least one PAH present at levels exceeding comparison values. The comparison values for PAHs (CTRSRs) are based on an assumption that contact with soil occurs daily for 30 years and that such contact is intense, like that which would occur in a backyard during gardening or children playing directly in the soil. Contact with surface soil at the middle school would be less intense and less frequent than what was assumed in developing the CTRSRs. Walking, running and picnicking are less likely to result in intense contact with soil than gardening or children playing directly in the soil. Exposure would also have been less likely on weekends and during the summer when school is not in session. Although staff remain at the school for more years than students, staff do not have the same activity patterns as students and therefore would not

[2]CT DPH calculated the 95%ile Upper Confidence Limit (UCL) on the average. The UCL is an estimate of the central tendency. It accounts for variability in the data and ensures that the mean is not underestimated. CT DPH used ProUCL (EPA, May 2001) to calculate the UCL.

have had as much opportunity for exposure as students. One of the primary reasons is that students walk from one classroom or building to another several times each day using the outdoor paths and walkways on the school grounds. Children in the neighborhood would also have had access to the school grounds but as mentioned previously, likely activities would be walking, running or riding bicycles which are not likely to result in intense contact with soil.

To help put potential past exposures to contaminants in surface soil into perspective, CT DPH calculated average[2] PAH concentrations. Average[2] concentrations ranged from 0.43 mg/kg (dibenz(a,h)anthracene) to 5.1 mg/kg (benzo(b)fluoranthene). These are substantially lower than the maximum concentrations used for the screening step. As stated previously, average[2] concentrations are more realistic estimates than the maximum concentrations for the levels people would have likely been exposed to over time.

Both the average[2] and maximum PAH concentrations in surface soil at Hamden Middle School are generally within ranges of typical background for PAHs in urban soil. Automobile and diesel emissions, tire wear and asphalt are major sources of PAHs in soil, especially near roadways. Residential wood burning, power plants, and incinerators are sources of PAHs in air. PAHs stuck to particles in air can eventually settle out onto the soil. Table 4 below presents typical urban soil background levels for select PAHs and compares them with maximum and average[2] concentrations for Hamden Middle School.

Table 4. Typical Urban Soil Background Levels for PAHs and PAHs Detected in Surface Soils at Hamden Middle School (HMS), 2000 and 2001.

Contaminant	Background Level (mg/kg)	Maximum PAH Concentration in Surface soil at HMS (mg/kg)	Average (as represented by the UCL) PAH Concentration in Surface Soil at HMS (mg/kg)
Benzo(a)anthracene	0.17-59	33	3.5
Benzo(b)fluoranthene	15-62	40	5.1
Benzo(a)pyrene	0.06-14	30	3.3
Indeno(1,2,3-cd)pyrene	8-61	13	1.6

Note: Background data from ATSDR 1995

Even though PAH concentrations are generally within background ranges and potential past contact with soil is not likely to have been significant, CT DPH did risk calculations to assess the theoretical cancer and noncancer risks associated with past exposure to the average[2] concentration of PAHs detected in surface soils on the Hamden Middle School grounds. The risk calculations indicate that theoretical noncancer and cancer risks are well below levels that would cause concern for adverse health impacts[3]. Attachment D shows the detailed exposure

[3]Risks were calculated for students (aged 11-13) who were assumed to come into contact with PAHs in soil by ingestion and dermal contact. Exposure frequency was assumed to be daily during the school year (5 days/week; 40 weeks/year = 200 days per year) for the three years that students spend at the middle school. The noncancer Hazard Index was 0.001. A hazard index below 1.0 means that noncancer

health effects are unlikely. Excess lifetime cancer risks were estimated to be approximately 3 in one million. This is considered to be a very small incremental cancer risk.

assumptions and risk calculations. Attachment D also includes background information about the health impacts from exposure to PAHs. This information is provided for purposes of general background and not to suggest that health effects are likely.

For all the reasons discussed above, CT DPH concludes that *past* exposures to PAHs in surface soil on the grounds of the Hamden Middle School are very unlikely to have caused a public health hazard. As previously mentioned, *current* exposures to surface soil are prevented by the multilayer cap. As long as the cap provides a barrier to direct contact with contaminants in surface soil, there will be no exposure and no health threat.

Soil Vapor

As stated previously, exposure to contaminants in soil vapor would only occur if there was infiltration of soil vapor contaminants into occupied spaces of the school buildings. Results of soil vapor tests indicated that the only finding was the presence of methane at concentrations of 2.3 percent to 5.4 percent beneath the boiler room floor, not in air of occupied spaces of the school. However, methane forms an explosive mixture with air at concentrations between 5 percent and 15 percent. Therefore, the presence of methane beneath the boiler room floor could have posed an explosion threat in the past, although it was never detected in the air of the boiler room or crawl space. When the methane threat was discovered, the school installed a continuous methane monitor with alarm in the boiler room to alert school personnel and town fire officials before methane levels reach dangerous levels.

Indoor Air

As previously stated, indoor air sample results were largely unremarkable. In several rooms, carbon dioxide levels slightly exceeded relevant guidelines; indicating that there may not be enough fresh air entering the school. In one room, the air temperature was slightly above the comfort range. These findings can cause building occupants to experience headaches and feelings of stuffiness or sleepiness. These are comfort issues and not permanent health impacts.

In one room (auditorium), naphthalene (a chemical in the PAH category) was detected at a concentration above the proposed CT Hazard Limit Value (HLV) (outdoor air limit) for chronic exposure (see Table 3). This HLV assumes continuous exposure for 30 years and is protective of both cancer and potential noncancer effects. Although the concentration found in the auditorium exceeds the proposed HLV, exposure that would occur there would not be continuous. At most, someone would spend one third of continuous exposure in the auditorium (i.e., 8 hours per day versus 24 hours per day). With this reduced exposure time, naphthalene levels detected in the auditorium are very unlikely to pose a health threat.

With regard to phenanthrene (another PAH compound), which was also detected in indoor air of the auditorium, there are no readily available health-based comparison values. However, phenanthrene is not considered an especially toxic PAH (ATSDR 1995). Thus, since levels of phenanthrene in indoor air are well below health-based comparison values for naphthalene, it can be concluded that exposure to the phenanthrene in the auditorium also does not pose a health concern.

As an additional point of reference, CT DPH reviewed literature data on typical home indoor air concentrations of PAHs. Air levels of phenanthrene measured in homes without cigarette smokers ranged from 57 to 110 ug/m3 (the presence of cigarette smoke would make the air levels even higher). Average indoor air naphthalene concentrations in homes have been reported to range from 0.1 to 1 ug/m3 (ATSDR 1995). Measured PAHs in the auditorium were 0.7 ug/m3 (phenanthrene) and 2 ug/m3 (naphthalene).

It should also be mentioned that tar-like odors were reported in the auditorium a number of years ago. At that time, a fan was installed to draw air from beneath the stage and vent it outside. It is very likely that the PAHs found in air of the auditorium were coming from creosote-soaked timbers that are present beneath the stage. A large number of PAHs are present in creosote (tar). On the day the air sampling was done in the auditorium, the fan was not operating. Follow-up samples taken while the fan was operating properly indicated that there were no detectable PAHs in the air.

The final indoor air finding was a detection of toluene in one room of the school at a level almost two times higher than the TAC for toluene. Toluene was detected in several other rooms in the school at levels well below the TAC. The TACs assume continuous exposure (24 hours per day, 7 days per week). Exposure to toluene in the school would be much less than 24 hours per day. With this reduced exposure time, exposure to toluene does not pose a health concern. As mentioned previously, toluene is a common solvent used in cleaning products, inks, paints and adhesives and the finding is likely due to background sources not waste contamination.

D. EVALUATION OF COMMUNITY HEALTH CONCERNS

Community health concerns were collected by CT DPH during numerous public meetings, meetings with school staff and students, and a public availability session. In addition, CT DPH has learned about community health concerns from the local health department, CT DEP and various contractors. Community concerns are summarized below. A response is provided following each concern.

1. Many Hamden Middle School staff report experiencing symptoms such as headaches, sinus infections, bronchitis, asthma, watery eyes, stuffy nose, congestion, and comfort issues such as room temperatures being too hot or too cold.

The indoor air quality study that was done at the Hamden Middle School in November 2000 found that in several rooms, carbon dioxide levels slightly exceeded relevant guidelines. This indicates that there may not be enough fresh air entering the school. Also reported was that air handling units in the school may not be working properly and air supply and return ducts and plenums have not been regularly cleaned and maintained. Finally, in one room, the air temperature was slightly above the comfort range. Lack of fresh air, temperatures above the

comfort range, and excessive dust in the air could be related to the symptoms reported by school staff. The indoor air study also noted evidence of moisture incursion in several locations within the school. Sources of moisture that are not addressed promptly can lead to mold growth, which can cause building occupants to experience a host of respiratory symptoms.

After the November 2000 indoor air study was completed, the school performed cleaning and maintenance on its air handling system. The inside of the school was also thoroughly cleaned. After this work was performed, many staff reported improvements in the symptoms they had previously experienced.

2. School staff members are concerned that the rate of cancer among staff is higher than expected and that this could be due to exposure to environmental chemicals from the landfill beneath the school.

There has been extensive environmental sampling inside and outside the Hamden Middle School. The types and concentrations of environmental chemicals in and around the middle school and the likely exposure to those chemicals is extremely unlikely to pose a health hazard. To receive an exposure to soil contaminants large enough to present a possible health hazard, a person would need to have frequent and very intense contact (for example, gardening) with the highest concentrations of contaminants every day for a lifetime. There is no evidence that this type of exposure has occurred in the past or will occur in the future.

With regard to cancer, it is important to recognize that cancer is not a single disease but many different diseases. The causes and risk factors for one type of cancer are different from the causes and risk factors for another type of cancer. Environmental exposures are more likely to be suspected in situations that involve only one or two types of cancer. It is also important to understand that cancer is relatively common. One of every three persons will be diagnosed with cancer at some point in their lifetime.

3. School staff requested that a health study be done at the school to address the question of whether there are elevated rates of cancer at Hamden Middle School and whether there is any association with the landfill. They are disappointed that such a health study has not been initiated.

Before CT DPH begins a health study to determine if hazardous contaminants at a site has caused health impacts, it must first establish that exposure to the hazardous contaminants has occurred and then determine whether that exposure is great enough to cause disease. At the Hamden Middle School, CT DPH has reviewed existing environmental data and has determined that exposure sufficient to cause disease has ***not*** *occurred. This is the primary reason why CT DPH has not initiated a health study at the school.*

4. Staff, students and parents are concerned that methane from beneath the school building may enter the building, posing a risk of explosion.

Methane was detected in two rounds of sampling, in several locations beneath the boiler room floor. Methane was never found in the air anywhere in occupied spaces in the school. As a safety precaution, a continuous methane monitor was installed in the boiler room and it has detected no methane at any time. This device is equipped with alarms that will sound ***before*** *methane levels reach potentially explosive levels. In addition, improved ventilation practices in the boiler room and crawlspaces have been instituted to reduce the potential for methane to build up to dangerous levels.*

5. School staff and parents have expressed concerns about how long the cap will be protective as a barrier against exposure to contaminated soils.

Although the cap is technically referred to as an "interim" cap, it will continue to be an effective barrier against soil contact for as long as it is maintained.

6. School staff and parents have complained about tar-like odors in the auditorium. They have questioned whether it is safe for people to spend time in the auditorium.

Air sampling done in the auditorium in December 2000 detected the presence of two PAHs, naphthalene and phenanthrene. It is very likely that the PAHs found in air of the auditorium were coming from creosote-soaked timbers that are present beneath the stage. A large number of PAHs are present in creosote (tar). As discussed previously, levels of PAHs in the auditorium were relatively low and people would not be likely to spend their entire school day, every day, in the auditorium. Thus, levels of PAHs in indoor air of the auditorium are very unlikely to pose a health threat. Moreover, when odors were first observed in the auditorium a number of years ago, a system was installed to draw air from beneath the stage and vent it outside. On the day the PAHs were detected, the fan was not operating. Follow-up samples taken while the fan was operating properly indicated that there were no detectable PAHs in the air. Limited sampling data indicates that even when the fan is not operating, it is safe for people to spend time in the auditorium. However, the venting system provides an extra measure of safety and should continue to be used.

7. CT DPH has been asked by concerned parents and staff whether Hamden Middle School should remain open and if contamination is present in the school at dangerous levels.

Based on a review of available environmental data, CT DPH concludes that the school can remain open and that contaminants from the landfill are not present in the school at dangerous levels.

E. CONCLUSIONS

Extensive environmental sampling at the Hamden Middle School indicates that contaminants associated with landfill waste are present in surface and subsurface soil beneath and around school buildings. There is no exposure and no risk from contaminants in subsurface soil as long as digging or other disturbance of soils at depth does not occur. Surface soils are currently covered with a multilayer cap which prevents exposure. As long as the cap is maintained, there

is no exposure and no risk from contaminants in surface soils. Regarding past exposures to surface soils, there was the potential for exposure to PAHs, arsenic and lead but not at levels that would result in adverse health impacts.

Landfill waste has not impacted indoor air in the school. With some minor exceptions, general indoor air quality parameters such as temperature, carbon dioxide and relative humidity are within recommended guidelines. Although naphthalene was detected in indoor air in the auditorium at levels above health-based comparison values, exposures are very unlikely to pose a health threat. Sampling data indicates that the existing venting system which draws air from beneath the stage and vents it outside, is reducing PAHs in the auditorium to nondetectable levels. Also, the source of the PAHs in the auditorium is not landfill waste but is likely to be from the creosote-soaked timbers present beneath the stage.

Groundwater appears to be impacted by landfill waste, but since groundwater is not used for drinking water, there is no exposure to groundwater. Soil vapor sampling indicates the presence of methane in one area beneath the boiler room floor. The methane could have posed an explosion threat in the past but a methane monitor has been installed as an early warning system.

ATSDR has a categorization scheme whereby the level of public health hazard at a site is assigned to one of five conclusion categories. ATSDR conclusion categories are included as Attachment E to this report. CT DPH has concluded that based on a review of existing environmental data, the Hamden Middle School presents no apparent public health hazard.

F. RECOMMENDATIONS

1. The multilayer soil cap installed over portions of contaminated surface soil on the school grounds should be regularly inspected by the Town of Hamden and maintained to ensure that it continues to provide an effective barrier against exposure to soil.

2. The methane alarm for the boiler room should be checked routinely by the Town of Hamden to ensure that it is working properly.

3. The Town of Hamden should ensure that air handling units in the school are regularly inspected, cleaned and maintained so that proper amounts of fresh air are being brought into the school.

4. Sources of moisture incursion in the school should be identified and corrected by the Town of Hamden as soon as possible to minimize the growth of mold.

5. The Town of Hamden should ensure that digging, excavation or other activity which penetrates into the soil anywhere on the school grounds, occur only with appropriate coordination with CT DEP.

6. The Town of Hamden should ensure that follow up indoor air testing be done in the school. This testing should include the parameters originally tested in November 2000 and should be done annually, or other reasonable time frame. The testing will indicate whether school indoor air quality has changed since November 2000.

G. PUBLIC HEALTH ACTION PLAN

Actions Taken

Since fall 2000, CT DPH staff, in conjunction with Quinnipiack Valley Health District and CT DEP, have conducted community involvement and health education activities regarding the Hamden Middle School, an adjacent school facility and daycare center (the Newhall Street School), and the surrounding neighborhood.

1. In December 2000, a public meeting was held regarding contaminated soil around the school. Over 300 teachers and parents attended.

2. A fact sheet was developed to address health concerns and distributed at the December meeting and subsequent meetings.

3. In December 2000, a meeting of school and community leaders was held to develop a plan to educate the school community about school contamination issues.

4. In January 2001, DPH, in conjunction with the Quinnipiack Valley Health District and CT DEP, conducted a special educational presentation for all middle school students about site contamination issues.

5. A fact sheet (*Environmental Hazards at Hamden Middle School: Q & A for Students*) was developed for middle school students and distributed to all students.

6. Two public availability sessions were held for school community and town residents, both followed by public meetings (1/11/01, 4/10/01).

7. A public meeting was conducted in February 2001 by state local agencies regarding preliminary neighborhood sampling data.

8. In May and June 2001, home visits were conducted to over 60 residents living in the neighborhood surrounding the Hamden Middle School to deliver sampling results and answer health concerns. These home visists were conducted by CT DPH and EPA staff.

9. On October 22, 2003, a public availability session was held to receive questions and comments on the draft release of this Public Health Assessment.

Actions Planned

1. CT DPH will continue to work with the Quinnipiack Valley Health District and CT DEP to provide technical assistance regarding developing sampling plans and evaluating data.

2. CT DEP will continue to participate in public meetings, availability sessions and other avenues for communicating health information about the site to the public.

3. CT DPH will evaluate new environmental sampling data as it becomes available.

4. CT DPH will conduct a community needs assessment in the neighborhood surrounding the Hamden Middle School. This needs assessment will focus on the the neighborhood rather than the Middle School because of the decision by the Town of Hamden to find a new location for the Middle School.

5. CT DPH will work with the Quinnipiack Valley Health District, the Town of Hamden and CT DEP as necessary to ensure that recommendations made in this Public Health Assessment are carried out in a reasonable timeframe.

6. CT DPH will prepare a written health consultation to document that recommendations were carried out and planned activities in the Public Health Action Plan were accomplished.

REFERENCES

ASHRAE 1999. Ventilation for Acceptable Indoor Air Quality, Atlanta, GA, American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE Standards 62-1999).

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CERTIFICATION

This Public Health Assessment for Soil, Soil Gas, Groundwater and Indoor Air Data at the Hamden Middle School was prepared by the Connecticut Department of Public Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the Public Health Assessment was initiated.

Technical Project Officer, SPS,SSAB,DHAC

The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this Public Health Assessment and concurs with its findings.

Chief, SPS, SSAB,DHAC,ATSDR

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ATTACHMENT A

April 18, 2001 Health Consultation
September 21, 2001 Health Consultation

ATTACHMENT B

FIGURE 1 HAMDEN MIDDLE SCHOOL

ATTACHMENT C

FACT SHEETS

ATTACHMENT D

RISK CALCULATIONS

FACT SHEET - PAHs

Hamden Middle School-Risk Calculations for PAHs

A. Noncancer risks, student aged 11-13 years
1. Ingestion Dose
ADD_i = IR*[PAH]*EF*ED*CF*1/BW*1/AT

ADD_i = 50 mg/d * 14 mg/kg*200d/y*3 yr* 10^{-6} kg/mg*1/46 kg*1/1095 days
= 8.3E-6 mg/kg/day

2. Dermal Dose
ADD_d = [PAH]*CF*AF*ABS*EF*ED*EV*SA*1/BW*1/AT

ADD_d = 14 mg/kg *10^{-6} kg/mg* 0.2 mg/cm^2/-ev * 0.13*200 d/y*3 y*1 ev/d*4570 cm^2 *1/46 kg* 1/1095 d

ADD_d = 1.98E-5 mg/kg/ day

3. Noncancer Hazard Index

HI = (ADD_i + ADD_d)/RfD
HI= (8.3E-6 + 1.98E-5) /0.02mg/kg/day
HI= 0.001

A Hazard Index of 1 means that the estimated dose is equal to the safe dose. A Hazard Index less than 1 indicates that the estimated dose is below the safe dose and noncancer health impacts are unlikely. A Hazard Index greater than 1 indicates that the estimated dose is above the safe dose and noncancer health impacts cannot be ruled out. In this case, the Hazard Index for PAHs is well below 1. This indicates that noncancer health impacts from PAHs are unlikely.

B. Cancer Risks
1. Ingestion Dose

$LADD_i$ = 50 mg/d * 4.8 mg/kg * 1E-6 kg/mg * 200 d/y* 3 y*1/46 kg * 1/25550 d
= 1.2 E-7 mg/kg/day

2. Dermal Dose

$LADD_d$ = 4.8 mg/kg *1E-6 kg/mg* 0.2 mg/cm^2/-ev * 0.13*200 d/y*3 y*1 ev/d*4570 cm^2 *1/46 kg* 1/25550 days
= 2.9E-7 mg/kg/day

3. Cancer Risk-PAHs

ELCR = ($LADD_d$ + $LADD_i$)* CSF
ELCR= (1.2 E-7 + 2.9E-7)*7.3 $(mg/kg/day)^{-1}$
ELCR= 3E-6

The Estimated Lifetime Risk for PAHs is 3 E-6 (3 in 1,000,000). This means that if 1,000,000 people were exposed to PAHs in soil at the concentration, frequency and duration of exposure assumed in the calculations detailed above, there would be a theoretical increase of 3 cancers above the number of cancers that would normally be expected to occur in the population of 1,000,000. Background rates of cancer in the U.S. are one in 2 or 3 (American Cancer Society, 1996). This means that in a population of 1,000,000, background numbers of cancer cases would be approximately 330,000 to 550,000. Past PAH exposures at the Hamden Middle School could theoretically have resulted in an increase of 3 cancer cases above the background number of 330,000 to 500,000 cancer cases. This represents an insignificant increased cancer risk.

WHERE:

ADD_i = average daily dose from ingestion
ADD_d = average daily dose from dermal contact
$LADD_i$ = lifetime average daily dose from ingestion exposure
$LADD_d$ = lifetime average daily dose from dermal exposure
IR = soil ingestion rate; 50 mg/day (EPA 1997, ATSDR 2002)*
AF = skin-soil adherence factor (central tendency estimate for child, based on measurements made among older children); 0.2 mg/cm^2 (EPA 2001)
ABS = Soil dermal absorption fraction
PAHs: 0.13 (EPA 2001)
SA = Skin surface area, 50th percentile face, forearms, hands, lower legs, feet, child aged 11-13; 4570cm^2 (EPA 2001)
[PAH] = PAH concentration in soil
noncancer**:** 14 mg/kg (Total 95 percentile UCL for all PAHs)
cancer: 4.8 mg/kg (Total TEF-adjusted 95 percentile UCL for all PAHs)
EF = exposure frequency; 200 days/year (school year Sept. through mid-June; 5 d/w, 40 weeks/year)
EV = event frequency; 1 ev/d
ED = exposure duration; 3 years
CF = conversion factor; 10^{-6} kg/mg
BW = 50th %tile body weight for age 11-13, average for male and female 46 kg; (EPA 1997)
AT = averaging time
for noncancer risk; 3 years (1095 days)
for cancer risk; 70 years (25550 days)
RfD = EPA Reference Dose
PAHs: naphthalene used as a surrogate for PAHs; 0.02 mg/kg/day (IRIS)
CSF = Cancer Slope Factor
PAHs: benzo(a)pyrene; 7.3 (mg/kg/day)-1 (IRIS)
HI = Hazard Index
CSF = Cancer Slope Factor

* EPA (1997) recommends using soil ingestion rates of 100 mg/day for child < 6 years and 50 mg/day a child/adult≥6 years. EPA states that these values represent best estimates of average soil ingestion rates. EPA programs have used 200 mg/day and 100 mg/day as conservative estimates of average soil intake rates. CT DPH opted to use the best estimate average value 50 mg/day rather than the more conservative estimates for the sake of consistency with other parameters describing the receptor which are also central estimates (for example, body weight and skin surface area).

Values used to calculate PAH concentrations for cancer and noncancer risk calculations.

PAH	95 percentile UCL (mg/kg)	Toxic Equivalency Factor(TEF)*	TEF Adjusted Concentration (mg/kg)
Benzo(a)anthracene	3.5	0.1	0.35
Benzo(b)fluoranthene	5.1	0.1	0.51
Benzo(a)pyrene	3.35	1	3.35
Indeno(1,2,3-cd)pyrene	1.6	0.1	0.16
Dibenzo(a,h)anthracene	0.43	1	0.43
Total	**14**	**---**	**4.8**

* ATSDR 1995

ATTACHMENT E: ATSDR INTERIM PUBLIC HEALTH HAZARD CATEGORIES

CATEGORY / DEFINITION	*DATA SUFFICIENCY*	*CRITERIA*
A. Urgent Public Health Hazard *This category is used for sites where short-term exposures (< 1 yr) to hazardous substances or conditions could result in adverse health effects that require rapid intervention.*	*This determination represents a professional judgement based on critical data which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.*	*Evaluation of available relevant information* indicates that site-specific conditions or likely exposures have had, are having, or are likely to have in the future, an adverse impact on human health that requires immediate action or intervention. Such site-specific conditions or exposures may include the presence of serious physical or safety hazards.*
B. Public Health Hazard *This category is used for sites that pose a public health hazard due to the existence of long-term exposures (> 1 yr) to hazardous substance or conditions that could result in adverse health effects.*	*This determination represents a professional judgement based on critical data which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.*	*Evaluation of available relevant information* suggests that, under site-specific conditions of exposure, long-term exposures to site-specific contaminants (including radionuclides) have had, are having, or are likely have in the future, an adverse impact on human health that requires one or more public health interventions. Such site-specific exposures may include the presence of serious physical or safety hazards.*
C. Indeterminate Public Health Hazard *This category is used for sites in which "critical" data are insufficient with regard to extent of exposure and/or toxicologic properties at estimated exposure levels.*	*This determination represents a professional judgement that critical data are missing and ATSDR has judged the data are insufficient to support a decision. This does not necessarily imply all data are incomplete; but that some additional data are required to support a decision.*	*The health assessor must determine, using professional judgement, the "criticality" of such data and the likelihood that the data can be obtained and will be obtained in a timely manner. Where some data are available, even limited data, the health assessor is encouraged to the extent possible t select other hazard categories and to support their decision with clear narrative that explains the limits of the data and the rationale for the decision.*
D. No Apparent Public Health Hazard *This category is used for sites where human exposure to contaminated media may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause any adverse health effects.*	*This determination represents a professional judgement based on critical data which ATSDR considers sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.*	*Evaluation of available relevant information* indicates that, under site-specific conditions of exposure, exposures to site-specific contaminants in the past, present, or future are not likely to result in any adverse impact on human health.*
E: No Public Health Hazard *This category is used for sites that, because of the absence of exposure, do NOT pose a public health hazard.*	*Sufficient evidence indicates that no human exposures to contaminated media have occurred, none are now occurring, and none are likely to occur in the future*	

**Such as environmental and demographic data; health outcome data; exposure data; community health concerns information; toxicologic, medical, and epidemiologic data; monitoring and management plans*