# PROTOCOL FOR INDOOR ENVIRONMENTAL SAMPLING
# ALLENDALE ELEMENTARY SCHOOL
# PITTSFIELD, MASSACHUSETTS

**Allendale Indoor PCB Environmental Sampling Workgroup**

**May 26, 2006**

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## INTRODUCTION

In order to address concerns about exposure opportunities to polychlorinated biphenyls (PCBs) at the Allendale Elementary School, the Allendale Indoor PCB Environmental Sampling Workgroup (workgroup) was formed. The workgroup is composed of representatives from the MA Department of Public Health's Center for Environmental Health Environmental Toxicology Program (MDPH/CEH/ETP); MA Department of Environmental Protection's Bureau of Waste Site Cleanup; Pittsfield Board of Health; University of New York at Albany's Institute for Health and the Environment (IHE); Spectrum Analytical, Inc. (SAI); Southwest Research Institute (SWRI); Allendale Elementary School; the Housatonic River Initiative; Simon's Rock College of Bard; and the Allendale School Task Force. The U.S. Environmental Protection Agency (USEPA) is providing technical assistance to the workgroup. The charge of the workgroup is to develop an indoor environmental sampling and analysis plan for this follow-up effort at the school.

## GOAL

The overall goal of the proposed sampling effort is to determine whether PCBs are present in the indoor environment of the Allendale Elementary School in areas where children, faculty, and staff may have opportunities for exposure; and to determine if health concerns are present and whether follow-up activities are warranted.

## OBJECTIVES

Specific objectives are to collect and analyze samples for PCBs utilizing both congener specific and Aroclor based standard methods. These samples will include: indoor air

(with an outdoor comparison sample), surface wipes, carpet surface dust, vacuum bag dust, and unit ventilator filters. The sampling objectives will serve to address several questions, including the following:

1. Are detectable concentrations of PCBs present in the indoor environment of the school?
2. Are detectable concentrations of PCBs present in areas of the school accessible to students and staff?
3. If PCBs are present in the school, could the concentrations present exposure opportunities or health concerns?

**LOCATION OF SAMPLES**

**<u>Air Samples</u>**:

<u>Location of Samples</u>: Samples will be collected from inside the school in, or in the vicinity of classrooms #21 and 28 and outside the school in the building nook between classrooms #23 and 24 (see Figure).

<u>Rationale</u>: Classroom #21 is the middle classroom in the new building wing and #28 is the middle classroom in the original building, both of which face the back of the school and the GE disposal area. Thus, both classrooms are representative of the two wings of the building and are on the side of the school that faces the landfills. Classroom #28 has water damaged ceiling tiles, which could provide an entry point for unfiltered outside air (MDPH 2005). Wind coming from the direction of the GE disposal area will likely pool in the area where the two wings of the school meet, which is between classrooms #23 and 24. Sampling at this location would likely constitute the highest PCBs concentrations, if any, near the school.

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**Wipe Samples**:

Location of Samples: Wipe samples will be taken to obtain a representative picture of possible concentrations of PCBs on frequently and infrequently touched hard surfaces inside the school. Samples will be collected from selected classrooms on the rear-side of the building, which faces the GE disposal site, as well as hallway corridors, the gymnasium, and several locations to be chosen on the day of sampling. In selected classrooms, samples will be collected from one windowsill and a wall on the opposite side of the classroom from the windows, representing frequently touched areas, and a window pane and the top shelf of a bookshelf, representing infrequently touched areas. The selected classrooms are #19, 24, 28, and 32. Four wipe samples will be collected from the two corridors that span the length of the two building wings. The wipe samples will be collected from one location on each side of the corridor, in each wing, above the area that is normally cleaned (approximately five feet). Wipe samples will be collected from the top of 1 or 2 hanging ceiling lights (depending on accessibility) that are located in the gymnasium. The hallway corridor and gymnasium samples represent infrequently touched surfaces (see Figure). Finally, several wipe samples will be collected from locations chosen during the sampling event.

Rationale: PCBs that could potentially enter the school through the air could potentially be bound to dust particles and settle onto surfaces. Therefore, collecting wipe samples from specific locations within the school will provide information on whether PCBs are present. Specific classrooms within the school were chosen based on information gathered during the MDPH/CEH site visit in November 2005 and contained in the MDPH/CEH Emergency Response/Indoor Air Quality Program's report, "Indoor Air Quality Assessment: Allendale Elementary School." All of the classrooms were chosen because they face the Hill 78 disposal area, they represent classrooms distributed along the entire length of the building facing the Hill 78 disposal area, and they have water-stained ceiling tiles. The water stains could be from leaks in the roof, which are a potential route for outside air to enter the classroom without passing through the unit ventilator filters (MDPH 2005). Open classroom windows and doors, possibly during

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warmer months or to let children outside, are also routes for unfiltered air to enter the classrooms. The ceiling lights in the gymnasium represent an area that is likely infrequently touched, except for an occasional light bulb change. Some work group members expressed concern that dust from the lights could become airborne or fall to the gymnasium floor during times of building activity/vibration.

**Unit Ventilator Filter Samples:**

Location of Samples: Each unit ventilator has three filters which lie in a row parallel to each other (i.e., the air passes through this row of filters) (MDPH 2005). For consistency, samples of unit ventilator filters will be collected from the center filter in each unit ventilator. Samples will be collected from classrooms # 21 and 25 (see Figure). These classrooms face the back of the school and the Hill 78 disposal area.

Rationale: Each occupied classroom within the school is provided heat and outside air by a unit ventilator. The unit ventilators intake air from both outside and from inside the room, mix it, and then vent it into the room. During cooler months, the unit ventilator heats the air before venting it into the room. During warmer months, the unit ventilator provides a source of outside air. Before air is vented into the room, it passes through a filter, which is intended to capture dust particles. The unit ventilator filters capture dust particles before they enter the classroom as they draw air in from the outside and they also capture dust particles that are inside the classroom by recirculating classroom air. PCBs that have attached to dust particles may become trapped in the filters. All of the classrooms were chosen because they face the Hill 78 disposal area. Classroom #25 was specifically selected because it is located in the building nook, where the two wings of the school meet. It is theorized that wind blowing from the Hill 78 disposal area towards the school would pool in the nook due to the shape of the building.

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**Carpet Surface Dust Samples:**

Location of Samples: Samples will be collected from classroom #19, a kindergarten room (see Figure).

Rationale:

1. Carpet can retain dust on its surface as individuals walk on it and airborne particles settle onto it.
2. Individuals can come into contact with this dust while touching or playing on the carpet.
3. Classroom #19 is one of the few classrooms that has carpet.
4. The classroom faces the GE disposal area, and has a water damaged ceiling tile, which could provide an entry point for unfiltered outside air (MDPH 2005).

**Vacuum Bag Sample:**

Location of Sample: Dust samples will be collected from a vacuum cleaner that is operated throughout the entire school.

Rationale: Dust settles throughout the entire school. The vacuum cleaner collects dust that settles on the floor, along with any possible PCBs. Sampling the contents of the vacuum cleaner bag will provide information on whether PCBs are present in the floor dust.

**TIMING OF SAMPLE COLLECTION**

Description: Samples will be collected during the week of June 12, 2006 (see Sample Packaging and Transport/Chain of Custody section for information on sample possession). The vacuum cleaner bag sample will be collected after the vacuum cleaner has been used for one school week (i.e., 5 days). Carpet surface dust, wipe and unit ventilator filter samples will be collected during a single school day during that week.

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Air samples will begin to be collected during the same school day as carpet surface dust, wipe, and unit ventilator filters (the machines run for 24 hours). Air samples need to be collected during active operation of the landfills and on a warm dry weather day, preferably after a period of wet weather. Air samples will be collected during two distinct sampling rounds over two days.

Rationale: PCBs can become airborne through a process of volatilization. This process can be increased when PCB-contaminated soil dries, as more PCBs enter the atmosphere (ASTDR 2000). The months of May and June typically involve periods of wet weather, followed by periods of dry, warm weather. Measurements of PCBs during this time period would likely be representative of the highest rates of PCB volatilization from Hill 78.

## SAMPLE COLLECTION METHODS

**Air Samples**:

Description: All samples will be collected by a trained technician with Environmental Compliance Services (ECS), an environmental consulting firm. Samples will be collected by following USEPA Method TO-4A. This method involves using a high volume sampler, which is a box-like structure that contains a motor and a cartridge, to collect and filter air onto a sorbent cartridge for 24 hours. The cartridge is then placed into a sterile glass jar, which is placed in a cooler.

Rationale: USEPA Method TO-4A is the standard method for collecting and analyzing air samples for PCBs. One sample will be collected from each location for each of the two sampling rounds and split by SWRI after being extracted into a solution. Co-located samples cannot be collected due to the logistics of collecting the air samples (e.g., shipping the equipment, running several loud machines in classrooms during the school day). The analytical methods require that the samples be cooled after collection and prior to analysis.

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**Wipe Samples**:

Description: All samples will be collected by a trained technician with ECS. Wipe samples will be collected using an SAI method titled, "Wipe Sampling Procedure for PCBs". This method involves wetting an absorbent pad with hexane, dabbing a 10 centimeter square area horizontally and vertically, and placing the pad in a sterile glass jar. Three co-located samples will be collected from each sample location (i.e., samples will be collected from an area adjacent to each other). The jars will be placed into a cooler.

Rationale: ECS technicians have been trained to collect environmental samples, including wipe samples. The SAI method ensures that any PCBs will become attached to the absorbent pad. While there is no available USEPA sample collection method for wipe samples, the analytical methods require that the samples be cooled after collection and prior to analysis. In order to produce three samples from each sample location for the three laboratories to analyze, co-located samples will be collected. Three samples cannot be collected from the same location because the sample collection method is intended to remove all possible PCBs from the location after the first wipe.

**Unit Ventilator Filter Samples**:

Description: All samples will be collected by a trained technician with ECS. Samples will be collected by using the following method: using sterile gloves and a pair of scissors, a 2"x2" section of the middle filter will be removed from three edges of the unit ventilator filter and placed into separate sterile glass jars. The jars will be placed into a cooler.

Rationale: The unit ventilators contain three filters, which are installed with metal spaces that prevent air from bypassing the filters (MDPH 2005). Due to this design, the air should have an equal probability of passing through each of the filters. The middle filter

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and clippings from the three edges were chosen simply to be consistent. One clipping will be analyzed by each of the three laboratories. While there is no available USEPA sample collection method for unit ventilator filter samples, the analytical methods require that the samples be cooled after collection and prior to analysis.

**Carpet Surface Dust Samples:**

Description: All samples will be collected by a trained technician with ECS. The samples will be collected according to a method developed by the USEPA Environmental Response Team utilizing a Nilfisk vacuum cleaner. The carpet will be divided into quadrants and a sample will be collected from three of the quadrants. The samples will be placed into a cooler.

Rationale: In order to produce three samples for the three laboratories to analyze, the carpet needs to be divided into sections. Three samples cannot be collected from the same location on the carpet because the sample collection method is intended to remove all possible surface dust after the first vacuuming. The analytical methods require that the samples be cooled after collection and prior to analysis.

**Vacuum Bag Sample:**

Description: The school vacuum cleaner will be operated in a normal fashion by the custodian. At the end of the week, the vacuum cleaner bag will be placed into a cooler.

Rationale: The custodian vacuums the school daily. The purpose of sampling the vacuum cleaner bag is to determine the levels of PCBs that may be present throughout the school. ECS staff will retain chain of custody of the vacuum at all times during the test week.

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## SAMPLE PACKAGING AND TRANSPORT/CHAIN OF CUSTODY

Description: ECS will maintain possession of the samples during and after collection. ECS will maintain possession of the school's vacuum cleaner when it is not in use and will be present when it is in use. Depending upon the time when sampling is completed, the samples may be stored in a refrigerator at ECS in Agawam (i.e., if the sampling is completed after the closing of mail facilities). ECS will package the samples into coolers and mail them to SWRI in San Antonio, Texas and IHE in Albany, New York and deliver them to SAI in Agawam, Massachusetts. SWRI will receive carpet surface dust, vacuum bag dust, wipe, unit ventilator filter, and air samples. SAI and IHE will receive carpet surface dust, wipe, and unit ventilator filter samples. SWRI will process the air and vacuum bag dust samples in order to extract any PCBs into a solution, which will be split into four aliquots. SWRI will ship an aliquot to SAI and IHE, analyze one aliquot, and hold onto an aliquot for QA/QC purposes (e.g., in case an aliquot is lost during shipping).

Rationale: For chain of custody purposes, it is important that ECS and the respective laboratories maintain possession of the samples during and after sample collection. The analytical methods require that the samples be cooled after collection and prior to analysis.

## SAMPLE ANALYSIS METHODS

All laboratories must follow detailed standard operation procedures (SOPs) that are agreed to prior to the start of sampling.

Description: Following their SOPs for sample preparation for PCB analysis, SWRI, SAI, and IHE will first process the samples into a solution in order to extract any PCBs.

Air and Vacuum Cleaner Bag Dust: SWRI will be analyzing air and vacuum cleaner bag dust samples for both particle-phase and vapor-phase PCB Aroclors and congeners using USEPA Method TO-4A. SWRI will be analyzing vacuum cleaner bag dust samples for

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both PCB Aroclors and congeners using USEPA Method TO-4A. SAI will be analyzing air and vacuum cleaner bag dust samples for PCB Aroclors using USEPA Method TO-4A. IHE will be analyzing air and vacuum cleaner bag dust samples for PCB congeners using a method based on two published research papers: DeCaprio et al. 2000, 2005.

Carpet Surface Dust, Wipes and Unit Ventilator Filters: SWRI will be analyzing carpet surface dust, wipe, and unit ventilator filter samples for PCB Aroclors using USEPA Method SW846: 8082 and for congeners using USEPA Method 1668A. SAI will be analyzing carpet surface dust, wipe, and unit ventilator filter samples for PCB Aroclors using USEPA Method SW846: 8082. IHE will be analyzing carpet surface dust, wipe, and unit ventilator filter samples for PCB congeners using a method based on two published research papers: DiCaprio et al. 2000, 2005.

Rationale: Three different laboratories (i.e., Spectrum Analytical Laboratory, Institute for Health and Environment Laboratory, and Southwest Research Institute) will be analyzing samples in order to address questions raised about previous testing that analyzed separate samples from the school for Aroclors and congeners and reported different results. USEPA Method SW846: 8082, 1668A, and TO-4A are certified by the USEPA. USEPA Method SW846: 8082 uses gas chromatography/mass spectrometry to detect PCBs, Method 1668A uses high resolution gas chromatography and high resolution mass spectrometry, and USEPA Method TO-4A uses gas chromatography/multi-detector detection. IHE bases their method from two published research papers, which describe the method for congener analysis in detail. This method uses parallel dual-column gas chromatography with electron capture detection.

**ANALYTES**

Aroclors: Aroclor is the industrial trade name for commercially produced mixtures of PCBs used in the manufacturing of electrical equipment at GE. The mixtures consist of varying amounts of chlorine, which are signified by the last two digits of their names. For example, Aroclor 1254 contains approximately 54% chlorine by weight, while

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Aroclor 1260 contains approximately 60% chlorine by weight. The exception is Aroclor 1016, which contains approximately 41% chlorine by weight (ATSDR 2000).

The samples will be analyzed for seven specific Aroclor mixtures: 1016, 1221, 1232, 1242, 1248, 1254, and 1260. These are the Aroclors that the USEPA Method SW846: 8082 has been tested for (USEPA 1996).

Congeners: Congeners are single, unique compounds within PCBs (ASTDR 2000). While there are a total of 209 different congeners, most are not commonly detected (McFarland and Clarke 1989). Based on a review of published literature on congeners detected in house dust and indoor air (e.g., Currado and Harrad 1998; Kohler et al. 2002; MacLeod 1981; Vorhees et al. 1997, 1999; Wallace et al. 1996; Wilson et al. 2001) their percent makeup in the above listed Aroclors (Camann et al. 2002; Camann et al. 2001; Levin et al. 2002; Rudel et al. 2003; Wolff et al. 1997), and the congeners that were analyzed for by IHE, the samples will be analyzed for 101 specific congeners: #1, 3, 4+2, 10, 7, 9, 6, 8, 19, 13, 18, 15, 17, 24+27, 32+16, 29, 26, 25, 31, 28, 33, 53, 51, 22, 45, 46, 52, 49, 47+59, 44, 42, 71, 64, 40, 67, 63, 74, 70, 66, 95, 91, 56, 92, 84, 90+101, 99, 83, 97, 87, 85, 136, 110, 77, 151, 144, 147+109, 123+149, 118, 134, 114, 146, 153, 132, 105, 141, 179, 137, 176, 130, 164+163+138, 158, 129, 187, 183, 128, 185, 174, 177, 171, 156, 201, 172, 180, 200, 170, 190, 199, 203, 196, 195, 194, 206. This list of PCB congeners includes the 18 PCB congeners which comprise at least 5% by weight of several Aroclor mixtures; many of them are prevalent in several of the Aroclor mixtures (ATSDR 2000, Camann 2006). This congener list also represents the full range of lower to higher chlorinated congeners.

## QA/QC PROCEDURES

Laboratory Control Sample: The accuracy of the laboratory analysis will be checked by having the laboratories analyze spiked sample media. An unused media for each sample type (i.e., cotton wipe, unit ventilator filter, and air cartridge filter) will be shipped to

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each laboratory. The laboratories will spike the media with a known PCB Aroclor or congener and then analyze the sample for it. This will provide percent recovery.

Matrix Duplicate: An intra-laboratory split sample which is used to document the precision of a method in a given sample matrix.

Method Blanks: Sample contamination resulting from the laboratory analytical methods will be checked by method blanks. Method blanks consist of an analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank will be carried through the complete sample preparation and analytical procedure.

Standard Reference Materials®: The comparability of the laboratory results will be checked by having each laboratory analyze standard reference materials® (SRMs). SRMs are produced by the National Institute of Standards and Technology (NIST) and are certified to contain a specific amount of a substance. This will help in comparing data from the different laboratories.

Surrogates: A surrogate is an organic compound that is similar to the target analyte (i.e., PCBs) in chemical composition and behavior in the analytical process, but which is not normally found in environmental samples.

Trip Blanks: Field sampling methods will be checked by collecting a trip blank using pre-cleaned sample containers provided by ECS. Trip blanks are used to assess field introduced PCB contamination into samples. Air and wipe trip blanks will comprise the sampling media placed in the sample container. Unit ventilator filter trip blanks will be comprised of clippings from new unit ventilator filters placed in the sample container. Trip blanks will be packaged at the school, like the regular samples, to capture any field-introduced PCBs. Trip blanks for each medium will be collected and analyzed by each laboratory.

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## DATA EVALUATION

The data will be evaluated by the MDPH/CEH/ETP using methodologies consistent with readily available guidance or methods, and consistent with evaluations contained in the public health assessments produced by MDPH (MDPH 2003a-h).

### Air Samples

Description: The air samples will be evaluated by using health-based screening values, such as the CREG, that have been scientifically peer reviewed or derived using scientifically peer reviewed values and published by ATSDR. If a concentration of PCB exceeds its screening value, adverse health effects are not necessarily expected. Rather, the concentration can be further evaluated for the specific situation (e.g., outdoor sample, classroom sample) to determine whether health effects might be possible. In addition to screening, the results from the air samples will also be used to calculate a lifetime average daily intake, which takes into account certain assumptions, such as the age specific average weight of the person, air intake rate [e.g., 10 meters cubed per day ($m^3$/day) for child, 15.2 $m^3$/day for adult], and the length of time in the building (e.g., 6 hours/day for 180 days/year for child, 8 hours/day for 180 days/year for adult). ATSDR has not developed an MRL for inhalation because of a lack of sufficient data on which to base an MRL. In lieu of this, the chronic oral MRL described above will be used for evaluating the risk of adverse noncancer health effects. The air sample results will also be compared to background values reported in previously published studies that evaluated PCB concentrations in air (e.g., ATSDR 2000, Vorhees et al. 1997).

Rationale: MDPH/CEH/ETP traditionally uses both quantitative and qualitative approaches to evaluating results. Examples of this can be seen in the Discussion sections of the public health assessments MDPH/CEH/ETP has written for the GE sites. These can be found on the MDPH website (www.mass.gov/dph/ceh), at the Berkshire Atheneum, or by calling MDPH to request a copy (617-624-5757).

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**Carpet Surface Dust, Vacuum Cleaner Bag Dust, and Wipe Samples**

Description**:** Carpet surface dust, vacuum cleaner bag dust, and wipe samples measure the possible concentration of PCBs in the dust and residue on a specific surface. Individuals (e.g., students, staff) that come into contact with PCBs that are in the dust and residue could potentially ingest them or the PCBs could be absorbed through their skin. The results from these samples will be used to calculate a lifetime average daily intake, which takes into account certain assumptions, such as the average weight of children and adults (e.g., 35 kilograms for child, 70 kilograms for adult), the amount of total soil adhered [e.g., 525 milligram per day (mg/day) for child, 326 mg/day for adult], and the length of time in the building (**e.g.,** 6 hours/day for 180 days/year for child, 8 hours/day for 180 days/year for adult). The lifetime average daily intake can be compared to standard comparison or screening values such as the ATSDR Minimum Risk Level (MRL), which is 0.00002 milligrams per kilogram per day [milligram per kilogram per day (mg/kg/day)] for chronic oral exposure. The MRL is an estimate of daily human exposure to a substance (e.g., PCBs) that is likely to be without an appreciable risk of adverse noncancer health effects over a specified duration of exposure. MRLs are derived from no-observed-adverse-effect-levels (NOAELs) or lowest-observed-adverse-effect-levels (LOAELs) from either human or animal studies. For cancer effects, estimated intake can be compared to Cancer Risk Evaluation Guides (CREGs). CREGs are derived assuming a lifetime of exposure in a residential setting. While there is not a CREG for the ingestion of PCBs in dust, there is a CREG of 0.4 mg/kg for the ingestion of PCBs in soil. These comparison values are intended to be used as guidance. It is also important to emphasize that exposures to children should be prevented or minimized to the extent possible.

With regard to skin contact with PCB dust from surfaces, the Exposure Factors Handbook has summarized literature for children on this topic (USEPA 1997). In general, the major factors that affect opportunities for exposure via skin contact (e.g., PCBs from surface dust wipe samples from indoor environments) are: how much PCB is in contact with the skin; the potential amount taken in by ingestion or skin absorption the amount of skin surface area exposed; and the duration of exposure. It is important to note that not all

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of the compounds (e.g., PCBs) found in a layer of dust/dirt on the skin surface may be taken into the body by ingestion or skin absorption. However, in many cases assumptions can be made to estimate what the upper limit of ingestion/absorption may be so as to know whether there is a reason to be concerned about health impacts. We know that a number of factors influence how much dust/dirt adheres to skin. Increased dust/dirt moisture levels, hand contact, and outdoor activities, particularly with wet soil contact (e.g., wetlands, riverbanks) will lead to greater dust/dirt adherence to skin. The wipe sample results will also be compared to values reported in previously published studies that evaluated PCB concentrations in dust (e.g., ATSDR 2000, Vorhees et al. 1999).

Rationale: There is little information available on federal or state guidelines or standards for evaluating PCB carpet surface dust, vacuum cleaner bag dust, or wipe sample results for human health purposes. The only guidelines that were found were a USEPA clean-up standard of 10 micrograms PCB per 100 square centimeters (10 μg/100 $cm^2$) for wipes collected from indoor residential surfaces that have been affected by a spill of a low-concentration PCB mixture (40 Code of Federal Regulations 761.125) and a clean-up standard of 0.1 μg/100 $cm^2$ developed by the California Department of Toxic Substance Control for PCB contamination in schools resulting from lighting retrofits (CDTSC 2003). Exposure will be estimated and compared to the MRL, NOAELs, and LOAELs. We will approach the interpretation of these samples utilizing a standard approach as described in the equation in the Exposure Factors Handbook (see Attachment).

**Unit Ventilator Filter Samples**

Description: The unit ventilator filter samples will be qualitatively evaluated by reviewing information on all other sample results and such factors as weather, location, etc. and by qualitatively comparing these results to indoor classroom results.

Rationale: There are no available federal or state guidelines or standards for evaluating PCB unit ventilator filter sample results for human health purposes. The unit ventilators are designed to transport outside air into the classroom, filter it, and to re-circulate the air once it is inside. As such, they can capture particulates with PCBs and hence provide a

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qualitative indicator of the presence of PCBs in fugitive dust. However, there is no direct exposure to the filters themselves (not accessible except occasionally to maintenance staff). For that reason, measurements in carpet surface dust, wipe, vacuum cleaner bag dust, and air samples are more important in evaluating exposure risks because individuals can come into contact with PCBs in those media. Results from unit ventilator filter samples may provide an understanding of potential exposure opportunities from particulate matter containing PCBs over extended periods of time.

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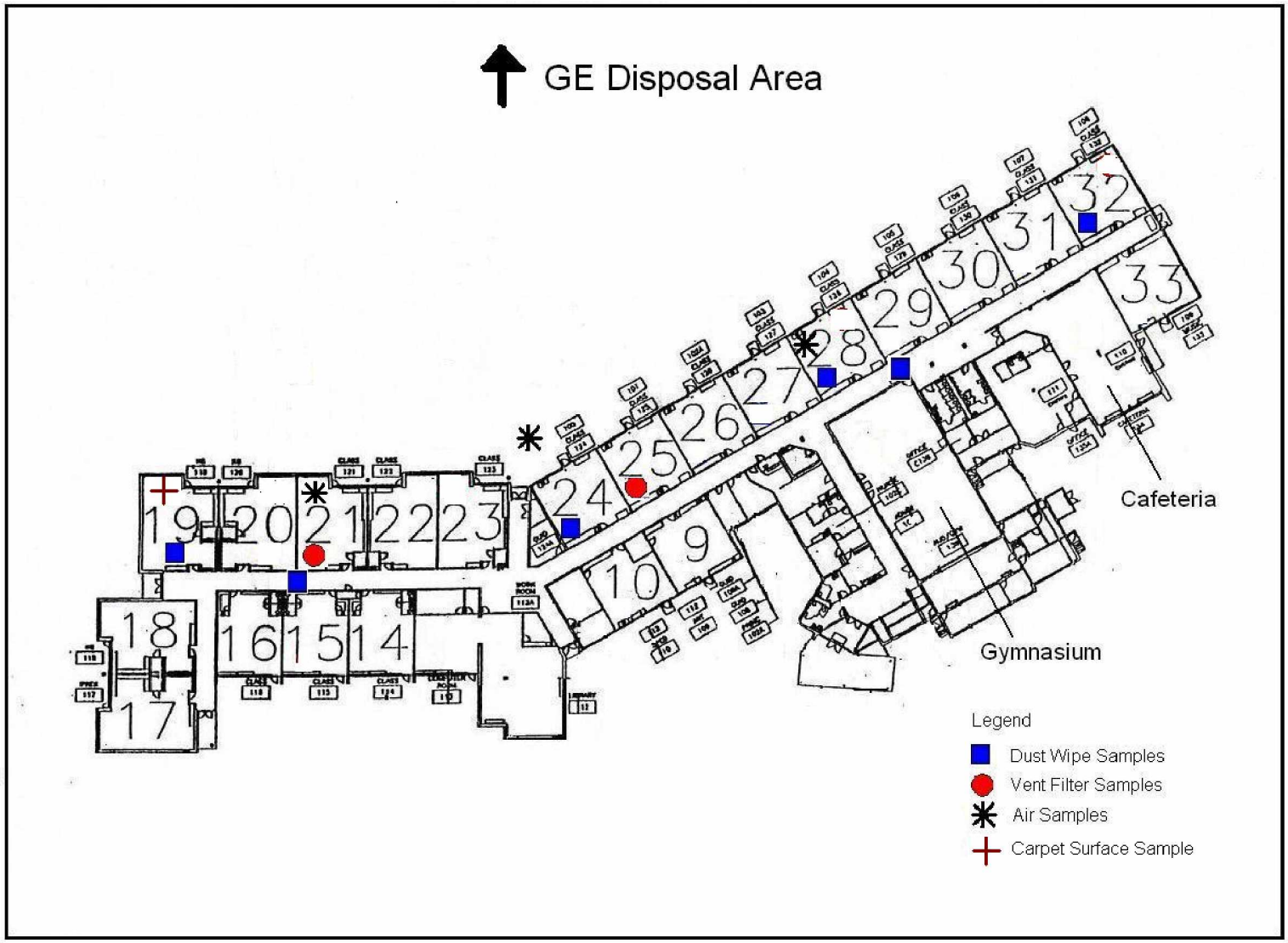
DRAFT

**FIGURE**


GE Disposal Area
Cafeteria
Gymnasium
Legend
Dust Wipe Samples
Vent Filter Samples
Air Samples
Carpet Surface Sample

## ATTACHMENT



### 6. DERMAL ROUTE

Dermal exposure can occur during a variety of activities in different environmental media and microenvironments (U.S. EPA, 1992). These include:

- Water (e.g., bathing, washing, swimming);
- Soil (e.g., outdoor recreation, gardening, construction);
- Sediment (e.g., wading, fishing);
- Liquids (e.g., use of commercial products);
- Vapors/fumes (e.g., use of commercial products); and
- Indoors (e.g., carpets, floors, countertops).

The major factors that must be considered when estimating dermal exposure are: the chemical concentration in contact with the skin, the potential dose, the extent of skin surface area exposed, the duration of exposure, the absorption of the chemical through the skin, the internal dose, and the amount of chemical that can be delivered to a target organ (i.e., biologically effective dose) (see Figure 6-1). A detailed discussion of these factors can be found in Guidelines for Exposure Assessment (U.S. EPA, 1992a).

This chapter focuses on measurements of body surface areas and various factors needed to estimate dermal exposure to chemicals in water and soil. Information concerning dermal exposure to pollutants in indoor environments is limited. Useful information concerning estimates of body surface area can be found in "Development of Statistical Distributions or Ranges of Standard Factors Used in Exposure Assessments" (U.S. EPA, 1985). "Dermal Exposure Assessment: Principles and Applications (U.S. EPA, 1992b), provides detailed information concerning dermal exposure using a stepwise guide in the exposure assessment process.

The available studies have been classified as either key or relevant based on their applicability to exposure assessment needs and are summarized in this chapter. Recommended values are based on the results of the key studies. Relevant studies are presented to provide an added perspective on the state-of-knowledge pertaining to dermal exposure factors. All tables and figures presenting data from these studies are shown at the end of this chapter.

### 6.1. EQUATION FOR DERMAL DOSE

The average daily dose (ADD) is the dose rate averaged over a pathway-specific period of exposure expressed as a daily dose on a per-unit-body-weight basis. The ADD is used for exposure to chemicals with non-carcinogenic non-chronic effects. For

compounds with carcinogenic or chronic effects, the lifetime average daily dose (LADD) is used. The LADD is the dose rate averaged over a lifetime.

For dermal contact with chemicals in soil or water, dermally absorbed average daily dose can be estimated by (U.S. EPA, 1992b):

$$ADD = \frac{DA_{event} \times EV \times ED \times EF \times SA}{BW \times AT} \qquad \text{(Eqn. 6-1)}$$

where:

- ADD = average daily dose (mg/kg-day);
- $DA_{event}$ = absorbed dose per event (mg/cm$^2$-event);
- EV = event frequency (events/day);
- ED = exposure duration (years);
- EF = exposure frequency (days/year);
- SA = skin surface area available for contact (cm$^2$);
- BW = body weight (kg); and
- AT = averaging time (days) for noncarcinogenic effects, AT = ED and for carcinogenic effects, AT = 70 years or 25,550 days.

This method is to be used to calculate the absorbed dose of a chemical. Total body surface area (SA) is assumed to be exposed for a period of time (ED).

For dermal contact with water, the $DA_{event}$ is estimated with consideration for the permeability coefficient from water, the chemical concentration in water, and the event duration. The approach to estimate $DA_{event}$ is different for inorganic and organic compounds. The nonsteady-state approach to estimate the dermally absorbed dose from water is recommended as the preferred approach for organics which exhibit octanol-water partitioning (U.S. EPA, 1992b). First, this approach more accurately reflects normal human exposure conditions since the short contact times associated with bathing and swimming generally mean that steady state will not occur. Second, the approach accounts for uptake that can occur after the actual exposure event due to absorption of residual chemical trapped in skin tissue. Use of the nonsteady-state model for organics has implications for selecting permeability coefficient ($K_p$) values (U.S. EPA, 1992b). It is recommended that the traditional steady-state approach be applied to inorganics (U.S. EPA, 1992b). Detailed information concerning how to estimate absorbed dose per event ($DA_{event}$) and $K_p$ values can be found in Section 5.3.1 of "Dermal Exposure Assessment: Principles and Applications" (U.S. EPA, 1992b).

For dermal contact with contaminated soil, estimation of the $DA_{event}$ is different from the estimation for dermal contact with chemicals in water. It is based on the concentration of the chemical in soil, the adherence factor of soil to skin, and the absorption fraction. Information for $DA_{event}$ estimation from soil contact can be found in U.S. EPA (1992b), Section 6.4.