

Health Consultation

Exposure Investigation Report

Dallas Avenue Neighborhood PCB Seattle, King County, Washington

May 16, 2006

Prepared by:
Washington State Department of Health
under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry



Forward

The Washington State Department of Health (DOH) has prepared this health consultation in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for health issues related to hazardous waste. This health consultation was prepared in accordance with methodologies and guidelines developed by ATSDR.

The purpose of this health consultation is to identify and prevent harmful human health effects resulting from exposure to hazardous substances in the environment. Health consultations focus on specific health issues so that DOH can respond to requests from concerned residents or agencies for health information on hazardous substances. DOH evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health. The findings in this report are relevant to conditions at the site during the time of this health consultation, and should not necessarily be relied upon if site conditions or land use changes in the future.

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For more information about ATSDR, contact the ATSDR Information Center at 1-888-422-8737 or visit the agency's Web site: www.atsdr.cdc.gov/.

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Glossary

Agency for Toxic Substances and Disease Registry (ATSDR)	The principal federal public health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.
Aquifer	An underground formation composed of materials such as sand, soil, or gravel that can store and/or supply groundwater to wells and springs.
Cancer Risk Evaluation Guide (CREG)	The concentration of a chemical in air, soil or water that is expected to cause no more than one excess cancer in a million persons exposed over a lifetime. The CREG is a <i>comparison value</i> used to select contaminants of potential health concern and is based on the <i>cancer slope factor</i> (CSF).
Cancer Slope Factor	A number assigned to a cancer causing chemical that is used to estimate its ability to cause cancer in humans.
Carcinogen	Any substance that causes cancer.
Comparison value	Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.
Contaminant	A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.
Dermal Contact	Contact with (touching) the skin (see route of exposure).
Dose (for chemicals that are not radioactive)	The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An “exposure dose” is how much of a substance is encountered in the environment. An “absorbed dose” is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.
Environmental Media Evaluation Guide (EMEG)	A concentration in air, soil, or water below which adverse non-cancer health effects are not expected to occur. The EMEG is a <i>comparison value</i> used to select contaminants of potential health concern and is based on ATSDR’s <i>minimal risk level</i> (MRL).

Environmental Protection Agency (EPA)	United States Environmental Protection Agency.
Exposure	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].
Groundwater	Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].
Hazardous substance	Any material that poses a threat to public health and/or the environment. Typical hazardous substances are materials that are toxic, corrosive, ignitable, explosive, or chemically reactive.
Ingestion	The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].
Ingestion rate	The amount of an environmental medium that could be ingested typically on a daily basis. Units for IR are usually liter/day for water, and mg/day for soil.
Inhalation	The act of breathing. A hazardous substance can enter the body this way [see route of exposure].
Inorganic	Compounds composed of mineral materials, including elemental salts and metals such as iron, aluminum, mercury, and zinc.
Lowest Observed Adverse Effect Level (LOAEL)	The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.
Maximum Contaminant Level (MCL)	A drinking water regulation established by the federal Safe Drinking Water Act. It is the maximum permissible concentration of a contaminant in water that is delivered to the free flowing outlet of the ultimate user of a public water system. MCLs are enforceable standards.
Media	Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.

<p>Minimal Risk Level (MRL)</p>	<p>An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see reference dose].</p>
<p>Model Toxics Control Act (MTCA)</p>	<p>The hazardous waste cleanup law for Washington State.</p>
<p>No apparent public health hazard</p>	<p>A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.</p>
<p>No Observed Adverse Effect Level (NOAEL)</p>	<p>The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.</p>
<p>Oral Reference Dose (RfD)</p>	<p>An amount of chemical ingested into the body (i.e., dose) below which health effects are not expected. RfDs are published by EPA.</p>
<p>Organic</p>	<p>Compounds composed of carbon, including materials such as solvents, oils, and pesticides that are not easily dissolved in water.</p>
<p>Parts per billion (ppb)/Parts per million (ppm)</p>	<p>Units commonly used to express low concentrations of contaminants. For example, 1 ounce of trichloroethylene (TCE) in 1 million ounces of water is 1 ppm. 1 ounce of TCE in 1 billion ounces of water is 1 ppb. If one drop of TCE is mixed in a competition size swimming pool, the water will contain about 1 ppb of TCE.</p>
<p>Plume</p>	<p>A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.</p>
<p>Reference Dose Media Evaluation Guide (RMEG)</p>	<p>A concentration in air, soil, or water below which adverse non-cancer health effects are not expected to occur. The RMEG is a <i>comparison value</i> used to select contaminants of potential health concern and is based on EPA's oral reference dose (RfD).</p>
<p>Route of exposure</p>	<p>The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].</p>

Surface Water	Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].
Volatile organic compound (VOC)	Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Summary and Statement of Issues

The Washington State Department of Health (DOH) has prepared this health consultation at the request of the Washington State Department of Ecology (Ecology). The purpose of the health consultation is to evaluate whether the Polychlorinated Biphenyls (PCB) found in house dust at the Dallas Avenue South Soil Removal site pose a health concern to residents in the community. DOH prepares health consultations under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

Background

The Dallas Avenue South Soil Removal site is located in a mixed residential, commercial, and industrial area in the South Park community of Seattle, Washington (Figure 1 and 2). PCBs were first detected by the City of Seattle (City) along and within the site surface soils in July 2004 with levels ranging from non-detect to 9 milligrams per kilogram (mg/kg) (Figure 3). The samples were analyzed for Aroclor compounds using U.S. Environmental Protection Agency (EPA) Method 8082. The only Aroclor detected was Aroclor 1260. The highest levels were discovered adjacent to the street near two residents along 17th Avenue South [1]. One of those houses is about 90 years old; the other home is around 70 years old [2].

The City and Public Health – Seattle and King County (PHSKC) conducted additional surface soil sampling from September through November 2004 to continue characterizing the extent of the PCB contamination. Soil samples were collected from the surface (0 – 6 inches) below ground surface (bgs) (Table 1). Again, Aroclor 1260 was the only Aroclor compound detected. DOH did review the chromatograms associated with the PHSKC data and found that low levels of Aroclor 1254 might also be present [1]. However, the Aroclor 1254 concentration is likely a small amount, and would not significantly affect the total PCBs levels [3]. It should be noted that some of the detection limits were elevated so it is possible that other Aroclor compounds could be present. The maximum Aroclor 1260 level in surface soils is 93 mg/kg [1, 4, 5]. The highest Aroclor 1260 level in sub-surface soils is 480 mg/kg [1].

Table 1: Soil Sample Data for Aroclor 1260 Results

Sample Medium	Maximum PCB Level	State MTCA Cleanup Level	Comparison value reference Source EMEG	Comparison value reference Source CREG
Surface Soil 1 – 6 inches	93 ppm	1 ppm	1 ppm	0.4 ppm
Sub Surface Soil > 6 inches	480 ppm	1 ppm	1 ppm	0.4 ppm

The City conducted interim actions in December 2004 to eliminate the community's potential exposure to the soil contaminants. Storm water control measures were taken in early December

to prevent contaminated street soils from being transported along the streets. This work was followed with the placement of asphalt on and adjacent to unpaved streets in mid-December [6]. Additional interim actions are planned for spring and summer 2005 at residential yards along 17th Avenue South where PCBs have been detected in grass covered yard soil and some gravel covered right-of-way soils [6].

Justification for the Exposure Investigation

The Washington State Department of Health (DOH) has determined a need for indoor dust sampling at residences located near the Dallas Avenue South Soil Removal site. PCB contaminated soils above Washington State soil cleanup levels (1 ppm) have been discovered along and adjacent to streets and in some residential yards (Table 1). Residents located along 17th Avenue South are concerned that PCB contaminated soil might have been tracked into their homes. Residents expressed concerns about exposure to PCB contaminated dust to Ecology and PHSKC at a community meeting on October 27, 2004. Because neither Ecology nor PHSKC have the expertise to conduct dust testing or to evaluate the data, Ecology requested DOH's assistance in collecting samples and evaluating the potential exposure pathway [7]. Evaluation of the house dust data will follow the exposure assumptions, exposure parameters and dose equations used in Appendix A.

Targeted Population

Residents living in the four homes near the Dallas Avenue South Soil Removal site are the exposed population. Adults occupy the two residences along 17th Avenue South near the area where the highest levels of PCBs were detected. If levels of concern are detected in these two homes, DOH will sample the two additional homes. Adults and children occupy the other two residences, which are located adjacent to the PCB contaminated soil along Dallas Avenue South.

Consent/Assent Form

An initial contact letter was sent to current residents of the two homes along 17th Avenue South (See Appendix B and C). The letter discusses the need for indoor dust sampling. A toll-free number was provided for further information. DOH, follow up this letter with a phone call in order to set a date for sampling.

Indoor Dust Sample Collection

Dust samples were collected according to the protocol developed by Fenske et al., which has been developed into a Standard Operating Procedure (SOP) included as Appendix D. Briefly, dust was collected using a high-volume, small-surface sampler (Nilfisk). Two samples was collected per residence from a high activity area within a measured surface of 1.0 m². The target sample mass will be 10 grams. Samples were delivered via DOH staff and analysis will be according to the contract laboratory protocol for PCB in dust.

Dust samples were delivered to:

Severn Trent Laboratories (STL)

Attn: Sample Receiving
5755 8th St W
Tacoma, Washington 98424

Results

The results were forwarded to the corresponding residence along with a letter of explanation. A toll-free number was provided with the results and DOH staffs were available for further discussion with each household. The results of the sampling are evaluated in this health consultation to determine whether a public health hazard exists for the residents.

PCBs were detected in house dust at levels ranging from 0.756 – 1.57 ppm (dust loading range from 2.18 – 16.67 g/m²) indicating that some PCBs were transported into the home from exterior sources (Dallas Ave road dust). PCBs were more highly concentrated on area rugs versus hard flooring. Rugs tend to trap dust and contaminants that bind to it. The majority of the dust collected in the home was trapped in area rugs.

Discussion

PCBs are a mixture of man-made organic chemicals. There are no known natural sources of PCBs in the environment. The manufacture of PCBs stopped in U.S. in 1977 because of evidence that it could build up in the environment and cause toxic health effects. Although no longer manufactured, PCBs can still be found in certain products such as old fluorescent lighting fixtures, electrical devices or appliances containing PCB capacitors made before PCB use was stopped, old microscope oil, and old hydraulic oil. Prior to 1977, PCBs entered the environment (soil, water, air) during the manufacture and use of PCBs. Today, PCBs can still enter the environment from poorly maintained hazardous waste sites, illegal or improper dumping of PCB wastes such as old hydraulic oil, leaks from electrical transformer that contain PCB oils, and disposal of old consumer products that contain PCBs[8].

PCBs enter the environment as mixtures of individual components known as congeners. There are 209 structural variations of PCB congeners, which differ on the number and location of chlorine atoms on the chemical structure. Most PCBs commercially produced in the U.S. are made up of standard mixtures called Aroclors. The conditions for producing each Aroclor favor the synthesis of certain congeners, giving each Aroclor a unique pattern based on its congener composition. No Aroclor contains all 209 congeners. Once in the environment, PCBs do not easily breakdown and may stay in the soil for months or years. PCBs stick to soil and sediment and will not usually moved deep into the soil with rainfall. As a result, PCBs are found worldwide. Small amounts of PCBs can be found in almost all outdoor and indoor air, soil, sediments, surface water, and animals. PCBs bioaccumulate in the food chain and are stored in the fat tissue. The major dietary source of PCBs is fish. PCBs are also found in meats and dairy products [8].

Health effects

When direct exposure to contaminants occurs, PCBs can get into peoples bodies by ingestion, inhalation and dermal (skin) contact. Some of the PCBs that enter the body are metabolized and

excreted from the body within a few days; others stay in the body fat and liver for months and even years. PCBs collect in milk fat and can enter the bodies of infants through breast-feeding [8]. Skin irritation, vomiting, nausea, diarrhea, abdominal pain, eye irritation, and liver damage can occur in people exposed to PCBs [8].

PCBs Analytical Analysis

There are several possible methods to analyze samples for PCBs including quantifying Aroclor mixtures, PCB homologues, or individual PCB congeners. Traditionally, PCBs analysis has focused on identifying and quantifying Aroclor levels in a sample using U.S. Environmental Protection Agency (EPA) Method 8082 Gas Chromatography/Electron Capture Detector (GC/ECD). This method was used at the Dallas Avenue Soil Removal site. It is quick and relatively inexpensive and provides a pattern recognition estimate of Aroclors that can be sum as total PCBs. Weathering can make it difficult to match an environmental sample with an Aroclor pattern, leading to difficulties in identification and quantification of PCBs [9]. Aroclor analysis may over or underestimate PCB concentrations.

PCB Homologues (defined by the level of chlorination) are subcategories of PCB congeners. Homologues can be analyzed using EPA Method 8082 GC/ECD or using EPA 8270 or 1668A Gas Chromatography / Mass Spectrometry (GC/MS). Interferences may overestimate total PCB concentration using GC/ECD approach for analysis. In addition, sample analysis cost can increase three to five times over Aroclor analysis. GC/MS approach analysis can increase analysis cost over 10 times per sample as compare to Aroclor analysis.

Individual PCB congener analysis (using GC/MS) offer several advantages over Aroclor analysis for environmental risk data evaluation. These advantages includes, generally lower detection limits, easier interpretation (less interference caused by co-eluting peaks) and more accurate than estimating Aroclors. Similarly, congener analysis can increase analysis cost over 10 times per sample as compare to Aroclor analysis. Currently, most of the available PCB toxicity data are for Aroclor mixtures. However, toxicity equivalency factors (TEFs) have been developed for several congeners.

The house dust samples collected as part of this EI were analyzed by Aroclors analysis. Because the previous soil samples were analyzed by Aroclors analysis and the significant cost savings over analyzing for specific congeners or homologues analysis.

Non-cancer effects

In order to evaluate the potential for non-cancer adverse health affects that may result from exposure to PCB in house dust, a dose is estimated for each route of exposure (ingestion, dermal, and inhalation). These doses are calculated for situations by which residents might contact the contaminated media. The total estimated dose is compared to a health guideline. If the estimated exposure dose is below the health guideline then the exposure is not likely to result in health effects. If the estimated dose exceeds the health guideline then additional analysis is needed to decide if health effects are likely.

EPA's oral reference dose (RfD) for PCB was the health guideline chosen to evaluate potential exposures from house dust. RfDs are doses below which non-cancer adverse health effects are not expected to occur. These doses take into account the differences between animals and humans and difference among people. They are derived from toxic effect levels obtained from human population and laboratory animal studies. Because of uncertainty in these data, the toxic effect level is divided by "safety factors" to produce the lower and more protective RfD. If a dose exceeds the RfD, this indicates only the potential for adverse health effects. The magnitude of this potential can be inferred from the degree to which this value is exceeded. If the estimated exposure dose is only slightly above the RfD, then that dose will fall well below the toxic effect level. The higher the estimated dose is above the RfD, the closer it will be to the actual toxic effect level. This comparison is known as a hazard quotient (HQ) and is given by the equation below:

Equation 1

$$HQ = \frac{\text{Estimated Dose (mg/kg-day)}}{\text{RfD (mg/kg-day)}}$$

The chronic oral RfD for PCB is 0.00002 mg/kg/day based on cellular necrosis in monkeys [10]. Other health effects that have occurred from exposure to PCBs in humans are skin irritation, vomiting, nausea, diarrhea, abdominal pain, eye irritation, and liver damage can occur in people exposed to PCBs [8].

Exposure doses were calculated for people exposed through all pathways. Exposure equations, assumptions are provided in Appendix A, Tables A1, and A2. This EI assumes people are exposed everyday for five years to the maximum level measured in house dust (1.57 ppm). The highest estimated exposure dose was 2.83 E-5 mg/kg/day and is slightly above the RfD (2.0 E-5 mg/kg/day) for a child (0 -5 years old). As mention above, since the estimated exposure dose is only slightly above the RfD, then that dose will fall well below the toxic effect level. Therefore, exposure to PCBs in house dust for five years should not result in any non-cancer adverse health effects.

Cancer effects

The EPA classifies PCB as a Group B2 probable human carcinogen. This means that there is sufficient evidence of carcinogenicity in animal studies, but inadequate evidence in human epidemiological studies. Cancer risk is estimated by calculating an exposure dose (Appendix A) similar to that described above and multiplying it by a cancer potency factor, also known as the cancer slope factor. Some cancer potency factors are derived from human population data. Others are derived from laboratory animal studies involving doses much higher than are encountered in the environment. Use of animal data requires extrapolation of the cancer potency obtained from these high dose studies down to real-world exposures. This process involves much uncertainty.

Current regulatory practice assumes that there is no “safe dose” of a carcinogen and that a very small dose of a carcinogen could give a very small cancer risk. Cancer risk estimates are, therefore, not yes/no answers but measures of chance (probability). Such measures, however uncertain, are useful in determining the magnitude of a cancer risk. The validity of the “no safe dose” assumption for all cancer-causing chemicals is not clear. Some evidence suggests that certain chemicals considered carcinogenic must exceed a threshold of tolerance before initiating cancer. For such chemicals, risk estimates are not appropriate. More recent guidelines on cancer risk from EPA reflect the potential that thresholds for some carcinogenesis exist. However, EPA still assumes no threshold unless sufficient data indicate otherwise.

<u>Cancer Risk</u>		
Cancer risk estimates do not reach zero no matter how low the level of exposure to a carcinogen. Terms used to describe this risk are defined below as the number of excess cancers expected in a lifetime:		
<u>Term</u>		<u># of Excess Cancers</u>
low	is approximately equal to	1 in 10,000
very low	is approximately equal to	1 in 100,000
slight	is approximately equal to	1 in 1,000,000
insignificant	is less than	1 in 1,000,000

This document describes cancer risk that is attributable to site-related contaminants in qualitative terms like low, very low, slight and no significant increase in cancer risk. These terms can be better understood by considering the population size required for such an estimate to result in a single cancer case. For example, a low increase in cancer risk indicates an estimate in the range of one excess cancer case per ten thousand persons exposed over a lifetime. A very low estimate might result in one excess cancer case per several tens of thousands exposed over a lifetime and a slight estimate would require an exposed population of several hundreds of thousands to result in a single case. DOH considers cancer risk insignificant when the estimate results in less than one cancer per one million exposed over a lifetime. The reader should note that these estimates are for excess cancers that might result in addition to those normally expected in an unexposed population. Cancer risks quantified in this document are an upper-bound theoretical estimate. Actual risks are likely to be much lower.

EPA has derived a cancer potency factor based on these studies so that cancer risk to humans can be quantified. Cancer risk is the likelihood, or chance, of getting cancer. In a worst-case scenario, the current highest level of PCB in house dust (1.57 ppm) would increase a person's cancer risk by 4 in 1,000,000 (4 excess cancers in a population of 1,000,000 people exposed) (See Appendix A - Table A3) and a lifetime cancer risk of 7 in 1,000,000. The reader should note that these estimates are for excess cancers that might result in addition to those normally expected in an unexposed population. This estimated risk is slight to very low.

Children’s Health Concerns

The unique vulnerabilities of infants and children demand special attention in communities that have contamination of their water, food, soil, or air. The potential for exposure and subsequent adverse health effects often increases for younger children compared with older children or adults. ATSDR and DOH recognize that children are susceptible to developmental toxicity that

can occur at levels much lower than those causing other types of toxicity. This vulnerability is a result of the following factors:

- Children are more likely to play outdoors and bring food into contaminated areas.
- Children are shorter and their breathing zone is closer to the ground, resulting in a greater likelihood to breathe dust, soil, and heavy vapors.
- Children are smaller and receive higher doses of chemical exposure per body weight.
- Children's developing body systems are more vulnerable to toxic exposures, especially during critical growth stages in which permanent damage may be incurred.

Although everyone is exposed to small amounts of PCBs, certain people may have higher levels of PCB exposure because of their eating habits or activities. The Food and Drug Administration (FDA) required limits for PCBs in food are 0.2 ppm in infant and junior foods, 1.5 ppm in milk, 2 ppm in fish and shellfish, and 3 ppm in poultry and red meat [8]. Most human exposure comes from dietary sources. For example, people that eat more fish than the general population may be exposed to more PCBs because fish are a common dietary source of PCBs.

During the evaluation of the house dust, DOH considered potential exposures to children, as well as to adults. The doses calculated for PCB is not expected to result in adverse health effects for children, or adults, based on comparison with RfD value. The assessment did find that chronic exposure to PCBs over many years (for example, 30 years) does indicate a very low to slight increased cancer risk.

Conclusions

No apparent public health hazard exists for residents exposed to PCBs found in house dust along Dallas Avenue.

Recommendations

1. Rugs should be shampooed or laundered with a mineral-oil-based cleaner or detergent to remove the PCBs (Lestoil or Mr. Clean and or regular laundry detergent).
2. The hardwood floors should be cleaned with a wet or damp disposable mop and a cleaning solution.

Public Health Action Plan

Action Completed

1. In December 2004, the City conducted placement of asphalt on and adjacent to unpaved streets to eliminate the community's potential exposure to the soil contaminants.
2. In December 2004, the City installed a temporary storm water collection and treatment system to control runoff from the newly paved roads.
3. In June 2005, the City removed PCBs found in two residential front yards on 17th Avenue South and removed gravel recently found to have elevated PCBs in the roadway shoulder on 16th Avenue South between Dallas Avenue South and South Cloverdale Street.

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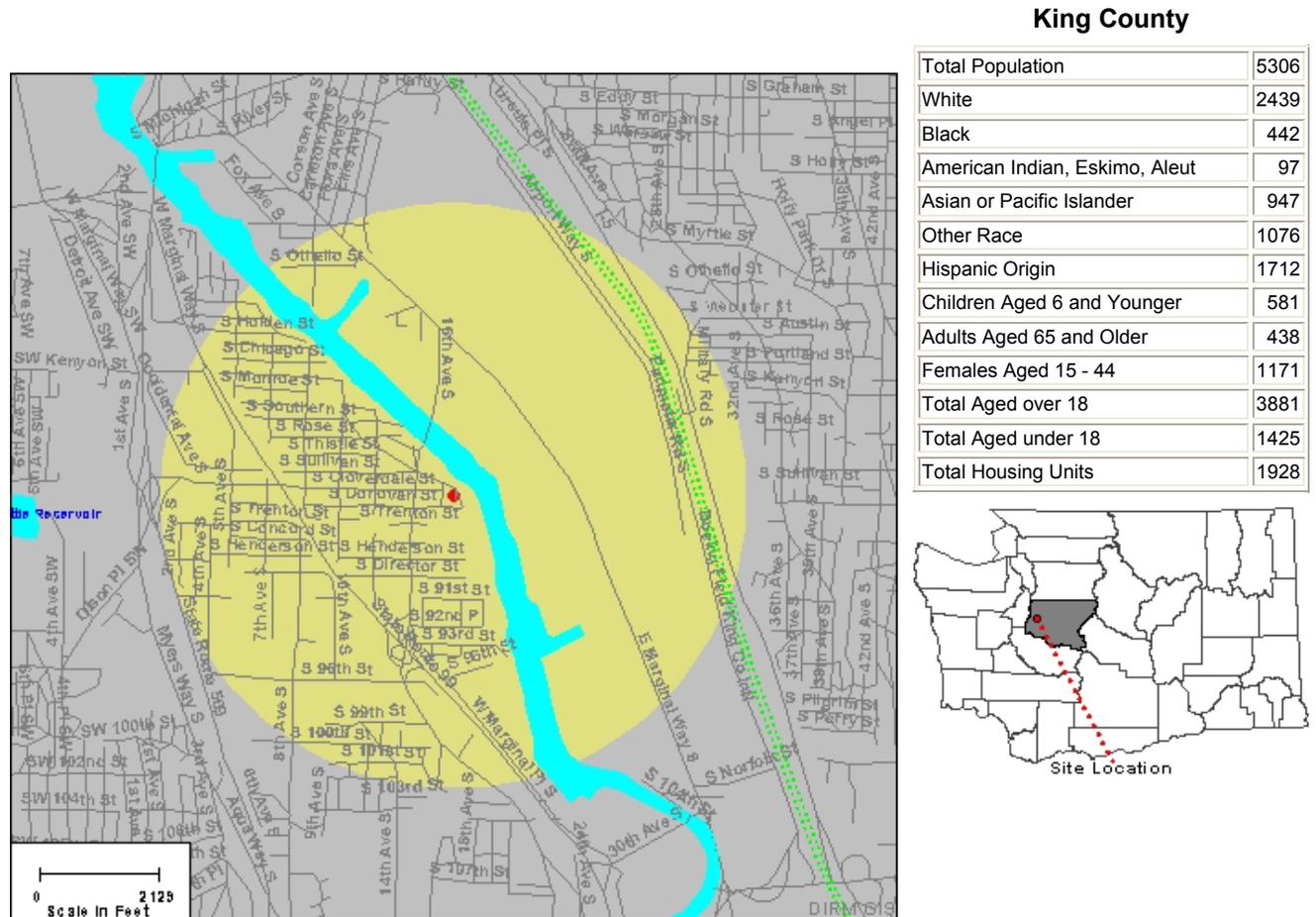
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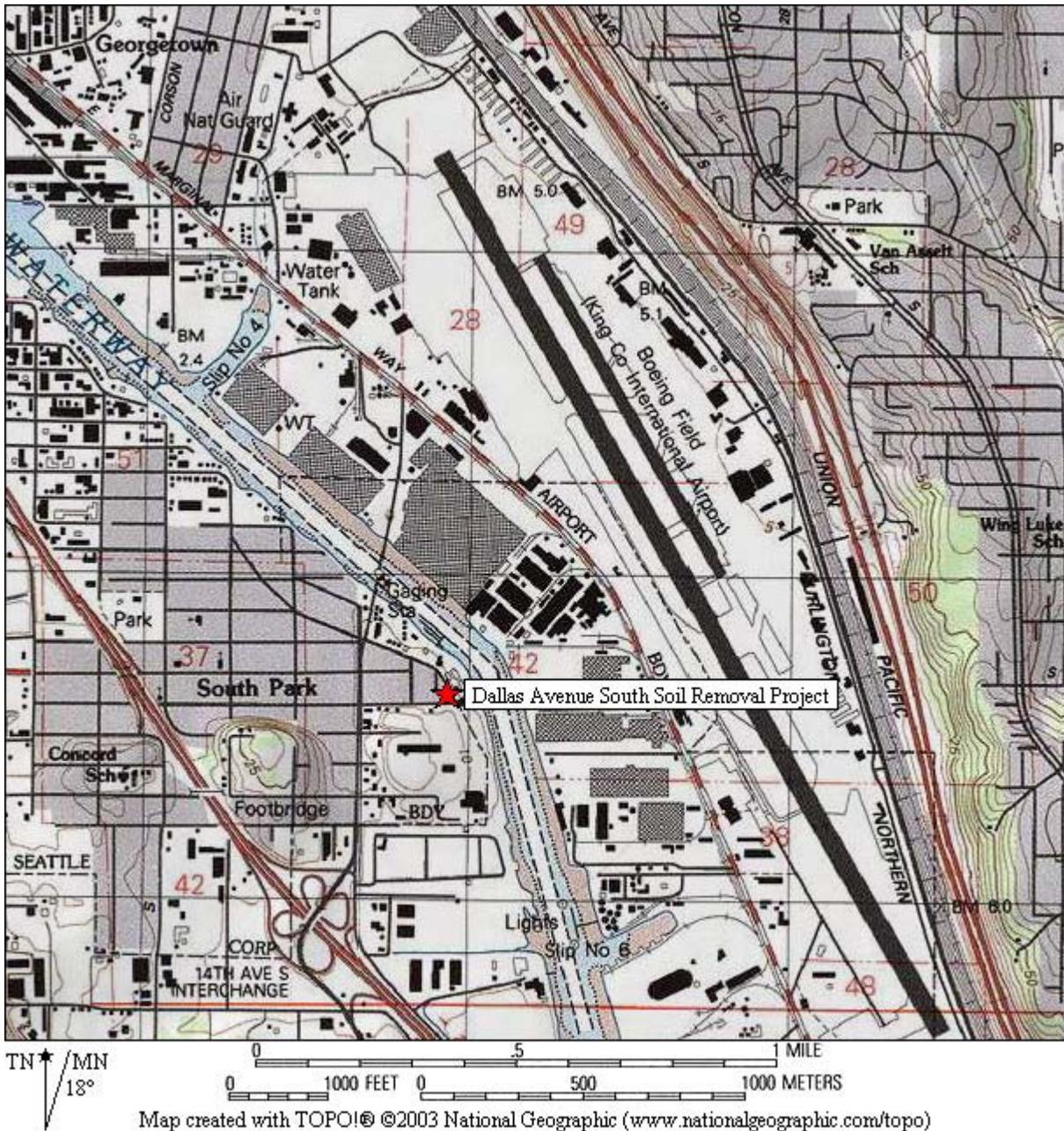
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Figure 1. Demographic Statistics Within One Mile of the Site* - Seattle, King County, Washington.



* Calculated using the area proportion technique. Source: 2000 U.S. CENSUS

Figure 2. Dallas Avenue South Soil Removal Project - Seattle, King County, Washington.



Appendix A

This section provides calculated exposure doses and assumptions used for exposure to PCB in house dust at Dallas Ave. Three different exposure scenarios were developed to model exposures that might occur. These scenarios were devised to represent exposures to a child (0-5 yrs), an older child, and an adult. The following exposure parameters and dose equations were used to estimate exposure doses from direct contact with PCB in house dust using general exposures parameters for soil exposure.

Exposure to PCB in house dust via ingestion, inhalation, and dermal absorption.

Total dose (non-cancer) = Ingested dose + inhaled dose + dermally absorbed dose

Ingestion Route

$$\text{Dose}_{\text{(non-cancer (mg/kg-day))}} = \frac{C \times CF \times IR \times EF \times ED}{BW \times AT_{\text{non-cancer}}}$$

$$\text{Cancer Risk} = \frac{C \times CF \times IR \times EF \times CPF \times ED}{BW \times AT_{\text{cancer}}}$$

Dermal Route

$$\text{Dermal Transfer (DT)} = \frac{C \times AF \times ABS \times AD \times CF}{ORAF}$$

$$\text{Dose}_{\text{(non-cancer (mg/kg-day))}} = \frac{DT \times SA \times EF \times ED}{BW \times AT_{\text{non-cancer}}}$$

$$\text{Cancer Risk} = \frac{DT \times SA \times EF \times CPF \times ED}{BW \times AT_{\text{cancer}}}$$

Inhalation of Particulate from Soil Route

$$\text{Dose}_{\text{non-cancer (mg/kg-day)}} = \frac{C \times SMF \times IHR \times EF \times ED \times 1/PEF}{BW \times AT_{\text{non-cancer}}}$$

$$\text{Cancer Risk} = \frac{C \times SMF \times IHR \times EF \times ED \times CPF \times 1/PEF}{BW \times AT_{\text{cancer}}}$$

Table A1. Exposure Assumptions for exposure to PCB contamination in house dust sample at Dallas Ave – Seattle, King County, Washington.

Parameter	Value	Unit	Comments
Concentration (C)	Variable	mg/kg	Maximum detected value
Conversion Factor (CF)	0.000001	kg/mg	Converts contaminant concentration from milligrams (mg) to kilograms (kg)
Ingestion Rate (IR) – adult	100	mg/day	Exposure Factors Handbook [23]
Ingestion Rate (IR) – older child	100		
Ingestion Rate (IR) - child	200		
Exposure Frequency (EF)	200	days/year	Average days in school year
Exposure Duration (Ed)	30 (5, 10,15)	years	Number of years at one residence (child, older child, adult yrs).
Body Weight (BW) - adult	72	kg	Adult mean body weight
Body Weight (BW) – older child	41		Older child mean body weight
Body Weight (BW) - child	15		0-5 year-old child average body weight
Surface area (SA) - adult	5700	cm ²	Exposure Factors Handbook
Surface area (SA) – older child	2900		
Surface area (SA) - child	2900		
Averaging Time _{non-cancer} (AT)	1825	days	5 years
Averaging Time _{cancer} (AT)	27375	days	75 years
Cancer Potency Factor (CPF)	2.0	mg/kg-day ⁻¹	Source: EPA: CPF are presented in Table A 3
24 hr. absorption factor (ABS)	0.14	unitless	Source: EPA Chemical Specific PCB
Oral route adjustment factor (ORAF)	1	unitless	Non-cancer (nc) / cancer (c) - default
Adherence duration (AD)	1	days	Source: EPA
Adherence factor (AF)	0.2	mg/cm ²	Child, older child
	0.07		Adult
Inhalation rate (IHR) - adult	15.2	m ³ /day	Exposure Factors Handbook
Inhalation rate (IHR) – older child	14		
Inhalation rate (IHR) - child	8.3		
Soil matrix factor (SMF)	1	unitless	Non-cancer (nc) / cancer (c) - default
Particulate emission factor (PEF)	1.45E+7	m ³ /kg	Model Parameters

Dust Ingestion Route of Exposure – Non-cancer

Table A2. Non-cancer hazard calculations resulting from exposure to PCB contamination in house dust sample at Dallas Ave – Seattle, King County, Washington.

Contaminant	Concentration (ppm)	Scenarios	Estimated Dose (mg/kg/day)			Total Dose	RfD (mg/kg/day)	Hazard quotient
			Incidental Ingestion of dust	Dermal Contact with dust	Inhalation of dust Particulates			
PCB	1.57	Child	2.01E-5	8.15E-6	5.75E-8	2.83E-5	2E-5	1.42
		Older child	3.67E-6	2.98E-6	3.54E-8	6.68E-6		0.33
		Adult	2.09E-6	1.17E-6	2.19E-8	3.28E-6		0.16

Dust Ingestion Route of Exposure - Cancer

Table A3. Cancer risk resulting from exposure to PCB contamination in house dust sample at Dallas Ave – Seattle, King County, Washington.

Contaminant	Max Concentration (ppm)	EPA cancer Group	Cancer Potency Factor (mg/kg-day ⁻¹)	Scenarios	Increased Cancer Risk			Total Cancer Risk
					Incidental Ingestion of Soil	Dermal Contact with Soil	Inhalation of Particulates	
PCB	1.57	B2	2.0	Child	2.68E-6	1.09E-6	7.66E-9	3.78E-6
				Older child	9.79E-7	7.95E-7	9.46E-9	1.78E-6
				Adult	8.36E-7	4.67E-7	8.77E-9	1.31E-6

Lifetime cancer risk: $3.78E-6 + 1.78E-6 + 1.31E-6 = 6.87E-6$

Appendix B

John/Jane Doe
XX YYYY Road
Seattle, WA

John/Jane Doe,

The Washington State Department of Health (DOH) is concerned about PCBs contamination in your yard. Soil in your neighborhood and yard was contaminated with PCB. Some steps have been taken to reduce your exposure by paving the adjacent road. DOH sent you a report about the health hazards linked to PCBs. DOH suggested sampling of indoor dust in your home. DOH is now offering free indoor dust sampling. Dust testing will help DOH decide if PCB exposure is a problem.

DOH is doing this study with the Agency for Toxic Substances and Disease Registry (ATSDR). The study is free of charge. If you are interested, I would explain the purpose of the procedure to you. A signed consent form for the dust sample is enclosed. This form is required to take part. You may change your mind at anytime.

Please contact me toll-free at 1-877-485-7316 or 360-236-3376 to set a date and/or to discuss any concerns that you may have.

Sincerely,

Lenford O'Garro
Public Health Advisor
Site Assessment Section
Office of Environmental Health Assessments
Washington State Department of Health

Att.: Consent Forms

Appendix C

Consent Form for Environmental Sampling Dallas Avenue Exposure Investigation

The Washington State Department of Health (DOH) invites you to join in an exposure study. We are concerned that you might have been exposed to PCBs. DOH and the Agency for Toxic Substances and Disease Registry (ATSDR) are offering free, voluntary PCB house dust sampling. This testing will help you know the level of PCBs in your house dust. It will also help DOH and ATSDR to determine what actions are needed. It will take about 30 minutes for DOH to sample the dust in your home.

Benefits

You will benefit by learning the PCB level in your home's dust. We will tell you how to reduce your exposure to PCBs.

Risks

There are no health risks from joining in this study. The results may affect your property value since they must be disclosed during any future sale of the property.

Procedure/Tests:

DOH staff will vacuum a high traffic area that you identify in your home. Up to four homes will be tested during this project.

Participation

Your participation is voluntary. Providing any information is voluntary. You can stop participating at any time. You must sign this form to take part in the sampling.

Results

The test results will be provided in writing in about three months. Results that are of immediate health concern will be reported to you as soon as they are known.

Confidentiality

State law protects confidentiality. Reports based on the results will not identify specific individuals in any way. Forms containing your name or address will be kept in locked cabinets at DOH. Only federal, state, or local public health and environmental agencies may review test results. These agencies must also protect this confidential information.

Contact

If you have any questions or if you feel this investigation or the testing has harmed you, please contact: Lenford O'Garro or Wayne Clifford of DOH at 1 (877) 485-7316.

Consent

The risks and benefits of this exposure study have been explained. All of your questions have been answered. You hereby consent to participate in the health investigation described above.

I, (print) _____, agree to have my house dust sampled for PCBs.

Signature: _____

Date: _____

Address: _____
Street

City State Zip code

Phone #: _____

Witness: _____
(Print name) (Signature)

Appendix D

Housedust Sampling Protocol

(Adapted from “Total Pesticide Exposure Study: Standard Operating Procedures- SOP Section 2. House Dust Sampling Procedures. University of Washington, Department of Environmental Health, Alex Lu, PhD”)

2.0 Objective

Collect house dust samples for measurement of PCB in order to provide an estimate of potential exposure to residents.

2.1 Materials

Nilfisk
Ethyl alcohol
Waste container with cap for ethyl alcohol
Disposable gloves
Kimwipe™
Measuring tape and masking tape
Housedust Sample Data Sheets
Sharpie and sample labels
Field notebook
Nilfisk GS-80 or GM-80 vacuum cleaner
Nilfisk GS-80 or GM-80 vacuum cleaner accessories (vacuum cleaner bags, polyliner bags, straight steel wand, 32-mm anti-static vacuum hose, 32-mm anti-static vacuum hose coupler components, and 5” upholstery nozzle)
Extension cord
Adapter (3-prong to 2-prong)
Vacuum template (1 m x 1 m template)
Ziplock plastic bags (9” x 13”)
Squeeze bottle (filled with deionized water)
Regular pen
Storage boxes (for transporting supplies)
Paper towels
Camel-hair paintbrush

2.2 Pre-field Preparation

Clean the Nilfisk vacuum hoses, curved plastic tubes, and upholstery nozzles with soap and water, tap water rinse and solvent rinse with ethyl alcohol.

2.3 Field Base Procedures

There are really no procedures that need to be performed at the Field Base with respect to the house dust samples. Simply keep the samples (in their ziplock bags) secured in a storage box or cooler (no ice is necessary).

2.4 On-site Preparation

1. Complete the Housedust Sample Data Sheet with homeowner.
2. Label each data sheet with the appropriate home owner identification number.
3. Date and initial all data sheets.

2.5 Criteria for Sampling

1. Explain to the parent that you wish to vacuum their carpet. Ask the parent where the best place is for plugging in the vacuum cleaner.
2. Ask the parent where the most frequently used areas of the home are located. This area usually includes the central living area of the home.
3. Collect a sample of approximately 10 grams from a high use carpeted area of the home. Sample another area of the carpet next to the area you just sampled if you do not collect sufficient dust. Do not sample within 3 feet of the doorway.

2.6 Housedust Sampling Procedures

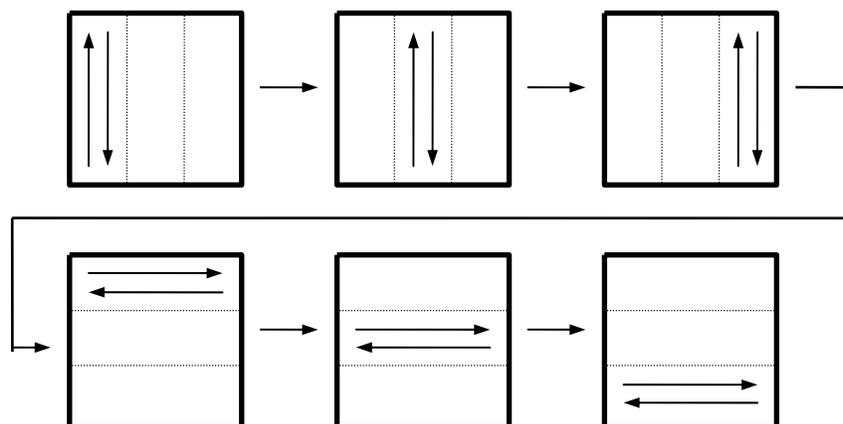
2.6.1 *Setting up the Nilfisk Vacuum Cleaner*

1. The Nilfisk unit is divided into three layers: the top layer is the high efficiency particulate air (HEPA) filter; the middle layer is where the motor and main filter can be found; and the lower layer is the container in which the polyliner and vacuum collection bags are placed.
2. Unsnap the two lower container clips and pull up on the Nilfisk unit handle to remove the top two-thirds of the Nilfisk unit. With a lightly moistened paper towel, wipe clean the lower container of the Nilfisk unit, in particular the hose socket where the hose connects to the Nilfisk unit. Attach a new vacuum collection bag by placing the plastic ring on the bag around the hose socket tube on the interior wall of the lower container of the Nilfisk unit. Carefully place a polyliner bag around the vacuum collection bag. The opening of the polyliner bag should loosely wrap around where the vacuum bag attaches to the hose socket tube.

3. Place the top two-thirds of the Nilfisk unit back onto the lower container until it fits snugly in the grooves. Snap shut the lower container clips.
4. Connect one end of the 2-m length of 32-mm anti-static hose to the coupler pieces and the other end to the curved plastic tube.
5. Attach the two steel wands together. The end that has the plastic ring around it should be connected to the curved plastic tube end of the vacuum hose. The 5" upholstery nozzle will fit snugly on the steel metal end of the two wands.
6. The coupler side of the vacuum hose can then be placed into the hose socket on the exterior of the Nilfisk unit itself. Turn the coupler clockwise to lock it into place.
7. Plug the power cord into the electric socket found on the top layer of the Nilfisk unit. Once the Nilfisk unit is plugged into an electric outlet, turn it on by pushing down on the blue button.

2.6.2. House Dust Sampling

1. Measure out a 1.0 m by 1.0 m template for the sampling area and tape it down with masking tape. Using the Nilfisk vacuum cleaner unit hooked up to the upholstery nozzle, vacuum the marked out area in a repetitive fashion (up, down, over; repeat (see diagram below)). Once the entire area has been vacuumed, vacuum the same area again in the same manner, but in a perpendicular direction to what was originally done (see diagram below). Completion of this procedure will ensure that each area within the vacuuming template will have been vacuumed over four times.



2. The dust collection procedure calls for a total dust sample of approximately 10 grams, although more is better. Sample another area of the carpet next to the area you just sampled if you do not collect sufficient dust.

» *Use the following floor, room, and area preference lists/protocols to help make decisions during the vacuuming procedure:*

A. Floor Preference

1. *Full carpet*
2. *Area rugs*
3. *Smooth floors*

B. Room Preference

1. *Living/common room*
2. *Child's bedroom*
3. *Kitchen/dining area*
4. *Use your judgment and be sure to record your choice*

C. Area Protocol

1. *Four (4) template areas for shaggy, ≥ 1 inch fiber carpet*
2. *Six (6) template areas for low < 1 inch carpet*
3. *Eight (8) template areas for smooth floors*

3. Once the vacuuming procedure has been completed, lift the vacuum hose off of the ground and allow air to be sucked in for about ten (10) to fifteen (15) seconds. This will ensure that any dust particles still in the vacuum hose will be sucked into the vacuum bag.
4. Turn off the Nilfisk unit. Allow the Nilfisk unit to sit undisturbed for at least thirty (30) seconds before doing anything else with it. This delay allows the dust to settle within the vacuum bag and reduces the chance of sample loss when the polyliner and vacuum bags are removed.
5. Unsnap the two lower container clips and remove the polyliner and vacuum collection bags within it. Fold the polyliner bag carefully, making sure to seal off the vacuum collection bag inside. Label the sample with appropriate sample number and description (subject ID number and initial "E" for entry, "L" for living room, "P" for playroom, "B" for bedroom) Record this information on the sample data sheet. Record on the Housedust Sample Data Sheet the location and size of the sample area. Transfer these two bags into a prelabeled ziplock bag.
6. Place the house dust sample into a storage box or cooler (36-qt) for transfer to the Field Base. No ice is necessary.
7. Remove the used hose and nozzle and set aside for cleaning at the Field Base. With a lightly moistened paper towel (use deionized water from the squeeze bottle), wipe clean the lower container of the Nilfisk unit which held the polyliner and vacuum

collection bags. In particular, clean the hose socket where the hose connects to the Nilfisk unit. A brush can be used to clean out hard-to-reach spots. Insert a new polyliner and new vacuum collection bag. If the vacuum is to be used again immediately, attach a previously decontaminated replacement hose and nozzle.

8. Wipe the template with a moistened paper towel and store for later use.

2.7. Cleaning the Nilfisk Unit and Accessories

1. The lower containers of the Nilfisk units should be wiped down with a lightly moistened paper towel each time the polyliner and vacuum bags are replaced. Be careful not to wet the insides of the Nilfisk unit too much as excess moisture will harm the motor and HEPA filter.
2. The used vacuum hoses, curved plastic tubes, and upholstery nozzles should be cleaned at the Field Base.
3. Place a polyliner and vacuum bag into a Nilfisk unit as described above in step 2.6.1. If available, it may be useful to keep one Nilfisk unit at the Field Base specifically for cleaning purposes. Also, one polyliner bag and one vacuum bag can be reused for the cleaning procedure. Change the bags only when they appear to be worn or full.
4. If available, use the long vacuum hose brush to scrub the interior of a used vacuum hose to remove any accumulated dust. If a vacuum hose brush is not available, tie a piece of string around a moistened paper towel or kimwipe and with the aid of the Nilfisk unit's suction, maneuver the string through the vacuum hose to one end. Once this is accomplished, pull the moistened towel through the hose. Repeat this process with new towels until the towels exit the hose in a reasonably clean state. Take caution to prevent the motor from overheating if the hose opening is plugged up.
5. After carefully cleaning the interior of the hose, attach it to the Nilfisk unit. Run the unit for about 15 seconds, holding the vacuum hose in a vertical position and gently tapping it to help any dislodged particles to be sucked into the vacuum collection bag. The interior of the hose can also be brushed while the Nilfisk unit is running, but caution must be used to prevent the motor from overheating if the hose opening is plugged up. Repeat this process for each used vacuum hose.
6. Wipe the curved plastic tube with a moistened paper towel to remove any visible dirt or dust.
7. The upholstery nozzles can be washed using warm water and a little bit of soap. Make sure they have fully dried before using them again.

Housedust Sample Data Sheets

Residence Location: _____

Residence ID: _____

Sample Location 1: _____ Sample Area 1 (m²): _____

Sample Location 2: _____ Sample Area 2 (m²): _____

Comments:

Operator: _____

Date: _____

Time: _____

Sample Key

Indoor Dust Samples	
Resident	ID Code

Certification

This Health Consultation was prepared by the Washington State Department of 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 health consultation was begun.

Alan Parham
Technical Project Officer, CAT, SPAB, DHAC
ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

Roberta Erlwein
Team Lead, CAT, SPAB, DHAC
ATSDR