Public Health Implications of Exposure to PCB-Contaminated Soil in Area Of Concern 2

Hamilton Sundstrand Site

Denver, Adams County, Colorado

Health Consultation

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Prepared By: Colorado Department of Public Health and Environment Under a cooperative agreement with the U.S. Department of Health and Human Services Agency for Toxic Substances and Disease Registry

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Foreward

The Colorado Department of Public Health and Environment's (CDPHE) Colorado Cooperative Program for Environmental Health Assessments has prepared this health consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the US Department of Health and Human Services and is the principal federal public health agency responsible for the health issues related to hazardous waste. This health consultation was prepared in accordance with the methodologies and guidelines developed by ATSDR.

The purpose of this health consultation is to identify and prevent harmful health effects resulting from exposure to hazardous substances in the environment. Health consultations focus on health issues associated with specific exposures so that the state or local department of public health can respond quickly to requests from concerned citizens or agencies regarding health information on hazardous substances. The Colorado Cooperative Program for Environmental Health Assessments (CCPEHA) evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur in the future, reports any potential harmful effects, and then recommends actions to protect public health. The findings in this report are relevant to conditions at the site during the time this health consultation was conducted and should not necessarily be relied upon if site conditions or land use changes in the future.

For additional information or questions regarding the contents of this health consultation, please contact the author of this document or the Principal Investigator/Program Manager of the CCPEHA:

Author: Thomas Simmons
Colorado Cooperative Program for Environmental Health Assessments
Environmental Epidemiology Section
Colorado Department of Public Health and Environment
4300 Cherry Creek Drive South Denver Colorado, 80246-1530
(303) 692-2961
FAX (303) 782-0904
Email: tom.simmons@state.co.us

Principal Investigator/Program Manager: Dr. Raj Goyal
Colorado Cooperative Program for Environmental Health Assessments
Environmental Epidemiology Section
Colorado Department of Public Health and Environment
4300 Cherry Creek Drive South Denver Colorado, 80246-1530
(303) 692-2961
FAX (303) 782-0904
Email: raj.goyal@state.co.us

Summary and Statement of Issues

Introduction

The Colorado Cooperative Program for Environmental Health Assessments' (CCPEHA) top priority is to ensure that all stakeholders have the best health information possible to protect the community from future health hazards associated with site-related contamination at the former Hamilton Sundstrand site in Denver, Adams County, CO. Specifically, this document provides health information on polychlorinated biphenyl contaminated soil in Area of Concern 2 (AOC 2), which is located in the southern portion of the Facility Parcel at the Hamilton Sundstrand site.

The Hamilton Sundstrand site is located at 2480 W. 70th Avenue in Denver. Hamilton Sundstrand manufactured and tested components for the aerospace industry. The site opened in 1955 and ceased operations in April of 2004. Various wastes were generated during operations at the plant including polychlorinated biphenyls (PCBs), solvents, and petroleum-based oils laden with tetrachloroethene and trichloroethene. Hamilton Sundstrand began decommissioning the Denver plant in 2002, a process that yielded approximately 777 tons of waste. Currently, the plant buildings and parking lots have been dismantled and the only buildings that remain onsite support remedial activities.

There are 2 main areas of the site including the Facility Parcel (43 acres) and the adjacent Vacant Parcel (138 acres). The Hazardous Materials and Waste Management Division of the Colorado Department of Public Health and Environment requested that CCPEHA conduct a health consultation to evaluate future public health hazards associated with site-related PCB contamination that remains in surface and subsurface soil in Area of Concern 2 (AOC 2) in the southern portion of the Facility Parcel. AOC 2 was the location of the Former Oil Collection Sump and Storm Water Discharge Area, which served as the primary collection and discharge point for storm water runoff from the Facility Parcel. PCB contamination was initially discovered in AOC 2 soil in the mid-1980's. Since this time, additional soil sampling and characterization of PCBs has been conducted in this area. This data will be used to evaluate the public health implications of future users contacting PCB contaminated soil in AOC 2.

An Environmental Covenant is currently in place to restrict future land-use of the entire Facility Parcel to a recreational/open space area. In addition, the site is currently fenced and locked. Therefore, the primary receptors of concern in AOC 2 are future recreational users, maintenance workers/groundskeepers, and construction workers that would erect recreational and/or maintenance buildings. The purpose of this health

consultation is to evaluate future health risks to these receptors from exposure to PCB soil contamination in AOC 2.

Overview

CCPEHA has reached one conclusion regarding the public health implications of future exposure to PCB contamination in AOC 2 soil.

Conclusion 1

It cannot currently be determined if contacting PCBs in soil in AOC 2 could harm the health of future recreational users, construction workers, and/or maintenance workers.

Basis for Decision

This conclusion was reached because critical exposure data (i.e., the PCB concentration in the preferred soil depth interval of 0-2 inches) and health information (i.e., chemical toxicity values or health effects levels) are unavailable for detected PCB compounds in surface and subsurface soil in AOC 2. At this time, the available information indicates the following:

- The qualitative/semi-quantitative evaluation of Aroclor 1242 and Aroclor 1248, based on the use of toxicity values for Aroclor 1254, indicates that non-cancer health hazards enter a range of potential concern for recreational children, construction workers, and maintenance workers because the estimated non-cancer doses are significantly higher than the health guideline (25, 30, and 14 times higher, respectively) and the comparison with health effects levels cannot be performed adequately due to a lack of a NOAEL for Aroclor 1254 in the scientific literature.

- The estimated theoretical cancer risks for future recreational users and maintenance workers are slightly higher than the acceptable cancer risk range. The estimated theoretical cancer risks for construction workers are within the acceptable cancer risk range. These risk estimates indicate a low increased risk of developing cancer.

Next Steps

To be prudent of public health, Hamilton Sundstrand should reduce exposure to PCB contaminated soil in AOC 2. This can include remediation and removal of PCB contaminated soil and/or the use of institutional controls.

For More Information

If you have immediate concerns about your health, you should contact your health care provider. For more information on this report, please call the health assessor, Thomas Simmons, at 303-692-2961 or principal investigator/program manager, Raj Goyal, at 303-692-2634.

Purpose

The Hazardous Materials and Waste Management Division (HWWMD) of the Colorado Department of Public Health and Environment (CDPHE) requested that the Colorado Cooperative Program for Environmental Health Assessments (CCPEHA) evaluate the public health implications associated with exposure to polychlorinated biphenyl (PCB) soil contamination in Area of Concern 2 (AOC 2) of the Hamilton Sundstrand site in Adams County, Colorado. The purpose of this document is to evaluate the potential health hazards of future exposure to PCB contaminated surface and subsurface soil in AOC 2.

Background

The former Hamilton Sundstrand facility is located at 2480 W. 70th Avenue in Denver, Adams County, Colorado (Figure 1). Hamilton Sundstrand manufactured and tested components for the aerospace industry including drive generators, fuel pumps, gears, turbines, actuators, electrical housings, and windings (ARCADIS 2007). The site consists of two main areas: the Facility Parcel and the adjacent Vacant Parcel (Figure 2). The Facility Parcel is 43 acres and consisted of the plant's main buildings, underground storage tanks, and an above ground storage tank. The Vacant Parcel, located to the east of the Facility Parcel, is 120 acres and was purchased in 1992. The Vacant Parcel served primarily as a buffer for the Hamilton Sundstrand site from the Perl Mack Neighborhood located north and east of the site. An additional 18 acres of land located east of the Vacant Parcel was purchased in 1994 and a seepage water remediation system was installed to control contaminated groundwater that was surfacing in this area.

Construction of the Hamilton Sundstrand facility began in 1955 and originally consisted of the Main Plant Building in the north-central portion of the Facility Parcel. Prior to 1955, the Facility Parcel was undeveloped and used for agriculture. In 1956, the Remote Facility located in the southwestern portion of the Facility Parcel was constructed. The Remote Facility operated until 1966 and was used to test Accessory Power Units for use on space vehicles and material handling and combustion testing of Otto Fuel for the U.S. Navy (ARCADIS 2007). In more recent years, the Remote Facility was vacant and used primarily for chemical storage of virgin products.

Environmental contamination was initially discovered at the site after a water and soil quality investigation was conducted in 1983. Numerous investigations followed and in August 2000, Hamilton Sundstrand entered into a Compliance Order on Consent with the U.S. Environmental Protection Agency (EPA) to address on and off-site contamination. Hamilton Sundstrand announced a phased closure of the Denver plant in October 2002 and ARCADIS was contracted to decommission the facility. The decommission process included the removal of piping, equipment, solid and hazardous waste; asbestos repair and abatement; and polychlorinated biphenyl (PCB) characterization, removal, and disposal. During this process, approximately 777 tons of waste was generated and disposed of. The plant ceased manufacturing operations in 2004. Currently, most of the buildings and parking lots have been destructed. The only buildings still in place house treatment facilities including soil vapor extraction systems, sparge systems, and air strippers. All current site activity revolves around remediation and characterization of waste.

Area of Concern 2 (AOC 2) is located in the far southern portion of the Facility Parcel at the Hamilton Sundstrand site. AOC 2 is the former location of the Oil Collection Sump and Storm

Water Discharge Area. The Oil Collection Sump was installed in the early to mid-1960s and storm water from throughout the Facility Parcel was gathered and routed to the sump. The early sump was a metal trough and baffle that was used as an oil-water separator. Water from the sump was discharged to the ground by a 100 ft. pipe aimed south. Standing water was evident in this area in aerial photographs taken the late 1960s and early 1970s. To control floods and the course of Little Dry Creek, which interfaced with sump discharge water, the northern portion of AOC 2 was covered with 2-3 ft. of fill material by the early 1970's. This action ended standing water in the sump discharge area. In the 1980s, an assortment of debris from demolition and excavation activities at the site was dumped on the northern portion of the primary fill, which created a rough and uneven surface. The collection sump operated until the mid-1980's at which time it was replaced with a concrete oil-water separator. Discharge from the new separator was conveyed directly to Little Dry Creek. During the summer of 2008, when the facility was being dismantled, the concrete oil-water separator was removed. Currently, storm water is conveyed to the sediment basin, which is located east of the former Oil Collection Sump and Storm Water Discharge Area.

PCBs have been detected in shallow soils of AOC 2 in areas that coincide with the historical standing water area. From 1985-2005, more than 50 soil samples were collected from AOC 2 to determine the nature and extent of PCB contamination in AOC 2. PCBs are primarily found in the fine grain alluvium near the middle of the historical standing water area. Historical Investigations indicate that PCBs were released in one event that occurred no later than 1968 (JCR 1985).

The results of previous groundwater investigations indicate that PCBs have not been detected in groundwater in AOC 2. PCBs were never detected in groundwater beneath AOC 2 during historical groundwater monitoring conducted between 1986 and 1991. Therefore, AOC 2 monitoring wells were abandoned in 1996. In 2009, ARCADIS conducted groundwater monitoring at 4 wells in AOC 2. PCBs were also not detected in this round of sampling and PCB contaminated groundwater does not appear to be of concern.

PCBs are a group of man-made, chlorinated organic compounds that are not known to occur naturally in the environment. There are approximately 209 different types of PCBs called congeners. In the U.S., PCBs were typically sold as mixtures of PCB congeners that were named Aroclors. Seven Aroclor mixtures constitute 35% of all PCBs commercially produced and 98% of all PCBs sold in the U.S. since 1970 (ATSDR 2000). Aroclors were named by the chlorine content of the mixture. For instance, Aroclor 1248 contains 48% chlorine and Aroclor 1254 contains 54% chlorine. In 1979, the manufacture of PCBs in the U.S. was banned because of growing evidence indicating that PCBs can build up in the environment and cause harmful health effects. Despite the ban on PCBs, they are found throughout the environment due to their widespread use prior to 1979 and their resistance to degradation.

Community Health Concerns

No specific community concerns have been noted regarding the focus of this investigation. Historically, residents in the Perl Mack Neighborhood, located north of the site, have been very concerned with contaminated groundwater stemming from the Hamilton Sundstrand site. The

major community concerns include the presence of solvent contaminated groundwater beneath their homes, vapor intrusion, and property values. The HMWMD has taken a number of actions to address these concerns including ongoing remediation of contaminated groundwater, installation of vapor mitigation systems at homes in the Perl Mack neighborhood, and frequent public meetings to keep residents up-to-date and involved in remedial activities at the site. Currently, community meetings occur on an as needed basis when major site activities are underway.

Discussion

The overall goal of this health consultation is to determine if PCB contaminated soil poses a public health hazard to future users and to make recommendations to protect public health if need be. The first steps of the health consultation process include an examination of the currently available environmental data and how individuals could be exposed to contaminants of potential concern (COPCs). If exposure pathways to COPCs exist, exposure doses are estimated and compared to health-based guidelines established by the ATSDR and EPA. This is followed by an in-depth evaluation if the estimated exposure doses exceed health-based guidelines.

Environmental Data

As mentioned previously, a number of investigations were spurred by the initial discovery of contamination in soil and groundwater within the Facility Parcel investigation conducted in 1983. In 1984, the investigation began on the Remote Facility located in the southern portion of the Facility Parcel (JCR 1985). A 1967 aerial photograph showed an area thought to be a large drainage pond south of the collection sump outfall pipe. Closer examination revealed that the suspected drainage pond was actually a gray to black PCB sludge layer that conformed to the drainage ditch.

Preliminary Soil and Groundwater Evaluation (JCR 1985)

Between May and October of 1984, thirty-three soil grab samples were collected and analyzed for PCBs by JCR Consulting. Eighteen samples were collected from 0-2 feet below ground surface (ft. bgs.) and the remaining fifteen soil samples were collected from 2-8 ft. bgs. Aroclor 1248 was the only PCB that was detected during this round of soil sampling. In soil samples collected from a depth of 0-2 ft. bgs., fifteen of the eighteen samples (83.3%) had detectable levels of Aroclor 1248. Detected concentrations of Aroclor 1248 at this depth ranged from 1.7 - 310 parts per million (ppm) with a mean concentration of 56.5 ppm from all samples (Table 1). Nearly half of the soil samples (39%) soil samples collected from 0-2 ft. bgs. had a concentration of Aroclor 1248 exceeding 50 ppm. These samples are located near the center of the former standing water area seen in aerial photographs (Figure 2). All the samples collected from the perimeter of the historical standing water area had undetectable levels of PCBs.

In the 2-8 ft. bgs. depth range, ten of the fifteen samples collected (66.7%) had detectable concentrations of Aroclor 1248. Detected concentrations of Aroclor 1248 ranged from 0.05 - 148 ppm with a mean concentration of 10.9 ppm over all samples collected at this depth. Only one soil sample had a concentration of Aroclor 1248 greater than 50 ppm. As with the soil samples collected from 0-2 ft. bgs., this sample was collected from the middle portion of the historical standing water area shown in Figure 3.

From this sampling event, it appears that the majority of PCB contaminated soil occurs near the middle of the main storm water discharge path for approximately 500 ft. in a southeasterly direction from the collection sump outfall pipe towards the corner of the Facility Parcel boundary. Higher concentrations of Aroclor 1248 were found in the 0-2 bgs. depth range. One sample collected from 2.1 ft. bgs. also had a relatively high concentration of Aroclor 1248. The soil sampling data collected during this event is shown in Table 1 and the sampling locations within AOC 2 are shown in Figure 3.

RCRA Facility Investigation (2003-2005)

ARCADIS drilled four soil cores in AOC 2 during phase 1 of the RCRA Facility Investigation conducted in 2003 (ARCADIS 2007). Soil grab samples were gathered from the surface (0-0.5 ft. bgs.) and were submitted for analysis of PCBs, Volatile Organic Compounds, Semi-volatile Organic Compounds, metals, mercury, cyanide, nitrate, and hydrazine. No information was found on the laboratory that conducted the testing or the EPA method that was used. However, all samples were assumed to be collected and analyzed in a manner suitable for use in this evaluation. PCBs were detected in two of the four soil samples and both detections were near the main storm water discharge pathway through AOC 2. Aroclor 1248 was detected in sample AOC 2-2 at a concentration of 44 ppm. Aroclor 1242 was detected in sample AOC 2-3 at a concentration of 1.8 ppm. Aroclor 1242 was not detected in the 1984 sampling event. Arsenic, chromium, lead, and benzo(a)pyrene were detected at low concentrations. VOCs and cyanide were not detected in this sampling event. The soil sampling locations within AOC 2 are shown in Figure 3 along with PCB results of this sampling round.

In 2005, 4 trenches were excavated and sampled within AOC 2 during phase 2 of the RCRA Facility Investigation. The trenches were approximately 60 ft. long, 2.5 ft. wide, and 8 ft. deep (Figure 3). Soil grab samples were collected from each trench at the 5-6 ft. bgs. depth range and were submitted for analysis of VOCs, SVOCs, the 7 Aroclor mixtures of PCBs, and metals. An additional soil sample was collected from the second trench and three soil samples were later collected from the trench material that was excavated. Thus, a total of eight soil samples were collected from the soil excavated from trenches in AOC 2 during phase 2 of the facility investigation. Aroclor 1242 was the only Aroclor mixture detected in the 8 trench samples at concentrations ranging from 0.029 – 120 ppm with a mean concentration of 46.6 ppm. All samples that had a concentration of Aroclor 1242 greater than 50 ppm occurred near the center of the historical standing water area within AOC 2, which is consistent with previous sampling events. The summary statistics of the soil samples collected during this event are presented in Table 2.

Contaminants of Potential Concern

To identify contaminants of potential concern (COPCs), the available soil data was screened soil comparison values established by the ATSDR, EPA, and state agencies. The comparison values (CVs) from these sources were reviewed and the most conservative, or health-protective, screening value was used to identify COPCs. All of the CVs used in this evaluation are derived for residential soil exposures, which are based on 350 days of exposure per year over a 30 year period. The use of residential CVs is considered protective of the individuals that are likely to come into contact with soil contaminants at the Hamilton Sundstrand facility. Therefore, if the

maximum concentration of any soil contaminant is below the respective CV, that contaminant is dropped from further evaluation since it is unlikely to present a health-risk to receptors. If the maximum value of a soil contaminant is above the respective CV, that contaminant is generally retained for further evaluation as a COPC. The identification of COPCs does not indicate that a health hazard exists from exposure to these contaminants, only that further evaluation is necessary. The selection of soil COPCs is summarized below in Table 3.

Table 3. Soil Screening and Selection of Contaminants of Potential Concern

Soil Contaminant	Maximum Detected Value (in mg/kg)	EPA Regional Screening Level (in mg/kg)	Basis of Source	ATSDR Comparison Value (in mg/kg)	Source	COPC
Aroclor 1242	120	0.22	Cancer	---	---	X
Aroclor 1248	310	0.22	Cancer	---	---	X

NOTES: COPC = Contaminant of Potential Concern, mg/kg = milligram contaminant per kilogram of soil

As shown, the maximum detected concentration of Aroclor 1242 and Aroclor 1248 exceeded the CV for these contaminants and they were retained for further evaluation as COPCs.

Exposure Evaluation

The objective of the exposure evaluation is to determine if and how individuals may come into contact with the soil contaminants in AOC 2 at the Hamilton Sundstrand site. The land-use of the area is examined to develop a conceptual site model that describes the potential receptors as well as the route, frequency, and duration of exposure for these individuals. Just because soil COPCs exist in this area does not mean that a public health hazard exists. If people do not come into contact with site-related contamination, adverse health effects cannot occur.

As mentioned previously, the focus of this evaluation is to examine future soil exposures in AOC 2. Currently, the activity at the Hamilton Sundstrand site is almost entirely associated with ongoing remedial activity. The only buildings that remain onsite house remedial equipment and staff. The Facility Parcel boundaries are enclosed within a 6 ft. security fence, which is kept locked when remedial personnel are not present. It is possible that people trespass onto the site, but there is no evidence to suggest that trespassing occurs and accessing the site appears to be somewhat difficult considering the locked security fence. Therefore, it is assumed that all current users are remedial staff and any site-related exposures that are occurring are limited to these workers. The evaluation of public health implications to remedial workers is beyond the scope of this evaluation. Therefore, current exposures were not considered further in this evaluation.

Future land-use of the Facility Parcel is limited due to an environmental covenant, which restricts the land-use to a recreational open space area. Under this scenario, three receptors could potentially contact PCB contaminants in soil within AOC 2 in the future. This includes recreational users, maintenance workers, and construction workers. Future residential exposures were not considered in this evaluation because of the environmental covenant that is in place and

the fact that AOC 2 lies in a 100 year floodplain area. Therefore, future residential development of AOC 2 is not a reasonable assumption.

All receptors come into contact with soil contaminants in a similar manner although the intensity of exposure varies based on the type of activities they perform. The primary routes of exposure to soil COPCs under the future potential exposure scenarios identified in this health consultation are incidental ingestion of soil and dermal contact with soil. Incidental ingestion of soil occurs in a variety of ways including while children are playing, hand-to-mouth activity, landscaping, gardening, and excavation. Skin coming into contact with soil contaminants, or dermal exposure, is another potential route of exposure for these receptors. Dermal exposure to soil occurs during the same type of activities noted above. Inhalation of dust particles containing COPCs is another potential route of exposure. However, inhalation of dust particles is a relatively minor route of exposure for the receptors identified in this health consultation and was not considered further. The exposure scenarios evaluated in this evaluation are summarized below in the Conceptual Site Model.

Table 4. Conceptual Site Model

Source	Point of Exposure	Affected Environmental Medium	Potentially Exposed Populations	Timeframe of Exposure	Route of Exposure
Industrial Waste	AOC 2 in the southern portion of the Facility Parcel at the Hamilton Sundstrand Site	Surface and subsurface soil	Child and Adult Recreational Users Maintenance Workers Construction Worker	Future (potential)	1) Incidental Ingestion and Dermal Exposure to Soil

NOTE: AOC 2 = Area of Concern 2. Inhalation of dust is considered a relatively minor route of exposure to soil COPCs in this evaluation and was not considered further.

As discussed in the Environmental Data section of this document, soil samples collected from AOC 2 have been collected from various depths up to 8 ft. bgs. However, it is very unlikely that all receptors will be exposed to soil at all depths that samples were collected from. In this evaluation, it was assumed that the 0-2 ft. depth interval would apply to recreational users only. Maintenance workers were assumed to come into contact with soil in the 0-4 ft. depth interval and construction workers could come into contact with soil in the 0-8 ft. depth interval during construction activities. Thus, the soil data from AOC 2 was divided into the appropriate depth intervals for each receptor and an exposure point concentration (EPC) was calculated that was used to estimate doses for each receptor. The EPC is a high-end arithmetic mean concentration of the soil data that is designed to account for random exposures throughout the entire exposure unit. In this case, the exposure unit for recreational users would be soil within AOC 2 at a depth of 0-2 ft. bgs. It should be noted, however, that soil samples collected from 0-2 inch bgs. depth interval would be preferable for recreational users. Due to a lack of soil data collected from the 0-2 inch bgs. depth interval, soil samples collected from 0-2 feet bgs. were used for recreational

exposures. The exposure unit for maintenance workers is soil within AOC 2 at a depth of 0-4 ft. bgs. and the exposure unit for construction workers is 0-8 ft. bgs. EPA's statistical software package called ProUCL, which was designed for this very purpose, was used to calculate the exposure point concentration for each receptor. The resulting EPCs calculated for each receptor in this evaluation can be found in Table A3 in Appendix A. It should be noted that the non-detected values were handled in accordance with the EPA ProUCL guidance (i.e., Half the detection limit was not used).

Public Health Implications

In general, exposure to PCBs has been associated with a variety of adverse health effects ranging from cancer to non-cancer health effects on the immunological, neurological, endocrine, and reproductive systems. To evaluate the public health implications of future receptors coming into contact with PCB contaminated soil in AOC 2, non-cancer and cancer exposure doses were calculated and compared to health-based reference values. Dose calculations are unique for each receptor based on the frequency, duration, and intensity of the particular exposure. Non-cancer and cancer doses are evaluated separately due to differences in the averaging time. More information regarding the exposure factors used in this document and the toxic potential of PCBs is available in Appendix A and B, respectively. Overall, it should be noted that no cancer or non-cancer values are available from the ATSDR or EPA for Aroclors 1242 and 1248. Therefore, the toxicity values (health guidelines) for Aroclor 1254 were used as surrogate values to qualitatively/semi-quantitatively evaluate non-cancer health hazards from exposure to Aroclors 1242 and 1248. For the cancer assessment, the oral slope factor for high-risk PCBs from the EPA Integrated Risk Information System (IRIS) was used.

Child and Adult Recreational Users

The estimated non-cancer doses for child and adult recreational users exceed the health-based guideline for exposure to Aroclor 1242 and Aroclor 1248 in soil at AOC 2. For children, the combined (i.e. ingestion and dermal exposure) estimated non-cancer dose from exposure to Aroclor 1242 in soil at AOC 2 is approximately 16 times greater than the health-based guideline for Aroclor 1254 (Table 7). The combined estimated non-cancer dose for children of Aroclor 1248 is approximately 9 times greater than the health-based guideline for Aroclor 1254. Therefore, the total combined exposure to both Aroclor mixtures is 25 times greater than the non-cancer health-based guideline for Aroclor 1254.

Exceeding the health-based guideline for Aroclor 1254 enters a range of potential concern that requires additional evaluation. As such, the non-cancer doses for children were compared to known adverse health effect levels following exposure to Aroclor 1254 that are documented in the scientific literature. In this case, a Lowest Observed Adverse Effect Level, or LOAEL, of 0.005 mg/kg-day is available for Aroclor 1254. The LOAEL value for Aroclor 1254 was again used as surrogate value since no established health effect levels are available for Aroclor 1242 and Aroclor 1248. A NOAEL, or No Observed Adverse Effect Level, is not available for Aroclor 1254 from the ATSDR or the EPA. The total estimated non-cancer dose of PCBs for children does not exceed the LOAEL value for Aroclor 1254. In fact, the total combined non-cancer doses for children are approximately 10 times less than the LOAEL value (Table B2). This indicates that significant health risks are not likely to occur from recreational children contacting

PCBs in soil at AOC 2. However, there is a significant gap in the health risk assessment due to a lack of a NOAEL value for Aroclor 1254 and no health-based guidelines for Aroclor 1242 and 1248. Overall, a high hazard quotient relative to the health-based guideline and lack of a NOAEL value for Aroclor 1254 is a potential concern.

For recreational adults, the estimated non-cancer dose of Aroclor 1242 is approximately 2 times greater than the health-based guideline for Aroclor 1254. The estimated adult non-cancer dose of Aroclor 1248 is approximately equivalent to the health-based guideline for Aroclor 1254 (Table 7). Thus, the combined non-cancer exposure dose from exposure to both PCB mixtures is approximately three times greater than the health-based guideline. However, the combined non-cancer dose is well below (84 times less than) the LOAEL value for Aroclor 1254 (Table B3). Since the combined non-cancer exposure doses are so much lower than the LOAEL value and only slightly above the health-based guideline, the likelihood of adult recreational users experiencing adverse health effects from contacting soil in AOC 2 is quite low. However, there is some uncertainty associated with this conclusion due to a lack of a NOAEL value for Aroclor 1254 and no health-based guidelines for Aroclor 1242 and Aroclor 1248.

Cancer risks are evaluated in a slightly different manner. Typically, carcinogenic exposure doses for recreational users are estimated using an age-adjusted equation that accounts for exposure as a child and adult over a 30 year period (6 years as child, 24 years as an adult) and are averaged over a lifetime. The estimated cancer doses are then compared to a cancer risk range, which gauges the degree of cancer risk. The high-end of the acceptable cancer risk range is 1E-04, or 100 excess cancer cases per million exposed individuals, and the low-end of the acceptable cancer risk range is 1E-06, or 1 excess cancer case per million exposed individuals. The combined (ingestion and dermal exposures) estimated age-adjusted theoretical cancer risk for recreational users is 8.1E-05 for Aroclor 1242 and 4.6E-05 for Aroclor 1248. Together, the total combined theoretical cancer risk for recreational users is 1.26E-04, or 126 excess cancer cases per million exposed individuals (Table 8). For child recreational users alone, the theoretical cancer risks for the total combined exposure to PCBs is 8.5E-05, or 85 excess cancer cases per one million exposed children. Overall, the estimated cancer risk for recreational users is slightly above or at the high-end (children) of the acceptable cancer risk range. This indicates a low increased risk of developing cancer from exposure to PCB contaminated soil in AOC 2 during recreational use. However, it should be noted that the estimated theoretical cancer risk for recreational users is well above the CDPHE long-term target cancer risk level of 1 excess cancer case per million people exposed (1E-06). In order to protect future users of AOC 2 and achieve CDPHE's long-term cancer risk goal, cleanup and/or removal of PCB-contaminated soil is recommended.

In addition, the overall cancer and non-cancer risks for recreational children and adults are associated with additional uncertainty because of the use of 0-2 ft. bgs. data as the surface soil data. Soil from the 0-2 ft. depth interval was used because no data is available at a depth interval of 0-2 inches. This assumption could result in an under- or over-estimation of risk. In addition, acute exposures (short term) to recreational children could also be of concern because there are hot spots of Aroclor 1248 and Aroclor 1242 in surface soil (0-2 ft) with maximum values of 310 ppm and 120 ppm, respectively. The maximum values are much higher than the exposure point concentrations used to calculate exposure doses for chronic (long term) risks. It is not likely that

individuals would contact PCBs at these concentrations on a chronic basis, but could be acutely exposed to hot spot contamination present in AOC 2. Acute health hazards cannot be evaluated at this time due to a lack of acute health guideline for all Aroclor mixtures.

Construction Worker Scenario

The estimated non-cancer exposure doses for construction workers are significantly above the health-based guideline for Aroclor 1254. As shown in Table 9, the combined non-cancer dose for Aroclor 1242 is twenty one times higher than the health-based guideline and the combined estimated dose for Aroclor 1248 is approximately ten times higher than the health-based guideline. Therefore, the total combined non-cancer dose estimated for construction workers in AOC 2 is thirty times higher than the health-based guideline for Aroclor 1254. However, the toal combined estimated non-cancer dose for construction workers is approximately eight times lower than the LOAEL value for Aroclor 1254 (Table B3). Therefore, it does not appear that there would be a significant non-cancer health hazard to construction workers from exposure to soil in AOC 2. There is a large degree of uncertainty associated with this conclusion due to a lack of a NOAEL value for Aroclor 1254 as well as a lack of health-based guidelines for Aroclor 1242 and Aroclor 1248. Overall, there is a concern regarding the potential for non-cancer health effects to construction workers since there is a very high hazard quotient of 30.0 relative to the health-based guideline, and there is not a NOAEL value for Aroclor 1254.

The estimated theoretical cancer risks for construction workers are well within the acceptable cancer risk range. The combined estimated cancer risk for Aroclor 1242 is 1.2E-05 and 5.5E-06 for Aroclor 1248. Thus, total combined theoretical cancer risk estimated for construction workers from exposure to PCBs in AOC 2 soil is 1.7E-05, or 17 excess cancer cases per million exposed individuals (Table 10). This level of cancer risk is well within the acceptable cancer risk range, which indicates a very low increased risk of future construction workers developing cancer from contacting Aroclor 1242 and 1248 in AOC 2 soil.

Maintenance Worker Scenario

The estimated non-cancer exposure doses for future maintenance workers is above the non-cancer health based guideline for Aroclor 1254, but below the lowest observed health effect level. The combined estimated non-cancer dose of Aroclor 1242 is approximately ten times higher than the non-cancer health-based guideline for Aroclor 1254 (Table 11). The combined estimated non-cancer exposure dose for maintenance workers of Aroclor 1248 is approximately 4 times the health-based guideline. Thus, the total combined non-cancer dose of PCBs for maintenance workers is approximately 14 times the non-cancer health-based guideline for Aroclor 1254. The estimated non-cancer doses for maintenance workers were compared to the LOAEL value for Aroclor 1254 and the combined estimated dose is approximately seventeen times lower than the LOAEL value published in the toxicological research (Table B3). Therefore, it does not appear that there would be a significant non-cancer health hazard to maintenance workers from exposure to Aroclor 1242 and 1248 in soil within AOC 2. Again, there is some uncertainty associated with this conclusion due to a lack of a NOAEL value for Aroclor 1254 as well as health-based guidelines for Aroclor 1242 and 1248. Overall, since there is a high hazard quotient of 14 relative to the health-based guideline and there is not a NOAEL value available for Aroclor 1254, there is some concern regarding the potential for non-cancer adverse health effects.

The estimated theoretical cancer risk for maintenance workers is slightly greater than the acceptable cancer risk range (Table 12). For Aroclor 1242, the combined estimated theoretical cancer risk is 1.45E-04. For Aroclor 1248, the combined estimated theoretical cancer risk is 6.1E-05. Thus, the total combined theoretical cancer risk for maintenance workers contacting Aroclor 1242 and Aroclor 1248 in AOC 2 soil is 2.07E-04, or 207 excess cancer cases per million exposed individuals. This indicates a low increased risk of maintenance workers developing cancer because the total estimated cancer risk is above the acceptable risk range.

Uncertainty Discussion

In general, the uncertainties associated with any risk-based health consultation are likely to over- or underestimate environmental exposures and the associated health hazards because all aspects of the exposure are typically unknown. This section of the discussion is not intended to be an in-depth description of all the uncertainties associated with this evaluation. Rather, the focus is to highlight the major assumptions and limitations that are specific to this evaluation and result in uncertainty.

- The overall chronic non-cancer and cancer risks, especially for recreational users and maintenance workers, from exposure to PCB contaminated soil in AOC 2 may be under- or over-estimated due to: (a) the use of the maximum concentration of Aroclor 1242 as the EPC because of the availability of only 7 samples; and (b) the use of surface soil data collected from the 0-2 ft. depth interval (vs. the preferred 0-2 in. bgs. depth interval). The 2005 soil data collected from the 0-6 in. bgs. was too limited to evaluate exposure and the associated health risks at this depth. Therefore, it was merged with the soil data collected from the 0-2 ft. bgs. depth interval.

- There are “hot spots” of high PCB contamination within AOC 2 that are much more concentrated than the exposure point concentration used to calculate the exposure doses. Acute exposure to PCBs in “hot spot” areas cannot be evaluated due to a lack of acute toxicity values for PCBs.

- There are no toxicity values for Aroclor 1242 or Aroclor 1248 from the ATSDR or the EPA. Therefore, the toxicity values for Aroclor 1254 were used to evaluate exposure to Aroclor 1242 and Aroclor 1248.

- The no observed adverse effect level (NOAEL) value for Aroclors 1242, 1248, or 1254 has not been determined by the ATSDR or the EPA. This introduces some uncertainty in the conclusions because the estimated exposure doses cannot be evaluated with a dose of Aroclor that has been shown to be without adverse non-cancer health effects.

- Using the lifetime averaging method to evaluate child cancer risks may underestimate short-term childhood exposure to carcinogens due to the early life susceptibilities of children.

Child Health Considerations

In communities faced with air, water, or food contamination, the many physical and behavioral differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health.

Child recreational users were evaluated in this health consultation using child-specific exposure factors. The potential for non-cancer adverse health effects in recreational children exceeded the health-based guideline, but not the lowest adverse health effect. Overall, the health risks of recreational children were higher than those estimated for recreational adults. As mentioned previously, there is some concern that the child cancer risks estimated in this evaluation may underestimate childhood cancer risk due to the early life susceptibility of children.

Conclusions

Based on the soil data and exposure pathways evaluated in this health consultation, CCPEHA has reached one conclusion regarding future exposures to PCB contaminated soil in the AOC 2 at the Hamilton Sundstrand site:

It cannot currently be determined if contacting PCBs in soil in AOC 2 could harm the health of future recreational users, construction workers, and/or maintenance workers. This conclusion was reached because critical exposure data and health information is unavailable for detected PCB compounds found in surface and subsurface soil within AOC. Specifically, chronic health-based guidelines for Aroclor 1242 and Aroclor 1248 are unavailable, no acute health guidelines are available from the EPA or ATSDR to evaluate the potential for acute health effects from child exposures to PCBs in soil, and no data are available for the preferred surface soil depth interval of 0-2 inches to evaluate acute and/or chronic health risks to recreational users.

It should, however, be noted that the available information indicates the following:

- The qualitative/semi-quantitative evaluation of Aroclor 1242 and Aroclor 1248, based on the use of toxicity values for Aroclor 1254, indicates that non-cancer health hazards enter a range of potential concern for recreational children, construction workers, and maintenance workers because the estimated non-cancer doses are significantly higher than the health guideline (25, 30, and 14 times higher, respectively) and the comparison with health

effects levels cannot be performed adequately due to a lack of a NOAEL for Aroclor 1254 in the scientific literature.

- The estimated theoretical cancer risks for future recreational users and maintenance workers are slightly higher than the acceptable cancer risk range. The estimated theoretical cancer risks for construction workers are within the acceptable cancer risk range. These risk estimates indicate a low increased risk of developing cancer.

Recommendations

Based on the conclusions reached in this health consultation, the following recommendations have been made to protect public health in the future from exposure to PCB contaminated soil in AOC 2:

To be prudent of public health, ARCADIS should remediate PCB contaminated soil in AOC 2 of the Facility Parcel at the Hamilton Sundstrand site. If removal of PCB contaminated soil is not an option, institutional controls should be established to further restrict activity in AOC 2. In particular, AOC 2 should not be used as a community garden because PCBs can be taken up by fruits and vegetables. This recommendation has been made to reduce the potential for non-cancer and cancer adverse health effects for recreational users, construction workers, and maintenance workers that are likely to occur in the future. It should be noted that remediation of PCBs in the area will be conducted in the near future.

Public Health Action Plan

The public health action plan for the site contains a description of actions that have been or will be taken by CCPEHA and other governmental agencies at the site. The purpose of the public health action plan is to ensure that this public health consultation both identifies public health hazards and provides a plan of action designed to mitigate and prevent harmful human health effects resulting from breathing, drinking, eating, or touching hazardous substances in the environment. Included is a commitment on the part of CCPEHA to follow up on this plan to be sure that it is implemented.

Public health actions that will be implemented include:

- As necessary, CCPEHA will review any additional data collected from the Hamilton Sundstrand site and evaluate the public health implications of the new data.

- Upon request, CCPEHA will provide assistance to State and Local environmental officials on sampling plans and analysis.

- CCPEHA will provide the appropriate level of health education on the findings of this health consultation to stakeholders and the community.

Author and Reviewers

Thomas Simmons
Health Assessor
Environmental Epidemiology Section
Colorado Dept. of Public Health and Environment
Phone: 303-692-2961
Fax: 303-782-0904
E-mail: tom.simmons@state.co.us

CDPHE Designated Reviewer:

Raj Goyal Ph.D
Principal Investigator
Environmental Epidemiology Section
Colorado Dept. of Public Health and Environment
Phone: 303-692-2634
Fax: 303-782-0904
E-mail: raj.goyal@state.co.us

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Additional Tables and Figures

Table 1. Initial AOC 2 Soil Sampling Data Summary (1984)

Contaminant	Statistics	0-2 ft. bgs. (in mg/kg)	2-8 ft. bgs. (in mg/kg)	All Data 0-8 ft. bgs. (in mg/kg)
Aroclor 1248	Minimum	1.7	0.05	0.05
	Mean	67.5	16.3	47.0
	Median	46	0.64	20.5
	Maximum	310	148	310
	% Detected	83.3%	66.7%	75.8%
	n	18	15	33

NOTE: Soil samples were analyzed for other Aroclor mixtures, but only Aroclor 1248 was detected.
ft. = feet, bgs. = below ground surface, *n* = number of samples, mg/kg = milligram contaminant per kilogram soil

Table 2. AOC 2 Facility Investigation Soil Sampling Data Summary (2003-2005)

Contaminant	Statistics	All Data 0-6 ft. bgs. (in mg/kg)
AROCLOR 1242	Minimum	0.029
	Mean	41.7
	Median	21
	Maximum	120
	% Detected	75%
	n	12
AROCLOR 1248	Minimum	N/a
	Mean	N/a
	Median	N/a
	Maximum	44
	% Detected	8%
	n	12

NOTE: Soil samples were analyzed for other Aroclor mixtures, but only Aroclor mixtures 1242 and 1248 were detected.
ft. = feet, bgs. = below ground surface, *n* = number of samples, mg/kg = milligram contaminant per kilogram soil

Table 5. Combined AOC 2 Soil Sampling Data Summary (1984-2005)

Contaminant	Statistics	0-2 ft. bgs. (in mg/kg)	0-4 ft. bgs. (in mg/kg)	0-8 ft. bgs. (in mg/kg)
AROCLOR 1242	Minimum	1.8	1.8	0.029
	Mean	25.3	25.3	31.3
	Median	24.7	24.7	21
	Maximum	120	120	120
	% Detected	57%	57%	75%
	n	7	7	12
AROCLOR 1248	Minimum	1.7	0.17	0.05
	Mean	42.9	33.1	27.2
	Median	45	32	21.4
	Maximum	310	310	310
	% Detected	64%	62%	58%
	n	25	37	45

NOTE: Soil samples were analyzed for other Aroclor mixtures, but only Aroclor 1242 and Aroclor 1248 were detected.
ft. = feet, bgs. = below ground surface, *n* = number of samples, mg/kg = milligram contaminant per kilogram soil

Table 6. Soil Screening and Selection of Contaminants of Potential Concern

Soil Contaminant	Maximum Detected Value (in mg/kg)	EPA Regional Screening Level (in mg/kg)	Basis of Source	ATSDR Comparison Value (in mg/kg)	Source	COPC
Aroclor 1016	ND	3.9	Non-cancer	4.0	Child RMEG	
Aroclor 1221	ND	0.14	Cancer	---	---	
Aroclor 1232	ND	0.14	Cancer	---	---	
Aroclor 1242	120	0.22	Cancer	---	---	X
Aroclor 1248	310	0.22	Cancer	---	---	X
Aroclor 1254	ND	0.22	Cancer	1.0	Child EMEG	
Aroclor 1260	ND	0.22	Cancer	---	---	

NOTES: EMEG = Environmental Media Evaluation Guide, RMEG = Reference Media Evaluation Guide, COPC = Contaminant of Potential Concern, ND = Not Detected

Table 7. Recreational Non-Cancer Hazard Quotients

Receptor	COPC	Ingestion Hazard Quotient	Dermal Hazard Quotient	Combined Hazard Quotient
Child	Aroclor 1242	**1.14E+01**	**4.47E+00**	**1.59E+01**
	Aroclor 1248	**6.46E+00**	**2.53E+00**	**9.00E+00**
	Total PCB Dose	**1.79E+01**	**7.00E+00**	**2.49E+01**
Adult	Aroclor 1242	**1.22E+00**	6.82E-01	**1.90E+00**
	Aroclor 1248	6.92E-01	3.87E-01	**1.08E+00**
	Total PCB Dose	**1.91E+00**	**1.07E+00**	**2.98E+00**

NOTE: COPC = Contaminant of Potential Concern, Hazard Quotient is equal to the estimated exposure dose divided by the health-based guideline for that contaminant.

Values bolded in red exceed the non-cancer health-based guideline for Aroclor 1254.

Table 8. Age-adjusted Recreational Cancer Dose Results and Theoretical Cancer Risks

Receptor	COPC	Ingestion Dose (mg/kg-day)	Dermal Absorbed Dose (mg/kg-day)	Combined Dose (mg/kg-day)	Theoretical Cancer Risk
Child & Adult	Aroclor 1242	2.79E-05	1.23E-05	4.02E-05	8.05E-05
	Aroclor 1248	1.59E-05	6.99E-06	2.29E-05	4.56E-05
	Total PCB Dose	4.37E-05	1.93E-05	6.30E-05	**1.26E-04**

NOTE: COPC = Contaminant of Potential Concern, mg/kg-day = milligram per kilogram body weight a day, PCB = Polychlorinated Biphenyl

Values bolded in red are slightly above the acceptable cancer risk range of 1E-06 to 1E-04.

Table 9. Construction Worker Non-Cancer Hazard Quotients

Receptor	COPC	Ingestion Hazard Quotient	Dermal Hazard Quotient	Combined Hazard Quotient
Adult	Aroclor 1242	**1.45E+01**	**6.09E+00**	**2.06E+01**
	Aroclor 1248	**6.74E+00**	**2.83E+00**	**9.57E+00**
	Total PCB Dose	**2.12E+01**	**8.92E+00**	**3.02E+01**

NOTE: COPC = Contaminant of Potential Concern, Hazard Quotient is equal to the estimated exposure dose divided by the health-based guideline for that contaminant.

Values bolded in red exceed the non-cancer health-based guideline for high-risk PCBs.

Table 10. Construction Worker Cancer Exposure Dose Results and Theoretical Cancer Risk

Receptor	COPC	Ingestion Dose (mg/kg-day)	Dermal Absorbed Dose (mg/kg-day)	Combined Dose (mg/kg-day)	Theoretical Cancer Risk
Adult	Aroclor 1242	4.14E-06	1.74E-06	5.89E-06	1.18E-05
	Aroclor 1248	1.93E-06	8.09E-07	2.73E-06	5.47E-06
	Total PCB Dose	6.07E-06	2.55E-06	8.62E-06	1.72E-05

NOTE: COPC = Contaminant of Potential Concern, mg/kg-day = milligram per kilogram body weight a day, PCB = Polychlorinated Biphenyl

Table 11. Maintenance Worker Non-Cancer Hazard Quotients

Receptor	COPC	Ingestion Hazard Quotient	Dermal Hazard Quotient	Combined Hazard Quotient
Adult	Aroclor 1242	**5.28E+00**	**4.88E+00**	**1.02E+01**
	Aroclor 1248	**2.23E+00**	**2.06E+00**	**4.30E+00**
	Total PCB Dose	**7.52E+00**	**6.94E+00**	**1.45E+01**

NOTE: COPC = Contaminant of Potential Concern, Hazard Quotient is equal to the estimated exposure dose divided by the health-based guideline for that contaminant.

Values bolded in red exceed the non-cancer health-based guideline for high-risk PCBs.

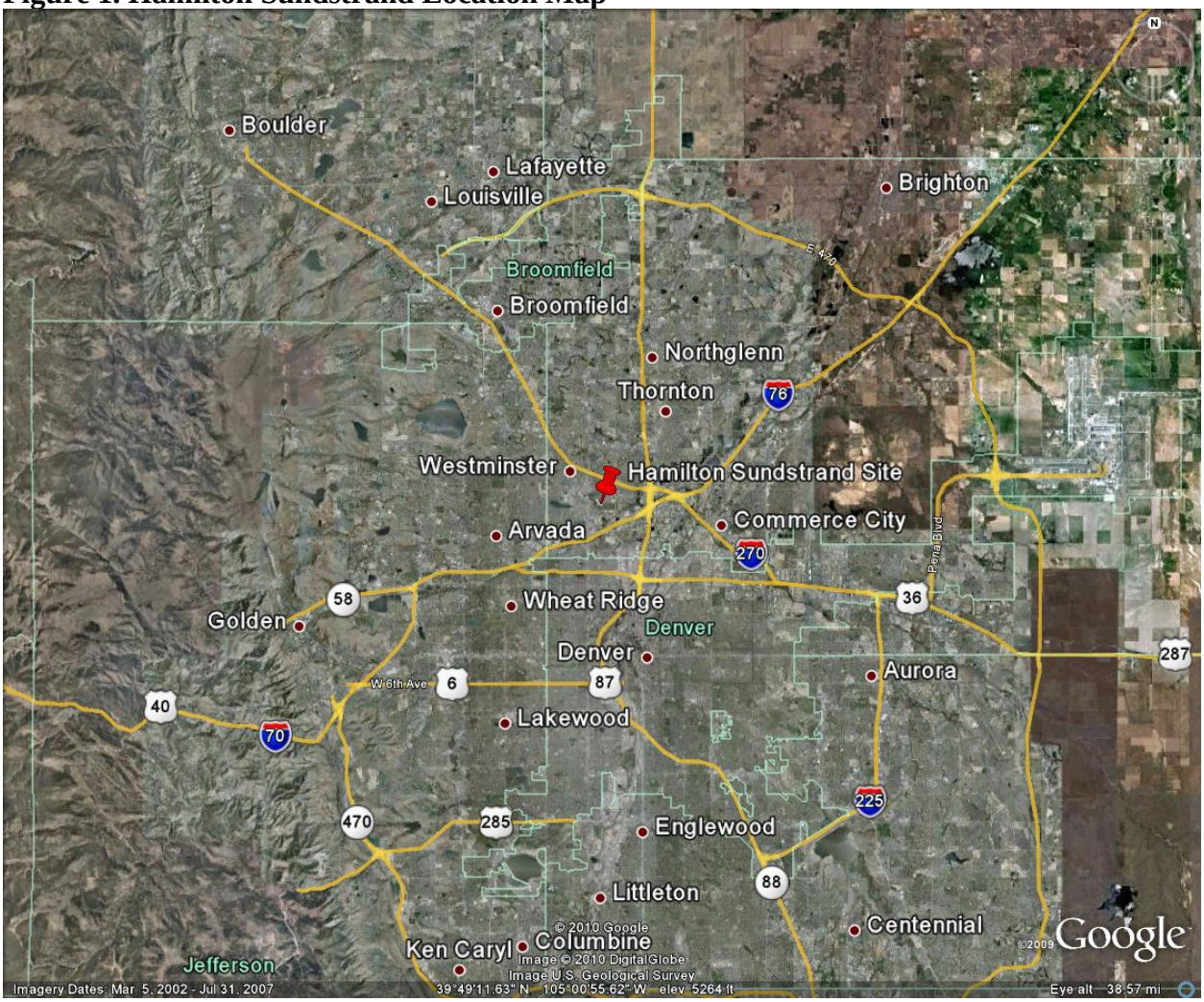
Table 12. Maintenance Worker Cancer Exposure Dose Results and Theoretical Cancer Risks

Receptor	COPC	Ingestion Dose (mg/kg-day)	Dermal Absorbed Dose (mg/kg-day)	Combined Dose (mg/kg-day)	Theoretical Cancer Risk
Adult	Aroclor 1242	3.77E-05	3.49E-05	7.26E-05	1.45E-04
	Aroclor 1248	1.59E-05	1.47E-05	3.07E-05	6.14E-05
	Total PCB Dose	5.37E-05	4.96E-05	1.03E-04	**2.07E-04**

NOTE: COPC = Contaminant of Potential Concern, mg/kg-day = milligram per kilogram body weight a day, PCB = Polychlorinated Biphenyl

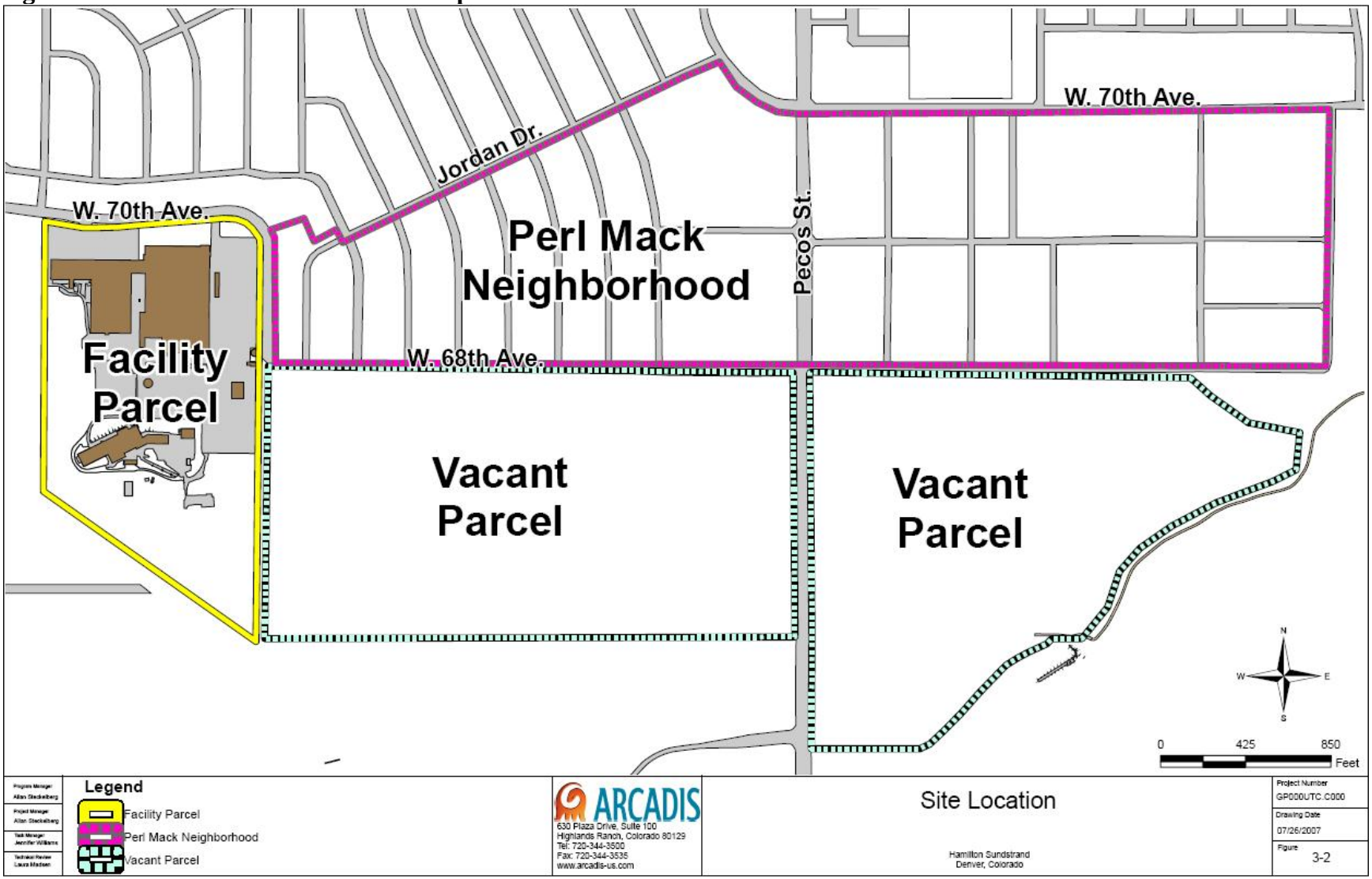
Values bolded in red are at the high-end of the acceptable cancer risk range of 1E-06 to 1E-04.

Figure 1. Hamilton Sundstrand Location Map



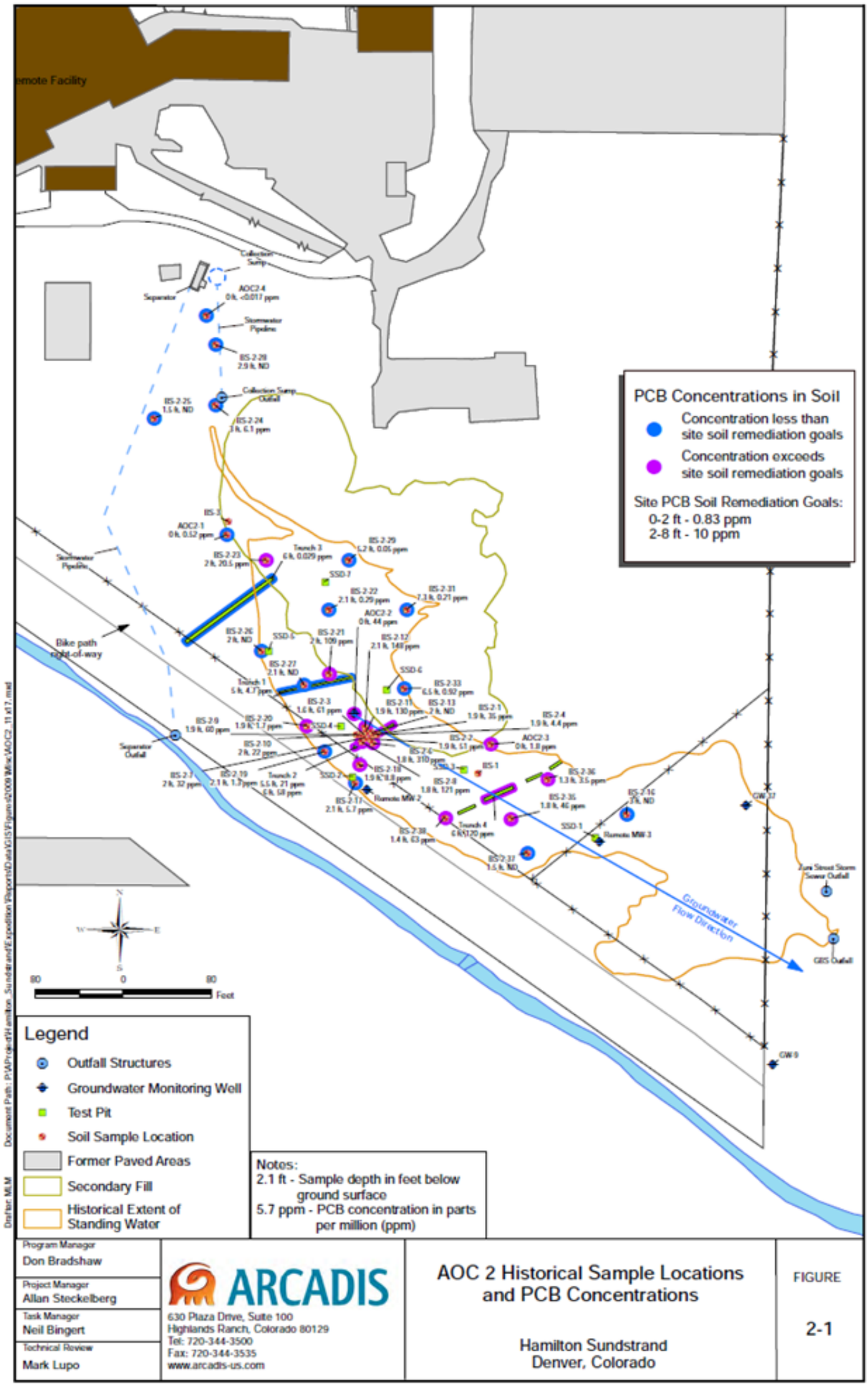
SOURCE: Google Earth

Figure 2. Hamilton Sundstrand Parcel Map



Source: ARCADIS 2007

Figure 3. Historical Soil Sampling Map



Source: ARCADIS 2010

Appendices

Appendix A. Additional Exposure Assessment Information

The first step to determine if adverse health effects are likely to occur from exposure to PCB contamination found in soil within AOC 2 of the Facility Parcel at the Hamilton Sundstrand site, is to estimate exposure doses for the people that are likely to come into contact with site-related contamination. The estimated exposure doses are designed to be conservative estimations of actual contaminant intake, accounting for the majority of potential exposures at the site. As mentioned previously in the document, exposure doses are only estimated for Contaminants of Potential Concern (COPC), which have exceeded the comparison values (CVs). Estimating the exposure dose requires assumptions to be made regarding various exposure parameters such as the frequency of a particular activity, duration of exposure to site-related contamination, and the amount of a particular substance that is taken in by an individual during a given activity. Site-specific exposure information is always preferable when estimating exposure doses. However, site-specific information is rarely available due to limited time, a lack of data, and financial constraints. In lieu of site-specific information, default exposure parameters that are established by the U.S. Environmental Protection Agency (EPA) and Agency for Toxic Substances and Disease (ATSDR) are used in the exposure dose estimation. At times, professional judgment is used when default values are not available or seem unreasonable for a particular site.

Three primary receptors were identified in this evaluation that are likely to come into contact with site-related contamination in the future: 1) child and adult recreational users, 2) maintenance workers, and 3) construction workers.

The primary exposure pathways evaluated in this health consultation are exposure to PCB contaminated soil through incidental ingestion and dermal exposure (skin contact). Overall, the main dose estimations calculated for the recreational users considered in this evaluation assume exposure to contaminated soil in AOC 2 for 52 days per year over a period of 6 yrs. for recreational children and 30 yrs. for recreational adults. For maintenance workers, it is assumed that they will be exposed to soil in AOC 2 for 225 days per year over a period of 25 yrs. For construction workers, it is assumed that they will be exposed to PCB contaminated soil in AOC 2 for 250 days per year for one year. The major exposure factors used for each receptor are listed below in Table A1.

Two routes of exposure exist for these exposure pathway scenarios: 1) incidental ingestion of soil containing PCBs and 2) dermal exposure to soil containing PCBs. Since both routes of exposure occur at the same time, the estimated doses for each exposure route are combined to form a total dose for each contaminant. In this case, both of the COPCs are PCB mixtures (Aroclor 1242 and Aroclor 1248). Therefore, the total dose for each PCB is added together to produce equivalent to the total exposure to PCBs in soil within AOC 2.

Non-cancer and cancer exposure doses are estimated for both pathways. The major difference between estimating non-cancer and cancer doses are that non-cancer doses are averaged over the exposure duration and cancer doses are averaged over a lifetime.

Table A1. Exposure Factors

Receptor	Recreational Users	Source of Exposure Factor[1]	Maintenance Worker	Source of Exposure Factor	Construction Worker	Source of Exposure Factor
Exposure Frequency (days/year)	52	Professional Judgment	225	Default Value (EPA 2002)	225	Professional Judgment
Exposure Duration (years)	6 (child) 30 (adult)	Default Residential Value (EPA 1997)	25	Default Value (EPA 2002)	1	Professional Judgment
Soil Ingestion Rate (mg/day)	200 (child) 100 (adult)	Default Residential Value (EPA 1997)	100	Default Value (EPA 2002)	330	Default Value (EPA 2002)
Surface Area Exposed (cm^2)	2,800 (child) 5,700 (adult)	Default Value (EPA 2004)	3,300	Default Value (EPA 2004)	3,300	Default Value (EPA 2004)
Adherence Factor (mg/cm^2)	0.2 (child) 0.07 (adult)	Default Value (EPA 2004)	0.2	Default Value (EPA 2004)	0.3	Default Value (EPA 2004)
Body Weight (kg)	15 (child) 70 (adult)	Default Value (PHAGM 2005)	70	Default Value (PHAGM 2005)	70	Default Value (PHAGM 2005)
Non-Cancer Averaging Time (days)	10,950	Default Value (PHAGM 2005)	9,125	Default Value (PHAGM 2005)	365	Default Value (PHAGM 2005)
Cancer Averaging Time (days)	25,550	Default Value (EPA 1997)	25,550	Default Value (EPA 1997)	25,550	Default Value (EPA 1997)

[1] Default exposure factors for recreational exposures do not currently exist. Site-specific conditions and professional judgment are used to determine the appropriate exposure factors for recreational users. The default values for the residential exposure scenario were used in this evaluation to describe recreational exposures with the exception of the exposure frequency factor. It was assumed that recreational exposures at this site would occur 52 days per year instead of the default exposure for residential exposures, which is 350 days per year. On average, this assumption accounts for recreational exposures occurring 1 day per week throughout the year or 2 days per week during the warmer months of the year.

Additional Table A1 NOTES

$cm.^2$ = square centimeters, kg. = kilogram, mg. = milligram, µg. = microgram

EPA (1997) = Environmental Protection Agency, Exposure Factors Handbook

EPA (2002) = Environmental Protection Agency, Supplemental Guidance for Developing Soil Screening Levels at Superfund Sites

EPA (2004) = Environmental Protection Agency, Risk Assessment Guidance for Superfund, Part E. Supplemental Guidance for Dermal Exposure

PHAGM (2005) = Agency for Toxic Substances and Disease Registry, Public Health Assessment Guidance Manual

Table A2. Chemical Specific Dermal Exposure Factors (EPA RAGS, Part E 2004)

COPC	Dermal Absorption Fraction (ABS_d)
Aroclor 1242	1.40E-01
Aroclor 1248	1.40E-01
Total PCBs	1.40E-01

Another critical component of the exposure dose estimation is the concentration of contaminants of potential concern that individuals are likely to be exposed to in a particular medium, which is referred to as the Exposure Point Concentration (EPC). As described in the main text, the exposure point concentration is unique for each receptor depending upon the exposure unit for that receptor. PCB data collected from AOC 2 at a depth of 0-2 ft. below ground surface was used for recreational users. However, the preferred soil depth for recreational users is soil at a depth interval of 0-2 inches below ground surface. No soil data from the 0-2 inch depth interval was available for review, so the most shallow soil data (0-2 ft. bgs.) was selected for recreational users. This could result in an over- or underestimation of risk if the concentration of soil contaminants at the 0-2 inch depth interval is lower or higher than found at the 0-2 ft. depth interval. For maintenance workers, soil data collected from AOC 2 at the 0-4 ft. depth interval was used. For construction workers, soil data collected from AOC 2 at the 0-8 ft. depth interval was for dose calculations.

Soil data for each receptor was combined and inserted into EPA's EPC statistical software called ProUCL. The resultant EPC is a high-end estimation of the average concentration based on a robust statistical package. When using limited data sets of less than 10 samples, the maximum concentration of that contaminant is selected as the EPC to be protective of public health. In this health consultation, the maximum value of 120 ppm for Aroclor 1242 was selected for recreational users (0-2 ft. bgs.) and maintenance workers (0-4 ft. bgs.). The EPCs of Aroclor 1242 and Aroclor 1248 are shown below in Table A3 for each receptor along with the statistical method used to calculate the EPC for each data set.

Table A3. Exposure Point Concentrations used in Dose Calculations

Contaminant of Potential Concern	Exposure Point Concentration (in mg/kg)*	Maximum Detected Concentration (in mg/kg)	Statistical Method	Depth (in feet)	Receptor
Aroclor 1242	120**	120	95% KM (Percentile Bootstrap) UCL	0-2	Child Recreational User
	120**	120	95% KM (Percentile Bootstrap) UCL	0-4	Outdoor Maintenance Worker
	89.9	120	95% KM (Chebyshev) UCL	0-8	Outdoor Construction Worker
Aroclor 1248	68.1	310	95% KM (Percentile Bootstrap) UCL	0-2	Child Recreational User
	50.7	310	95% KM (Percentile Bootstrap) UCL	0-4	Outdoor Maintenance Worker
	41.7	310	97.5% KM (t) UCL	0-8	Outdoor Construction Worker

* As calculated by ProUCL 4.00.05. The statistical method shown is the ProUCL recommended method.
** According to EPA Region 8 risk assessment guidance, if less than ten samples are available from a given medium, the maximum detected value should be selected for use as the Exposure Point Concentration. In this case, only 7 samples of Aroclor 1242 were available from the 0-2 ft. bgs. and 0-4 ft. bgs. depth intervals.

Dose Estimation

Non-cancer and cancer health endpoints are evaluated differently so the estimation of exposure dose also differs slightly (non-cancer doses are averaged over the timeframe of exposure and cancer doses are averaged over a lifetime). The exposure dose equations used in this evaluation are presented below (Equations 1-4).

Equation 1. Non-Cancer Soil Ingestion Dose

$$\textbf{Non-Cancer Dose} = (C_s * IRS * CF * EF * ED) / BW * AT_{NC}$$

Where:
C_s = Chemical Concentration in Soil (in mg/kg or milligrams contaminant per kilogram of soil)
IRS = Ingestion Rate of Soil (in milligrams of soil per day)
CF = Conversion Factor (in kilograms per milligram)
EF = Exposure Frequency (in days per year)
ED = Exposure Duration (in years)
BW = Body Weight (in kilograms)
AT_{NC} = Non-Cancer Averaging Time (in days)

Example: Non-cancer recreational child ingestion dose of Aroclor 1242 (Table A5) =>
(120 mg/kg * 200 mg/day * 1* 10^{-6} kg/mg * 52 days per year * 6 years) / (15 kg. * 2,190 days)
= **$2.28 * 10^{-4}$ mg/kg-day**

Equation 2. Cancer Soil Ingestion Dose

$$\textbf{Cancer Dose} = (C_s * CF * IRS_{adj} * EF) / AT_C$$

Where:
C_s = Chemical Concentration in Soil (in mg/kg or milligrams contaminant per kilogram of soil)
IRS_{adj} = Age-adjusted Ingestion Rate of Soil (in milligrams per day kilogram)
CF = Conversion Factor (in kilograms per milligram)
AT_C = Cancer Averaging Time (in days)

Example: Age-adjusted recreational cancer ingestion dose of Aroclor 1248 (Table 6) =>
(68.1 mg/kg * 1.28 * 10^{-6}mg/kg-day * 114.3 mg-yr/kg * 52 days/year) / (25,550 days)
= $1.59 * 10^{-5}$ mg/kg/day

Equation 3. Non-Cancer Dermal Absorbed Dose from Soil

$$\textbf{DA event (DAev)} = C_s * CF * AF * ABS_d$$

$$\textbf{DAD (mg/cm}^2\textbf{-event)} = \frac{DAev * EF * ED * SA}{BW * AT_{NC}}$$

Where:
DAev = Absorbed dose per event (in milligrams per square centimeter event)
$\mathbf{C_s}$ = Chemical concentration in soil (in milligrams contaminant per kilogram soil)
CF = Conversion factor (in kilograms per milligram)
AF = Adherence Factor (milligram per square centimeter event)
$\mathbf{ABS_d}$ = Dermal Absorption Fraction
EF = Exposure Frequency (in days per year)
ED = Exposure Duration (in years)
SA = Skin Surface Area (in square centimeters)
BW = Body Weight (in kilograms)
$\mathbf{AT_{NC}}$ = Non-Cancer Averaging Time (in days)

Example: Non-cancer recreational adult dermal absorbed dose of Aroclor 1242 (Tables A4 &A5) =>

DA_{ev} = 120 mg/kg * $1*10^{-6}$ kg/mg * 0.07 mg/cm^2-event * 1.4 * 10^{-1} = **$1.18 * 10^{-6}$ mg/cm^2-event**

DAD = ($1.18 * 10^{-6}$ mg/cm^2-event * 52 days * 30 years * 5,700 cm^2) / (70 kg. * 10,950 days) = **$1.37 * 10^{-5}$ mg/kg-day**

Equation 4. Cancer Dermal Absorbed Dose

$$\textbf{DA event (DAev)} = C_s * CF * AF * ABS_d$$

$$\textbf{DAD (mg/cm}^2\textbf{-event)} = \frac{DAev * EF * ED * SA}{AT_C * BW}$$

Where:
DAev = Absorbed dose per event (in milligrams per square centimeter event)
IRW_{adj} = Age-adjusted dermal absorption factor (in square centimeter-year per kilogram)
EF = Exposure Frequency (in days)
SA = Skin Surface Area (in square centimeters)
AT_C = Cancer Averaging Time (in days)
BW = Body Weight (in kilograms)

NOTE: The DA event calculation for non-cancer and cancer dermal absorbed dose equations is the same (DA_{ev} only needs to be calculated one time).

Example: Theoretical Cancer Dermal Dose for Maintenance Workers from Aroclor 1248 (Table A4 and Table 10) =>

DA_{ev} = 50.7 mg/kg * $1*10^{-6}$ kg/mg * 0.2 mg/cm^2-event * 1.4 * 10^{-1} = **$1.42 * 10^{-6}$ mg/cm^2-event**

DAD = ($1.42*10^{-6}$ mg/cm^2-event * 225 days * 25 years * 3,300 cm^2)/ (70 * 25550 days) = **$1.47*10^{-5}$mg/kg-day**

Table A4. Dermal Absorbed Dose Per Event (DA_{ev})

Receptor	DA_{ev} for Aroclor 1242	DA_{ev} for Aroclor 1248
Child Recreational User	3.36E-06	1.91E-06
Adult Recreational User	1.18E-06	6.67E-07
Maintenance Worker	3.36E-06	1.42E-06
Construction Worker	3.77E-06	1.75E-06

Table A5. Recreational Non-Cancer Exposure Dose Results

Receptor	COPC	Ingestion Dose (mg/kg-day)	Dermal Absorbed Dose (mg/kg-day)	Combined Dose (mg/kg-day)	Health-based Guideline (mg/kg-day)
Child	Aroclor 1242	**2.28E-04**	**8.94E-05**	**3.17E-04**	2.00E-05
	Aroclor 1248	**1.29E-04**	**5.07E-05**	**1.80E-04**	2.00E-05
	Total PCB Dose	**3.57E-04**	**1.40E-04**	**4.97E-04**	2.00E-05
Adult	Aroclor 1242	**2.44E-05**	1.36E-05	**3.81E-05**	2.00E-05
	Aroclor 1248	1.38E-05	7.74E-06	**2.16E-05**	2.00E-05
	Total PCB Dose	**3.83E-05**	**2.14E-05**	**5.97E-05**	2.00E-05

NOTE: mg/kg-day = milligram per kilogram body weight a day, COPC = Contaminant of Potential Concern, PCB = Polychlorinated Biphenyl

Values bolded in red exceed the non-cancer health-based guideline for high-risk PCBs.

Table A6. Construction Worker Non-Cancer Exposure Dose Results

Receptor	COPC	Ingestion Dose (mg/kg-day)	Dermal Absorbed Dose (mg/kg-day)	Combined Dose (mg/kg-day)	Health-based Guideline (mg/kg-day)
Adult	Aroclor 1242	**2.90E-04**	**1.22E-04**	**4.12E-04**	2.00E-05
	Aroclor 1248	**1.35E-04**	**5.66E-05**	**1.91E-04**	2.00E-05
	Total PCB Dose	**4.25E-04**	**1.78E-04**	**6.03E-04**	2.00E-05

NOTE: mg/kg-day = milligram per kilogram body weight a day, COPC = Contaminant of Potential Concern, PCB = Polychlorinated Biphenyl

Values bolded in red exceed the non-cancer health-based guideline for high-risk PCBs.

Table A7. Maintenance Worker Non-Cancer Exposure Dose Results

Receptor	COPC	Ingestion Dose (mg/kg-day)	Dermal Absorbed Dose (mg/kg-day)	Combined Dose (mg/kg-day)	Health-based Guideline (mg/kg-day)
Adult	Aroclor 1242	**1.06E-04**	**9.76E-05**	**2.03E-04**	2.00E-05
	Aroclor 1248	**4.46E-05**	**4.13E-05**	**8.59E-05**	2.00E-05
	Total PCB Dose	**1.50E-04**	**1.39E-04**	**2.89E-04**	2.00E-05

NOTE: mg/kg-day = milligram per kilogram body weight a day, COPC = Contaminant of Potential Concern, PCB = Polychlorinated Biphenyl

Values bolded in red exceed the non-cancer health-based guideline for high-risk PCBs.

Appendix B. Toxicological Evaluation

The basic objective of a toxicological evaluation is to identify what adverse health effects a chemical causes, and how these adverse effects depend on dose. The toxic effects of a chemical also depend on the route of exposure (oral, inhalation, dermal), the duration of exposure (acute, sub-chronic, chronic or lifetime), the health condition of the person, the nutritional status of the person, and the life style and family traits of the person. In this evaluation, chronic oral exposures were evaluated.

The U.S. Environmental Protection Agency (EPA) and the Agency for Toxic Substances and Disease (ATSDR) have established oral reference doses (RfD) and minimal risk levels (MRL) for non-cancer effects. An RfD is the daily dose in humans (with uncertainty spanning perhaps an order of magnitude), including sensitive subpopulations, that is likely to be without an appreciable risk of non-cancer adverse health effects during a lifetime of exposure to a particular contaminated substance. An MRL is the dose of a compound that is an estimate of daily human exposure that is likely to be without an appreciable risk of adverse non-cancer effects of a specified duration of exposure. The acute, intermediate, and chronic MRLs address exposures of 14 days or less, 14 days to 365 days, and 1-year to lifetime, respectively. The health-based guidelines for the contaminants of potential concern for this evaluation are listed below.

Table B1. Oral Health-based Guidelines for the contaminants of potential concern

Contaminant Of Potential Concern	Oral Health-based Guideline (mg/kg-day)	Source of Oral Health-based Guideline	Oral Slope Factor (mg/kg-day^{-1})	Source of Oral Slope Factor
Aroclor 1242*	2.00E-05	ATSDR Chronic MRL for Aroclor 1254	2.00E+00	EPA IRIS Summary on Aroclor 1254
Aroclor 1248*	2.00E-05	ATSDR Chronic MRL for Aroclor 1254	2.00E+00	EPA IRIS Summary on Aroclor 1254

Note:

* Potential health risks of exposure to Aroclor 1242 and Aroclor 1248 were evaluated using the high-risk PCB toxicity values provided in EPA IRIS. The ATSDR Chronic Oral MRL is equivalent to the non-cancer EPA IRIS toxicity value for high-risk PCBs, although the MRL was technically derived for Aroclor 1254.

The same values were used for the dermal exposure pathway without adjustment for gastrointestinal absorption in accordance with EPA RAGs Part E.

mg/kg-day = milligrams of contaminant per kilogram body weight a day

MRL = Minimal Risk Level

IRIS = Integrated Risk Information System

Table B2. Oral Adverse Health Effect Levels

Contaminant Of Potential Concern	LOAEL (mg/kg-day)	Source
Aroclor 1254*	5.00E-03	LOAEL value from the derivation of ATSDR Chronic MRL for Aroclor 1254

* Potential health risks of exposure to Aroclor 1242 and Aroclor 1248 were evaluated using the high-risk PCB toxicity values provided in EPA IRIS. The ATSDR Chronic Oral MRL is equivalent to the non-cancer EPA IRIS toxicity value for high-risk PCBs, although the MRL was technically derived for Aroclor 1254.

Table B3. Comparison of Combined (i.e. Ingestion and Dermal) Estimated Non-cancer Doses of Aroclor 1242 and Aroclor 1248 with the LOAEL value for Aroclor 1254

Receptor	Combined Non-cancer Dose for Aroclor 1242 (mg/kg-day)	Combined Non-cancer Dose for Aroclor 1248 (mg/kg-day)	Total Combined Non-cancer Dose of PCBs (mg/kg-day)	LOAEL value for Aroclor 1254 (mg/kg-day)	LOAEL Hazard Quotient
Child Recreational User	3.17E-04	1.80E-04	4.97E-04	5.00E-03	9.9E-02
Adult Recreational User	3.81E-05	2.16E-05	5.97E-05	5.00E-03	1.21E-02
Maintenance Worker	2.03E-04	8.59E-05	2.89E-04	5.00E-03	5.78E-02
Construction Worker	4.12E-04	1.91E-04	6.03E-04	5.00E-03	1.2E-01

NOTE: mg/kg-day = milligrams of contaminant per kilogram body weight a day, LOAEL = Lowest Observed Adverse Effect Level, LOAEL HQ is equal to the total combined estimated dose divided by the LOAEL value. LOAEL HQs greater than 1 exceed the LOAEL. In this case, all LOAEL values are below 1.

Appendix C. ATSDR ToxFAQs on Polychlorinated Biphenyls

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

POLYCHLORINATED BIPHENYLS

Division of Toxicology ToxFAQs™ **February 2001**

This fact sheet answers the most frequently asked health questions (FAQs) about polychlorinated biphenyls. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Polychlorinated biphenyls (PCBs) are a mixture of individual chemicals which are no longer produced in the United States, but are still found in the environment. Health effects that have been associated with exposure to PCBs include acne-like skin conditions in adults and neurobehavioral and immunological changes in children. PCBs are known to cause cancer in animals. PCBs have been found in at least 500 of the 1,598 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What are polychlorinated biphenyls?

Polychlorinated biphenyls are mixtures of up to 209 individual chlorinated compounds (known as congeners). There are no known natural sources of PCBs. PCBs are either oily liquids or solids that are colorless to light yellow. Some PCBs can exist as a vapor in air. PCBs have no known smell or taste. Many commercial PCB mixtures are known in the U.S. by the trade name Aroclor.

PCBs have been used as coolants and lubricants in transformers, capacitors, and other electrical equipment because they don't burn easily and are good insulators. The manufacture of PCBs was stopped in the U.S. in 1977 because of evidence they build up in the environment and can cause harmful health effects. Products made before 1977 that may contain PCBs include old fluorescent lighting fixtures and electrical devices containing PCB capacitors, and old microscope and hydraulic oils.

What happens to PCBs when they enter the environment?

❑ PCBs entered the air, water, and soil during their manufacture, use, and disposal; from accidental spills and leaks during their transport; and from leaks or fires in products containing PCBs.

❑ PCBs can still be released to the environment from hazardous waste sites; illegal or improper disposal of industrial wastes and consumer products; leaks from old electrical transformers containing PCBs; and burning of some wastes in incinerators.

❑ PCBs do not readily break down in the environment and thus may remain there for very long periods of time. PCBs can travel long distances in the air and be deposited in areas far away from where they were released. In water, a small amount of PCBs may remain dissolved, but most stick to organic particles and bottom sediments. PCBs also bind strongly to soil.

❑ PCBs are taken up by small organisms and fish in water. They are also taken up by other animals that eat these aquatic animals as food. PCBs accumulate in fish and marine mammals, reaching levels that may be many thousands of times higher than in water.

How might I be exposed to PCBs?

❑ Using old fluorescent lighting fixtures and electrical devices and appliances, such as television sets and refrigerators, that were made 30 or more years ago. These items may leak small amounts of PCBs into the air when they get hot during operation, and could be a source of skin exposure.

❑ Eating contaminated food. The main dietary sources of PCBs are fish (especially sportfish caught in contaminated lakes or rivers), meat, and dairy products.

❑ Breathing air near hazardous waste sites and drinking contaminated well water.

❑ In the workplace during repair and maintenance of PCB transformers; accidents, fires or spills involving transformers, fluorescent lights, and other old electrical devices; and disposal of PCB materials.

How can PCBs affect my health?

The most commonly observed health effects in people exposed to large amounts of PCBs are skin conditions such as acne and rashes. Studies in exposed workers have shown changes in blood and urine that may indicate liver damage. PCB exposures in the general population are not likely to result in skin and liver effects. Most of the studies of health effects of PCBs in the general population examined children of mothers who were exposed to PCBs.

Animals that ate food containing large amounts of PCBs for short periods of time had mild liver damage and some died. Animals that ate smaller amounts of PCBs in food over several weeks or months developed various kinds of health effects, including anemia; acne-like skin conditions; and liver, stomach, and thyroid gland injuries. Other effects

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Agency for Toxic Substances and Disease Registry

of PCBs in animals include changes in the immune system, behavioral alterations, and impaired reproduction. PCBs are not known to cause birth defects.

How likely are PCBs to cause cancer?

Few studies of workers indicate that PCBs were associated with certain kinds of cancer in humans, such as cancer of the liver and biliary tract. Rats that ate food containing high levels of PCBs for two years developed liver cancer. The Department of Health and Human Services (DHHS) has concluded that PCBs may reasonably be anticipated to be carcinogens. The EPA and the International Agency for Research on Cancer (IARC) have determined that PCBs are probably carcinogenic to humans.

How can PCBs affect children?

Women who were exposed to relatively high levels of PCBs in the workplace or ate large amounts of fish contaminated with PCBs had babies that weighed slightly less than babies from women who did not have these exposures. Babies born to women who ate PCB-contaminated fish also showed abnormal responses in tests of infant behavior. Some of these behaviors, such as problems with motor skills and a decrease in short-term memory, lasted for several years. Other studies suggest that the immune system was affected in children born to and nursed by mothers exposed to increased levels of PCBs. There are no reports of structural birth defects caused by exposure to PCBs or of health effects of PCBs in older children. The most likely way infants will be exposed to PCBs is from breast milk. Transplacental transfers of PCBs were also reported In most cases, the benefits of breast-feeding outweigh any risks from exposure to PCBs in mother's milk.

How can families reduce the risk of exposure to PCBs?

❑ You and your children may be exposed to PCBs by eating fish or wildlife caught from contaminated locations. Certain states, Native American tribes, and U.S. territories have issued advisories to warn people about PCB-contaminated fish and fish-eating wildlife. You can reduce your family's exposure to PCBs by obeying these advisories.

❑ Children should be told not play with old appliances, electrical equipment, or transformers, since they may contain PCBs.

❑ Children should be discouraged from playing in the dirt near hazardous waste sites and in areas where there was a transformer fire. Children should also be discouraged from eating dirt and putting dirty hands, toys or other objects in their mouths, and should wash hands frequently.

❑ If you are exposed to PCBs in the workplace it is possible to carry them home on your clothes, body, or tools. If this is the case, you should shower and change clothing before leaving work, and your work clothes should be kept separate from other clothes and laundered separately.

Is there a medical test to show whether I've been exposed to PCBs?

Tests exist to measure levels of PCBs in your blood, body fat, and breast milk, but these are not routinely conducted. Most people normally have low levels of PCBs in their body because nearly everyone has been environmentally exposed to PCBs. The tests can show if your PCB levels are elevated, which would indicate past exposure to above-normal levels of PCBs, but cannot determine when or how long you were exposed or whether you will develop health effects.

Has the federal government made recommendations to protect human health?

The EPA has set a limit of 0.0005 milligrams of PCBs per liter of drinking water (0.0005 mg/L). Discharges, spills or accidental releases of 1 pound or more of PCBs into the environment must be reported to the EPA. The Food and Drug Administration (FDA) requires that infant foods, eggs, milk and other dairy products, fish and shellfish, poultry and red meat contain no more than 0.2-3 parts of PCBs per million parts (0.2-3 ppm) of food. Many states have established fish and wildlife consumption advisories for PCBs.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological profile for polychlorinated biphenyls (PCBs). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs™ Internet address is http://www.atsdr.cdc.gov/toxfaq.html . ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

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