Health Consultation

Evaluation of Potential Soil Exposures of Future Residents

HAMILTON-SUNDSTRAND RCRA SITE

DENVER, ADAMS COUNTY, COLORADO

Prepared by the
Colorado Department of Public Health and Environment

JULY 26, 2010

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Statement and Summary of Issues

Introduction

The Colorado Cooperative Program for Environmental Health Assessments (CCPEHA) and the Agency for Toxic Substances and Disease (ATSDR) Registry's top priority is to ensure that all stakeholders have the best health information possible to protect the community from current and future health hazards associated with the Hamilton Sundstrand site in Adams County, Colorado.

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, 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 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 the potential public health hazards associated with site-related contamination that remains in subsurface soil of the Facility Parcel. An Environmental Covenant is currently in place to restrict future land-use of the Facility Parcel to a recreational use area. However, it is possible this Covenant could be removed in the future potentially allowing the area to be developed into a residential neighborhood. The purpose of the health consultation is to evaluate this hypothetical scenario to assist stakeholders in making future risk management decisions regarding future land use of the northern portion of the Facility Parcel. Environmental characterization of soil is ongoing in the southern portion of the Facility Parcel. Once these efforts are complete, an additional health consultation will be conducted to address the same concerns on the southern portion of the Facility Parcel.

Overview

CCPEHA and ATSDR have reached one conclusion regarding potential soil exposures of future residents in the northern portion

of the Facility Parcel at the Hamilton Sundstrand site. This hypothetical exposure scenario was designed to assist stakeholders in making risk management decisions regarding future land-use.

Conclusion 1

It cannot currently be determined if future residential exposure to chemicals present in subsurface soil would harm people's health.

Basis for Decision

This conclusion was reached because critical health information (i.e., chemical toxicity values or health effects levels) is unavailable for multiple chemicals that were detected in the subsurface soil in the northern portion of the Facility Parcel at the Hamilton Sundstrand site. In addition, potential exposures to chemicals through the soil vapor intrusion in the indoor air and consumption of homegrown fruits and vegetable cannot be evaluated at this time due to a lack of environmental data. It should, however, be noted that the available information indicates the following:

- Theoretical cancer risks for future residents from contacting chemicals with known toxicity values through incidental ingestion and skin contact are just above the high-end of acceptable cancer risk range. This indicates that exposure to contaminants found in the subsurface soil at the Hamilton Sundstrand Facility Parcel are associated with a low to moderate increased risk of developing cancer. In addition, the estimated non-cancer hazards from incidental ingestion and skin contact are not likely to be significant.

- The qualitative evaluation for PCBs without toxicity values indicates that potential exposure to PCBs enters into a range of potential concern since the combined estimated exposure doses significantly exceed the health-based guideline. Furthermore, toxicity information is lacking for six other compounds that were detected in subsurface soil.

Next Steps

The Environmental Covenant in place on the northern portion of the Facility Parcel should remain to prohibit the use of this area as a residential neighborhood because: (1) there are uncertainties associated with this evaluation, which includes detected chemicals without known toxicity values and potential exposures pathways that cannot currently be evaluated; and (2) subsurface soils need to be remediated to the CDPHE acceptable cancer risk level of one in a million for the residential use.

For More Information

If you have concerns about your health, you should contact your health care provider. Please call Thomas Simmons at 303-692-2961 for more information on the Hamilton Sundstrand site health consultation.

Purpose

The Hazardous Materials and Waste Management Division (HWWMD) of the Colorado Department of Public Health and Environment (CDPHE) requested that the CCPEHA evaluate the potential health effects from exposure to soil if the Hamilton Sundstrand site is developed into residential properties in the future. Residential soil exposures are the only exposure scenario evaluated here since all other pathways have been eliminated or exposures have been reduced to health based levels (i.e., surface and shallow soils) or are currently undergoing remediation (groundwater/vapor intrusion pathway). This health consultation will assist city and state officials make risk-management decisions regarding future land-use at the Hamilton Sundstrand site.

Background

The Hamilton Sundstrand site 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. The site consists of two main areas: the Facility Parcel and the Vacant Parcel (Figure 2). The Facility Parcel is 43 acres and consisted of the buildings, underground storage tanks, and an above ground storage tank. The buildings included the Main Plant Building, the Remote Facility, and the Tape Manufacturing Building. 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 agricultural purposes. 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. In more recent years, the Remote Facility was vacant and used primarily for chemical storage of virgin products. The Tape Manufacturing Building was constructed in 1966 and was connected to the west side of the Main Plant Building. In 1992, the Groundwater Treatment Facility was constructed as part of the Groundwater Barrier System to control contaminated groundwater stemming from the site.

The Vacant Parcel, located to the east of the Facility Parcel, is 120 acres and was purchased in 1992. The Vacant Parcel was used for agriculture prior to acquisition and served primarily as a buffer for the Hamilton Sundstrand site. Groundwater flow is to the east and contaminated groundwater originating from the site lies beneath the Facility

Parcel. 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.

Environmental contamination at the site was initially discovered in 1983 after a water and soil quality investigation was conducted. The investigators recommended the removal of 333 cubic yards of soil in the southern portion of the Facility Parcel and an annual groundwater monitoring program. 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 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 in the southern portion of the Facility Parcel.

During 2008-2009, shallow (0-8 ft.) contaminated soil was removed from the Facility Parcel, disposed of offsite, and replaced with clean soil. Therefore, the only possible site-related soil contamination that exists is in the subsurface soil. The focus of this health consultation is to address the potential future residential exposures to subsurface soil in the northern parcel of the site.

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 at 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, and frequent public meetings to keep residents up-to-date and involved in remedial activities at the site. Now community meetings occur on an as needed basis.

Discussion

The overall goal of the public health consultation process is to determine if site-related contamination poses a public health hazard and to make recommendations to protect

public health if need be. The first steps 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

Subsurface soil data (8-15 ft.) is the only environmental data that was reviewed in this health consultation since the focus of the investigation is future residential soil exposures in the Facility Parcel. Clean soil is present from 0-8 ft. below ground surface, which is protective of recreational users. Therefore, the only possible site-related soil contamination exists in the subsurface soil. All subsurface soil data (8-15 ft. bgs.) that has been collected from the Facility Parcel was reviewed for this investigation. The data was collected from April 1987 through November 2006 and was analyzed for a variety of contaminants depending on the location of the sample and the potential contaminants in that particular sampling location. Subsurface sampling locations for the Facility Parcel are shown in Figure 3. In general, subsurface soil data was collected in a step-wise fashion beginning with a screening analysis of multiple contaminants (i.e. hundreds) to more focused analysis as contaminants of potential concern were identified. In total, more than 11,000 data points from the northern portion of the Facility Parcel were reviewed for this evaluation. The subsurface soil investigation included but is not limited to the following chemical groups: metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, PCBs, total petroleum hydrocarbons (TPHs), and polycyclic aromatic hydrocarbons (PAHs). The samples were sent to offsite analytical laboratories and analyzed with the appropriate EPA-approved analysis methods depending on the constituents under investigation.

As shown in Table 1, a number of contaminants were detected in subsurface soil in the northern portion of the Facility Parcel. Aluminum, arsenic, barium, chromium, cobalt, copper, iron, lead, manganese, nickel, vanadium, and zinc were detected in all of the soil samples analyzed for this evaluation. The maximum detected values of arsenic and chromium were 28.8 mg/kg and 20.1 mg/kg, respectively. The concentrations of the other detected metals were unremarkable. PCBs were also detected frequently, but appear to be localized in hot spots as opposed to being widely dispersed. PCB 1248 was found at a maximum concentration of 35.0 mg/kg. Other notable contaminant detections include tetrachloroethene and trichloroethene (PCE and TCE). Both solvents were found frequently and were widely dispersed in subsurface soil throughout the northern portion of the Facility Parcel. The maximum concentration of PCE and TCE was 160 mg/kg and 3.8 mg/kg, respectively.

Contaminants of Potential Concern

To identify COPCs, the available environmental data was screened with comparison values established by the ATSDR and EPA. The comparison values (CVs) from both

agencies were reviewed and the most conservative value was selected for the screening process (Table 1). The (CVs) used in this evaluation are derived for residential exposure scenarios (i.e. residential exposure to surface soil). Residential-use comparison values are based on 350 days exposure per year over a period of 30 years (Table 1). Using these CVs is considered conservative and protective of the residential exposure scenario under consideration in this evaluation. Therefore, if the maximum concentration of a particular contaminant is below the CV, it is dropped from further evaluation. If the maximum concentration of the contaminant is above the CV, it is generally retained for further analysis as a COPC. However, exceeding the CV does not indicate that a health hazard exists; only that additional evaluation is warranted.

Table 2. COPC Selection Summary

Contaminant	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	CV Source
Arsenic	2.88E+01	3.90E-01	EPA RSL-Cancer
Benzene	7.20E+00	1.10E+00	EPA RSL-Cancer
Chromium*	2.01E+01	2.90E-01	EPA RSL-Cancer
1,1-Dichloroethane	5.90E+00	3.30E+00	EPA RSL-Noncancer
Ethylbenzene	6.10E+01	5.40E+00	EPA RSL-Noncancer
Naphthalene	5.60E+01	3.60E+00	EPA RSL-Noncancer
PCB 1242	8.00E-01	2.20E-01	EPA RSL-Cancer
PCB 1248	3.50E+01	2.20E-01	EPA RSL-Cancer
Total PCBs	1.10E+01	2.20E-01	EPA RSL-Cancer
Tetrachloroethene	1.60E+02	5.50E-01	EPA RSL-Cancer
Trichloroethene	6.20E+01	2.80E+00	EPA RSL-Cancer

* The risk-based values for chromium VI (most conservative) were used to evaluate chromium since the valence state of detected chromium is unknown.
RSL: Regional Screening Level

As shown in Table 2, eleven COPCs were selected for further evaluation in this investigation. COPCs include metals, VOCs, PCBs, and one PAH. The majority of the selected COPCs are oral carcinogens with the exception of 1,1-dichloroethane, ethylbenzene, and naphthalene. In addition, six chemicals (iodomethane, phenanthrene, n-butylbenzene, p-butylbenzene, isopropyltoluene, and 1,2,4-trimethylbenzene) were detected, but have no CVs (i.e. no toxicity values) were also retained as COPCs.

Exposure Evaluation

The exposure evaluation examines future land-use at this site to develop a conceptual site model that describes how people could come into contact with site-related contamination in soil. Simply having contamination in the environment does not indicate there is a public health hazard. Therefore, it is necessary to determine if and how individuals can be exposed to the contamination. As mentioned previously, this health consultation focuses on potential residential exposures to soil in the northern portion of the Facility Parcel at the Hamilton Sundstrand site. Currently, an Environmental Covenant is in place to limit future use of the Facility Parcel to recreational use only. As mentioned previously,

shallow contaminated soil has been excavated and removed from the property. Sampling was conducted to confirm that shallow soil was protective of recreational users. However, the purpose of this investigation is to assist stakeholders in making future risk management decisions by evaluating soil exposures in the Facility Parcel if it were to be developed for residential use some time in the future. The current plans for future land-use of the entire site are shown in Figure 4.

If the Facility Parcel was developed for residential use in the future, subsurface soil would be excavated and graded during construction. Surface and subsurface soils would likely be mixed during this process, but it is impossible to predict the degree and nature of the resulting "surface soil" that would be present in the yards of these homes. Thus, the most conservative scenario is that 100% of the contaminated subsurface soil becomes surface soil. This was the assumption used in this evaluation to remain protective of potential future residents' health. Assuming that contaminated soil has been brought to the surface, there are two primary routes of potential exposure for future residents, incidental ingestion and dermal exposure to contaminants. Inhalation of dust particles is considered an insignificant pathway and not evaluated here. Incidental ingestion of soil occurs in a variety of ways including while children are playing, hand-to-mouth activity, landscaping, gardening, and ingestion of household dust containing soil. Dermal exposure to soil occurs during the same type of activities; however, dermal exposure is only important for certain contaminants that have the ability to cross the skin barrier. In addition, two other potential exposure pathways exist that cannot be evaluated at this time: inhalation of soil vapors from vapor intrusion into homes and ingestion of homegrown fruits and vegetables. The COPCs identified in this evaluation have the ability to volatilize from subsurface soil and enter homes in the vapor state, which is referred to as vapor intrusion. However, no soil gas data is currently available, so this exposure pathway cannot be evaluated.. In addition, the COPCs can also bioconcentrate in homegrown foodstuffs. Again, data are not available for chemical concentrations in home grown fruits and vegetables. Therefore, this exposure pathway cannot be evaluated. The exposure scenario used in this evaluation is summarized below in the Conceptual Site Model (Table 3).

Table 3. Conceptual Site Model: Potential Exposure Pathways

Source	Point of Exposure	Affected Environmental Medium	Potentially Exposed Populations	Timeframe of Exposure	Route of Exposure
Industrial Waste	Northern Portion of the Facility Parcel at the Hamilton Sundstrand Site	Subsurface soil	Child and Adult Residents	Future (Potential)	1) Incidental Ingestion and Dermal Exposure to Surface Soil*, 2) Inhalation of soil vapors via vapor intrusion, [a]3) Ingestion of homegrown fruits and vegetables [a]

Note: *The assumption made in this model is that during construction, subsurface soil will be brought to the surface where residents could be exposed.
[a] These exposure pathways cannot be evaluated due to lack of environmental data.

Public Health Implications

Evaluating the public health implications of exposure to soil contaminants is a multi-step process. For all contaminants that exceed the CV, exposure doses are estimated for non-cancer and cancer endpoints (if the COPC is a carcinogen). The estimated exposure doses are then compared with non-cancer and cancer health-based guidelines to evaluate if adverse health effects are likely from contacting soil contaminants. If the estimated exposure dose is higher than the health-based reference levels, further evaluation is conducted.

To estimate exposure doses, one must make assumptions such as how much soil will be accidentally ingested over a period of time. These assumptions, or exposure factors, can be based on scientific literature, site-specific information, or professional judgment. The exposure factors used in this evaluation are the standard default values recommended by the EPA and/or ATSDR for the residential exposures. These default parameters represent the reasonable maximum exposure, which characterize risk to an individual at the upper end of the risk distribution (i.e., it describes exposure above the 90th percentile of the population distribution). Many factors determine individual responses to chemical exposures. These factors include the dose, duration, and individual factors such as age, gender, diet, family traits, lifestyle, and state of health. For these reasons, this evaluation cannot determine the actual health risk to any one particular individual. More information regarding the exposure factors used in this document and the toxic potential of risk driving chemicals is available in Appendix A and Appendix B, respectively.

Exposure doses were estimated for non-cancer and theoretical cancer risk for all COPCs (arsenic, benzene, chromium, 1,1-dichloroethane, ethylbenzene, naphthalene, PCB 1242, PCB 1248, total PCBs, PCE and TCE) identified in this evaluation. Dermal exposure is only evaluated for the COPCs that have the chemical-specific values necessary for the dose calculation. Of the COPCs identified in this evaluation, these values are available for arsenic, naphthalene, and PCBs.

As shown in Tables 4 and A4, the non-cancer doses for incidental ingestion are well below the corresponding health-based guideline for all COPCs (arsenic, benzene, chromium, 1,1-dichloroethane, ethylbenzene, naphthalene, PCE and TCE) identified in this assessment that have non-cancer toxicity values. In addition, the non-cancer dose for dermal contact to soil contaminants is also below the health-based guidelines for arsenic and naphthalene (Tables 5 and A5). This indicates that exposure to these contaminants in soil in the Facility Parcel is associated with a low risk of developing non-cancer health effects.

It is important to note that non-cancer hazards for PCB 1242, PCB 1248, and total PCBs cannot be quantitatively evaluated because of the unavailability of non-cancer health

guidelines. However, non-cancer health hazards of PCBs were qualitatively evaluated by comparing the non-cancer doses for PCBs 1242, PCB 1248, and total PCBs with the non-cancer health based guideline for PCB 1254, which has non-cancer toxicity value available (Table 6). The estimated non-cancer doses for children of PCB 1248 exceeded the health-based guideline for PCB 1254 ($2 * 10^{-5}$ mg/kg-day) for both incidental ingestion and dermal contact with soil. When the estimated non-cancer doses of PCB 1248 are combined for cumulative exposure, the combined doses exceed the health-based guideline for PCB 1254 in both child and adult residents. For children, the combined dose of PCB 1248 exceeds the health-based guideline for PCB 1254 by more than 1 order of magnitude (12x). However, the combined estimated doses of PCB 1248 for both children and adults are significantly below (> 10 x) the Lowest-Observed-Adverse-Effect-Level (LOAEL) of 0.005 mg/kg/day for PCB 1254. The estimated doses for PCB 1248 enter into a range of potential concern for non-cancer hazards (particularly for children) since the combined estimated doses are 12 times greater than the health-based guideline for PCB 1254., but nearly 20 times lower than the LOAEL value for PCB 1254. In addition, a No Observed Adverse Effect Level (NOAEL) is not available for PCB 1254. The estimated non-cancer doses for PCB 1242 were below the health-based guideline for PCB 1254 for both child and adult residents. The combined estimated non-cancer doses for ingestion and dermal exposures for total PCBs exceeded the health-based guideline of PCB 1254 for children. However, the estimated doses of total PCBs for children were below the Lowest-Observed-Adverse-Effect-Level (LOAEL) of 0.005 mg/kg/day for PCB 1254.

Table 6. Qualitative evaluation of non-cancer hazards for PCBs with no toxicity values

PCB Isomer	**Combined Child Doses** (mg/kg-day)	**Combined Child HQ**	**Combined Child LOAEL HQ**	**Combined Adult Doses** (mg/kg-day)	**Combined Adult HQ**	**Combined Adult LOAEL HQ**
PCB 1242	5.26E-06	2.6E-01	1.1E-03	6.32E-07	3.2E-02	1.3E-04
PCB 1248	**2.48E-04**	**1.2E+01**	5.0E-02	**2.96E-05**	**1.5E+00**	5.9E-03
Total PCBs	**1.00E-04**	**5.0E+00**	2.0E-02	1.20E-05	6.0E-01	2.4E-03
Combined PCB 1242 and PCB 1248	**2.53E-04**	**1.3E+01**	5.1E-02	**3.02E-05**	**1.5E+00**	6.0E-03

Notes: Bolded values indicate that the estimated dose exceeds the health-based guideline for PCB 1254.
Oral RfD for PCB 1254 equals 2.0E-05 mg/kg-day, LOAEL value for PCB 1254 equals 5.0E-03 mg/kg-day

Theoretical cancer risks were estimated for all carcinogens by the oral route of exposure. This includes arsenic, benzene, chromium, 1,1-dichloroethane, ethylbenzene, PCBs, PCE and TCE. Of these COPCs, arsenic, benzene, and hexavalent chromium are classified as known human carcinogens. An age-adjusted equation, which includes exposure from

childhood to adulthood, was used to estimate the theoretical cancer risk in this evaluation. For incidental ingestion, the theoretical cancer risk for each individual contaminant is below or within the acceptable cancer risk range of $1*10^{-6}$ to $1*10^{-4}$, or 1 excess cancer case per one million exposed individuals to 100 excess cancer cases per one million exposed individuals (Tables 7 and A6). The same is true of the theoretical cancer risk from dermal exposure (Table 8 and A7). However, it is important to note that the cumulative theoretical cancer risks for all carcinogenic COPCs from incidental ingestion of soil and dermal contact with soil slightly exceeds the acceptable cancer risk range of $1*10^{-6}$ to $1*10^{-4}$ at $1.2 * 10^{-4}$ (Table 9). The major contributors to the estimated cumulative cancer risk are PCBs, arsenic, chromium, and PCE. This indicates that the potential exposure of future residents to COPCs in soil is associated with a low to moderate increased risk of developing cancer. It is also important to note that arsenic is a naturally occurring soil contaminant. A portion of the theoretical cancer risks found in this health consultation are due to naturally occurring arsenic in soil and are not a result of site-related contamination. For this reason, if the Facility Parcel is developed into a neighborhood in the future, arsenic levels in soil should be reduced to background arsenic levels.

Chemicals with no toxicity values

The following six chemicals listed in Table 10 have no health-based guidelines or toxicity reference values (i.e. MRLs, RfDs, NOAEL, and LOAEL). Also, the carcinogenic potential of these chemicals is not known. Therefore, the potential for adverse health effects cannot be evaluated at this time.

Table 10. Chemicals with no toxicity reference values

Chemical	Maximum concentration (µg/kg)
Iodomethane	7.80E-01
n-Butylbenzene	2.10E+03
Phenanthrene	1.50E+02
p-Isopropyltoluene	1.90E+03
sec-Butylbenzene	9.00E+02
1,2,4-Trimethylbenzene	2.60E+05

Uncertainty

This is not intended to be an in-depth discussion of all uncertainties. Rather, the focus is to highlight the major assumptions and limitations that are specific to this evaluation. In general, the uncertainties inherent in any risk assessment are likely to over- or underestimate exposures and health hazards. The magnitude of this uncertainty is generally unknown. Some of the major uncertainties of this evaluation are briefly noted below.

- The assumption of 100% metal bioavailability arsenic-contaminated soils. This is a conservative assumption based on what is known of the reduced bioavailability of metals in soils.
- Cancer and non-cancer toxicity values for trichloroethene and tetrachloroethene are under evaluation by the EPA.
- At this time, the potential for non-cancer hazards (acute and chronic) from PCBs and 1,2,4-trimethylbenzene cannot be fully evaluated due to the unavailability of health based guidelines (i.e., ATSDR MRLs or EPA RfDs). Non-cancer PCB hazards were qualitatively evaluated using the non-cancer health-based values for PCB 1254.
- Cancer and/or noncancer health based guidelines are not available for six chemicals. Therefore, the potential for health impacts cannot be evaluated for these chemicals.
- Soil vapor intrusion and consumption of homegrown fruits and vegetables cannot be evaluated at this time due to a lack of data.
- It is not known if the currently available data represents all hot spots of chemicals in subsurface soil.
- The assumption that 100% of the contaminated subsurface soil becomes surface soil results in an overestimation of health risks.
- The site-specific cancer risks are overestimated because of: (1) the assumption of 100% chromiumVI in soil; and (2) the contribution of background risks from naturally occurring arsenic and chromium. This uncertainty can be addressed by remediating these metals to the site-specific background levels.

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. In this evaluation, child health concerns were evaluated and no special health concerns were identified for children for chemicals with health based guidelines. It is, however, important to note that the non-cancer hazards for PCBs, especially acute hazards, cannot be evaluated for children due to the unavailability of health based guidelines. In addition, the qualitative evaluation of chronic noncancer hazards for various PCBs indicated a potential for health concern for children.

Conclusions

CCPEHA and ATSDR have reached the following one conclusion regarding future soil exposures to residents if the Facility Parcel at the Hamilton Sundstrand site is developed into a neighborhood in the future:

It cannot currently be determined whether future potential exposures to chemicals present in soil through skin contact, accidental ingestion, soil vapor intrusion, and consumption of home grown produce will harm people' s health. This conclusion was reached because: (1) health-based guidelines are not available for PCBs and 6 other chemicals; and (2) inhalation of vapors from soil vapor intrusion and consumption of contaminated homegrown vegetables cannot be evaluated at this time due to a lack of data. It should, however, be noted that the available information indicates the following:

- For chemicals with known toxicity values (arsenic, benzene, chromium, 1,1-dichloroethane, ethylbenzene, naphthalene, PCBs, tetrachloroethene, and trichloroethene), the estimated theoretical cancer risks through incidental ingestion and skin contact for future residents are just above the high-end of acceptable cancer risk range of one in a million to 100 in a million excess cancer cases. This indicates that exposure to contaminants found in the soil in the northern portion of the Facility Parcel at the Hamilton Sundstrand Facility Parcel is associated with a low to moderate increased risk of developing cancer. In addition, the estimated non-cancer doses from incidental ingestion and skin contact are well below the health-based guideline for all chemicals with known toxicity values (arsenic, benzene, chromium, 1,1-dichloroethane, ethylbenzene, naphthalene, tetrachloroethene, and trichloroethene). This indicates that exposure to these contaminants in soil in the Facility Parcel is associated with a low risk of developing non-cancer health effects.

- The qualitative evaluation of PCBs (1248, 1242, and total PCBs using the non-cancer health guideline for PCB 1254 indicates a potential concern for non-cancer health hazards in children from exposure to PCB 1248. The combined estimated non-cancer doses of PCB 1248 for children enter a range of potential concern because these values are significantly higher (12x) than the health-based guideline for PCB 1254, but are nearly 20 times below a level of immediate health concern (i.e., LOAEL).

Recommendations

Based upon CCPEHA's review of the environmental data, exposure pathways, and potential public health implications of exposure to soil contaminants located in the northern portion of the Facility Parcel at the Hamilton Sundstrand site, the following actions are appropriate and protective of future residents.

- CDPHE and the owners of the property should maintain the enforceable Environmental Covenant on the Facility Parcel, which prohibits future residential development because: (1) there are uncertainties associated with this evaluation, which includes detected chemicals without known toxicity values and potential exposures pathways that cannot currently be evaluated due to a lack of data; and (2) subsurface soils need to be remediated to the CDPHE acceptable cancer risk level of one in a million for an individual chemical for the residential use.

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:

- CCPEHA will conduct another health consultation on the southern portion of the Facility Parcel at the Hamilton Sundstrand site.

- 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.

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Tables and Figures

Table 1. Hamilton Sundstrand Subsurface Soil Data Summary and Contaminant of Potential Concern Selection

Contaminant	Minimum (in µg/kg)	Maximum (in µg/kg)	Mean (in µg/kg)	Median (in µg/kg)	*n*	Detection Frequency	Comparison Value (in µg/kg)	CV Source	COPC?
Acetone	5.90E+00	8.90E+03	7.46E+02	2.15E+01	76	36.8%	5.00E+07	ATSDR Child RMEG	No
Aluminum	2.99E+06	2.31E+07	1.25E+08	1.03E+07	5	100.0%	5.00E+07	ATSDR Child RMEG	No
Antimony	6.60E+02	1.80E+03	1.31E+03	1.40E+03	41	19.5%	2.00E+04	ATSDR Child RMEG	No
Arsenic	8.30E+02	2.88E+04	5.19E+03	3.70E+03	44	100.0%	3.90E+02	EPA RSL	Yes
Barium	7.30E+04	2.14E+06	2.84E+05	1.76E+05	41	100.0%	1.00E+07	ATSDR Child cEMEG	No
Benzene	1.90E+02	7.20E+03	1.89E+03	9.80E+02	80	7.5%	1.10E+03	EPA RSL	Yes
Beryllium	2.40E+02	1.10E+03	7.02E+02	7.30E+02	41	80.5%	1.00E+05	ATSDR Child cEMEG	No
Bis(2-ethylhexyl)phthalate	2.90E+01	3.30E+03	6.26E+02	7.40E+01	23	47.8%	3.50E+04	EPA RSL	No
Bromomethane	8.40E-01	8.40E-01	N/a	N/a	76	2.6%	7.30E+03	ATSDR Child RMEG	No
2-Butanone (MEK)	1.80E+00	1.60E+03	1.30E+02	6.90E+00	76	25.0%	2.80E+07	ATSDR Child RMEG	No
Butyl Benzyl phthalate	2.40E+01	5.00E+01	3.93E+01	4.40E+01	21	14.3%	2.60E+05	EPA RSL	No
Cadmium	5.80E+01	4.80E+02	1.38E+02	8.40E+01	41	24.4%	5.00E+03	ATSDR Child	No

								cEMEG	
Carbon disulfide	1.60E+00	2.30E+00	N/a	N/a	73	2.7%	8.20E+05	EPA RSL	No
Chlorobenzene	2.50E+00	2.50E+00	N/a	N/a	76	1.3%	2.90E+05	EPA RSL	No
Chloromethane	8.50E-01	1.10E+00	9.50E-01	9.60E-01	76	6.6%	1.20E+05	EPA RSL	No
4-Chloro-3-Methylphenol	8.30E+02	1.60E+03	1.22E+03	1.22E+03	22	8.3%	6.10E+06	EPA RSL	No
Chromium	2.00E+03	2.01E+04	1.10E+04	1.06E+04	41	100.0%	2.90E+02	EPA RSL	Yes
Cobalt	1.30E+03	1.05E+04	5.98E+03	6.20E+03	41	100.0%	2.30E+04	EPA RSL	No
Copper	4.40E+03	2.78E+04	1.15E+04	1.12E+04	41	100.0%	5.00E+05	ATSDR Child iEMEG	No
1,4-Dichlorobenzene	2.40E+00	2.40E+00	N/a	N/a	76	1.3%	2.40E+03	EPA RSL	No
1,1-Dichloroethane	5.10E-01	5.90E+03	3.64E+02	7.60E+00	76	46.1%	3.30E+03	EPA RSL	Yes
1,1-Dichloroethene	6.90E-01	2.30E+03	2.72E+02	4.90E+00	76	22.4%	2.40E+05	EPA RSL	No
cis-1,2-Dichloroethene	6.80E-01	2.70E+04	2.42E+03	4.70E+01	55	45.4%	7.80E+05	EPA RSL	No
1,2-Dichloroethene (total)	7.50E-01	2.70E+04	2.38E+03	5.30E+01	76	34.2%	7.00E+05	EPA RSL	No
trans-1,2-Dichloroethene	9.30E-01	9.30E-01	N/a	N/a	55	1.8%	1.50E+05	EPA RSL	No
Di-n-butyl phthalate	4.40E+01	4.40E+01	N/a	N/a	21	4.8%	6.10E+06	EPA RSL	No
1,4-Dioxane	1.10E+02	8.30E+02	3.15E+02	1.60E+02	4	100.0%	4.40E+04	EPA RSL	No
Ethylbenzene	1.20E+00	6.10E+04	1.20E+04	7.60E+03	80	18.8%	5.40E+03	EPA RSL	Yes
Fluorene	6.30E+02	6.30E+02	N/a	N/a	24	4.2%	2.00E+06	ATSDR Child RMEG	No
Iron	5.34E+06	2.27E+07	1.41E+07	1.18E+07	5	100.0%	5.50E+07	EPA RSL	No
Isopropylbenzene	9.80E-01	1.00E+04	2.82E+03	3.40E+03	55	20.0%	2.10E+06	EPA RSL	No
Lead	3.40E+03	1.78E+04	1.01E+04	9.90E+03	41	100.0%	4.00E+05	EPA RSL	No
Manganese	2.16E+05	4.71E+05	3.21E+05	2.97E+05	5	100.0%	1.80E+06	EPA RSL	No
Mercury	1.70E+01	2.80E+01	N/a	N/a	14	14.3%	2.30E+04	EPA RSL	No
Methacrylonitrile	7.80E+01	7.80E+01	N/a	N/a	52	1.9%	3.20E+03	EPA RSL	No
Methyl methacrylate	9.00E+00	9.00E+00	N/a	N/a	52	1.9%	4.80E+06	EPA RSL	No
Methylene chloride	6.80E+00	1.70E+03	4.20E+02	8.20E+00	76	9.2%	1.10E+04	EPA RSL	No
2-Methylnaphthalene	2.00E+02	2.40E+03	N/a	N/a	24	8.3%	2.00E+05	ATSDR Child	No

								RMEG	
4-Methyl-2-pentanone	1.80E+02	1.80E+02	N/a	N/a	76	1.3%	5.30E+06	EPA RSL	No
Mineral Spirits	7.70E+05	1.30E+07	N/a	N/a	21	9.5%	NA	NA	No
Naphthalene	1.20E+02	5.60E+04	1.83E+04	1.25E+04	79	7.6%	3.60E+03	EPA RSL	Yes
Nickel	3.70E+03	1.84E+04	9.81E+03	9.50E+03	41	100.0%	1.00E+06	ATSDR Child RMEG	No
Nitrate	8.80E+02	1.20E+03	N/a	N/a	3	66.7%	8.00E+07	ATSDR Child RMEG	No
PCB 1242	5.60E+01	8.00E+02	N/a	N/a	31	6.4%	2.20E+02	EPA RSL	Yes
PCB 1248	3.40E+01	3.50E+04	8.80E+03	8.30E+01	31	12.9%	2.20E+02	EPA RSL	Yes
PCB 1254	4.80E+01	1.20E+02	N/a	N/a	31	6.4%	2.20E+02	EPA RSL	No
PCB 1260	4.00E+01	4.00E+01	N/a	N/a	31	3.2%	2.20E+02	EPA RSL	No
Total PCBs	9.60E+01	1.10E+04	2.52E+03	2.20E+03	44	79.6%	2.20E+02	EPA RSL	Yes
n-Propylbenzene	4.20E+00	4.30E+04	9.35E+03	5.65E+03	55	21.8%	3.40E+06	EPA RSL	No
Selenium	3.90E+02	9.10E+02	6.25E+02	6.10E+02	41	36.6%	3.00E+05	ATSDR Child cEMEG	No
Silver	2.20E+02	3.80E+02	2.92E+02	2.70E+02	41	12.2%	3.00E+05	ATSDR Child cEMEG	No
Tetrachloroethene	4.20E-01	1.60E+05	1.17E+04	2.90E+02	79	50.6%	5.50E+02	EPA RSL	Yes
Thallium	4.00E+02	1.10E+03	7.21E+02	6.60E+02	41	17.1%	4.00E+03	ATSDR Child cEMEG	No
Tin	4.80E+02	3.70E+03	1.32E+03	1.15E+03	36	66.7%	2.00E+07	ATSDR Child iEMEG	No
Toluene	1.10E+00	6.70E+04	1.61E+04	5.30E+03	80	18.8%	4.00E+06	ATSDR Child RMEG	No
1,2,4-Trichlorobenzene	1.10E+02	1.30E+03	N/a	N/a	76	2.6%	2.20E+04	EPA RSL	No
1,1,2-Trichloroethane	9.10E-01	1.30E+01	7.10E+00	7.40E+00	76	4.0%	1.10E+03	EPA RSL	No

Trichloroethene	8.10E-01	6.20E+04	3.83E+03	7.90E+00	76	43.4%	2.80E+03	EPA RSL	Yes
1,2,4-Trimethylbenzene	5.30E-01	2.60E+05	4.17E+04	7.15E+03	55	36.4%	6.20E+04	EPA RSL	Yes
1,3,5-Trimethylbenzene	9.60E+00	8.80E+04	2.33E+04	7.20E+03	55	23.6%	7.80E+05	EPA RSL	No
Vanadium	8.70E+03	4.20E+04	2.57E+04	2.52E+04	41	100.0%	2.00E+05	ATSDR Child iEMEG	No
m&p-Xylene	1.60E+01	2.90E+05	6.35E+04	3.30E+04	55	23.6%	3.40E+06	EPA RSL	No
o-Xylene	1.20E+01	1.20E+05	2.58E+04	1.20E+04	55	23.6%	3.80E+06	EPA RSL	No
Xylenes (total)	1.20E+00	4.30E+05	6.61E+04	3.00E+03	81	27.2%	6.30E+05	EPA RSL	No
Zinc	1.61E+04	7.34E+04	4.05E+04	3.91E+04	41	100.0%	2.00E+07	ATSDR Child RMEG	No

Note: Contaminants of Potential Concern (COPCs) are selected by comparing the maximum detected concentration with the screening value.

- EPA RSL= Environmental Protection Agency's Regional Screening Level is based on EPA methodology. Available at http://www.epa.gov/reg3hwmd/risk/human/rbconcentration_table/Generic_Tables/index.htm
- cEMEG = Chronic Environmental Media Evaluation Guide
- iEMEG = Intermediate Environmental Media Evaluation Guide
- RMEG = Reference Dose Media Evaluation Guide

Table 4. Non-cancer Hazard Quotients of Incidental Soil Ingestion at the Hamilton Sundstrand Site

Area	Contaminant of Potential Concern	Residential Children Non-cancer Hazard Quotients	Residential Adults Non-cancer Hazard Quotients
Facility Parcel (North Portion)	Arsenic	3.73E-01	4.00E-02
	Benzene	1.57E-03	1.68E-04
	Chromium	5.11E-02	5.48E-03
	1,1-Dichloroethane	4.78E-05	5.12E-06
	Ethylbenzene	5.09E-04	5.45E-05
	Naphthalene	2.69E-03	2.88E-04
	Tetrachloroethene	3.12E-02	3.34E-03
	Trichloroethene	3.41E-01	3.65E-05

Notes: Hazard Quotients are simply the estimated exposure dose for non-cancer health effects divided by the applicable health-based guideline. Hazard Quotients less than 1 indicate that the estimated dose is below the health-based guideline. Non-cancer toxicity values are not available for all PCBs. The health-based guidelines for TCE are based on the EPA NCEA value of 3.0E-04 mg/kg-day^{-1}, which has been withdrawn.

Table 5. Non-cancer Hazard Quotients of Dermal Contact with Soil at the Hamilton Sundstrand Site

Area	Contaminant of Potential Concern	Residential Children Non-cancer Hazard Quotients	Residential Adults Non-cancer Hazard Quotients
Facility Parcel (North Portion)	Arsenic	3.14E-02	4.79E-03
	Naphthalene	9.80E-04	1.50E-04

Notes: Hazard Quotients are simply the estimated exposure dose for non-cancer health effects divided by the applicable health-based guideline. Hazard Quotients less than 1 indicate that the estimated dose is below the health-based guideline.

Table 7. Theoretical Cancer Risks of Incidental Soil Ingestion at the Hamilton Sundstrand Site

Area	Contaminant of Potential Concern	Residential Age-adjusted Cancer Risks
Facility Parcel (North Portion)	Arsenic	2.06E-05
	Benzene	4.24E-08
	Chromium	9.39E-06
	1,1-Dichloroethane	6.68E-09
	Ethylbenzene	6.85E-08
	PCB 1242	9.27E-07
	PCB 1248	4.35E-05
	Total PCBs	1.76E-05
	Tetrachloroethene	2.06E-05
	Trichloroethene	7.38E-08
	Combined Ingestion Theoretical Cancer Risk*	**9.52E-05**

Notes: Acceptable Cancer Risk Range is 1.00E-06 (low-end) to 1.00E-04 (high-end).
* Includes PCBs 1248 and 1242 and not total PCBs risks because total PCBs were only analyzed for in one sampling event in 1987. After it was discovered that PCBs were present, the remaining soil samples were analyzed for PCB isomers.

Table 8. Theoretical Cancer Risks of Dermal Contact with Soil at the Hamilton Sundstrand Site

Area	Contaminant of Potential Concern	Residential Age-adjusted Cancer Risks
Facility Parcel (North Portion)	Arsenic	1.94E-06
	PCB 1242	4.09E-07
	PCB 1248	1.92E-05
	Total PCBs	7.77E-06
	Combined Dermal Theoretical Cancer Risk*	**2.15E-05**

Notes: Acceptable Cancer Risk Range is 1.00E-06 (low-end) to 1.00E-04 (high-end).
* Includes PCBs 1248 and 1242 and not total PCBs risks because total PCBs were only analyzed for in one sampling event in 1987. After it was discovered that PCBs were present, the remaining soil samples were analyzed for PCB isomers.

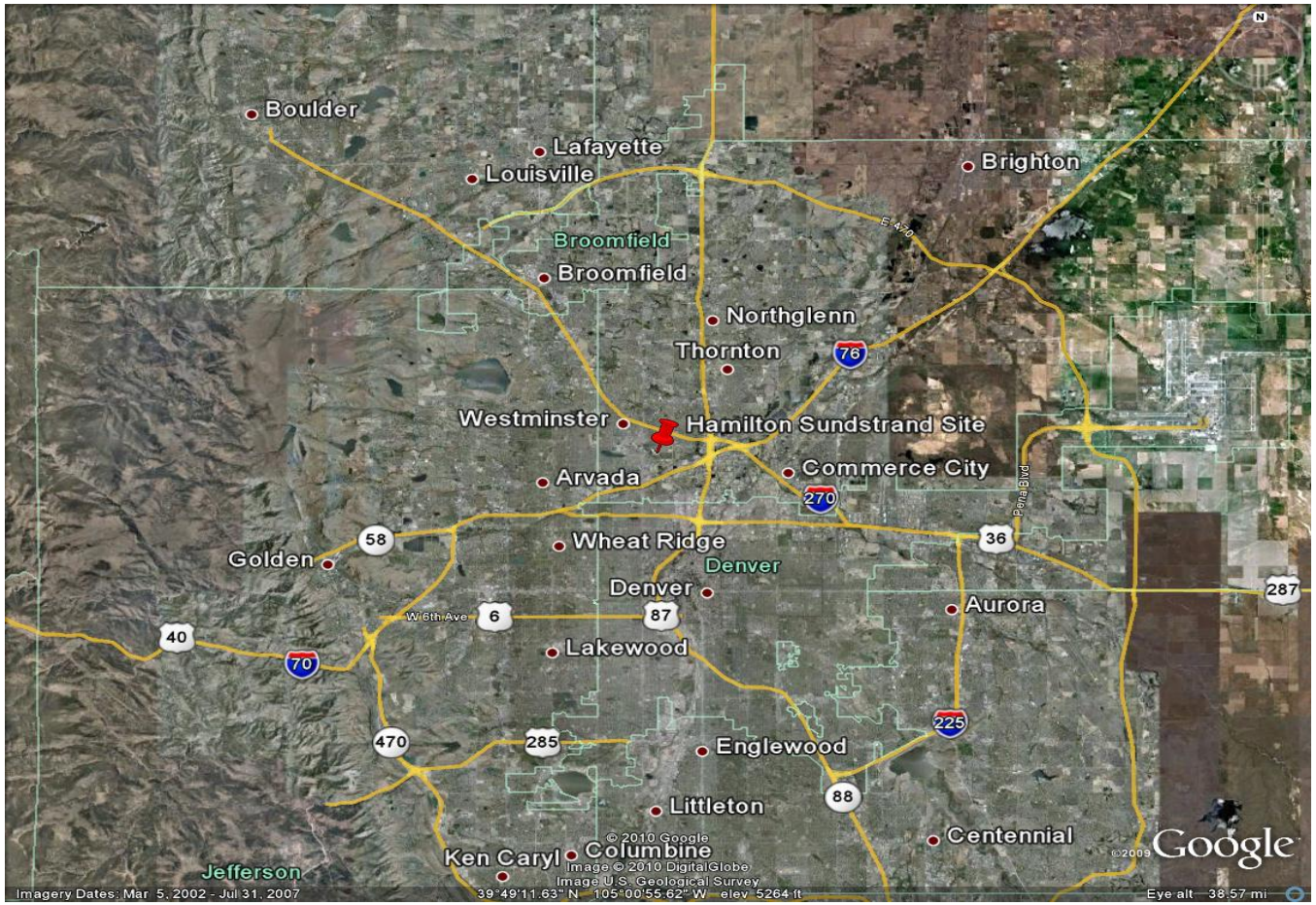
Table 9. Combined Theoretical Cancer Risks from Incidental Ingestion and Dermal Contact with Soil at the Hamilton Sundstrand Site

Area	Contaminant of Potential Concern	Residential Age-adjusted Cancer Risks from Incidental Soil Ingestion	Residential Age-adjusted Cancer Risks from Dermal Contact with Soil	Cumulative Residential Age-adjusted Cancer Risks from dermal and ingestion Exposure
Facility Parcel (North Portion)	Arsenic	2.06E-05	1.94E-06	2.25E-05
	Benzene	4.24E-08	N/a	4.24E-08
	Chromium	9.39E-06	N/a	9.39E-06
	1,1-Dichloroethane	6.68E-09	N/a	6.68E-09
	Ethylbenzene	6.85E-08	N/a	6.85E-08
	PCB 1242	9.27E-07	4.09E-07	1.34E-06
	PCB 1248	4.35E-05	1.92E-05	6.27E-05
	Total PCBs	1.76E-05	7.77E-06	2.54E-05
	Tetrachloroethene	2.06E-05	N/a	2.06E-05
	Trichloroethene	7.38E-08	N/a	7.38E-08
	Total Cancer Risks*	**9.52E-05**	**2.15E-05**	**1.17E-04**

Notes: Acceptable Cancer Risk Range is 1.00E-06 (low-end) to 1.00E-04 (high-end).
N/a = Not Applicable
* Includes PCBs 1248 and 1242 and not total PCBs risks because total PCBs were only analyzed for in one sampling event in 1987. After it was discovered that PCBs were present, the remaining soil samples were analyzed for PCB isomers.

Figures

Figure 1. Hamilton Sundstrand Site Location Map



SOURCE: Google Earth

Figure 2. Hamilton Sundstrand Parcel Location Map

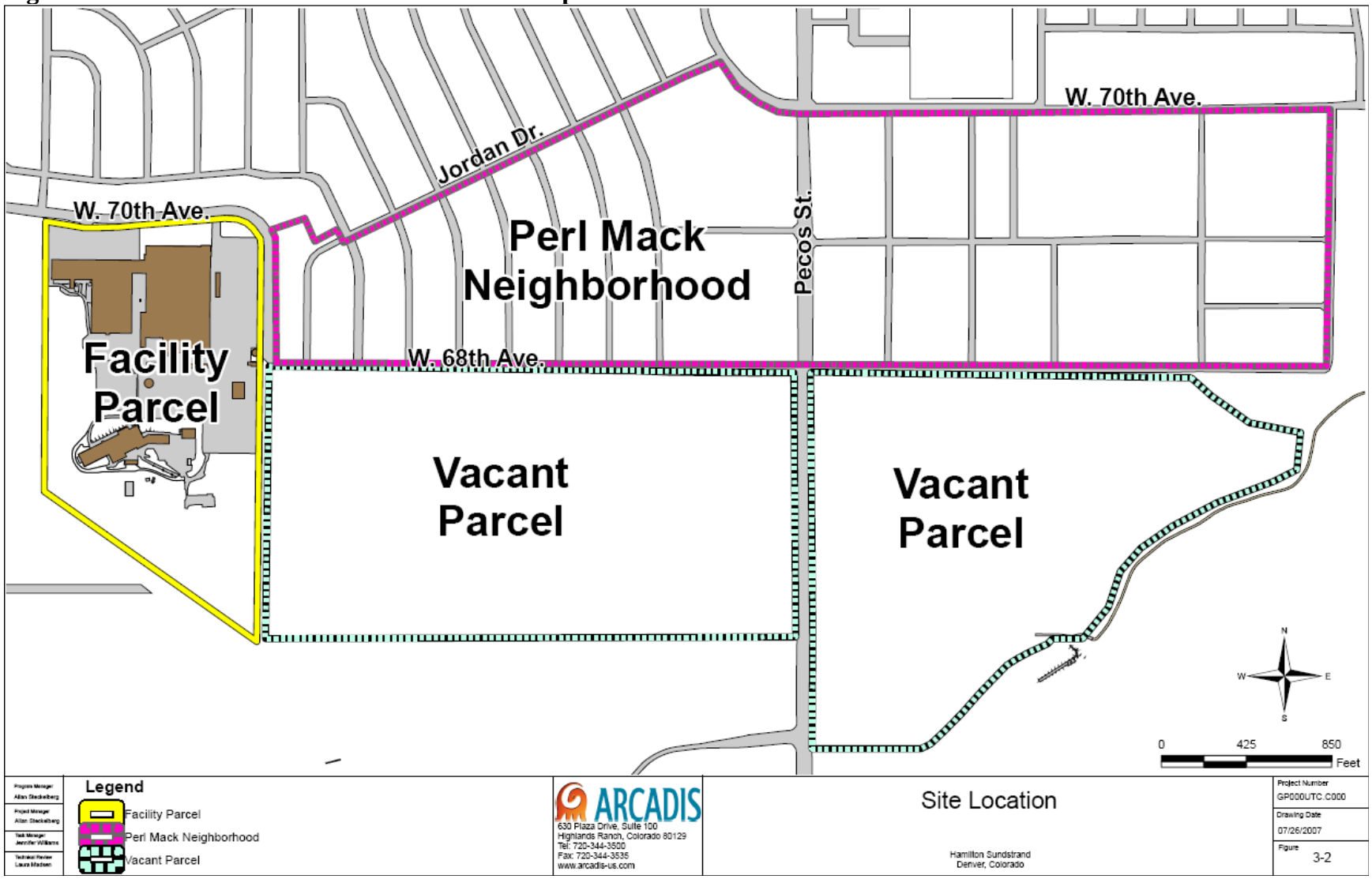


Figure 3. Hamilton Sundstrand Soil Sampling Location Map

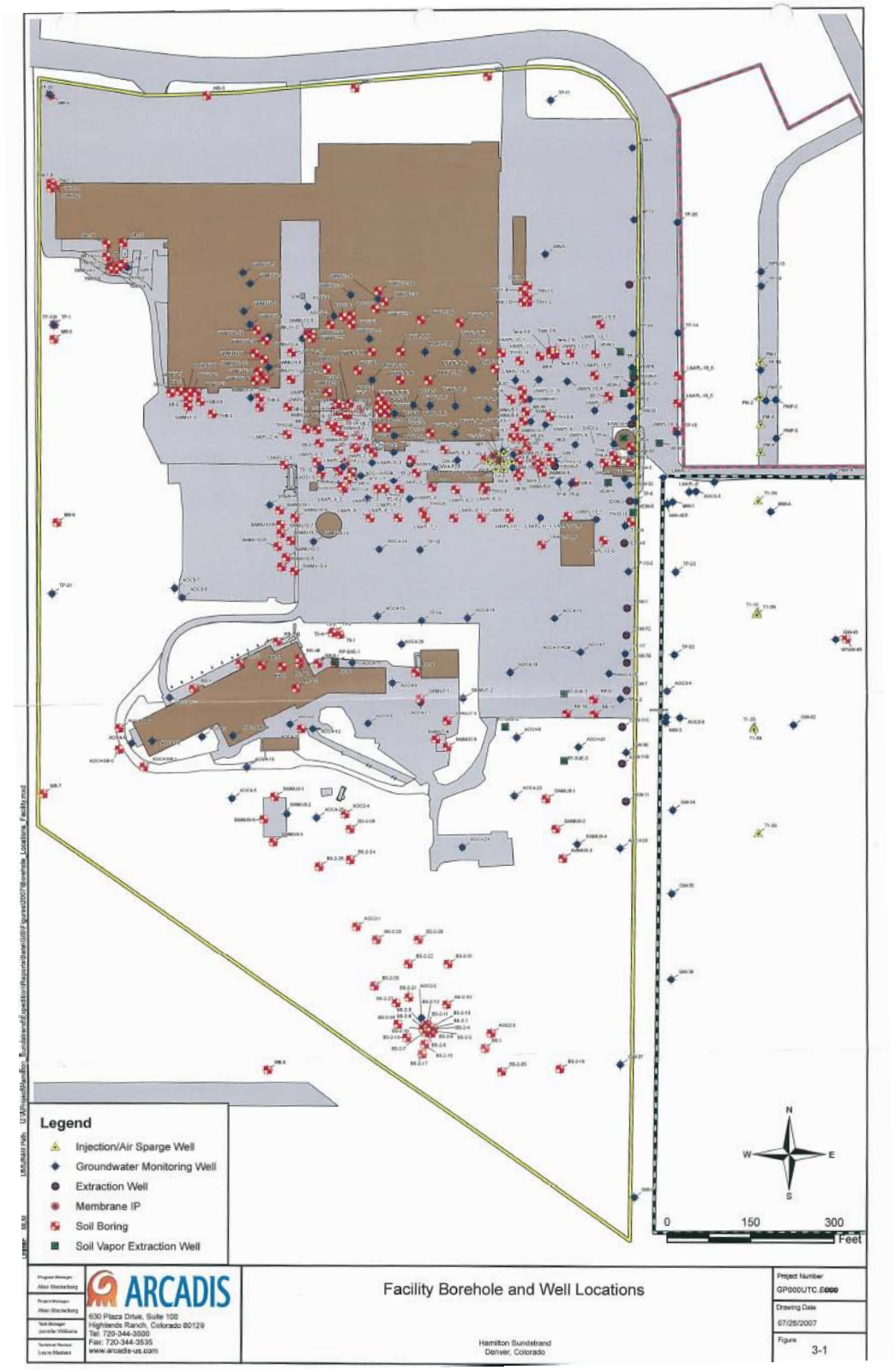
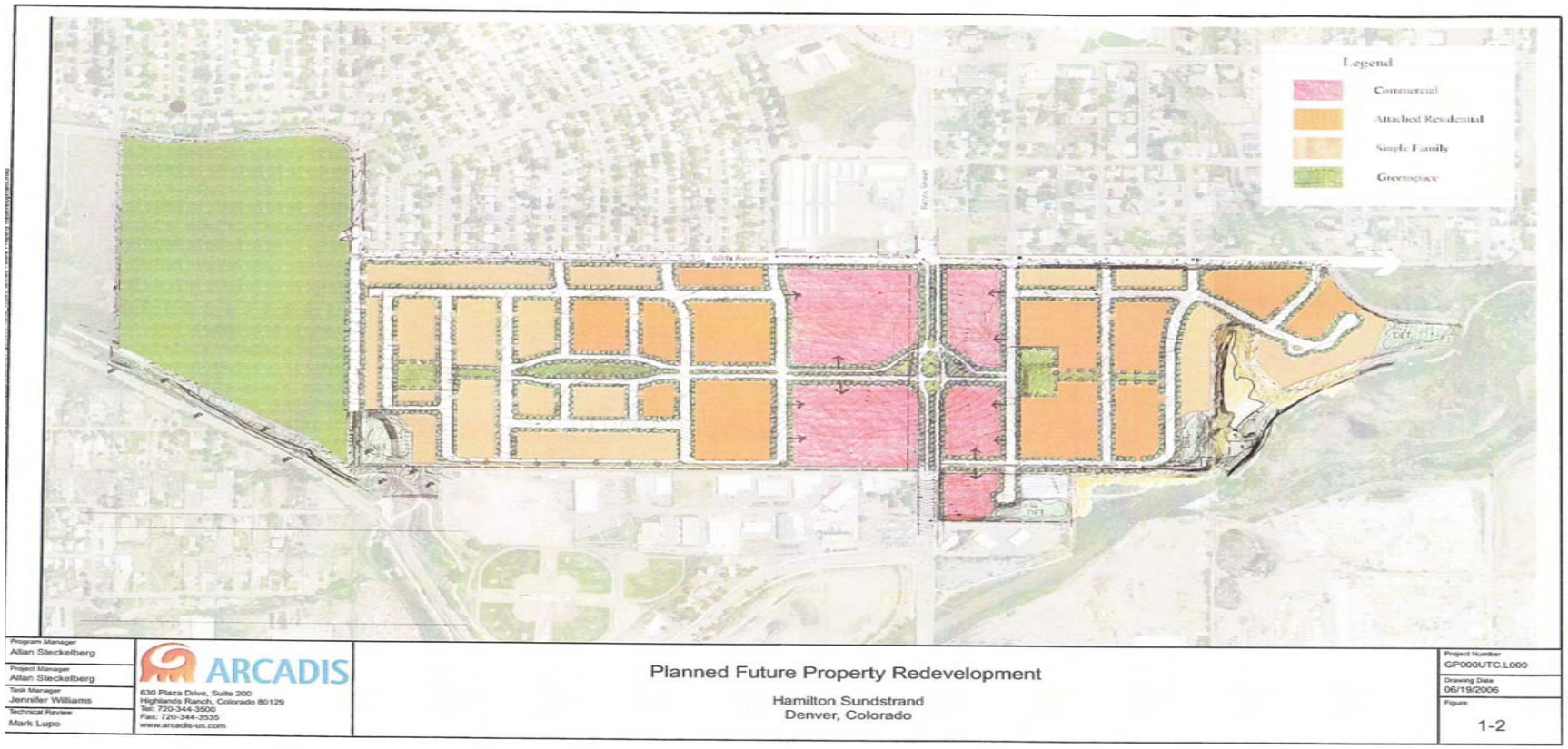


Figure 4. Hamilton Sundstrand Future Land-Use Designations
GreemN



NOTES:

- Green = Greenspace, Tan = Single Family, Orange = Attached Residential, Pink = Commercial

Appendices

Appendix A. Additional Exposure Assessment Information

The first step to determine if adverse health effects are likely to occur from exposure to contamination found 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) since the contaminants with concentrations below the CV are not likely to result in adverse health effects. Estimating the exposure dose requires assumptions to 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. 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 the site exposures.

Two primary receptors were identified in this evaluation that are likely to come into contact with site-related contamination in the future, child and adult residents. The major exposure factors used are listed below in Table A1.

Table A1. Exposure Assumptions

Receptor	Body Weight (BW)	Exposure Frequency (F)	Exposure Duration (ED)	Soil Ingestion Rate* (IRS)	Soil Adherence Factor** (AF)	Skin Surface Area** (SA)	Non-cancer Averaging Time (AT_{NC})	Cancer Averaging Time (AT_C)	Conversion Factor (CF)
Child Residents	15 kg.	350 days per year	6 years	200 mg. per day	0.2 mg/cm^2-ev	2800 cm^2	10950 days	25550 days	10^{-9} kg/µg
Adult Residents	70 kg.	350 days per year	30 year (non-cancer) 24 years (cancer)	100 mg. per day	0.07 mg/cm^2-ev	5700 cm^2	10950 days	25550 days	10^{-9} kg/µg

Notes:
*Age-adjusted soil ingestion rate (IRS_{adj}) equals 114.3 mg-yr./kg, based on the exposure duration of 6 years as a child and 24 years as an adult
**Age-adjusted dermal exposure factor (SFS_{adj}) 360 mg-yr/kg-event (EPA RAGS, Part E 2004)
$cm.^2$ = square centimeters
kg. = kilogram
mg. = milligram
µg. = microgram

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

COPC	Dermal Absorption Fraction (ABS_d)
Arsenic	3.00E-02
Naphthalene	1.30E-01
PCB 1242	1.40E-01
PCB 1248	1.40E-01
Total PCBs	1.40E-01

Another critical component of the exposure dose estimation is the concentrations of chemicals that individuals are likely to be exposed to in a particular medium or the Exposure Point Concentration (EPC). The EPA has established guidelines for determining the EPC. In Region 8, if there are less than 10 samples available for a contaminant, the maximum detected concentration is used as the EPC since very little is known about the actual concentration in a particular medium and area. In situations where there are more than 10 samples for an analyte, the available data is inserted into a statistical software package designed to calculate EPCs called ProUCL. Generally speaking, the resulting EPC is the 95% Upper Confidence Limit (UCL) on the mean (average) concentration assuming a normal distribution of the data. The EPCs used in this evaluation are presented in Table A2 below along with the method used to determine the value.

Table A3. Soil COPC Exposure Point Concentrations (μg /kg)

Area of Investigation	Receptor	Contaminant of Potential Concern	Exposure Point Concentration* (μg/kg)
Hamilton Sundstrand Facility Parcel (North Portion)	Future Child and Adult Residents	Arsenic	8.76E+03
		Benzene	4.92E+02
		Chromium	1.20E+04
		1,1-Dichloroethane	7.48E+02
		Ethylbenzene	3.98E+03
		Naphthalene	4.21E+03
		PCB 1242	2.96E+02
		PCB 1248	1.39E+04
		Total PCBs	5.63E+03
		Tetrachloroethene	2.44E+04
		Trichloroethene	7.99E+03
		1,2,4-Trimethylbenzene	2.57E+04

* ProUCL 4.0 recommended statistical method used to calculate EPC

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.

Non-Cancer Surface Soil Ingestion Dose

$$\text{Non-Cancer Dose} = (C_s * IRS * CF * EF) / BW$$

Where: $EF = (F * ED) / AT_{NC}$

C_s = Concentration of Contaminant in Soil (µg/kg)
EF = Exposure Factor
See Table A1 for additional details on exposure assumptions

Age-Adjusted Soil Ingestion Cancer Dose

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

Non-Cancer Dermal Absorbed Dose

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

$$\text{DAD (mg/kg-day)} = \frac{DAev * F * ED * SA}{BW * AT_{NC}}$$

DA event = Dermal Absorbed per event (mg/cm^2-event)
See Table A1 for additional details on exposure assumptions

Age-Adjusted Cancer Dermal Absorbed Dose

$$\text{DAD (mg/kg-day)} = \frac{C_s * CF * ABS_d * SFS_{adj} * F}{C}$$

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Table A4. Incidental Soil Ingestion Non-cancer Exposure Dose Estimations

COPCs	Child Ingestion Dose (mg/kg-day)	Adult Ingestion Dose (mg/kg-day)	Health-based Guideline (mg/kg-day)
Arsenic	1.12E-04	1.20E-05	3.00E-04
Benzene	6.29E-06	6.74E-07	4.00E-03
Chromium	1.53E-04	1.64E-05	3.00E-03
1,1-Dichloroethane	9.56E-06	1.02E-06	2.00E-01
Ethylbenzene	5.09E-05	5.45E-06	1.00E-01
Naphthalene	5.38E-05	5.77E-06	2.00E-02
PCB 1242	3.78E-06	4.05E-07	NA
PCB 1248	1.78E-04	1.90E-05	NA
Total PCBs	7.20E-05	7.71E-06	NA
Tetrachloroethene	3.12E-04	3.34E-05	1.00E-02
Trichloroethene	1.02E-04	1.09E-05	3.00E-04
1,2,4-Trimethylbenzene	3.29E-04	3.52E-05	NA

Table A5. Dermal Non-cancer Exposure Dose Estimations

COPC	Dermal Absorbed Dose Child (mg/kg-day)	Dermal Absorbed Dose Adult (mg/kg-day)
Arsenic	9.41E-06	1.44E-06
Naphthalene	1.96E-05	2.99E-06

Table A6. Incidental Soil Ingestion Cancer Exposure Dose Estimations

COPC	Age-adjusted Dose (mg/kg-day)	Age-Adjusted Risk
Arsenic	1.37E-05	2.06E-05
Benzene	7.70E-07	4.24E-08
Chromium	1.88E-05	9.39E-06
1,1-Dichloroethane	1.17E-06	6.68E-09
Ethylbenzene	6.23E-06	6.85E-08
PCB 1242	4.63E-07	9.27E-07
PCB 1248	2.18E-05	4.35E-05
Total PCBs	8.82E-06	1.76E-05
Tetrachloroethene	3.82E-05	2.06E-05
Trichloroethene	1.25E-05	7.38E-08
All Ingestion Cancer Risk	NA	9.52E-05*

* Includes theoretical cancer risks of PCB 1242 and 1248. Combined risk does not include theoretical cancer risks from total PCBs.

Table A7. Dermal Cancer Exposure Dose Estimations

COPC	Age-Adjusted Dose (mg/kg-day)	Age-Adjusted Risk
Arsenic	1.30E-06	1.94E-06
PCB 1242	2.04E-07	4.09E-07
PCB 1248	9.60E-06	1.92E-05
Total PCBs	3.89E-06	7.77E-06
All Dermal Cancer Risk	NA	2.15E-05*

* Includes theoretical cancer risks of PCB 1242 and 1248. Combined risk does not include theoretical cancer risks from total PCBs.

Appendix B. Toxicological Evaluation

The basic objective of a toxicological evaluation is to identify what adverse health effects a chemical causes, and how the appearance of these adverse effects depends on dose. The toxic effects of a chemical also depend on the route of exposure (oral, inhalation, dermal), the duration of exposure (acute, subchronic, 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 Reference Dose (mg/kg-day)	Oral Slope Factor ($mg/kg\text{-}day^{-1}$)
Arsenic	3.00E-04	1.50E+00
Benzene	4.00E-03	5.50E-02
Chromium	3.00E-03	5.00E-01
1,1-Dichloroethane	2.00E-01	5.70E-03
Ethylbenzene	1.00E-01	1.10E-02
Naphthalene	2.00E-02	NA
PCB 1242	NA	2.00E+00
PCB 1248	NA	2.00E+00
Total PCBs	NA	2.00E+00
PCB 1254	2.00E-05	2.00E+00
Tetrachloroethene	1.00E-02	5.40E-01
Trichloroethene	4.00E-04	5.90E-03

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

CERTIFICATION

This Hamilton Sundstrand RCRA Site Health Consultation was prepared by the Colorado Department of Public Health and Environment 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. Editorial review was completed by the Cooperative Agreement partner.

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

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