Health Consultation

GOODMAN OIL SITE (2850 West Fletcher Street)
Soil and Indoor Air Contamination Evaluation & Health Consultation
BOISE, IDAHO

March 8, 2012

Prepared by

Idaho Department of Health and Welfare
Division of Public Health
Bureau of Community and Environmental Health
Under Cooperative Agreement with
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

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Foreword

This Public Health Consultation was supported in part by funds from the Comprehensive Environmental Response, Compensation, and Liability Act through a cooperative agreement with the Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services. It was completed in accordance with approved methodologies and procedures existing at the time the Public Health Consultation was initiated. Editorial review was completed by the cooperative agreement partner. This document has not been reviewed and cleared by ATSDR.

The Public Health Consultation is an approach used by the Agency for Toxics Substances and Disease Registry (ATSDR) and the Idaho Division of Public Health's Bureau of Community and Environmental Health (BCEH) to respond to requests from concerned residents for health information on hazardous substances in the environment. The health consultation process evaluates environmental sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health.

For more information about ATSDR, contact their Information Center at:
1-800-232-4636 or visit the agency's Home Page: http://www.atsdr.cdc.gov.

SUMMARY

INTRODUCTION

In Idaho, the Bureau of Community and Environmental Health (BCEH) serves the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent people from coming into contact with harmful toxic substances. The Goodman Oil Site in Boise, Idaho was used for unregulated dumping prior to the mid-1920s. From 1927 to 2009 the site was used for bulk petroleum sales, as a fleet maintenance facility, and as a commercial rock crushing, and landscaping yard. The property is currently owned by Goodman Oil Corporation and has been vacant since late 2009. The Idaho Department of Environmental Quality Brownfields Program provided funds to perform a Phase I Environmental Site Assessment (ESA) and a limited Phase II ESA to evaluate soil, soil vapor and groundwater impacts related to past use. This Public Health Consultation examines the levels of the contaminants found in soil and indoor air during these ESAs and whether or not the levels could harm the health of construction workers, trespassers and future users of the Site.

CONCLUSION 1

BCEH concludes that touching, breathing, or accidentally swallowing the contaminants found in the soil and dust at locations at the Goodman Oil Site in Boise is not expected to harm people’s health because the amount of the contaminants in the soil are below levels of health concern.

BASIS FOR DECISION

The levels of contaminants in soil at the Goodman Oil Site are considered low because they are below screening levels that are deemed safe. BCEH believes that any breathing of dust, contact with the soil or incidental ingestion (swallowing) of the soil is not expected to harm people’s health. While lead concentration in surface soil is elevated at the Site, currently there are no residents living at the Site and any exposure to the soils by trespassers would not occur on a regular basis.

CONCLUSION 2

BCEH concludes that breathing the air in the buildings where sub-slab soil vapor was monitored on the site is not expected to harm people’s health because the amounts of contaminants in the indoor air are below levels of health concern.

BASIS FOR DECISION

The levels of contaminants estimated to be found in indoor air are very low. There are no people living at the Site and any exposure to the property owners or trespassers would be very limited,

	further reducing potential risk.
NEXT STEPS	BCEH will communicate these findings to the Idaho Department of Environmental Quality (IDEQ) upon completion of this Public Health Consultation. BCEH will remain in contact with IDEQ to address any future developments at this site.
FOR MORE INFORMATION	If you have concerns about your health, you should contact your health care provider. You can also contact BCEH at 1-208-334-5929 or email bceh@dhw.idaho.gov and ask for information on site soils at Goodman Oil Site.

Purpose and Statement of Issues

The Bureau of Community and Environmental Health (BCEH), Division of Public Health, Idaho Department of Health and Welfare (IDHW) has a cooperative agreement with the Federal Agency for Toxic Substances and Disease Registry (ATSDR) to conduct public health assessments and consultations for sites in Idaho. This health consultation was done as part of this cooperative agreement. The public health consultation was initiated at the request of the Idaho Department of Environmental Quality (IDEQ) to further examine IDEQ findings concerning human health risk. BCEH agreed to review the environmental sampling data provided by IDEQ and write a public health consultation for the site. This report evaluates contaminants in soils and sub-slab soil vapor at the Goodman Oil Site, chemical concentrations, and the risk these chemicals could pose to people at the Site.

Background

Site Description

The Goodman Oil Site is located at 2850 West Fletcher Street in Boise, Idaho within Ada County (see Figure 1). The population of the metropolitan area is approximately 205,671. The Site is west of 27th Street, south of West Fairview Avenue, and north of the Interstate I-84 connector. The Site is bordered to the west by the Boise River and the Boise River Greenbelt walk/bike path, to the east by Midas Mufflers, to the south by the Symposium Bar and Boise City Fire Training Facility, and to the north by Treasure Valley RV Sales and US Bank. The current zoning for the area and the primary use of the land around the Goodman Oil Site is commercial.

Sources of Contamination

Historical land use of the Goodman Oil Site indicates three major activities: waste dumping; a vehicle storage/maintenance site with bulk fuels, lubricants, oil and automobile supplies (e.g., tires, batteries); and a gravel crushing/landscaping business. The age of the buildings and structures onsite suggest the presence of asbestos and lead-based paint. Vehicle emissions, and emissions such as those from commercial furnaces, wood burning, and burning of other materials for training purposes (i.e., Boise Fire Training) constitute other indirect sources of contamination for Goodman Oil Site.

Environmental Data

In early 2010 URS Corporation (URS) performed a Phase I Environmental Site Assessment (ESA), which identified petroleum and metal contaminants in the soil. As a result, a limited Phase II ESA was performed in May 2010. Results of the limited sampling of the Phase II ESA suggested lead contamination in surface soil and demonstrated the need for further testing to better define areas of contamination. As part of the Phase II ESA, URS also conducted an inspection and survey for asbestos containing materials and lead paint within the 5 buildings located at the Goodman Oil Site. In September 2010, IDEQ contracted with STRATA through the Brownfields Program to further quantify lead contamination and collect additional data for a risk assessment. The STRATA investigation was performed to assist in determining present or probable future risk to human health or the environment. The contaminants discussed in this health consultation were sampled at various locations by URS and STRATA. A list of all the compounds that were sampled at the Site is presented in Appendix A.

For the analysis of the environmental data BCEH used a conservative approach by calculating the geometric mean, 95% upper confidence limit (UCL), and average values depending on the number of detected values. For example BCEH used the geometric mean for soil lead values, 95% UCL was calculated for all other surface soil metals, and averages were used for the sub-slab soil vapor data. Data from the URS sampling event of May 2010 were used to analyze the results of polyaromatic hydrocarbons and volatile organic compounds in soil (Appendix B). A total of 19 subsurface soil samples (2-8.5 feet deep) including two sample replicates from different locations (Former Fuel Island, Former Warehouse, Vehicle Shop, Former Storage, Primary Transfer Area, Existing Tank, Former Home, and Former Vehicle Repair Shop) (Figure 2) were evaluated for 17 polyaromatic hydrocarbons and 9 semi-volatile compounds. A separate set of 10 surface soil samples were selected for analysis of polychlorinated biphenyls (7 Aroclors) from different locations across the Site (Appendix C).

Sub-surface and composite metal soil sampling data from STRATA and URS were available for analysis (Appendices D1, D2, and D3); however, only the surface soil sampling data were considered in this analysis because it constitutes a more likely exposure pathway. Samples from the STRATA sampling effort of September 2010 were collected using multi-incremental composite surficial soil sampling and discrete interval surface soil sampling. Composite samples were collected using 10 aliquot samples from 12 sites surrounding the location of the former home on the Site. Sample locations were laid out in the field approximately 50 feet long by 10 feet wide and located parallel by long axis to each side of the former home as well as stacked 3 deep away from the former home. Sample aliquots were randomly selected using coordinates generated using Microsoft Excel (STRATA, 2010). Composite surficial soil samples were collected using a 1-inch diameter soil probe with a liner from the surface to 6-inches in depth. Soil samples were analyzed by Environmental Science Corporation (ESC) Laboratory in Mt. Juliet, Tennessee.

A total of three sub-slab gas vapor samples were collected. Two were collected at the Vehicle Shop location and one from the Former Warehouse (Appendix E). A one-inch diameter hole was bored through the concrete slab and approximately 1-3 inches into underlying sediment at each location. Soil vapor sample points consisted of a 6-inch length of tubular stainless steel screen connected to flexible Teflon tubing lowered into each boring. Soil vapor samples were collected by attaching a 6-liter Summa canister with SIM-certified flow controllers at each point. A total of three soil vapor samples (2 samples and one replicate) at the Former Warehouse location were collected to a depth of 3 feet below ground surface. Soil vapor samples were analyzed by Air Toxics Ltd of Folsom, California for 16 volatile organic compounds. In this health consultation only sub-slab soil vapor data were included in the analysis.

It is important to point out that although groundwater sampling data were available; they were excluded from analysis of a potential health risk because of a lack of a complete exposure pathway from this source given the accessibility to treated water.

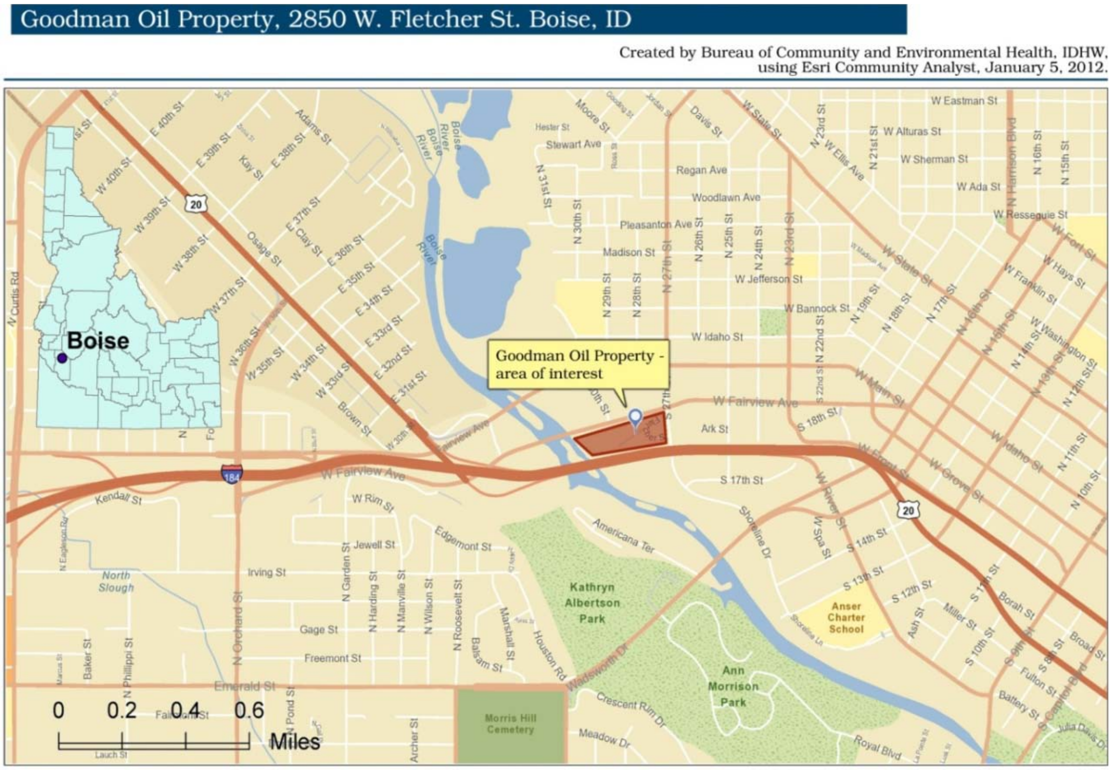

Figure 1: Goodman Oil Property, Boise, Idaho, Location Map

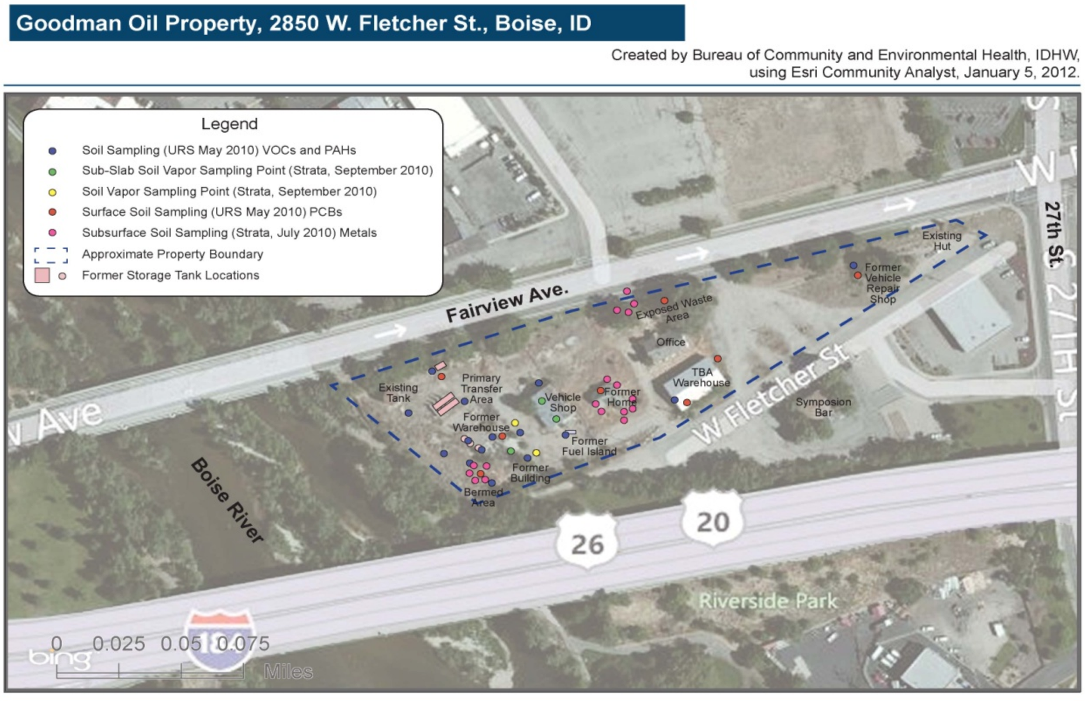

Figure 2: Sampling Sites location

Analysis

Risk Assessment Methodology

In order to evaluate public health issues related to soil and vapor intrusion contamination at Goodman Oil Site, BCEH followed a two-step methodology. First, BCEH obtained environmental soil and sub-slab soil vapor sampling data from IDEQ. To avoid underestimating possible exposure, 95% UCL values for all the soil metal data were calculated for each sampling site using the EPA Pro-UCL program. An exception was lead; given the very high and very low lead concentrations in surface soils, a geometric mean using the 12 available values was calculated. In the case of sub-slab soil vapor data, average values were calculated instead of the 95% UCL given the small number of detected values (i.e., less than 8). EPA's recommended Screening-Level Johnson and Ettinger Model [2] was used with site-specific sub-slab soil vapor concentrations to predict estimated indoor air concentrations. Second, BCEH used health-based comparison values (CVs) to screen out contaminants unlikely to cause adverse health effects. For the remaining contaminants that exceeded their health-based CVs, BCEH made further determinations to evaluate whether the level of environmental contamination and exposure indicated an elevated public health risk.

*CVs **are not** thresholds for adverse health effects*. That is, CVs do not represent a level at which a person exposed to a contaminant level above the CV will likely suffer health consequences. This is because CVs are typically set at levels many times lower than the levels at which health effects were observed in experimental animals or in human epidemiologic studies. CVs are also deemed protective because they include safety factors that account for more sensitive populations, such as young children.

For non-cancer risk CVs, BCEH used ATSDR's Environmental Media Evaluation Guides (EMEGs) and Reference Dose Media Evaluation Guides (RMEGs) when available. When these CVs were not available, BCEH used EPA Regions 3, 6, and 9 Regional Screening Levels (RSLs) and other health-based standards as needed. The non-cancer CVs are used to screen contaminants to determine if they are likely to pose a health concern. If the concentration of a contaminant in soil is at or below the CV for that contaminant, then it is very unlikely that the exposure to the contaminant over a lifetime will lead to adverse non-carcinogenic (non-cancer) health effects.

If a contaminant is above its CV, then further evaluation is needed. To further evaluate the possible health effect of exposure to a contaminant, a dose is calculated and compared to known doses, such as ATSDR's Minimum Risk Level (MRL), that have been set to be protective. The soil ingestion rate used in this health consultation to determine dose for adults in a non-cancer chronic exposure situation is calculated using values from the EPA's Exposure Factors Handbook: 2011 Edition [1] and it is intended to represent soil and dust exposure to the general adult population. The body weight assumed was 70 kilograms (kg) for an average adult. Once calculated, if a dose is above an ATSDR MRL or an EPA Reference Dose (RfD), a further comparison is made to determine if the estimated dose is comparable to either the No Observable Adverse Effect Level (NOAEL) or the Lowest Observable Adverse Effect Level (LOAEL). The NOAEL is the dose at which no health effects have been documented from exposure to the substance and the LOAEL is the lowest dose at which any health effect has been documented in health studies.

For cancer risk CVs, BCEH used ATSDR's Cancer Risk Evaluation Guides (CREGs) and EPA Regions 3, 6, and 9 Regional Screening Levels (RSLs). These cancer RSLs represent a harmonizing of the screening levels developed by EPA Regions 3, 6, and 9 and, along with the CREGs are estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million (10^{-6}) people over the course of a lifetime (70 years). EPA cancer slope factors (CSFs) or Inhalation Unit Risks from EPA Regions 3, 6, and 9 RSLs were used to calculate the excess cancer risk and the modified cancer risk for the vapor intrusion pathway.

Again, if the concentration of a chemical is less than its CV, it is unlikely that exposure would result in adverse health effects, and further evaluation of exposures to that chemical is not necessary. If the concentration of a chemical exceeds a CV, adverse health effects from exposure are not automatically expected, but potential exposures to that chemical from the site should be further evaluated. The cancer soil ingestion rate used in this report is intended to represent soil and dust exposure to the general adult population. For the calculation of the inhalation dose, BCEH used the default value of 15.2 m^3/day (males 19-65+ years) recommended by ATSDR. The body weight assumed is 70 kg for an average adult. To make exposures scenarios realistic, BCEH used two potential exposure scenarios (trespasser and construction worker) to calculate the theoretical cancer risk of the contaminants that exceeded the CV cancer value.

Polycyclic Aromatic Hydrocarbons

Polycyclic aromatic hydrocarbons (PAHs) comprise more than 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances. PAHs are usually found as a mixture containing two or more of these compounds, such as soot.

PAHs level of toxicity to humans is directly correlated to a PAH's molecular weight. For example, high molecular weight PAHs may cause cancer in humans while low molecular weight PAHs may not cause cancer. Benzo(a)pyrene (BaP) has been well characterized as the most carcinogenic of the group [3]. In this Health Consultation, BaP was used as a surrogate to assess potential human risks associated with PAHs in soils. To address the total effect of PAHs, individual PAHs that had the highest concentration and detected values at the Site were converted to BaP toxic equivalent (TEQ) values using established toxic equivalency factors (TEFs) (Appendices F1 and F2). BCEH used the two exposure scenarios (trespasser and construction worker) and the BaP TEQ concentration to estimate an exposure dose (Appendix G), which then was compared to an intermediate no observable adverse effect level (NOAEL). The theoretical excess life time cancer risk was calculated using the exposure doses of the two exposure scenarios and the cancer slope factor (See Appendix G).

Exposure Pathways

To determine whether people are, were, or could be exposed in the future to the contaminants found on the Site, the environmental and human components that lead to exposure were evaluated. An exposure pathway is composed of: 1) a source of contamination; 2) a movement of the contamination through air, water, and/or soil; 3) human activity, such as construction work or trespassing where the contamination exists; 4) human contact with the contaminant through touching, breathing, swallowing and/or drinking; and, 5) a population that can potentially be exposed. If all five elements are present, an exposure pathway is said to exist.

At the Goodman Oil Site, a complete exposure pathway exists for soil exposure. In the past workers were exposed to contaminated soil surrounding the former and current buildings on-site. Since 2009, the Site has been unoccupied. In 2010, contaminants were found in the soils, soil vapor, and sub-slab samples in different locations within the Site. It is likely that trespassers, future construction workers, and those using the area of the Site adjacent to the Boise River greenbelt may be exposed to the contaminants during dry weather and windy conditions. Exposure is also likely to occur with hand to mouth incidental exposure. BCEH examined the vapor intrusion pathway using sub-slab data and found that trespassers or visitors may be exposed through inhalation if they were inside the buildings where samples were taken. Given the location and current use of the site and the presence of two busy streets, it is less likely that children would be exposed to soil contaminants; however, trespassers using the abandoned buildings as a shelter, and future construction workers will come into contact with the soils and the vapor intrusion.

Discussion

For this health consultation BCEH limited its analyses to intermediate and chronic exposures at the Site. The presence of busy highways, the lack of residential areas and nearby playgrounds suggests there is no need for a pica child scenario (i.e., a child that eats non-food items such as dirt) at the Goodman Oil Site. Intermediate and chronic exposures to adults are potential exposure scenarios that were considered in the analyses and are discussed below.

Intermediate Exposure: Non-Cancer

Intermediate exposure CVs are used to determine if exposures to a substance for more than two weeks and up to a year may cause health problems. Lead was the only contaminant exceeding an intermediate CV (Table 1). The EPA's regional screening level for lead in residential soil is 400 mg/kg and was used as an intermediate CV. Laboratory results showed a range of 190 to 23,000 mg/kg lead in surface soil taken near the Former Home on the Site. Fifty-eight percent (7 of 12) of the composite samples tested (See Appendix D3) were higher than the CV of 400 mg/kg. For comparison purposes a geometric mean was calculated for lead in surface soil since it was more representative of the overall lead contamination at the site. The geometric mean for lead is 657 mg/kg and is greater than the residential screening value of 400 mg/kg. There are currently no reference doses (i.e., MRLs, NOAEL or LOAELs) for use in gauging lead effects on human health. This is because no research has shown that there is a safe level of lead exposure. The EPA blood lead prediction models (Integrated Exposure Uptake Biokinetic Model and the Adult Blood Lead Model) were not used in this case because there are no current residents at the Site. The Site is zoned as commercial so no current residential exposure is possible and the EPA blood lead models assume residential exposure scenarios. Also, any exposure to trespassers would be very limited and not of sufficient duration to use in the adult blood lead model. Due to the fact that there are no residents on site and the screening CV for lead was established to keep young children safe from harm while at home, BCEH does not believe that the Site poses a health risk to anyone under current site use. However, future development plans would need to consider the possible human health effects for exposure to lead prior to project start.

Table 1: Lead concentration in soils at Goodman Oil Site above non-cancer screening comparison values

Location	Metal	Concentration range in mg/kg	Concentration used for comparison mg/kg	Comparison Value (CV) non-cancer in mg/kg		Exceeds CV? Yes or No
				Chronic	Intermediate	
Former Home[1]	Lead	190-23,000	657[2]	NA	400[4]	Yes

1 = STRATA multi-increment sampling September 2010
2 = Geometric mean
4 = EPA's Regional Screening Level for residential soil

Chronic Exposure: Non-Cancer

Chronic exposure CVs are used to determine if exposures to a substance that occurs for a year or longer may cause health problems. All the metal 95% UCLs or geometric mean values from surface soil samples were below their non-cancer CV. Similarly, all the estimated indoor air values were below the intermediate or chronic non-cancer CVs (Table 2). Thus, BCEH believes that the levels of contaminants on the Site do not pose a cancer health risk to anyone.

Some of the contaminants lacked chronic CV values to use for screening to determine if more evaluation was needed. The contaminants without a chronic soil CV were: acenaphthylene, fluoranthene, fluorene, phenanthrene, 2-chlorophenanthere, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. All of these compounds are PAHs, so the analyses of their chronic toxic effects were covered by a TEQ approach which is discussed below. Other contaminants without a chronic CV were chromium and silver. The chromium UCL value is below total chromium geometric mean value in the United States (37 mg/kg) [4], and the silver UCL value is slightly above concentrations found in natural soils in the United States (0.3 mg/kg) [5] and thereby is not likely to cause any non-cancer health problems.

Chronic Exposure: Cancer

To determine if exposure to contaminants in the soil posed a cancer risk, BCEH compared the analytical results to cancer CVs. The theoretical cancer risk for arsenic found to be above its cancer CV is shown in Table 3 and the calculations are in Appendix G. The cancer CVs from ATSDR and EPA are based on the possibility of an individual getting cancer over a lifetime from chronic (long-term) exposure. For contaminants in soil, the 95% UCL was calculated with ProUCL software using sampling data from surface soil and the result was compared to soil cancer CVs. BCEH considered the two conservative exposure scenarios for the Former Home location that consisted of a duration of 8 hours a day, 5 days a week and 6 months on-site for one year (construction workers) and 3 weeks on-site for one year (trespassers) (Appendix G). Results indicate a possible 8 cancer exceedances in 100 million construction workers exposed and 1 cancer exceedance for 100 million trespassers exposed to the 95% UCL of arsenic detected at the Former Home location (Table 3). Since cancer is very common and the highest risk estimate for this estimated exposure is 8 excess cancers per 100 million people exposed, BCEH believes that the levels of contaminants in the soil at the Former Home location are not likely to increase the risk of developing cancer above the normal risk one has of developing cancer in his or her lifetime.

Table 2: Calculation of the Best Estimate Indoor Air Prediction Using the Screening-Level Johnson and Ettinger Model at Goodman Oil Site

Location	VOCs	Average Concentration (µg/m^3) in sub-slab	Best Estimated Concentration in indoor air (µg/m^3)	Model Output Best Estimate Cancer Excess	Non-Cancer CVs µg/m^3		Cancer CV µg/m^3	Exceeds Cancer-CV Yes or No?
					Intermediate	Chronic		
FW	1,1,1-Trichloroethane	*1.5	0.004	0	4,000[1]	NA	NA	No
VS	Benzene	1.63	0.004	$1x10^{-8}$	20[1]	10[1]	0.1[2]	No
VS	Toluene	7.25	0.019	0	5,200[3]	300[1]	NA	No
FW	1,1,1,2 Tetrachloroethane	*10	0.024	$7x10^{-8}$	NA	NA	0.1[2]	No
VS	Ethyl Benzene	1.37	0.003	$2x10^{-9}$	9,000[1]	300[1]	0.97[3]	No
VS	m,p-Xylene	16.98	0.039	0	3,000[1]	200[1]	NA	No

1 = ATSDR Chronic or Intermediate Environmental Media Evaluation Guide values (not differentiated in child or adult)
2 = ATSDR Cancer Risk Evaluation Guide (CREG)
3 = EPA Region 6 and Region 9 cancer risk-based Regional Screening Levels
* = Single values
NA = Not Available
FW = Former Warehouse
VS = Vehicle Shop

The cancer risk from vapor intrusion was evaluated using sub-slab soil vapor data inputted into the Johnson and Ettinger Model. The model's output provided an estimate of the indoor contaminant concentration which was then used to compare to their cancer CVs. All the estimated indoor air values were below either the intermediate or the chronic cancer CVs.

Toluene, 1,1,1-trichloroethane, and m,p-xylene are not considered carcinogenic and have no cancer CVs (Table 2). Since cancer is very common and the highest risk estimate for this estimated exposure through indoor air exposure at the Former Warehouse and Vehicle Shop locations is 7 cancers per 100 million people exposed, BCEH believes that the levels of contaminants in sub-slab at the Former Warehouse and Vehicle Shop are not likely to increase the risk of getting cancer above the normal risk one has of developing cancer in his or her lifetime. Therefore, BCEH has determined that the levels of 1,1,1-trichloroethane, benzene, toluene, 1,1,1,2-tetrachloroethane, ethylbenzene, and xylene in indoor air are unlikely to harm construction workers or trespassers at the Former Warehouse or Vehicle Shop locations on-site.

Laboratory analysis shows that the samples taken from the Former Warehouse had the highest levels of the polyaromatic hydrocarbons (PAHs). Results from the TEQ approach for PAHs showed a BaP TEQ of 0.8 mg /kg (Table 4 and Appendices F1 and F2), which exceeded the cancer CV value of 0.1 mg/kg. Using our two scenarios (construction worker and trespasser) and using the BaP TEQ of 0.8 mg/kg, the estimated exposure dose for a construction worker was 0.0000002 mg/kg/day and 0.000000003 mg/kg/day for a trespasser (Appendix G). NOAELs and LOAELs calculated using mice were the only comparative values found in the literature [6]. An intermediate NOAEL of 1.3 mg/kg/day was observed for mice exposed to BaP. The LOAEL (2.6 mg/kg/day) is based upon the appearance of gastric tumors [6]. The estimated exposure of PAHs using the TEQ approach for both construction workers and trespassers is several orders of magnitude below the NOAEL and LOAEL for BaP. Thus, BCEH does not expect exposure in soil to PAHs at the Former Warehouse to result in adverse health effects.

Table 3: Contaminant Concentrations in Soils at Goodman Oil Site Above Cancer Screening Comparison Values

Location	Metal	95 % Upper Confidence Limit * mg/kg	Cancer CV in mg/kg	Exceeds CV Yes or No?	Theoretical excess life time cancer risk[3]
Former Home[1]	Arsenic	15.61	0.5[2]	Yes	8×10^{-8} (construction workers) 1×10^{-8} (trespassers)

1 = STRATA composite soil sampling September 2010
2 = ATSDR Cancer Risk Evaluation Guide (CREG)
3 = The first value indicates the risk for construction workers, assuming an exposure duration of 5 days a week an 6 months on-site for one year. The second value indicates the risk for trespassers, assuming exposure duration of three weeks on-site for one year.
* = 95 % Upper Confidence Limit (UCL) values calculated using EPA Pro-UCL program when the number of detected values were higher or equal than 8.

Benzo(a)pyrene and some others PAHs have been classified as “probable human carcinogen” [5]. This classification is largely based on animal studies. Evidence of carcinogen effects of BaP or other PAHs in humans is lacking. The increased theoretical cancer risk BCEH calculated for construction workers and trespassers from accidentally eating contaminated soil with PAHs (Appendix G and Table 4), is 2 additional cases in 100 million construction workers and 4 excess cancers in 1 billion trespassers. Since all the estimated cancer risks for this location are very low, BCEH believes that the levels of contaminants in the soil at the Former Warehouse are not likely to increase the risk of getting cancer above the normal risk one has of developing cancer in his or her lifetime.

It is important to note that cancer risk estimates do not provide definitive answers about whether or not a person will get cancer; rather, they are measures of chance (probability). Cancer is a common illness, with many different forms that result from a variety of causes; not all are fatal. According to the American Cancer Society, nearly half of all men and one-third of all women in the U.S. population and in Idaho will develop cancer at some point in their lives. Since cancer is very common and the highest risk estimate for this estimated exposure is 6 excess cancers per 10 million people exposed to contaminated soil and 5 excess cancers per 10 million people exposed to contaminated indoor air, *BCEH believes that the levels of contaminants in the soil or indoor air are not likely to increase the risk of getting cancer above the normal risk one has of developing cancer in his or her lifetime.* This does not imply that contaminant levels should be ignored at the Goodman Oil Site. Exposure to contaminated soils that can lead to ingestion should be avoided whenever possible, and uncovered soils can be covered with turf, fresh soil, or other landscaping to reduce possible exposures.

Table 4: Benzo(a)pyrene Toxicity Equivalent Value That Exceeded Cancer Risk Evaluation Guidelines (CREG)

Location	Benzo(a)pyrene Toxic equivalents[2] mg/kg	Comparison Value in mg/kg	Exposure Dose mg/kg/day	Cancer oral slope factor (mg/kg)/day[4]	Theoretical excess life time cancer risk[5]
Former Warehouse[1]	0.8	0.1[3]	2×10^{-7} 3×10^{-8}	7.3	2×10^{-8} (construction workers) 4×10^{-9} (trespassers)

1 = Calculations were done from the sample with the highest concentrations of Polyaromatic hydrocarbons, which corresponded to Former Warehouse location (See Appendix E2)
2 = EPA's Provisional Guidance for Quantitative Risk Assessment of PAHs (1993), as reported in ATSDR Toxicological profile for PAHs (1995) (For calculation details see Appendices F1 and F2)
3 = ATSDR Cancer Risk Evaluation Guide (CREG)
4 = EPA's Integrated Risk Information System (IRIS)
5 = The first value indicates the risk for construction workers, assuming an exposure duration of 5 days a week and 6 months on-site for one year. The second value indicates the risk for trespassers, assuming exposure duration of three weeks on-site for one year.

Hazardous Construction Materials in Onsite Buildings–Asbestos

As part of the URS Phase II ESA an assessment of the presence of asbestos in the five buildings present at the site (Existing Hut, TBA Warehouse, Office, Former Home, and Vehicle Shop) was completed. Suspected asbestos containing materials (vinyl flooring, duct tape, vinyl tile, and mastic) were shipped to an EPA-approved lab. Results showed the presence of asbestos. Since there is no analysis for asbestos in environmental media (soil, air, sediment, water) we were not able to determine potential health risks from exposures. However, since it is known that there are asbestos-containing materials on site, any future use of the site must have safeguards put into place to comply with federal and state regulations regarding disturbing and/or removing asbestos containing materials.

Uncertainties. The data reviewed in this health consultation were from different sampling efforts, in different years, and done by two different consulting companies. Although several sampling sites and samples were analyzed to be representative of the Site, bias can be introduced by having results from different sources. Also, it is important to note that many of the laboratory results, particularly for polyaromatic hydrocabons, polychlorinated biphenyls and volatile organic compounds were flagged as not detected (see Appendices A, B, C, D and E). This analysis excluded any contaminant that was flagged as not detected. For the analysis of the vapor intrusion pathway BCEH used the Johnson and Ettinger Model using two sub-slab soil vapor data for one location (Vehicle Shop) and one sample for another location (Former Warehouse). EPA 1992 [6] recommends the use of at least 8 samples for a robust data set using this type of vapor intrusion model; however given the lack of indoor air sampling BCEH believes this approach provides a solid indication that soil vapor is not a health risk at this time. Any future development would need to take into account the contaminants in the soil and the possibility of future vapor intrusion.

Conclusions

Exposure to the measured contaminants in soil is unlikely to result in any adverse public health effects. The main concern is the elevated concentrations of lead in the soil, above the CV for residential soil; however, since the most sensitive population (i.e., children and pregnant women) are not permanent residents of the Site or adjacent areas and potentially exposed populations (i.e., trespassers and construction workers) will be present at the Site intermittently, BCEH does not expect health effects in adults or children associated with exposure to lead in soil at the Goodman Oil Site.

Based upon the evaluation of the vapor intrusion pathway using the Johnson and Ettinger Model, BCEH analyzed available sub-slab data in specific existing buildings at the Site to predict indoor air concentrations and if any chronic and/or cancer risk might exist for potential trespassers or construction workers. Based upon the 2010 available sub-slab data, BCEH does not expect to see health effects in trespassers or construction workers associated with exposure to chemicals present in indoor air at the Goodman Oil Site. Therefore, the exposures at the Goodman Oil Site represent no apparent public health hazard. Any future development would need to consider the contamination level prior to initiation of the project.

Recommendations

1. Access to the Site should be controlled and all buildings that remain in the area should remain uninhabited.

2. The owners should implement soil remediation processes, including vegetation coverage to avoid soil erosion.
3. The owners should institute legal restrictions to the Site, if they have not already done so, to prohibit digging or other activities that may result in exposure to contaminated soil.
4. For any future construction on the Site, air monitoring activities and a personal protective equipment program should be implemented to minimize the human health risk from asbestos and lead paint exposure.
5. Depending on the future use of the Site, air monitoring would be necessary as a precautionary measure to avoid exposures.
6. Any future development should take into account the contaminants in the soil and the possibility of vapor intrusion into new construction.
7. Before and during the construction process signs should be placed to indicate the presence of contaminated soil around the area to avoid any accidental exposure.
8. If new environmental monitoring data become available, BCEH should review the data to determine if a new Public Health Consultation is needed.

Public Health Action Plan

Actions planned

1. BCEH will communicate these findings to IDEQ upon completion of this PHC.
2. BCEH will coordinate with IDEQ to implement educational or technical assistance activities as needed.
3. The Site will be closed off April 10, 2012 and will be part of IDEQ's Voluntary Cleanup Program. BCEH will follow up with IDEQ on the results of the Site cleanup.

Report Preparation

This Public Health Consultation for the Goodman Oil Site was prepared by the Idaho Department of Health and Welfare under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, and procedures existing at the date of publication. Editorial review was completed by the cooperative agreement partner.

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8.

Selected Glossary

Acute Occurring over a short time.

Agency for Toxic Substances and Disease Registry (ATSDR)
The principal federal public health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.

Analyte
A substance measured in the laboratory. A chemical for which a sample (such as water, air, or soil) is tested in a laboratory. For example, if the analyte is lead, the laboratory test will determine the amount of lead in the sample.

Cancer Risk
A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Cancer Slope Factor
A number assigned to a cancer causing chemical that is used to estimate its ability to cause cancer in humans.

Carcinogen
A substance that causes cancer.

Chronic
Occurring over a long time (more than 1 year).

Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Dose
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink

contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

EPA
The U.S. Environmental Protection Agency.

Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [**acute**], of intermediate duration [**intermediate**], or long-term [**chronic**].

IDEQ
The Idaho Department of Environmental Quality.

Ingestion rate
The amount of an environmental medium which could be ingested typically on a daily basis. Units are in milligram per kilogram of soil per day for this study.

Intermediate Occurring over a time more than 14 days and less than one year.

Lowest Observed Adverse Effect Level (LOAEL)
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

Media
Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.

mg/kg
Milligram per kilogram.

No Observed Adverse Effect Level (NOAEL)
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

Oral Reference Dose (RfD)
An amount of chemical ingested into the body (i.e., dose) below which health effects are not expected. RfDs are published by EPA.

Relative Potency Factor (RPF)
It is extensively utilized for the estimation of risk from exposure to PAH mixtures and provides a cancer risk estimate for the whole mixture by summing the carcinogenic potential of individual PAHs relative to an index compound (e.g., benzo[a]pyrene).

Route of exposure

The way people come into contact with a hazardous substance. Three routes of exposure are breathing (**inhalation)**, eating or drinking (**ingestion**), or contact with the skin (**dermal contact**).

Toxic Equivalent (TEQ)
It is a single figure resulting from the product of the concentration and individual TEF values of each congener.

Volatile organic compounds (VOCs)
Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, methylene chloride, and methyl chloroform.

Appendices

Appendix A: Goodman Oil Sampling - Analytical Results Compared to Non-cancer and Cancer CVs

Contaminant	Predicted Cancer Risk (Average, 95% UCL, Geometric mean)	CV Non-Cancer (mg/kg)		CV Cancer (mg/kg)
		Intermediate	Chronic	
VOCs (mg/kg)				
Benzene	0.0066	NA	30[1]/40[2]	10[3]
Toluene	0.272	1,000[4]/10,000[5]	NA	NA
Ethylbenzene	0.112	20,000[4]/300,000[5]	NA	5.4[6]
Total Xylenes	0.685	20,000[4]/300,000[5]	10,000[1]/100,000[2]	NA
Naphthalene	0.0311	1,000[4]/10,000[5]	NA	3.6[6]
1,2-Dichloroethane	6.7 $x10^{-4}$	10,000[4]/100,000[5]	NA	8[3]
1,2-Dibromoethane	ND	NA	NA	0.4[3]
Anthracene	0.117*	500,000[4]/ 1000,000[5]	NA	NA
Acenaphthene	0.136	30,000[4]/400,000[5]	NA	NA
Acenaphthylene	0.0488	NA	NA	NA
Benzo(a)anthracene	0.0512*	NA	NA	0.15[6]
Benzo(a)pyrene	0.0754*	NA	NA	0.1[3]
Benzo(b)fluoranthene	0.155*	NA	NA	0.15[6]
Benzo(g,h,i)perylene	0.0681	NA	NA	NA
Benzo(k)fluoranthene	0.0361	NA	NA	1.5[6]
Chrysene	0.0982*	NA	NA	15[6]
Dibenz(a,h)anthracene	0.0173	NA	NA	0.015[6]
Fluoranthene	0.094*	20,000[4]/300,000[5]	NA	NA
Fluorene	0.082	20,000[4]/300,000[5]	NA	NA
Indeno(1,2,3-cd) pyrene	0.0539*	NA	NA	0.15[6]
Naphthalene	0.029*	30,000[4]/400,000[5]	NA	3.6[6]
Phenanthrene	0.114*	NA	NA	NA
Pyrene	0.21*	1,700[6]	NA	NA
1-Methylnaphthalene	0.012	NA	4,000[1]/50,000[2]	22[6]
2-Methylnaphthalene	0.0378*	NA	2,000[1]/30,000[2]	NA
2-Chloronaphthalene	0.0295	6,300[6]	NA	NA
Metals (mg/kg)				
Mercury	2.2*	NA	10[6]	NA
Arsenic	**15.6***	NA	20[1]/200[2]	**0.5[3]**
Barium	247.7*	10,000[4]/100,000[5]	10,000[1]/100,000[2]	NA
Cadmium	ND	30[4]/400[5]	5.0[1]/ 70[2]	1800[6]
Chromium	17.6*	230[6]	NA	0.29[6]
Lead	**657****	**400[6]**		NA
Selenium	ND	NA	300[1]/4,000[2]	NA
Silver	0.61*	390[6]	NA	NA
PCBs (mg/kg)				
Aroclor 1260	0.0496	NA	NA	0.22[6]
VOCs (μg/m^3)				
Vinyl Chloride	ND	80[7]	NA	0.1[3]
1,1-Dichloroethene	ND	80[7]	NA	NA
1,1-Dichloroethane	ND	NA	NA	1.5[6]
cis-1,2-Dichloroethene	ND	NA	NA	NA
1,1,1-Trichloroethane	0	4,000[7]	NA	NA
Benzene	$1x10^{-8}$	20[7]	10[7]	0.1[3]
1,2-Dichloroethane	ND	NA	2,000[7]	0.04[3]
Trichloroethene	ND	NA	NA	NA
Toluene	0	5,200[6]	300[7]	NA

Contaminant	Predicted Cancer Risk (Average, 95% UCL, Geometric mean)	CV Non-Cancer (mg/kg)		CV Cancer (mg/kg)
1,1,2-Trichloroethane	ND	NA	0.21[6]	0.06[3]
1,1,1,2 Tetrachloroethane	$7x1^{8}$	NA	NA	0.1[3]
Ethyl Benzene	$2x10^{-9}$	9,000[7]	300[7]	0.97[6]
m,p-Xylene	0	3,000[7]	200[7]	NA
1,1,2,2-Tetrachloroethane	ND	NA	NA	0.02[3]
trans-1,2-Dichloroethene	ND	800[7]	NA	NA
Methyl tert-butyl ether	ND	2,000[7]	2,000[7]	9.4[6]

1 = ATSDR Child Chronic Environmental Media Evaluation Guide
2 = ATSDR Adult Chronic Environmental Media Evaluation Guide
3 = ATSDR Cancer Risk Evaluation Guide (CREG)
4 = ATSDR Child Intermediate Environmental Media Evaluation Guide
5 = ATSDR Adult Intermediate Environmental Media Evaluation Guide
6 = EPA Region 6 and Region 9 cancer risk-based Regional Screening Levels. CVs reported for chromium correspond to chromium VI
7 = ATSDR Chronic or Intermediate Environmental Media Evaluation Guide values (not differentiated in child or adult)
Values without asterisks represent average values
* 95 % Upper Confidence Limit
** Geometric mean
NA = Not Available
ND = Non detect value
Values in bold represent exceedances compared to CV values

Appendix B: Goodman Oil Soil Sampling – Polyaromatic Hydrocarbons and Volatile Organic Compounds Analytical Results (URS Sampling May 2010)

Analyte	Sample Identification					
	DP-1	DP-2	DP-2D	DP-3	DP-4D	DP-5
Benzene	<0.00042	0.032 J^{QC}	0.0041 J^{QC}	<0.1 US	0.00053 J	<0.00042
Toluene	<0.00033	0.036 J^{QC}	0.0041 J, J^{QC}	2.4	0.0015 J	<0.00033
Ethylbenzene	<0.00032	0.0043 J^{QC}	0.00057 J, J^{QC}	0.53	<0.00032	<0.00032
Total Xylenes	0.0018 J	0.039 J^{QC}	0.0055 J^{QC}	4.4	0.00051 J	<0.00046
Naphthalene	<0.00028	0.02 J^{QC}	0.0017 J, J^{QC}	1 J	<0.00028	<0.00028
1,2-Dichloroethane	<0.00038	0.00067 J	<0.00038	<0.088 US	<0.00038	<0.00038
1,2-Dibromoethane	<0.00031 US	<0.00031 US	<0.00031 US	<0.072 US	<0.00031 US	<0.00031 US
Anthracene	<0.0013	0.088 J	0.066 J	<0.013	0.0032 J	<0.0013
Acenaphthene	<0.0013 U, J^{QC}	<0.025 U, J^{QC}	<0.025	<0.013	0.002 J	<0.0013
Acenaphthylene	<0.0011 U, J^{QC}	0.15 J^{QC}	0.07 J	<0.011	0.0017 J	<0.0011
Benzo(a)anthracene	<0.00096	0.1 J	0.15	0.022 J	0.02	<0.00096
Benzo(a)pyrene	<0.00083	0.26	0.26 J	<0.0083	0.026 J, J^{QC}	<0.00083
Benzo(b)fluoranthene	<0.0014	0.46	0.7	<0.014	0.044 J, J^{QC}	<0.0014
Benzo(g,h,i)perylene	0.0047 J	0.3	0.21 J	<0.0098	0.013 J, J^{QC}	<0.00098
Benzo(k)fluoranthene	<0.0012	0.12	<0.058	<0.012	0.015 J, J^{QC}	<0.0012
Chrysene	<0.00087	0.36	0.38	<0.0087	0.027	<0.00087
Dibenz(a,h)anthracene	<0.00089	0.084 J	<0.044 US	<0.0089	<0.0044 U, J^{QC}	<0.00089
Fluoranthene	<0.00081	0.23	0.34	0.013 J	0.039	<0.00081
Fluorene	0.0014 J	<0.02	0.043 J	0.016 J	0.0017 J	<0.001
Indeno(1,2,3-cd) pyrene	<0.00088	0.23	0.17 J	<0.0088	0.012 J, J^{QC}	<0.00088
Naphthalene	0.0084 J^{QC}	0.077 J, J^{QC}	0.041 J	0.019 J	0.0027 J	<0.0014
Phenanthrene	0.0011 J	0.076 J	0.093 J	0.024 J	0.019	<0.00098
Pyrene	0.0011 J	0.7	0.76 J^{QC}	0.035 J	0.038 J^{QC}	<0.00096 U, J^{QC}
1-Methylnaphthalene	0.012	0.034 J	<0.03	0.022 J	0.0019 J	<0.0015
2-Methylnaphthalene	0.018 J^{QC}	0.076 J, J^{QC}	0.047 J	0.027 J	0.0032 J	<0.002
2-Chloronaphthalene	<0.001 U, J^{QC}	<0.021 U, J^{QC}	<0.021	<0.01	0.0032 J	<0.001

VOCs = Volatile organic compounds
PAHs= Polycyclic aromatic hydrocarbons
J = Estimated value detected above the method detection limit but below the reporting limit
US = Sensitivity issue: not detected at reporting limit above regulatory standards
DP-1 to DP-5 = Sample IDs from samples corresponding to different locations:
DP-1 = Former Fuel Island, DP-2 = South East of Former Warehouse, DP-2D = Former Warehouse, DP-3 = Former Warehouse, DP-4 = Former Warehouse, DP-5 = Vehicle Shop

Appendix B Continued: Goodman Oil Soil Sampling – Polyaromatic Hydrocarbons and Volatile Organic Compounds Analytical Results (URS Sampling May 2010)

Analyte	Sample Identification					
	DP-6	DP-7	DP-10	DP-11	DP-12	DP-13
Benzene	<0.00042	<0.00042	<0.00042	<0.00042	<0.00042	<0.00042
Toluene	0.0017 J	<0.00033	<0.00033	<0.00033	<0.00033	<0.00033
Ethylbenzene	0.026	<0.00032	<0.00032	<0.00032	<0.00032	<0.00032
Total Xylenes	0.34	<0.00046	<0.00046	<0.00046	<0.00046	<0.00046
Naphthalene	0.015	0.0042 J	<0.00028	<0.00028	0.0033 J	<0.00028
1,2-Dichloroethane	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038	<0.00038
1,2-Dibromoethane	<0.00031 US	<0.00031 US	<0.00031 US	<0.00031 US	<0.00031 US	<0.00031 US
Anthracene	0.72	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013
Acenaphthene	0.27	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013
Acenaphthylene	0.054 J	<0.0011	<0.0011	<0.0011	<0.0011	<0.0011
Benzo(a)anthracene	<0.019	<0.00096	<0.00096	<0.00096	<0.00096	<0.00096
Benzo(a)pyrene	<0.017	<0.00083	<0.00083	<0.00083	<0.00083	<0.00083
Benzo(b)fluoranthene	<0.029	<0.0014	<0.0014	<0.0014	<0.0014	<0.0014
Benzo(g,h,i)perylene	<0.02	<0.00098	<0.00098	<0.00098	<0.00098	<0.00098
Benzo(k)fluoranthene	<0.023	<0.0012	<0.0012	<0.0012	<0.0012	<0.0012
Chrysene	<0.017	<0.00087	<0.00087	<0.00087	<0.00087	<0.00087
Dibenz(a,h)anthracene	<0.018	<0.00089	<0.00089	<0.00089	<0.00089	<0.00089
Fluoranthene	0.12	<0.00081	<0.00081	<0.00081	<0.00081	<0.00081
Fluorene	0.57	<0.001	<0.001	<0.001	<0.001	<0.001
Indeno(1,2,3-cd) pyrene	<0.018	<0.00088	<0.00088	<0.00088	<0.00088	<0.00088
Naphthalene	0.12 J	<0.0014	<0.0014	<0.0014	<0.0014	<0.0014
Phenanthrene	0.62	<0.00098	<0.00098	<0.00098	<0.00098	<0.00098
Pyrene	0.43 J^{QC}	<0.00096 U, J^{QC}	<0.00096 U, J^{QC}	<0.00096 U, J^{QC}	<0.00096 J^{QC}	<0.00096 U, J^{QC}
1-Methylnaphthalene	0.49	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015
2-Methylnaphthalene	0.16	<0.002	<0.002	<0.002	<0.002	<0.002
2-Chloronaphthalene	0.058 J	<0.001	<0.001	<0.001	<0.001	<0.001

VOCs = Volatile organic compounds
PAHs= Polycyclic aromatic hydrocarbons
J = Estimated value detected above the method detection limit but below the reporting limit
US = Sensitivity issue: not detected at reporting limit above regulatory standards
DP-6 to DP-13 = Sample IDs from samples corresponding to different locations:
DP-6 = Former Storage Tank Northwest of Primary Transfer Area, DP-7= Primary Transfer Area, DP-10 = North East of Former Warehouse, DP-11 = Vehicle shop, DP-12 = South Existing Tank, DP-13 = West of Former House

Appendix B Continued: Goodman Oil Soil Sampling – Polyaromatic Hydrocarbons and Volatile Organic Compounds Analytical Results (URS Sampling May 2010)

Analyte	Sample Identification						
	DP-14	DP-14_D	DP-15	DP-16	DP-17	DP-18	DP-19
Benzene	<0.00042	NA	0.0025	0.0018	0.0018	<0.00042	DP-19
Toluene	0.00038 J	NA	0.005 J	<0.00033	0.00089 J	<0.00033	0.0031
Ethylbenzene	0.00032	NA	0.00039 J	<0.00032	<0.00032	<0.00032	0.0013 J
Total Xylenes	0.00046	NA	0.0066	<0.00046	<0.00046	<0.00046	<0.00032
Naphthalene	<0.00028	NA	0.0017 J	<0.00028	<0.00028	<0.00028	<0.00046
1,2-Dichloroethane	<0.00038	NA	<0.00038	<0.00038	<0.00038	<0.00038	<0.00028
1,2-Dibromoethane	<0.00031 US	NA	<0.00031 US	<0.00031 US	<0.00031 US	<0.00031 US	<0.00038
Anthracene	<0.0013	<0.0013	0.003 J	0.0018 J	0.0036 J	<0.0013	<0.00031 US
Acenaphthene	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	<0.0013	0.016
Acenaphthylene	<0.0011	<0.0011	<0.0011	<0.0011	0.0075	<0.0011	<0.0013
Benzo(a)anthracene	0.0088	0.0068	0.0029 J	0.011	0.021	<0.00096	0.0098
Benzo(a)pyrene	0.0023 J, J^{QC}	0.0012 J, J^{QC}	0.004 J, J^{QC}	0.011	0.028	<0.00083	0.14
Benzo(b)fluoranthene	0.0038 J, J^{QC}	0.002 J, J^{QC}	0.0058 J, J^{QC}	0.017	0.039	<0.0014	0.16 J^{QC}
Benzo(g,h,i)perylene	0.0011 J, J^{QC}	<0.00098 U, J^{QC}	0.0023 J, J^{QC}	0.0039 J	0.0092	<0.00098	0.19 J^{QC}
Benzo(k)fluoranthene	<0.0012 U, J^{QC}	<0.0012 U, J^{QC}	0.003 J, J^{QC}	0.0054 J	0.021	<0.0012	0.069 J^{QC}
Chrysene	0.0016 J	0.00092 J	0.012	0.011	0.024	<0.00087	0.066 J^{QC}
Dibenz(a,h)anthracene	<0.00089 U, J^{QC}	<0.00089 U, J^{QC}	<0.00089 U, J^{QC}	<0.00089	0.0031 J	<0.00089	0.13
Fluoranthene	0.0042 J	0.0025 J	0.0067	0.021	0.048	<0.00081	0.021 J, J^{QC}
Fluorene	<0.001	<0.001	<0.001	<0.001	0.0018 J	<0.001	0.21
Indeno(1,2,3-cd) pyrene	0.001 J, J^{QC}	<0.00088 U, J^{QC}	0.0018 J, J^{QC}	0.0035 J	0.0091	<0.00088	0.0042 J
Naphthalene	<0.0014	<0.0014	<0.0014	0.0033 J	0.0036 J	<0.0014	0.069 J^{QC}
Phenanthrene	0.0028 J	0.0017 J	0.0024 J	0.01	0.025	<0.00098	0.0052 J
Pyrene	0.0037 J, J^{QC}	0.0018 J, J^{QC}	0.011 J^{QC}	0.017 J^{QC}	0.032 J^{QC}	<0.00096 J^{QC}	0.058
1-Methylnaphthalene	<0.0015	<0.0015	<0.0015	0.0052 J	0.0047 J	<0.0015	0.2 J^{QC}
2-Methylnaphthalene	<0.002	<0.002	0.0028 J	0.0047 J	0.0042 J	<0.002	<0.0015
2-Chloronaphthalene	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0026 J
							<0.0010

VOCs = Volatile organic compounds
PAHs= Polycyclic aromatic hydrocarbons
J = Estimated value detected above the method detection limit but below the reporting limit
US = Sensitivity issue: not detected at reporting limit above regulatory standards
DP-14 to DP-19: Sample IDs from samples corresponding to different locations:
DP-14 = West of Former House, DP-14-D = West of Former House, DP-15 =South West of Former House, DP-16 = TBA Warehouse, DP-17 Former Vehicle repair shop, DP-18 Former Storage Tank, DP-19 = Former Storage Tank West of Former House.

Appendix C: Goodman Oil Soil Sampling – Polychlorinated Biphenyls Analytical Results (URS Sampling May, 2010)

Analyte/ Site ID	PCB 1016	PCB 1221	PCB 1232	PCB 1242	PCB 1248	PCB 1254	PCB 1260
SS-1	<0.0035	<0.0061 US	<0.0051	<0.0061 US	<0.0053	<0.0038	0.012
SS-3	<0.0035	<0.0061 US	<0.0051	<0.0061 US	<0.0053	<0.0038	0.016
SS-4	<0.0035	<0.0061 US	<0.0051	<0.0061 US	<0.0053	<0.0038	0.089
SS-5	<0.070 D	<0.12 D, US	<0.10 D	<0.12 D, US	<0.11 D	<0.075 D	<0.094 D
SS-7	<0.0035	<0.0061 US	<0.0051	<0.0061 US	<0.0053	<0.0038	<0.0047
SS-12	<0.0035	<0.0061 US	<0.0051	<0.0061 US	<0.0053	<0.0038	0.0077 J
SS-13	<0.0035	<0.0061 US	<0.0051	<0.0061 US	<0.0053	<0.0038	0.013 J
SS-15	<0.0035	<0.0061 US	<0.0051	<0.0061 US	<0.0053	<0.0038	<0.0047
SS-19	<0.0035	<0.0061 US	<0.0051	<0.0061 US	<0.0053	<0.0038	<0.0047
SS-20	<0.0035	<0.0061 US	<0.0051	<0.0061 US	<0.0053	<0.0038	0.16

All results are in mg/kg
Data collected from URS in May 2010
J = Estimated value below the lowest calibration point. Confidence correlated with concentration
US = Sensitivity issue: not detected at reporting limit above regulatory standard
D = Sample dilution
SS-1 to SS-20 = Sample IDs from samples corresponding to different locations:
SS-1 = South of Former Warehouse, SS-3 = Former Warehouse, SS-4 = Former Warehouse, SS-5 = Bermed Area, SS-7 = North West of Existing Tank, SS-12 = Former Home, SS-13 = South West of Warehouse, SS-15 = Warehouse, SS-19 = Exposed Waste Area, SS-20 = Former Vehicle Repair Shop

Appendix D1: Goodman Oil Soil Sampling – Metals Analytical Results (URS Sampling May 2010)

Metal/ Site ID	Mercury	Arsenic	Barium	Cadmium	Chromium	Lead	Selenium	Silver
SS-1	0.011 J	1.6	52	0.28	14	100	<0.32	0.61
SS-2	0.045	9.4	130	0.99	17	100	<1.6 D	1.2
SS-3	0.018 J	2.6	160	2.7	70	230	<0.32	0.67
SS-4	0.019	14	88	1.8	12	220	<1.6 D	1.1
SS-5	0.24	7.4	350	2	70	930	<0.32	0.61
SS-6	0.091	7.6	64	1.8	28	640	<3.2 D, US	1.5
SS-6D	0.89	6.2	69	1.3	20	520	<1.6 D	0.99
SS-7	<0.010 US	3.5	24	<0.040	4.6	210	<0.32	0.41 J
SS-8	0.22	3	68	1.4	11	130	<1.6 D	0.81
SS-9	0.31	3.9	96	2.4	10	120	3	0.53
SS-10	0.83 J^{QC}	13	840	5.4	15	6,600	<0.32	1.3
SS-11	1.6	14	2,800	4.8	21	18,000	<1.6 D	2.2
SS-12	0.54	15	540	2.7	13	2,000	<0.32	1.2
SS-13	0.18	6.3	82	1	10	180	<0.32	0.89
SS-14	0.1	3	110	0.96	12	220	<3.2 D, US	0.8
SS-15	0.053	7.1	110	0.17 J	11	41 J^{QC}	<0.32	0.94
SS-16	0.88	9.2	230	1.3	13	280	<0.32	0.96
SS-16D	1.4	10	180	1.4	16	300	<0.32	1
SS-17	1.9	21	380	2.6	21	870	<0.32	2.2
SS-18	0.46	6.4	170	0.65	14	180	<0.32	0.92
SS-19	3.6	19	310	3.1	22	1,600	<1.6 D	4
SS-20	0.025	3.4	130	2	25	410	<1.6 D	0.9

All results are in mg/kg
Data collected from URS in May 2010
J = Estimated value: detected above the method detection limit but below the report limit
S = Sensitivity issue: not detected at reporting limit above regulatory standard
J^{QC} = Estimated value based on QC evaluation
D = Sample dilution
SS-1 to SS-20 = Sample IDs from samples corresponding to different locations:
SS-1 = South of Former Warehouse, SS-2 = Former Warehouse, SS-3 = Former Warehouse, SS-4 = Former Warehouse, SS-5 = Bermed Area, SS-6 = Primary Transfer Area, SS- 6D Primary Transfer Area (replicate), SS-7 = North West of Existing Tank, SS-8 = Vehicle Shop, SS-9 = Vehicle Shop, SS-10 = Former Home, SS-11 = Former Home, SS-12 = Former Home, SS-13 = South West of Warehouse, SS-14 = Warehouse, SS-15 = Warehouse, SS-16 = Office, SS-16D = Office (replicate), SS-18 = Office, SS-19 = Exposed Waste Area, SS-20 = Former Vehicle Repair Shop

Appendix D2: Goodman Oil Soil Sampling – Metals Analytical Results (STRATA Sampling July 2010)

Metal/Site ID	Mercury	Arsenic	Barium	Cadmium	Chromium	Lead	Selenium	Silver
SS-21	0.47	10	140	0.48	13	320	<1.1	<0.53
SS-22	0.99	9.4	190	0.97	20	320	9.1	0.6
SS-23	0.14	16	220	0.94	21	370	8.5	0.23 J
SS-24	0.11	3	120	0.39	14	95	6.1	<0.56
SS-25	0.08	5.9	350	1.8	58	700	<1.0	<0.50
SS-26	0.038	3.7	30	0.14 J	8.8	40	0.69 J	<0.50
SS-27	0.15	16	190	1.2	25	260	<1.0	0.21 J
SS-28	0.092	10	560	3.2	100	1,700	<1.0	<0.50
SS-29	1.6	9.7	160 V,J3	0.47	13	300 V,J3	1.2 J3	0.4 J,P1
SS-30	0.97	9.9	130	0.47	12	290	1.1	0.16 J
SS-31	0.79	8.6	250	0.66	14	430 B	7.3	0.27 J
SS-32	0.21	4.6	91	0.18 J	10	84 B	4.8	<0.51
SS-33	2.7	9.8	270	1.2	21	700	8.6	0.33 J
SS-34	0.86	6	160	1.1	20	400 B	7.8	0.27 J
SS-35	2.3	16	450	1.3	25	1,200	0.98 J	0.84
SS-36	2	23 J3	340 V	1	23	840 J3,V	0.9 J, P1	0.65 P1

All results are in mg/kg
Data collected from STRATA on July 21, 2010
J3 = The associated batch QC was outside the established quality control range precision
B = The indicated compound was found in the associated method blank as well as the laboratory sample
P1 = RPD value not applicable for sample concentrations less than 5 times the reporting limit
V = Additional QC information: the sample concentration is too high to evaluate accurate spike recoveries
J = Estimated value below the lowest calibration point. Confidence correlated with concentration
SS-21 to SS-36 = Sample IDs from samples corresponding to different locations:
SS-21, SS-22, SS-23, and SS-24 = Exposed Waste Area; SS-25, SS-26, SS27, and SS-28 = Bermed Area; SS-29, SS-30, SS-31, SS-32, SS-33, SS-34, SS-35, SS-36 = Former Home

Appendix D3: Goodman Oil Soil Sampling – Metals Analytical Results (STRATA Sampling July 2010)

Metal/Site ID	Mercury	Arsenic	Barium	Cadmium	Chromium	Lead	Selenium	Silver
DU-1	1.2	15	290	<0.26	17	23,000	<5.2 O	0.28 J
DU-2	1.8	21	320	<1.3 O	20	1,200	<10 O	1
DU-3	2.5	19	340	<1.3 O	18	820	<10 O	0.86
DU-4	0.42	12	110	<0.28	12	240	<5.7 O	0.22 J
DU-5	0.93	12	180	<0.25	14	1,200	<5.1 O	0.24 J
DU-6	0.96	12	180	<0.26	12	300	<5.1 O	0.36 J
DU-7	2.7	12	180	<0.26	20	310	<5.1 O	0.45 J
DU-8	0.49	12	110	<0.25	13	190	<5.1 O	0.35
DU-9	0.52	14	220	<0.26	15	630	<5.2 O	<0.52
DU-10	4.1	15	220	0.083 J	20	540	<5.1 O	0.53
DU-11	2.2 J3,V	11	160	<0.25	15	410	<5.1 O	0.63
DU-12	1.6	12	200	<0.3	16	400	<6.0 O	0.5 J
SS-10	2.4	6.6	150	0.72	7.8	240	<1.0	<0.51
SS-11	1.1	17	320	<1.3 O	15	2,200	<11 O	1.1
SS-12	0.16	8.6	130	0.25 J	7.5	290	<5.2 O	3
SS-29	20	15	750	<0.04 J	34	2,100	<5.3 O	0.92

All results are in mg/kg
SS= Subsurface soil samples
DU-1 to DU-12 = Multi-increment Composite samples
J = (EPA)-Estimated value below the lowest calibration point. Confidence correlates with concentration
J3 = The associated batch QC was outside the established quality control range for precision
O = (ESC) Sample diluted due to matrix interferences that impaired the ability to make accurate analytical determination. The detection limit is elevated in order to reflect the necessary dilution
DU-1 to DU-12 = Composite Sampling units surrounding the Former House location
SS-10 = South of Former Home, SS-11 = Southeast of Former Home, SS-12 =Northwest of Former Home, SS-29 = North of Former Home

Appendix E: Goodman Oil Soil Sampling – Soil Vapor and Sub-Slab Analytical Results (STRATA Sampling September, 2010)

Analyte/ Sampling Site	SVP-1 (Vehicle shop)	SVP-2 (Vehicle shop)	SVP-3 (Former Warehouse)	VP-1 (West of the Former warehouse)	VP-2 (Former Warehouse)	VP-2D (Former Warehouse)
Vinyl Chloride	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ND	ND	1.5	ND	0.22	0.23
Benzene	0.36	2.9	1.4	42	8.1	6.7
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND
Trichloroethene	ND	ND	ND	32	16	16
Toluene	1.5	13	1.7	110	15	16
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND
Tetrachloroethene	6.5	4.4	10	11	8.4	8.6
Ethyl Benzene	0.24	2.5	0.78	17	2.5	2.6
m,p-Xylene	1.36	16.3	7.1	186	14.5	14.4
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND
Methyl tert-butyl ether	ND	ND	ND	ND	ND	ND

All results are in micrograms per cubic meter
ND = not reported above laboratory detection limits
SVP1, SVP-2, and SVP-3 = Sub-Slab Soil Vapor Samples
VP-1, VP-2, and VP-2D = Soil Vapor Samples

Appendix F1: Toxic Equivalency Factors (TEFs)[1] for Polycyclic aromatic hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons (PAHs)	Toxic Equivalency Factors (TEFs)[1]
Acenaphthene	0.001
Acenaphthylene	0.001
Anthracene	0.01
Benzo(a)anthracene	0.1
Benzo(a)pyrene (BaP)	1.0
Benzo(a)fluoranthene	0.1
Benzo(g,h,i)perylene	0.01
Benzo(k)fluoranthene	0.1
Chrysene	0.01
Dibenzo(a,h)anthracene	5.0
Fluoranthene	0.001
Fluorene	0.001
Indeno(1,2,3-cd)pyrene	0.1
2-Methylnaphthalene	0.001
Naphthalene	0.001
Phenanthrene	0.001
Pyrene	0.001

Source: [3]
1 = Toxic Equivalency Factors (TEFs) It is a way to express the toxicity of a mixture of toxic compounds (e.g., polycyclic aromatic hydrocarbons) in a single number, which indicates the degree of toxicity compared to the surrogate compounds for example Benzo(a)pyrene (BaP)..

Appendix F2: Toxic Equivalency Factors (TEFs)[1] for Polycyclic aromatic hydrocarbons (PAHs)

Contaminant	Concentration (mg/kg)	Toxic Equivalency Factor[2]	Benzo(a)pyrene Toxic Equivalents
Benzo(a)pyrene	0.260	1.000	0.260
Benzo(a)anthracene	0.100	0.100	0.010
Benzo(g,h,i)perylene	0.300	0.010	0.003
Benzo(b)fluoranthene	0.460	0.100	0.046
Benzo(k)fluoranthene	0.120	0.100	0.012
Chrysene	0.360	0.010	0.004
Dibenz(a,h)anthracene	0.084	5.000	0.420
Indeno(1,2,3-cd)pyrene	0.230	0.100	0.023
Total Benzo(a)pyrene Toxic Equivalents			**0.8**

1 = Benzo(a)pyrene Toxic Equivalent (TEQ), it is a single figure resulting from the product of the concentration and individual TEF values of each congener.
2 = Toxic Equivalency Factors (TEFs), it is a way to express the toxicity of a mixture of toxic compounds (e.g., polycyclic aromatic hydrocarbons) in a single number, which indicates the degree of toxicity compared to the surrogate compounds for example Benzo(a)pyrene (BaP).

Appendix G: Cancer Risk Calculations

Dose Calculation Formula

$$D = \frac{C \times IR \times BF \times CF \times EF}{BW}$$

D = Dose in milligram per kilogram of body weight per day (mg/kg-day)
C = Contaminant concentration in milligrams per kilogram (mg/kg)
IR[1] = Ingestion rate in mg/kg
BF = Bioavailability Factor (default used 1)
CF = Conversion Factor $1x10^{-6}$
EF[2] = Exposure Factor in days per year exposed/365
BW = Body Weight (default for adult 70 kg)

Sources:
1 = EPA Exposure Factors Handbook. Central Tendency for Adult ingestion of soil and dust
2 = Exposure factor for likely scenarios at site
    Scenario 1: construction workers (5 days per week for 6 months over 1 year)
    Scenario 2: trespassers (3 weeks over 1 year)

Excess Cancer Risk Calculation

$$Cancer\ Risk = Dose \times Cancer\ Slope\ Factor$$

Dose = mg/kg-day
Cancer Slope Factor = EPA cancer slope factors from IRIS

Arsenic (15.61 mg/kg soil at Former Home)

Lifetime

Construction Worker Scenario

$$\text{Dose (mg/kg per day)} = \frac{\text{C (mg/kg soil) x IR (kg soil ingested per day) x CF } (10^{-6}) \text{ x EF}}{\text{BW (kg)}}$$

$$= \frac{15.61 \times 50 \times 10^{-6} \times 0.35}{70}$$

$= 3.9 \times 10^{-6}$ mg/kg body weight per day (Exposure Dose)

Cancer Slope Factor = 1.5 mg/kg-day^{-1}

Risk = Dose (mg/kg-day) x CSF (mg/kg-day^{-1}) x (Exposure years/70)

$3.9 \times 10^{-6} \times 1.5 \times 1/70 = 8 \times 10^{-8}$ (Approximately 8 in 100 million)

Trespasser Scenario

$$\text{Dose (mg/kg per day)} = \frac{\text{C (mg/kg soil) x IR (kg soil ingested per day) x CF } (10^{-6}) \text{ x EF}}{\text{BW (kg)}}$$

$$= \frac{15.61 \times 50 \times 10^{-6} \times 0.058}{70}$$

$= 6.47 \times 10^{-7}$ mg/kg body weight per day (Exposure Dose)

Cancer Slope Factor, PRG Region 6 and 9 (CSF) = 1.5 mg/kg-day-1

Risk = Dose (mg/kg-day) x CSF (mg/kg-day-1) x (Exposure years/70)

$6.47 \times 10^{-7} \times 1.5 \times 1/70 = 1 \times 10^{-8}$ (Approximately 1 in 100 million)

Cancer Risk Comparison Levels = 1 x 10^{-6}

Benzo(a)pyrene (Using the toxic equivalent factor approach)

Lifetime

Construction Worker Scenario

Dose (mg/kg per day) = $\frac{\text{C (mg/kg soil) x IR (kg soil ingested per day) x CF } (10^{-6}) \text{ x EF}}{\text{BW (kg)}}$

$= \frac{0.8 \times 50 \times 10^{-6} \times 0.35}{70}$

$= 2 \times 10^{-7}$ mg/kg body weight per day (Exposure Dose)

Cancer Slope Factor = 7.3 mg/kg-day-1

Risk = Dose (mg/kg-day) x CSF (mg/kg-day^{-1}) x (Exposure years/70)

$2 \times 10^{-7} \times 7.3 \times (1/70) = 2 \times 10^{-8}$ (Approximately 2 in 100 million)

Trespasser Scenario

Dose (mg/kg per day) = $\frac{\text{C (mg/kg soil) x IR (kg soil ingested per day) x CF (10-6) x EF}}{\text{BW (kg)}}$

$= \frac{0.8 \times 50 \times 10^{-6} \times 0.058}{70}$

$= 3.3 \times 10^{-8}$ mg/kg body weight per day (Exposure Dose)

Cancer Slope Factor = 7.3 mg/kg-day-1

Risk = Dose (mg/kg-day) x CSF (mg/kg-day-1) x (Exposure years/70)

$3.3 \times 10^{-8} \times 7.3 \times (1/70) = 4 \times 10^{-9}$ (Approximately 4 in 1 billion)

Cancer Risk Comparison Levels = 1 x 10^{-6}