Health Consultation

Ballard Sand Pits

(a.k.a. Brine Service Company, Cal Allen Pits

Corpus Christi (Cal Allen Area), Nueces County, Texas

EPA FACILITY ID: TXD980622922

DECEMBER 1, 2003

Prepared by:
The Texas Department of Health
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Summary and Statement of Issues

The Texas Department of Health Environmental Epidemiology and Toxicology Division (TDH[1]), under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), reviewed environmental data collected by the Railroad Commission of Texas (RCT) and evaluated the potential for contamination from the waste pits at the Ballard Sand Pits site to pose a health hazard to the people living nearby. This health consultation was initiated to address the community's concern that flooding may have spread contamination from the waste pits into residential yards and water wells. In addition, TDH and Corpus Christi Nueces County Health District (CCNCHD) surveyed the community members living in subdivisions nearest the waste pits (Riverside, Twin Lakes, and Wade Riverside subdivisions) to document their health concerns.

Based on plausible exposure scenarios and using the maximum contaminant concentrations measured in the waste pits, TDH concluded that the exposure to material from the waste pits poses no apparent public health hazard to either workers or trespassers. Under some theoretical conditions, however, the contaminants in the waste pits could pose a health hazard to small children (22 pounds) if they were to regularly trespass on the site. Because it is unlikely that a child of this size would frequent the site, TDH concluded that exposure is unlikely and that the material in the waste pits poses no apparent public health hazard to small children.

The arsenic levels in the residential soil are within those normally found in soil from this part of the United States. Based on conservative exposure estimates, we would not expect the arsenic in the soil to pose a public health hazard. Levels of arsenic and barium, although detected in residential drinking water wells, were below current drinking water standards.

The survey conducted by TDH and CCNCHD documents the community health concerns of people living in the Riverside, Twin Lakes, and Wade Riverside subdivisions. The most common health concerns reported were related to the digestive system. Due to the low survey response rate (40 percent) and small numbers of respondents (160), associations between health concerns expressed by the community and chemicals found in the waste pits could not be made.

[1] Abbreviations and Acronyms are listed and described in Appendix A.

Background

Site Description and History

The Ballard Sand Pits property is an active sand and gravel quarry in an unincorporated part of Nueces County off State Highway 73. The property contains two pits, an “East Pit” and a “West Pit,” that may have received drilling mud and possibly refinery waste [1]. The East Pit is immediately to the west of homes on Nimrod Circle in the Twin Lakes Subdivision (Appendix B; Figure 1). There are two other neighborhoods in the vicinity of the pits, the Riverside subdivision to the north and the Wade Riverside subdivision to the south (Appendix B; Figure 1). The entire area, consisting of the Ballard Sand Pits property and the adjacent residential neighborhoods, is within the 100-year floodplain of the Nueces River [2]. According to community members, their homes have flooded four times between 2001 and 2002.

In the summer and fall of 2002 heavy rains caused the Nueces River to flow over its banks; some of the residential water wells were under water [3]. In October 2002, to test whether the flooding affected the water quality of the wells near the waste pits, the Railroad Commission of Texas (RCT) tested water from four of the residential wells [1]. The RCT tested the water for total petroleum hydrocarbons (TPH), volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), pesticides, herbicides, metals, chlorides, coliform bacteria, and total dissolved solids (TDS).

After the floodwaters subsided, the RCT collected additional samples to characterize the contents of the waste pits to determine whether material from the pits had been transported to residential soil, and to further determine whether contaminants from the pits had been transported into residential water wells [6,7]. Material from the pits, residential surface soil, and water from the wells were tested for TPH, VOCs, SVOCs, PCBs, and metals.

Community Health Concerns

In January 2003, at the request of State Representative Jaime Capelo, TDH staff attended a community meeting with the RCT, the Texas Commission on Environmental Quality (TCEQ), the CCNCHD, the County Engineer, and an aide to State Representative Juan Hinojosa. Approximately 65 households were invited to the neighborhood meeting. Community members voiced concerns that their health problems might be due to chemicals from the waste pits. Many community members expressed concerns about the flooding of their homes. Some community members were concerned that the sand being mined from the property was contaminated.

Following this meeting, at the request of the State Representative's office, TDH and CCNCHD developed a survey tool to document and enumerate the community's health concerns. The survey was delivered to all of the 135 homes located in the subdivisions nearest the waste pits (Appendix B; Figure 1). Fifty-four household surveys (40 percent) were completed and returned to TDH. Because the survey was specifically designed to document community health concerns and because the response rate of the community was low, no associations between the documented health concerns and the chemicals found in the waste pits can or should be made. Fifty-eight percent of the respondents reported their overall health to be *Poor* or *Fair*; 42% of the respondents reported their overall health as *Very Good* or *Good*.

The survey respondents were asked to list all health concerns (both symptoms and diagnosed illnesses) for each person identified in the survey. Approximately 43% of the 160 people indicated at least one health concern, while 56.9% did not report a single health concern. The most common health concerns reported were related to the digestive system (Appendix C; Table 1).

There were statistically significant differences in the percent of people reporting digestive system related health concerns by the household's water source. Thirty households identified a private well as the source of the home's tap water. Fourteen households use a public water supply source; six identified the Nueces River as the source for water. Approximately 80% of those returning the survey said they drank bottled water instead of the tap water.

Conclusions based on these results must be limited due to the design of the survey, the low response rate, the high number of questions left blank by the participants, and the inability to account for potential confounding risk factors. The cause of the differences cannot be determined from this survey as it was designed only to collect and document the health concerns, not to determine their causes.

Discussion

Introduction

The environmental sampling data used in this report includes data collected by the RCT in 2002 and 2003 [1-7]. In preparing this report TDH/ATSDR relied on the information provided in the referenced documents and assumed adequate quality assurance/quality control (QA/QC) procedures were followed with regard to data collection, chain-of-custody, laboratory procedures, and data reporting.

In considering the potential public health significance of these sample results we recognize that some of the data used in this assessment were not necessarily collected with the goal of assessing exposure. For example, the waste pit samples were collected below the ground surface and for the purpose of characterizing the contents of the pits. Exactly who may come into contact with the contaminated waste in the pits, residential soil, or residential well water, how often they may come into contact with these media, and how much of the media they may come into contact with is not known. As such, the exposure estimates used in this consultation are theoretical and in many cases worse case scenarios. They should not be taken to apply to any specific individual.

To assess the potential health risks associated with the contaminants found in the various media (waste pits, residential yard soil, and residential well water), TDH compared each contaminant detected with its health-based assessment comparison (HAC) values for non-cancer and cancer endpoints. HAC values are guidelines that specify levels of chemicals in specific environmental media (soil, air, and water) that are considered safe for human contact.

TDH used either the Agency for Toxic Substances and Disease Registry's (ATSDR's) minimal risk levels (MRLs) or the U.S. Environmental Protection Agency's (EPA's) reference doses (RfDs) to derive the non-cancer HAC values. MRLs and RfDs are based on the assumption that there is an identifiable exposure threshold (both for the individual and for populations) below which there are no observed adverse effects. Thus, MRLs and RfDs are estimates of daily exposures to contaminants that are unlikely to cause adverse non-cancer health effects even if exposure occurs for a lifetime. The cancer risk comparison values that TDH used in this consultation are based on EPA's chemical-specific cancer slope factors (CSFs), an estimated excess lifetime risk of one cancer in one-million (1×10^{-6}) exposed people, and an exposure period of 70 years. TDH used standard assumptions for body weight (10 kilograms, child; 70 kilograms, adult), soil ingestion (200 milligrams per day, child; 100 milligrams per day, adult trespasser; 50 milligrams per day, adult worker), and water ingestion (1 liter per day, child; 2 liters per day, adult) to calculate the HAC values. Since many of the assumptions used to calculate HAC values are conservative with respect to protecting public health, exceeding a HAC value does not necessarily mean that adverse health effects will occur. However, exceeding a HAC value does suggest that potential site-specific exposure to the contaminant warrants further consideration.

In some instances, we compare contaminant concentrations in water to EPA's maximum contaminant levels (MCLs). MCLs are chemical-specific maximum concentrations allowed in water delivered to the users of a public water system; they are considered protective of public health over a lifetime (70 years) of exposure at an ingestion rate of 2 liters per day. In addition to potential health effects, the setting of MCLs also may be influenced by available technology and economic feasibility. Although MCLs are only enforceable on public water systems, we often use them as a guide to help assess the potential public health implications of contaminants found in water from other sources.

Environmental Contamination

Contaminants in Material from the Waste Pits

A total of twelve (12) samples, eight (8) from the East Pit and four (4) from the West Pit, were collected at various depths below the ground surface [7]. TPH was detected in both pits and was generally higher in samples from the West pit. The following individual constituents exceeded their respective health-based screening values: benzene, toluene, benzo[a]pyrene, naphthalene, PCBs, arsenic, chromium, and lead (Appendix C; Table 2].

Contaminants in Soil from Residential Yards

Surface soil samples were collected from nineteen (19) residential yards. Arsenic and other metals were the only contaminants measured at levels above their respective detection limits. Arsenic was the only constituent found in the soil at concentrations above one of its health-based screening values (0.5 milligram per kilogram [mg/kg]). The levels of arsenic measured (0.71-3.79 mg/kg) were comparable to background soil levels reported for the Western United States (range less than [<] 0.1-97 milligrams per kilogram [mg/kg] [; average 7.0 mg/kg) [8]. One sample of oil-coated vegetation contained TPH (C6-C35) at a concentration of 136,000 mg/kg. TPH was not detected in any of the residential soil samples.

Contaminants in Water from Residential Wells

In October 2002, arsenic was detected in water from four residential wells near the pits at concentrations that ranged from 31 to 39 micrograms per liter (µg/L) [6,7]. In December 2002, after the floodwaters had subsided, water from 16 residential wells was collected. Arsenic (7.28 µg/L-45.2 µg/L) and barium (27.9 µg/L-861 µg/L) were the only constituents detected at levels exceeding their respective health-based screening values.

Potential Public Health Implications

The Waste Pits

Currently, access to the sand quarry property is limited to those people who work at the site; however, because the site is not completely fenced, trespassers (including children and adolescents) could gain access to contaminated areas. Thus, it is possible that workers and/or trespassers could be exposed to the material in the waste pits. Using the maximum contaminant concentrations found in the pits we conservatively estimate that exposure to this material (through incidental ingestion) could result in risk estimates for workers (50 mg/day) and trespassers (100 mg/day) that qualitatively indicate no apparent increased excess lifetime risk for developing cancer (Figures 2 and 3). The range of risk estimates presented for workers is based on exposures occurring 1 to5 days per week for 5 to 30 years (Figure 2). Similarly the range of risk estimates presented for trespassers is based on exposures occurring 1 to 5 days per week for 1 to 9 years (Figure 3). Thus, while exposures are possible, it is unlikely that they would result in adverse cancer health effects. Based on the available information we conclude that the material in the pits poses no apparent public health hazard, either to workers or trespassers. Several of the contaminants found in the East and West pits also exceeded their respective non-cancer screening values for children. These include toluene, naphthalene, PCBs, arsenic, chromium, and lead. These screening values are based on a 10-kilogram child (approximately 22 pounds) regularly ingesting 200 mg of the waste material every day. As it is unlikely that a child of this size would regularly frequent the site unsupervised, the exposure assumptions used to calculate these screening values, as applied to this site, are conservative.

Residential Areas

Nearby residents could be exposed to material from the waste pits if it was transported to off-site soil or to residential wells during flood events. TPH, which was found in both of the pits, was not found in the residential soil or residential water wells. Arsenic, a naturally occurring element in the earth's crust, was detected in residential soil at concentrations consistent with normal background concentrations. Arsenic and barium both were detected in residential well water at concentrations above their respective screening values. Arsenic is a naturally occurring element in the earth's crust and the concentrations found in the soil were consistent with normal background concentrations. Qualitatively, chronic exposure to the concentrations of arsenic in the soil would result in no apparent increased lifetime risk for developing cancer. This estimate is conservative with respect to protecting public health as it is based on a person ingesting 200 mg of soil everyday for 70 years.

Arsenic

The highest concentration of arsenic found in the well water (45.2 µg/L), is actually below the current maximum contaminant level for this contaminant (50 µg/L); however, it is above the new MCL (10 µg/L) that will go into effect in 2006. The concentrations of arsenic in many of the wells also exceed both the non-cancer and cancer screening values. The most likely route of exposure to these contaminants in the water is through ingestion, either by drinking it in beverages or by cooking with it.

The potential effects of ingesting arsenic in drinking water are highly dependent on the dose (how much is ingested). The most common effects include gastrointestinal irritation, decreased production of red and white blood cells, abnormal heart function, blood vessel damage, impaired nerve function causing a "pins and needles" sensation in the hands and feet, and a group of skin diseases, including hyperkeratosis. Most of the non-cancer effects begin to occur at similar oral exposure levels. Ingestion of water with 300 micrograms per liter to 30,000 micrograms per liter of arsenic can cause stomach and intestinal irritation. The levels observed in this area (7.28-45.2 µg/L) are orders of magnitude lower than the levels normally associated with these types of effects. The minimal dose at which these effects usually are observed in humans after chronic ingestion of arsenic ranges from 12 to 100 micrograms of arsenic per kilogram of body weight per day (µg/kg/day). Based on the maximum concentration of arsenic measured in the water a child (10 kg) would have to drink between 3 and 22 liters of water per day to receive such a dose (Appendix C; Table 3). A 70 kg adult would have to drink between 19 and 155 liters of water per day to receive such a dose. Children and adults typically drink 1 and 2 liters per day, respectively.

Although there are no scientific reports that suggest arsenic can injure pregnant women or their fetuses, studies of animals show that doses large enough to cause illness in pregnant females also may cause low birth weight, fetal malformations, or fetal death. One of the most characteristic effects of long-term oral exposure to inorganic arsenic is a pattern of skin changes that includes a darkening of the skin and formation of hyperkeratotic warts or corns on the palms, soles, and torso. Currently this end-point is considered the most appropriate basis for establishing a chronic oral Minimal Risk Level (MRL) or Reference Dose (RfD). However, other end-points (liver injury, vascular disease, and neurological effects) also appear to have similar thresholds [9].

In one study of a very large population, Tseng (1968) found no adverse effects in any person with an average total daily intake of inorganic arsenic (water plus food) of 0.0008 mg/kg/day [10]. This study has served as the basis for both ATSDR's MRL and EPA's RfD, both of which are 0.0003 mg/kg/day [11]. Both the RfD and the MRL were derived by dividing the 0.0008 mg/kg/day no observed adverse effects level (NOAEL)[2] by an uncertainty factor of three (3) to account for both the lack of data on reproductive toxicity and to account for some uncertainty as to whether the NOAEL accounts for all sensitive individuals. The lowest dose, associated with the epidemiologic studies, at which adverse effects were observed, was 0.014 mg/kg/day.

Based on the concentrations measured in some of the wells from these residences children could be exposed to arsenic at doses up to four times the no observed adverse effects level. Adults could be exposed to arsenic at doses up to two times the no observed adverse effects level. Neither children nor adults would be likely to receive doses approaching those at which adverse effects have been observed. With respect to non-cancer health effects we would consider the levels found in some of these wells to be slightly elevated; however, the likelihood of actually observing adverse effects is low.

EPA also classifies arsenic as a known human carcinogen based on sufficient evidence from human data. An increase in lung cancer mortality was observed in multiple human populations

[2] The highest exposure level at which there were no statistically or biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control; some effects may be produced at this level, but they are not considered adverse, nor precursors to adverse effects.

exposed primarily through inhalation. Also, increased mortality from multiple internal organ cancers (liver, kidney, lung, and bladder) and an increased incidence of skin cancer (non-malignant) were observed in populations consuming water high in inorganic arsenic [12]. We Used EPA's cancer slope factor (CSF) for arsenic to estimate the potential increased lifetime cancer risks associated with exposure to arsenic in the water from each of the wells. For people who drink 2 liters of water per day, 350 days per year, for 30 years, there may be a low increased lifetime risk for cancer (Appendix C; Table 4).

Barium

The maximum concentration of barium detected in well water (861µg/L) exceeded the non-cancer screening value for children (700µg/L). This screening value, derived from EPA's RfD for barium of 0.07 mg/kg/day, is based on hypertension as the health endpoint of concern and a weight-of-evidence approach supported by the finding of hypertensive effects in humans who ingested acutely high doses of barium compounds, in workers who inhaled dusts of barium ores, in animals given barium intravenously, and in rats exposed to barium in drinking water while on restricted diets [13, 14]. Lower dose human studies did not report any significant effects either on blood pressure or kidney function but did identify a NOAEL of 0.21 mg-barium/kg/day. An uncertainty factor of 3 was used to derive the RfD to account for some database differences and potential differences between adults and children.

Based on the concentrations measured in the wells from these residences it is unlikely that either children or adults would be exposed to barium at doses that would result in statistically or biologically significant increases in the frequency or severity of adverse effects. The concentrations of barium measured in these wells also are substantially below the MCL that EPA has promulgated for this contaminant (2,000 µg/L).

Other Constituents Measured in the Wells

Fecal coliform bacteria were not detected in any of the water wells; however, the levels of chlorides (550-2,250 milligrams per liter [mg/L]) and Total Dissolved Solids (1,540-2,930 mg/L) indicate that well water in the area is slightly saline.

Children's Health Concerns

ATSDR's Child Health Initiative

TDH and ATSDR recognize that the unique vulnerabilities of infants and children demand special emphasis. Children are at greater risk than adults from certain kinds of exposures to hazardous substances emitted from waste sites and emergency events. Children are more likely to be exposed because they play outdoors and often bring food into contaminated areas. They are shorter than adults and breathe dust, soil, and heavy vapors that are close to the ground. Children are smaller than adults, resulting in higher doses of chemical exposure per unit of body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Consequently, children who drink water contaminated with toxic substances may be at greater risk for toxic effects than adults who consume the same water. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

In an effort to account for children's unique vulnerabilities, TDH/ATSDR considered the potential exposure to contaminants that children might receive from contact with waste material, residential soil, and well water.

Conclusions

Based on available information, TDH/ATSDR concluded that:

1. The contaminants in the waste pits pose no apparent health hazard to workers or trespassers at the site. Under some theoretical conditions the contaminants could pose a health hazard to small children if they were to regularly come in contact with (play) in the waste pit material. However, because this site is an active quarry, a child of this size is not likely to be left unattended there; therefore, this exposure situation is not likely to occur.

2. Arsenic was the only contaminant detected in residential soil at levels that are above a health-based screening value; however, arsenic is a natural element in the earth's crust and the levels found were well within those normally found in soil from this part of the United States. Based on conservative exposure estimates we would not expect the arsenic in the residential soil to pose a public health hazard.

3. Other than constituents that contribute to the salinity and aesthetic quality of the water, arsenic and barium were the only contaminants found at levels above their respective health-based screening values. Neither was detected above its current MCL, indicating that the risks that people would incur from exposure to these contaminants in the well water would be the similar to the risks currently deemed acceptable for any public drinking water system. It is important to note that the MCL for arsenic will be lowered to 10µg/L in 2006; the arsenic concentrations measured in 15 of the wells exceed this new standard. While it is unlikely that either children or adults would be exposed to arsenic or barium at doses that would result in statistically or biologically significant increases in the frequency or severity of adverse non-cancer effects, the margin of safety above the respective NOAELs is small, particularly for small children. Additionally, we estimate that chronic exposure to the levels of arsenic in this water could result in a low increased excess lifetime risk for developing cancer.

4. Based on the data provided at the time this report was initiated, we could not determine with any degree of certainty the source of the arsenic found in the wells. Arsenic is a naturally occurring element and is commonly found in some groundwater. The data did

not indicate the presence of other waste pit constituents in either the well water or the residential soil.

Public Health Action Plan

Actions Completed

1. The RCT sampled residential drinking water wells and provided the sampling results to the well owners.
2. The RCT sampled residential yards that were most likely to be affected by overflow from the waste pits during the floods and provided the test results to the occupants of the households.
3. The TDH and CCNCHD surveyed residents of Riverside, Wade Riverside, and Twin Lakes subdivisions to gather their health concerns.
4. The TCEQ tested sand used for the beach reconstruction project for metals and found no problems.
5. The TCEQ put in six shallow groundwater monitoring wells in and near the waste pits and sampled them for site contaminants.

Actions Recommended

1. Continue to limit site access to site workers and consider fencing and/or posting warning signs around the East and West waste pits.
2. Individual well owners should consider connecting to an approved potable drinking water source.
3. The flooding issue should be addressed by the appropriate entities.

Actions Planned

1. The TDH plans to provide this report and survey results to the community and appropriate agencies.
2. The TCEQ plans to evaluate monitoring well sampling data to determine appropriate actions.

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CERTIFICATION

This Ballard Sand Pits public health consultation as prepared by the Texas Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the public health consultation was initiated.

Technical Project Officer, SPS, SSAB, DHAC, ATSDR

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

Chief, State Programs Section, SSAB, DHAC, ATSDR

APPENDICES

APPENDIX A: Acronyms and Abbreviations

ATSDR	Agency for Toxic Substances and Disease Registry
CCNCHD	Corpus Christi Nueces County Health Department
CDI	Chronic Daily Intake
CREG	Carcinogenic Risk Evaluation Guide
CSF	Cancer Slope Factor
CVD	Cardiovascular Disease
EMEG	Environmental Media Evaluation Guide
EPA	United States Environmental Protection Agency
HAC	Health Assessment Comparison Value
MCL	Maximum Contaminant Level
MRLs	Minimal Risk Levels
NOAEL	No Observed Adverse Effect Level
PCBs	Polychlorinated Biphenyls
QA/QC	Quality Assurance/Quality Control
RfD	Reference Dose
RMEG	Reference Dose Media Evaluation Guide
RCT	Railroad Commission of Texas
SVOCs	Semi-volatile Organic Compounds
TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
TCEQ	Texas Commission on Environmental Quality
TDH	Texas Department of Health
TDS	Total Dissolved Solids
TNRCC	Texas Natural Resource Conservation Commission
TPH	Total Petroleum Hydrocarbons
VOCs	Volatile Organic Compounds

APPENDIX B: Figures -- Figure 1. Ballard Sand Pits - Area Households

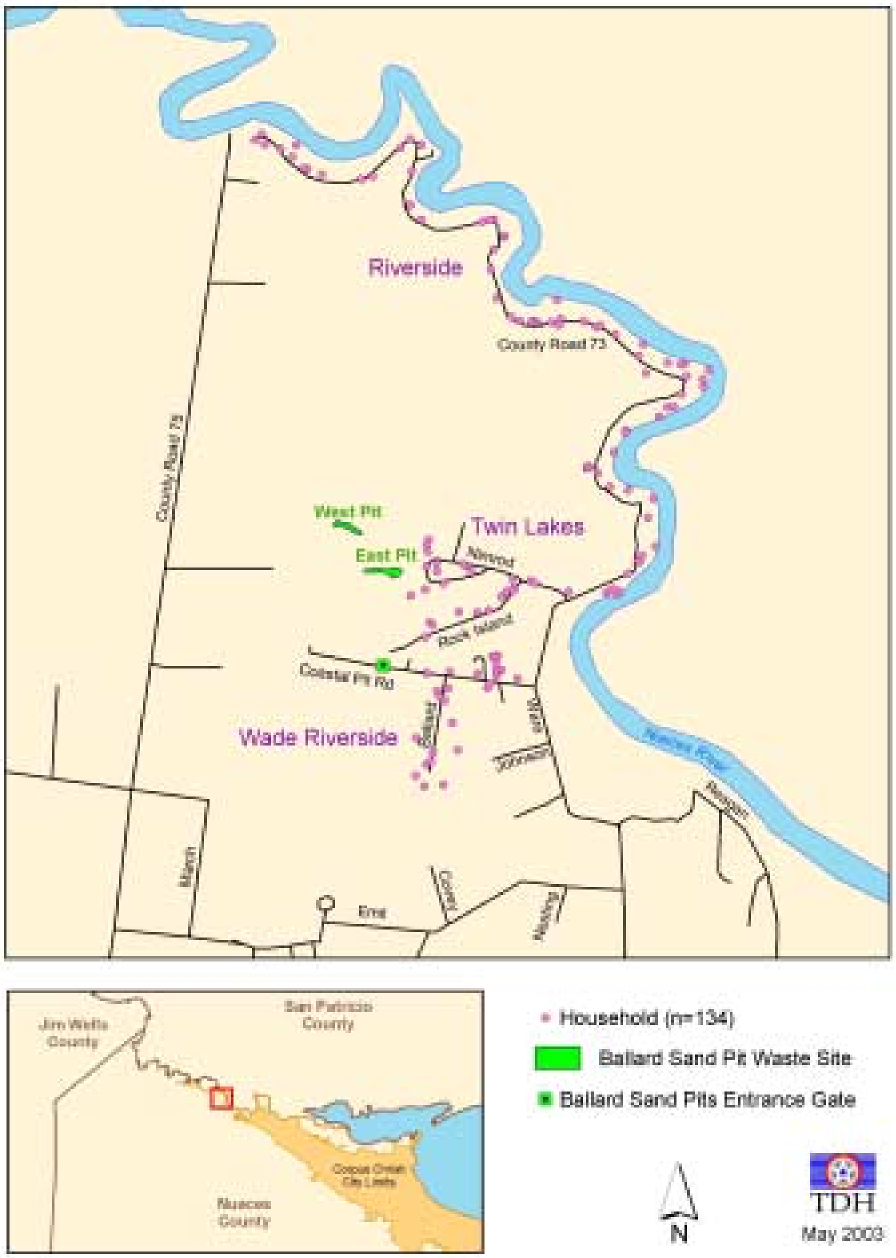


Figure 2. Estimated Excess Lifetime Cancer Risks for Workers Regularly Ingesting Waste Material

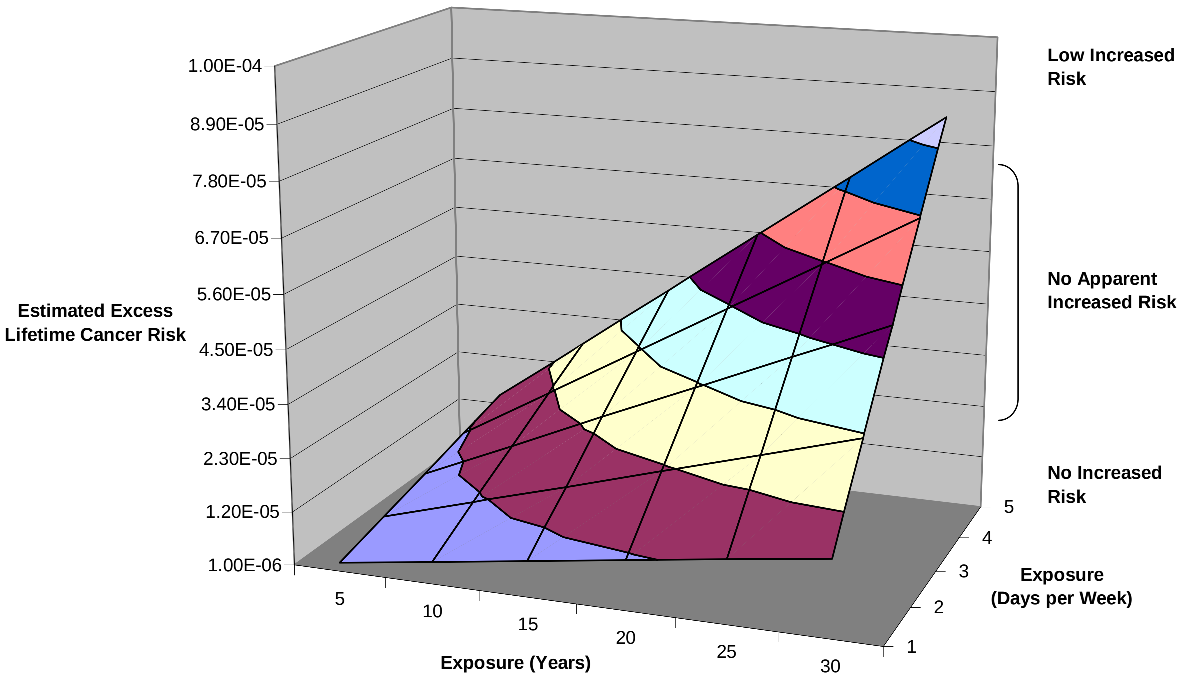
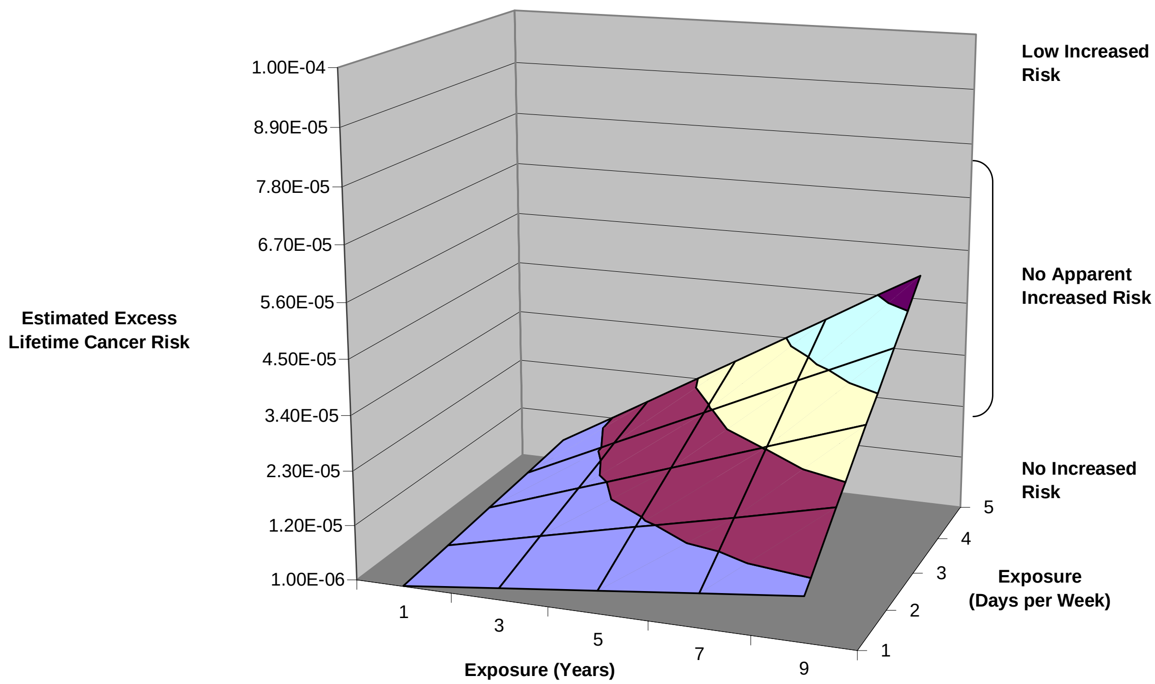


Figure 3. Estimated Excess Lifetime Cancer Risks for Trespassers Periodically Ingesting Waste Material



APPENDIX C: Tables

Table 1 - Percent of People with Each Health Concern

Health Concern	People with Concern	
	n	% (n/N)
Upper Gastrointestinal	15	(9.40)
Headache/Migraine	14	(8.80)
Respiratory System	12	(7.50)
Skin	11	(6.90)
Infections	10	(6.30)
Allergies	8	(5.00)
Lower Gastrointestinal	8	(5.00)
Joint/Ligament	8	(5.00)
Heart Disease	6	(3.80)
Muscle/Tendon	6	(3.80)
Diabetes	5	(3.10)
Female System	5	(3.10)
Hair	5	(3.10)
Fatigue	5	(3.10)
Generalized CVD	4	(2.50)
Mouth Sores	4	(2.50)
Balance	4	(2.50)
Blood	3	(1.90)
Cancer - Skin (localized)	3	(1.90)
Injury/Poisoning	3	(1.90)
Psychiatric – Depression/Anxiety	3	(1.90)
Swelling	3	(1.90)
Brain/Spine/Stroke	2	(1.30)
Fever	2	(1.30)
Cancer – Blood	1	(0.60)
Cancer - Not Specified	1	(0.60)
Infertility	1	(0.60)
Cold Sweats	1	(0.60)
Insomnia	1	(0.60)

N = 160 (Total number of people in survey)
“n”=Number of people with concern
CVD – Cardiovascular disease

Table 2.

Subsurface Pit Constituents Exceeding Health-based Screening Values December 2002			
Constituent	East Pit Range (mg/kg)	West Pit Range (mg/kg)	HAC Value (mg/kg)
VOCs			
Benzene	69-2720	980-3440	10 CREG[1]
Toluene	16.1*-1130	53.1*-1530	1000/10000 intEMEG
SVOCs			
Benzo[a]pyrene	all nd	nd-12.8J	0.1 CREG
Naphthalene	64*-311*	233*-1420	1000/10000 intEMEG
PCBs	(<0.115)*-2.93	0.478-17.8	1/10 chrEMEG[2]; 0.4 CREG
Metals			
Arsenic	0.825-10.7	13.5-52.4	20/200 chrEMEG; 0.5 CREG
Total chromium	(9.56)**-433	778-3000	200/2000 RMEG[3]
Lead	5.62-138**	196-453	400 EPA action level

* none above health-based screening values
** none was the more toxic chromium VI; therefore this constituent was dropped from further evaluation.
J – estimated value
[1] Carcinogenic Risk Evaluation Guide
[2] Environmental Media Evaluation Guide
[3] Reference Dose Media Evaluation Guide

Table 3 – Amount of Water Ingestion Required to Reach Dose Comparison Levels

Arsenic (µg/L)	# Liters a 10 kg child would have to drink to exceed the CDI[1]		# Liters a 70 kg adult would have to drink to exceed the CDI	
	Dose of 12 µg/kg/day[2]	Dose of 100 µg/kg/day	Dose of 12 µg/kg/day	Dose of 100 µg/kg/day
7.28	16	137	115	962
15.8	8	63	53	443
16.8	7	60	50	417
17.1	7	58	49	409
17.8	7	56	47	393
21.4	6	47	39	327
27.8	4	36	30	252
28.1	4	36	30	249
32	4	31	26	219
33.7	4	30	25	208
33.8	4	30	25	207
34	4	29	25	206
34	4	29	25	206
34.7	3	29	24	202
39	3	26	22	179
45.2	3	22	19	155

[1] Chronic Daily Intake

[2] Micrograms per kilogram per day

Table 4.

Estimated Population Cancer Risks Associated with Arsenic Levels in Residential Drinking Water Wells		
Arsenic Levels in Residential Water Wells (µg/L)	Calculated Increased Risk of Developing Cancer	Qualitative Increased Risk of Developing Cancer over a Lifetime
7.28	1.28E-04	Low increased risk
15.8	2.78E-04	Low increased risk
16.8	2.96E-04	Low increased risk
17.1	3.01E-04	Low increased risk
17.8	3.14E-04	Low increased risk
21.4	3.77E-04	Low increased risk
27.8	4.90E-04	Low increased risk
28.1	4.95E-04	Low increased risk
32	5.64E-04	Low increased risk
33.7	5.94E-04	Low increased risk
33.8	5.94E-04	Low increased risk
34	5.99E-04	Low increased risk
34	5.99E-04	Low increased risk
34.7	6.11E-04	Low increased risk
39	6.87E-04	Low increased risk
45.2	7.96E-04	Low increased risk