Letter Health Consultation

Evaluation of the Potential Public Health Implications Associated with the Brownfields Redevelopment of a Former Equipment Maintenance and Storage Facility into Affordable Housing Units
Habitat for Humanity Estes Valley Site:
An EPA Targeted Brownfield Assessment Site

Estes Park, Larimer County, Colorado

Prepared by
Colorado Department of Public Health and Environment

FEBRUARY 4, 2013

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

Health Consultation: A Note of Explanation

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

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

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LETTER HEALTH CONSULTATION

TO: Alissa Schulz, Project Manager, HMWMD/CDPHE

FROM: Thomas Simmons, Health Assessor, CCPEHA/DCEED/CDPHE

SUBJECT: Evaluation of the Potential Public Health Implications Associated with the Redevelopment of a Former Automotive Maintenance and Storage Facility Into Affordable Housing in Estes Park, Larimer County, Colorado (Habitat for Humanity Site)

CC: Raj Goyal, Principal Investigator, CCPEHA/DCEED/CDPHE

DATE: 2/4/2013

This letter health consultation is in response to your request for an evaluation of the potential public health implications associated with surface and subsurface soils at the Habitat for Humanity Brownfield's Redevelopment site (the site) located in Estes Park, Larimer County, Colorado. The former use of the site and potential contaminants of concern in soil were considered in this evaluation. Soil contaminant data from the Colorado Department of Public Health and Environment's (CDPHE, the department) 2011 Phase II Environmental Site Assessment (ESA) was used as the basis of this evaluation (CDPHE 2011b, CDPHE 2011c). Please note that the evaluation of groundwater data is beyond the scope of this letter health consultation. If requested, the possible public health implications of exposure to contaminants in groundwater can be evaluated in a separate letter health consultation.

Background

The site is located at 995 Dry Gulch Road, Estes Park, Larimer County, Colorado. The parcel of land is currently owned by The Estes Park Community Resource Center. It comprises approximately 0.82 acres in a mixed commercial and residential setting (Figure 1). According to the Larimer County Assessor's Office, the parcel was originally developed in 1955 (CDPHE 2011a). A vacant, one-story commercial building containing approximately 1,800 square feet of interior floor space is the only building on the property at this time. The building is constructed of block masonry, with a concrete slab on grade, and a gable roof with what appears to be asphalt shingles. The windows of the building are currently boarded up. At one time, a residential structure was also located onsite to the southwest of the existing structure, but has since been demolished. The exterior grounds consist of grass vegetated cover and exposed soil in areas.

The site has been utilized as a storage/maintenance facility for a number of entities since at least 1955. Based on historical aerial photographs and interviews with individuals familiar with the site, the property and existing building were originally constructed for use by a construction/excavation company, which stored construction equipment and

vehicles at the site and also conducted light maintenance of their vehicles and equipment (oil changes, lubrication, etc.). Maintenance activities could have included oil changes of trucks and heavy equipment, greasing/lubricating various mechanical equipment, refueling diesel trucks and diesel equipment, washing/rinsing heavy equipment utilizing the floor drains and French drain, and the potential use of solvents for degreasing parts.

According to the Colorado Department of Labor and Employment-Office of Petroleum Safety records, the site has two "Permanently Closed" Underground Storage Tanks (USTs) (1 x 1,000-gallon diesel UST, and 1 x 500-gallon used oil UST) that were reportedly last used on January 1, 1989. There is no record of whether the USTs were 'closed' in place or if they were removed from the site. In addition, two above ground storage tanks (AST) were also present at one time, but have since been removed. A 1,000 gallon fuel oil tank was located on the east side of the existing structure, near the overhead doors. It was used to heat the building during the winter. The other AST was a 300 gallon diesel tank used to refuel vehicles and equipment. However, one of the previous owners claimed that the AST's have not been used for the past several years and were disposed of sometime in the late 1990's. No ASTs are currently present onsite (CDPHE 2011a).

Previous site owners lived in the home that was demolished in 2009 (CDPHE 2011a). The home had a well and septic system. The septic system was presumably removed in 2009 when the home was demolished, but the status of the well is unknown (CDPHE 2011a). However, no other groundwater well is currently thought to exist onsite at the time of this evaluation. One of the previous owners stated that a water line also ran to the existing structure, but it is unclear if it was ever actually connected inside the building.

The site has been vacant for the past few years. Habitat for Humanity of Estes Valley submitted an application for a Targeted Brownfields Assessment to purchase the property, demolish the existing structure and redevelop the property "for a use that benefits the community, which will likely include the construction of one or more units of affordable housing" (CDPHE 2011b).

Environmental Soil Data

Previous environmental investigations at the site include a 2005 Limited Site Investigation (LSI) that was conducted by Terracon of Fort Collins, CO, and a 2011 Phase II Environmental Site Assessment (ESA) that was conducted by the department. As part of these investigations, soil samples were collected in and around areas potentially contaminated from former site activities. The 2005 LSI was conducted for the Estes Park Salud Foundation, which was interested in purchasing the property to construct its Salud Family Health Center facility. However, the Foundation later decided to purchase a property east of and adjacent to the site for its Family Health Center Facility. Habitat for Humanity of Estes Valley submitted the Targeted Brownfield Assessment (TBA) application in May 2011, which spurred the additional investigation by the department later that year. The 2005 LSI was utilized primarily as supplemental background information in this evaluation. The more comprehensive Phase II ESA,

conducted by the department was used as the basis of this health consultation (CDPHE 2011c).

2011CDPHE Phase II Environmental Site Assessment

A total of eight soil borings were drilled onsite (i.e., SB-1, SB-2, SB-3, SB-4, SB-5, SB-6, SB-6a, SB-7and a total of ten (10) soil samples were collected as part of the Phase II ESA. Soil samples were collected based on field observations (i.e., visual, odors, etc, if any) and were collected in accordance with CDPHE Standard Operating Procedures. Eight shallow subsurface soil samples and one opportunity depth soil sample were collected. In addition, one shallow subsurface soil sample was collected from the interior french drain. All soil samples were analyzed for volatile organic compounds (VOC's), semi-volatile organic compounds (SVOC's), and 8 total Resource Conservation and Recovery Act (RCRA) regulated metals. In addition, four soil samples were analyzed for polychlorinated biphenyls (PCB's). Soil sampling results are shown in Table A1 and A2 and the sampling locations are shown in Figure 2.

No VOC, SVOC, RCRA-regulated Metals, or PCBs were found in soil above regulatory cleanup standards. Arsenic, barium, chromium, and lead were detected in nearly all soil samples collected from the site. This is to be expected since metals are naturally occurring in soil. Acetone, 2-butanone, methylene chloride, and bis(2-ethylhexyl)phthalate were detected at low levels in sample SB-8, which was collected from the French drain inside the existing structure. This could be associated with solvent and/or automotive fluid contamination. No other VOCs or SVOCs were detected in the remaining soil samples with the exception of bis(2-ethylhexyl)phthalate in Sample SB-6a, which was collected near the eastern site boundary. However, the detected concentration (0.766 milligram per kilogram) is well below the Colorado Soil Evaluation Value for residential properties of 35 mg/kg. It should also be noted that no VOCs or SVOCs were detected in sample SB-5, which was collected from the location of the former ASTs.

Selection of Contaminants of Potential Concern

To identify surface soil contaminants of potential concern (COPCs), all of the soil data was screened against comparison values established by the ATSDR and EPA. The screening values from both agencies were reviewed and the most conservative value was selected as the Comparison Value (CV) (Table A3). The screening values used to identify COPCs in surface soil were derived for residential soil exposure scenarios. ATSDR's soil comparison values for chronic exposures are based on daily exposure to soil over a period longer than 1 year. The EPA's residential soil screening values are based on 350 days of exposure per year over a period of 30 years (assumes 15 days away from the home per year). Using these CVs for screening is considered conservative and protective of individuals that might come into contact with soil contaminants after the redevelopment of the site into residential property. Therefore, if the maximum concentration of a particular contaminant is below the CV it is dropped from further evaluation. If the maximum concentration of the contaminant is above the CV; it is generally retained for further analysis as a COPC. However, exceeding the CV does not indicate that a health hazard exists; only that additional evaluation is warranted.

The soil COPC selection is shown in Table A3. Arsenic and chromium had maximum detected concentrations greater than the residential CVs and were selected as COPCs. Chromium speciation was not conducted during laboratory analysis. Therefore, the chromium detected in soil was selected as a COPC based on the most toxic form of chromium (hexavalent chromium or chromium VI). This is a conservative approach in that the total chromium found at the site most likely contains a significant fraction of the less toxic trivalent chromium (chromium III). All VOCs and SVOCs were well below the residential screening values.

Conceptual Site Model

The site is currently vacant and unrestricted. No significant exposure to any site-related contamination is likely to be occurring at this time. The only known current use of the site is by those conducting environmental investigations and site visits, which is not likely to result in any significant exposure since trained professionals are present during these times. If the site is redeveloped by the Habitat for Humanity Estes Valley in the future, residential exposures are going to be the primary exposure scenario of concern. This health consultation evaluates potential future community members' exposure to soil contaminants. Evaluating potential exposures to contaminants through other media (e.g., groundwater, surface water, and indoor air) is beyond the scope of this health consultation.

Individuals living onsite following the redevelopment effort will likely be exposed to soil contaminants via three routes of exposure to COPCs: 1) incidental ingestion of surface soil, 2) dermal contact with surface soil, and 3) inhalation of soil particles suspended in air (fugitive dust). Dermal contact with metals is considered a relatively insignificant exposure pathway due to the limited ability of metal contaminants to cross the skin barrier and enter the bloodstream. Therefore, dermal contact with metals in surface soil was not quantitatively addressed in this evaluation. Inhalation of dust is typically not considered an important pathway in terms of public health unless there is evidence to suggest a significant mechanical disturbance of the soil as in ATV riding and/or high, sustained winds. At this site, no such evidence exists, so this pathway was not quantitatively evaluated in this health consultation. While there may be some exposure that is unaccounted for from dermal exposure and inhalation of fugitive dusts, these pathways are not likely to significantly alter the body burden of doses received from incidental ingestion. Incidental ingestion of surface soil is considered the primary pathway of exposure to soil contaminants at the site.

A summary of the exposure assessment information is presented below in the Conceptual Site Model.

Conceptual Site Model

Source	Area of Exposure	Affected Environmental Medium	Timeframe of Exposure	Potentially Exposed Population	Route of Exposure	Pathway Designation
Soil and Ground-water	995 Dry Gulch Rd. Estes Park, CO (the site)	Surface and Subsurface Soil	Future	Child and Adult Residents	Incidental Soil Ingestion	Potential
					Inhalation of Fugitive Dust	Potential*
					Dermal Exposure to Soil Contaminants	Potential**

NOTE:
* Inhalation of fugitive dusts is not considered an important exposure scenario in this evaluation because there is no evidence to suggest any significant mechanical disturbance of soil at the site. Therefore, the concentration of soil contaminants in dust is likely to be low and is not quantitatively evaluated in this health consultation.
** Dermal exposure to surface soil contaminants is a complete exposure pathway. However, since metals have a limited ability to cross the skin barrier and enter the blood stream, this pathway is considered insignificant and is not quantitatively evaluated in this health consultation.

Public Health Implications

The potential for non-cancer and cancer health effects is evaluated independently due to differences in methods of health risk estimation. For example, the exposure dose for calculating estimated cancer risk is averaged over the lifetime of the individual whereas the exposure dose for non-cancer health hazards is averaged over the duration of exposure. To evaluate the potential for non-cancer health effects, the estimated exposure dose for each COPC is compared to health-based guidelines developed by the ATSDR and EPA. If the estimated exposure dose is below the health-based guidelines, adverse non-cancer health effects are not likely to occur. If the estimated non-cancer exposure dose is above the health-based guideline, additional evaluation of the potential health effects associated with the exposure is warranted. To evaluate potential cancer risks, the estimated theoretical lifetime risks for cancer are compared with the EPA target cancer risk range of 1×10^{-6} to 1×10^{-4}, or one excess cancer case per million exposed individuals to 100 excess cancer cases per million exposed individuals.

Contaminant exposure doses for future residents were estimated using the standard default exposure factors established by the EPA and the ATSDR. For child residents, this includes exposure to 200 mg. of soil per day for 350 days per year over a period of 6 years. For adult residents, the estimated doses were derived using 100 mg. of soil per day for 350 days per year over a period of 30 years. As mentioned previously, the estimation of cancer risk is averaged over a lifetime, which is assumed to be 70 years in this evaluation. Cancer risks were estimated for exposure during childhood and adulthood (adult exposure adjusted to a duration of 24 years). These risks can be added together to represent exposure over a period spanning from birth to the age of 30 years.

The estimated non-cancer hazards are shown in Table A4. The estimated doses for arsenic and chromium are below the non-cancer health-based guidelines for child and adult residents. This indicates a very low increased risk of developing non-cancer health effects from exposure to soil while living at the future residential development. Moreover, the combined hazard index (sum of hazard quotient from each COPC) from exposure to both COPCs is below or equal to one for child and adult residents. Please note that this is based on the conservative assumption that all chromium is in the hexavalent form.

The estimated cancer risks associated with residents exposed to contaminants in soil are shown in Table A5. All of the estimated cancer risks are within the target cancer risk range established by the EPA. The highest estimated lifetime cancer risk for the resident over a period of 30 years (combined child and adult) at the maximum detected concentration for an individual chemical is for chromium, which is equivalent to 4.8×10^{-5}, which means out of million people exposed 48 additional cancer cases might occur. This estimated risk is at the low-end of the EPA cancer risk range. This is assuming that all chromium found in soil at the site is hexavalent chromium. The more likely valence state of chromium is trivalent chromium, which is less toxic and not considered a carcinogen. The estimated cancer risk associated with exposure to arsenic in soil over a period of 30 years is 2.3×10^{-5}. Which means 23 additional cancer cases might occur out of million people exposed to arsenic in soil at the site. Thus, the cumulative lifetime cancer risk from exposure to both COPCs is 7.1×10^{-5} or 71 additional cancer cases might occur out of million people exposed during residential exposure to soil at the site. This level of cancer risk is well within the EPA cancer risk range, particularly considering the conservative exposure assumption of chromium found onsite as hexavalent chromium and 100% bioavailability of metals. Therefore, the estimated non-cancer and cancer risks are likely to be overestimated and are associated with a very low risk of developing adverse health effects from exposure to soil while living at the future Habitat for Humanity property.

Uncertainty/Limitations of the Evaluation

In general, any risk evaluation is likely to over- or underestimate environmental exposures and the associated health risks because of the uncertainty associated with various exposure assumptions and toxicity values. The major assumptions and limitations that are specific to this evaluation and result in uncertainty are as follows.

A limited amount of surface and subsurface soil data currently exists. This limitation is overcome by using the maximum detected concentration as the exposure point concentration which may result in over- or under-estimation of risk. The overall cancer and non-cancer risks are likely to be over-estimated based on the assumption of 100% bioavailability of metals from soil ingestion and the assumption of 100% hexavalent chromium in soil. The soil samples that were collected as part of the Phase II assessment were taken from areas where known, or potential, sources of contamination existed in the past (e.g. beneath the above ground storage tanks, floor drain inside the existing structure). However, no information exists regarding the location of two underground storage tanks that were permanently closed in the late 1980's. Soil sampling could not be

conducted to evaluate any potential releases from these tanks to soil because the whereabouts of these tanks is currently unknown.

Conclusions

Based on a review of the available environmental soil data and the evaluation of the public health implications associated with potential residential exposure at the future Habitat for Humanity's residential redevelopment, CCPEHA has reached one conclusion.

Residential exposure to contaminants in soil is not likely to harm the health of future residents of the Habitat for Humanity Estes Valley Brownfields site. This conclusion was reached because the estimated non-cancer and cancer risks are below levels of concern. Specifically, the estimated cumulative non-cancer hazard indices from incidental ingestion of arsenic and chromium are below 1 for children and adults. In addition, the estimated lifetime excess cancer risks resulting from residential exposure to soil are within the acceptable cancer risk range, which indicates a very low increased risk of developing cancer.

It should be noted that this conclusion is based on the current environmental data collected to date and the purported site use at the time this evaluation was conducted. If additional environmental data becomes available or an alternative land-use/exposure scenario is selected in the future, the findings of this health consultation should be reconsidered.

Recommendations

Based upon a thorough review of the current soil data and the associated public health implications of residential exposure at the Habitat for Humanity Estes Valley Brownfields site, the following recommendations were made to protect public health:

- With respect to future residential exposures to soil, no additional action is necessary based on what is currently known about the site because the individual and cumulative cancer and non-cancer risk is at or below CDPHE risk management goal.

- CDPHE should ensure that individuals participating in the demolition and reconstruction of the site are familiar with the identification and handling of stained soil and underground storage tanks. In addition, a soils management plan should be established prior to redevelopment activities to ensure the proper handling and/or removal of soil contamination or USTs if encountered during future redevelopment.

Public Health Action Plan

The public health action plan for the site contains a description of actions that have been or will be taken by CCPEHA and other governmental agencies at the site. The purpose of the public health action plan is to ensure that this public health consultation both

identifies public health hazards and provides a plan of action designed to mitigate and prevent harmful human health effects resulting from breathing, drinking, eating, or touching hazardous substances in the environment. Included is a commitment on the part of CCPEHA to follow up on this plan to be sure that it is implemented.
Public health actions that will be implemented include:

- As necessary, CCPEHA will review any additional data collected from the Habitat for Humanity Estes Valley Brownfields site.

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

- Upon request, CCPEHA will provide health education on the findings of this health consultation to stakeholders and the community.

References

U.S. Environmental Protection Agency, Region 9 (EPA 2012). *Regional Screening Levels*, last update April 2012. Available on the Internet at: http://www.epa.gov/region9/superfund/prg/, Accessed July 2012.

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Colorado Department of Public Health and Environment, Hazardous Materials and Waste Management Division (CDPHE 2011a). *Targeted Brownfields Assessment, Phase I Environmental Site Assessment on the Habitat for Humanity Housing Site;* August 2011.

Colorado Department of Public Health and Environment, Hazardous Materials and Waste Management Division (CDPHE 2011b). *Targeted Brownfields Assessment, Sampling and Analysis Plan for the Phase II Environmental Site Assessment on the Habitat for Humanity Housing Site;* October 2011.

Colorado Department of Public Health and Environment, Hazardous Materials and Waste Management Division (CDPHE 2011c). *Targeted Brownfields Assessment, Analytical Results Report for the Phase II Environmental Site Assessment on the Habitat for Humanity Housing Site;* November 2011.

Report Preparation

This Letter Health Consultation was prepared by the Colorado Department of Public Health and Environment (CDPHE) under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved agency methodology existing at the time the letter health consultation was initiated. Editorial review was completed by the cooperative agreement partner. The Agency for Toxic Substances and Disease Registry has reviewed this health consultation and concurs with its findings based on the information presented in this report. ATSDR's approval of this document has been captured in an electronic database, and the approving reviewers are listed below.

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Appendix A. Tables

Table A1. Soil Sample Results for Metals (Samples collected in October 2011)

Sample ID	Date	Arsenic (in mg/kg)	Barium (in mg/kg)	Cadmium (in mg/kg)	Chromium (in mg/kg)	Lead (in mg/kg)	Selenium (in mg/kg)	Silver (in mg/kg)	Mercury (in mg/kg)
SB-1 (0-2.5')	10/17/2011	**1.4**	173	ND	32.1	27.3	ND	ND	ND
SB-2 (2.5-5')	10/17/2011	**1.6**	160	ND	37.6	3.6	ND	ND	ND
SB-3 (5-7.5')	10/17/2011	**1.7**	129	ND	40.8	9.8	ND	ND	ND
SB-4 (5-6')	10/18/2011	**1.6**	116	ND	32.4	21	ND	ND	ND
SB-5 (3-4')	10/18/2011	**2.7**	69.7	ND	18.1	8.9	ND	ND	ND
SB-6 (2.5-5')	10/18/2011	**1.7**	109	ND	26.0	3.3	ND	ND	ND
SB-6a (7')	10/18/2011	ND	99.9	ND	39.8	106	ND	ND	ND
SB-7 (2-4')	10/17/2011	ND	231	ND	61.6	2.6	ND	0.83	ND
SB-8 (0-1')	10/17/2011	**9.8**	189	1.1	28.9	167	ND	0.68	ND
Maximum Detected Concentration		**9.8**	231	1.1	61.6	167	ND	0.83	ND

NOTE: One soil sample collected from SB-5 at a depth of 17ft. was not included in the evaluation because exposure to soil at this depth is not likely to occur.

Table A2. Soil Sample Results for Volatile Organic Compounds and Semi-Volatile Compounds (Samples collected in October 2011)

Sample ID	Date	Acetone	2-Butanone (MEK)	Methylene chloride	All Other VOC's	bis(2-Ethylhexyl) phthalate	All Other SVOC's
SB-1 (0-2.5')	10/17/2011	ND	ND	ND	ND	ND	ND
SB-2 (2.5-5')	10/17/2011	ND	ND	ND	ND	ND	ND
SB-3 (5-7.5')	10/17/2011	ND	ND	ND	ND	ND	ND
SB-4 (5-6')	10/18/2011	ND	ND	ND	ND	ND	ND
SB-5 (3-4')	10/18/2011	ND	ND	ND	ND	ND	ND
SB-6 (2.5-5')	10/18/2011	ND	ND	ND	ND	ND	ND
SB-6a (7')	10/18/2011	ND	ND	ND	ND	0.766	ND
SB-7 (2-4')	10/17/2011	ND	ND	ND	ND	ND	ND
SB-8 (0-1')	10/17/2011	0.106	0.0494	0.0099	ND	6.2	ND
Maximum Detected Concentration		0.106	0.0494	0.0099	ND	6.2	ND

NOTE: One soil sample collected from SB-5 at a depth of 17ft. was not included in the evaluation because exposure to soil at this depth is not likely to occur.

Table A3. Selection of Contaminants of Potential Concern in Soil

Analyte	Maximum Detected Concentration (in mg/kg)	ATSDR Comparison Value (in mg/kg)	EPA Regional Screening Value (in mg/kg)	Selected as COPC
Arsenic	9.8	0.5 (CREG)	0.39 (cancer)	X
Barium	231	10,000 (cEMEG)	15,000 (non-cancer)	
Cadmium	1.1	5 (cEMEG)	70 (non-cancer)	
Chromium	61.6	50* (cEMEG)	0.031* (cancer)	X
Lead	167	N/a	400 (non-cancer)	
Selenium	ND	300 (cEMEG)	390 (non-cancer)	
Silver	0.83	300 (RMEG)	390 (non-cancer)	
Mercury	ND	NA	10 (non-cancer)	
Acetone	0.106	50,000 (RMEG)	61,000 (non-cancer)	
2-Butanone (MEK)	0.0494	30,000 (RMEG)	28,000 (non-cancer)	
Methylene chloride	0.0099	350 (CREG)	56 (cancer)	
bis (2-Ethylhexyl) phthalate	6.2	NA	35 (cancer)	

NOTE: COPC: Contaminant of Potential Concern, mg/kg: milligram contaminant per kilogram soil, ATSDR: Agency for Toxic Substances and Disease Registry, EPA: Environmental Protection Agency, MEK: Methyl Ethyl Ketone, CREG: Cancer Risk Evaluation Guide, cEMEG: chronic-duration Environmental Media Evaluation Guide, RMEG: Reference Dose Media Evaluation Guide, NA: Not Available

TableA4. Non-cancer Hazard Quotients associated with Residential Soil Exposures

COPC	Surface Soil		Sub-surface Soil		Maximum Detected (Surface and Sub-surface Soil)	
	Child	***Adult***	***Child***	***Adult***	***Child***	***Adult***
Arsenic	4.2E-01	4.4E-02	1.2E-01	1.2E-02	4.2E-01	4.5E-02
Chromium	4.1E-01	9.0E-02	7.9E-01	1.7E-01	7.9E-01	1.7E-01
Hazard Index	***8.3E-01***	***1.4E-01***	***9.0E-01***	***1.9E-01***	***1.2E+00***	***2.2E-01***

NOTE: COPC: Contaminant of Potential Concern, 4.0E-01 is equivalent to $4.2 * 10^{-1}$ or 0.42, Hazard Quotient (HQ) is the ratio of the estimated dose in relation to the health-based guideline (i.e. Estimated Dose/Health-based Guideline), Hazard Index is the sum of all HQ's.

Table A5. Theoretical Cancer Risks associated with Residential Soil Exposures

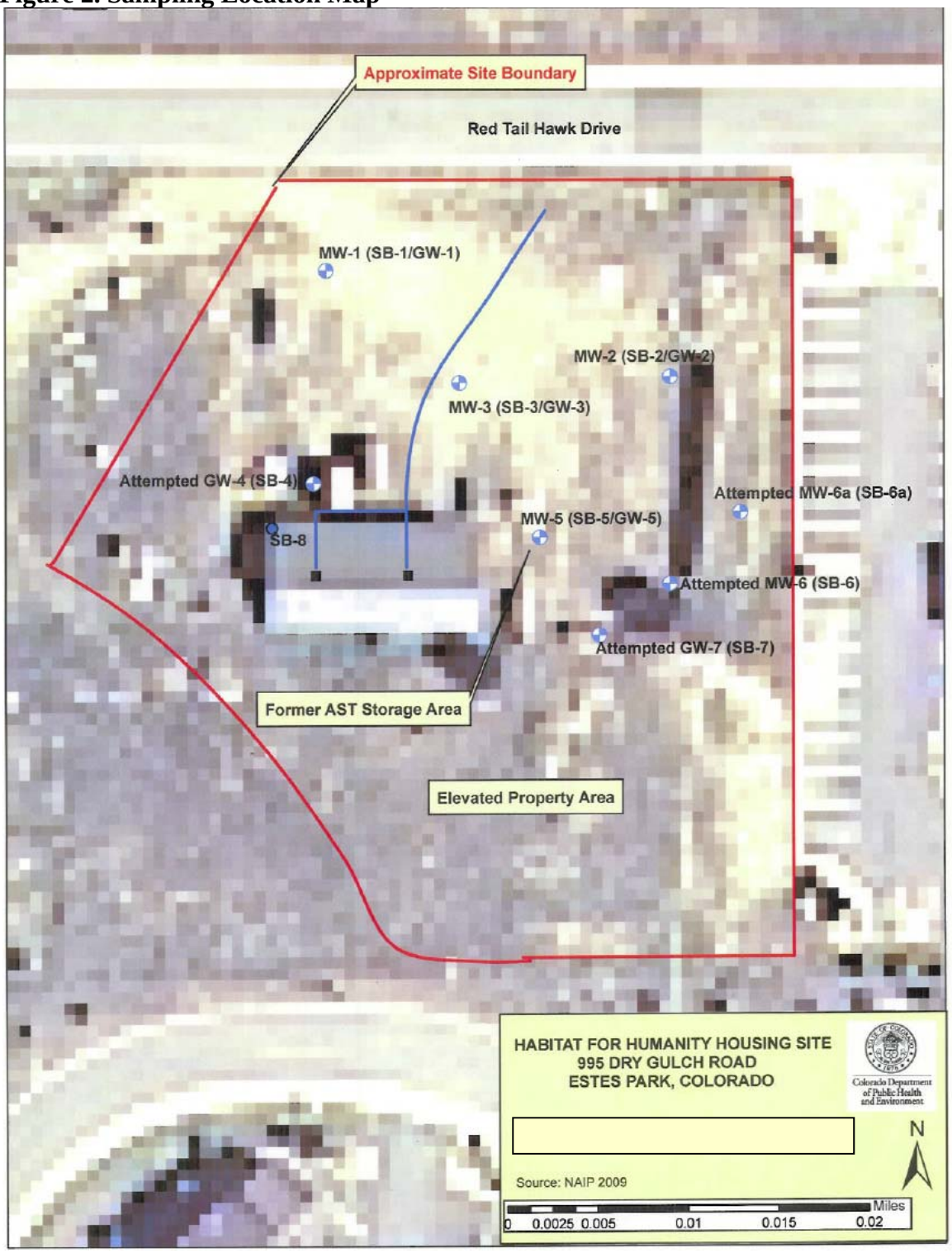
COPC	Surface Soil			Sub-surface Soil			Maximum Detected (Surface and Sub-surface Soil)		
	Child	***Adult***	***Combined***	***Child***	***Adult***	***Combined***	***Child***	***Adult***	***Combined***
Arsenic	1.6E-05	6.9E-06	2.3E-05	4.4E-06	1.9E-06	6.3E-06	1.6E-05	6.9E-06	2.3E-05
Chromium	1.8E-05	7.5E-06	2.5E-05	3.4E-05	1.4E-05	4.8E-05	3.4E-05	1.4E-05	4.8E-05
Cumulative Cancer Risk	***3.4E-05***	***1.4E-05***	***4.8E-05***	***3.8E-05***	***1.6E-05***	***5.5E-05***	***5.0E-05***	***2.1E-05***	***7.1E-05***

NOTE: COPC: Contaminant of Potential Concern, 1.6E-05 is equivalent to $1.6 * 10^{-5}$ or 16 excess cancer cases per million exposed individuals

Figure 1. Site Location Map

SOURCE: CDPHE 2011c

Figure 2. Sampling Location Map



SOURCE: CDPHE 2011