TECHNICAL MEMORANDUM – DRAFT CH2MHILL

Interim Deliverable for the Human Health Risk Assessment – RAGS Part D Tables – South Minneapolis Site

FROM: CH2M HILL Human Health Risk Assessment Team

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Executive Summary

This Technical Memorandum (TM) presents the approach and proposed assumptions to be used in the baseline human health risk assessment (HHRA) for soils at the South Minneapolis Site ("the Site"). The approach and assumptions presented below are consistent with the EPA-approved Work Plan for the Site, which included a description of the future Human Health Risk Assessment activities **(CH2MHILL, 2005).** This TM is an interim document that includes the standard Risk Assessment Guidance for Superfund (RAGS): Volume I Human Health Evaluation Manual (HHEM) Part D, Tables 1 through 6 (excluding Tables 2 and 3, which will be provided after the validated data are available from the Phase 2 Remedial Investigation [RI]). After the Phase 2 RI analytical data are incorporated into the database and comments on the approach and assumptions are received from the public, a baseline HHRA will be prepared in TM format which will include quantitative risk estimates for potential soil, outdoor air, indoor dust, and garden vegetable exposures (RAGS Part D Tables 7-10). In addition, health-protective remedial goals will be identified for residents with vegetable gardens and construction workers; site-specific background concentrations will also be discussed. The overall conceptual site model (CSM) is presented in **Table 1 of Appendix A** and is described in the following sections.

An overview of the contents of this TM was presented at the September 26, 2006 public meeting. During that meeting, community members commented that the proposed exposure durations for residents and construction workers seemed low, and that the homegrown fruit ingestion scenario was not included. Based on these comments, revised (longer) exposure durations are included in this TM, and the relative significance of the homegrown fruit ingestion pathway (in relation to vegetable ingestion) is being evaluated. Recommendations and rationale for alternative values and exposure scenarios are welcome from the public. We will attempt to validate non-standard (site-specific) exposure factor values with existing documentation, where available.

1. Data To Be Used in the HHRA

The source of arsenic in South Minneapolis Neighborhood soil is airborne deposition of grasshopper poison that was manufactured at the nearby CMC Heartland Lite Yard Site from 1938 to 1944. The arsenic cycle in soils is a complex process involving many biotic and abiotic processes that control its overall fate and environmental impact. Arsenic can be present in soil in various oxidation states and chemical species depending on the soil pH and oxidation-reduction potential (**ATDSR, 2005**). The specific form of arsenic currently present at the Site has not been determined.

Soil samples were collected during the Phase 1 and Phase 2 RI, and during post-excavation sampling at remediated properties. For each property sampled, a five-point composite soil sample was collected from the yard from depth intervals within 0-18 inches. If more than one sizable yard was present on a property (e.g., front yard, side yard, and/or backyard), one five-point composite sample was collected from each yard. Currently, the available draft dataset consists of 7,521 soil samples for arsenic analysis. All data used in the HHRA will be validated in accordance with EPA's Quality Assurance/Quality Control (QA/QC) process. The soil samples were collected by various companies or organizations from the general areas identified below:

- **Residential yards not remediated as of April 15, 2006** - 0 to 3 inch interval; collected by the EPA; EPA's Fully Integrated Environmental Location Decision Support (FIELDS) group; a contractor under the EPA Response Engineering and Analytical Contract ("REAC"); Minnesota Department of Agriculture (MDA); and Minnesota Department of Health (MDH) from June 2001 through November 2005.
- **Remediated residential properties** – 12 to 18 inch interval; post-excavation samples collected by REAC and EPA from October 2004 through November 2005.
- **School properties sampled in Summer 2006** – 0 to 3 inch interval; collected by the EPA in 2006.
- **Right-of-Way areas along streets** - 0 to 3 inch interval; collected by the MDH, FIELDS, and EPA from June 2001 through October 2005.
- **Vacant land** - 0 to 3 inch interval; collected by FIELDS in August 2005.

The currently available soil samples were divided into five data groupings (residential, commercial, commercial/industrial, schools, and vacant) based on the current usage of the property where the sample was collected. In addition, 14 soil samples were collected from right-of-way areas along streets, but will not be included in the HHRA calculations.

2. Potential Receptors

The Site is situated in a densely-populated residential area with scattered industrial/commercial properties. Due to the higher exposure frequency and duration for residents compared to workers and schoolchildren, the HHRA will focus on residential exposure scenarios. Industrial and commercial workers would be exposed to the same soil depth interval, but at a lower exposure frequency and shorter exposure duration than adult residents. Likewise, schoolchildren would be exposed to the same soil depth interval, but at a lower exposure frequency and shorter exposure duration, than residential children. In addition, industrial/commercial workers would likely not eat vegetables grown at the

workplace. Therefore, the risks estimated for adult residents and child residents can conservatively represent the risks to industrial/commercial workers and schoolchildren, respectively, from soil exposures.

The following receptors were identified at the Site and will be evaluated in the HHRA:

- **Residents** – child and adult residents at residential properties; and
- **Construction Workers** –workers engaged in short-term remodeling or construction activities at residential properties to depths of 5 feet. [1]

The draft human health CSM presents potential exposure media, exposure points, receptors (current and future), and exposure routes, and is provided in **Table 1** of **Appendix A**.

3. Data Evaluation

The maximum detected concentrations of arsenic in soil from the five current data groupings were compared to the human health risk-based screening level identified in the EPA Region 9 Preliminary Remediation Goal (PRG) table issued in October 2004 (**Table 2** of **Appendix A**). The PRG is based on a residential scenario and target excess lifetime cancer risk (ELCR) of $1x10^{-6}$ **(EPA Region 9, 2004)**.

The background range of arsenic in surface soil (10 to 16 mg/kg) was identified for the site in early 2006 based on samples collected in the South Minneapolis neighborhood (**CH2M HILL, 2006**). Concentrations up to 10 mg/kg were identified as clearly background at the site. Concentrations between 10 mg/kg and 16 mg/kg were identified as potentially impacted and indistinguishable from either background or impacted soils, while concentrations above 16 mg/kg were concluded to be clearly impacted by the site.

4. Exposure Pathways to Be Quantified in the HHRA

Various potential exposure pathways will be quantified in the HHRA.[2] For both adult and child residents, potential accidental ingestion (via hand-to-mouth activities), dermal contact (through the skin), and inhalation (outdoor air) exposures of arsenic in soil and outdoor air will be quantified. In addition, potential intakes will be quantified for ingestion of homegrown garden vegetables based on modeled concentrations in vegetables grown in impacted soil. [3]

At residential properties, indoor dust may be impacted from tracking soil indoors or from fugitive dust emissions from yard soil that have migrated indoors through open windows or doors. Indoor dust samples have not been collected to date, but a limited study of indoor dust concentrations will be conducted in Fall 2006 for homes situated on properties with soil spanning the range of detected concentrations.[4] The dust samples that will be collected

[1] The exposure duration associated with this scenario was questioned at the September 26, 2006 public meeting; a revised (higher) exposure duration is included in this TM, but alternate exposure durations and rationale may be provided to the EPA. We will attempt to validate site-specific values with existing documentation.

[2] The public may provide input on additional exposure pathways that are reasonable for the site. It is requested that rational and documentation, if available, accompany the suggested revisions.

[3] The exclusion of homegrown fruit was questioned at the September 26, 2006 public meeting. Specific fruit types and accompanying rationale are requested from the public, in addition to the types of vegetables grown and the number of months eaten.

[4] Volunteers who will allow indoor dust samples to be collected from their homes are currently being sought.

during the Phase 2 RI will be incorporated into the HHRA, and accidental ingestion exposures to dust will be quantified.

5. Exposure Factors

To assess potential exposures to arsenic at the Site, potential intakes will be quantified after potential exposure point concentrations (EPCs) have been identified. A soil EPC based on background (16 mg/kg) will be presented in the RAGS D tables. In addition, three additional soil EPCs (e.g., 25 mg/kg, 95 mg/kg, and 2,880 mg/kg, depending on the final range of detected concentrations) will be evaluated in the Risk Characterization section of the HHRA to encompass the range of detected soil concentrations during the Phase 1 and Phase 2 RI. Multiple soil EPCs will not be presented in RAGS D table format since risk estimates are directly proportional to EPCs, and when risk estimates are calculated for one soil EPC, the estimated risks associated with other EPCs can be calculated by applying the ratio of the original EPC to the original estimated risk.

The reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios will be estimated for residents and construction workers. The term "RME" refers to a type of high-end exposure estimated by using default values, and is typically used as the basis for action at a Superfund site. The term "CTE" refers to an average exposure that is more likely to occur at a site. The proposed exposure factors to be used in the RME intake calculations are presented in **Tables 4.1 RME** through **4.5 RME** of **Appendix A,** while the proposed exposure factors to be used in the CTE intake calculations are presented in **Tables 4.1 CTE** through **4.5 CTE** of **Appendix A.** The majority of the RME and CTE exposure factors are standard default exposure factors presented in EPA guidance **(EPA, 1991; EPA, 1997; EPA, 2004b)**, while others are site- or region- specific parameters determined based on best professional and scientific judgment, as appropriate. A brief summary of absorption factors and non-standard, site-specific exposure factors is presented below. Additional (standard) exposure factors are provided in **Tables 4.1** through **4.5**.

Soil Exposure Frequencies for Residents

A regional-specific soil exposure frequency will be used in the intake calculations for dermal and inhalation exposures to soil. The proposed soil exposure frequency was identified based on consideration of local climate conditions – specifically, the number of days where the soil is not snow-covered (and the ground is not frozen) and it is not raining.

Based on climate data from October 1959 to May 1979, the mean number of days with snow cover of one inch or more in Minneapolis is 100. The average date of the first 1-inch snow cover is November 22 and the average day of the last 1-inch snowfall is April 2 (**University of Minnesota, 1982**). These data indicate that the snow cover is not continuous for the entire period from November 22 through April 2. Therefore, continuous snow cover was assumed for the months of December, January, and February (i.e., no snowfall for 275 days per year).

Based on data available on the Internet at www.weatherbase.com, the average number of days with rainfall in Minneapolis during the months of March through November is 90. Subtracting 90 days (i.e., days with rainfall) from 275 days (i.e., days without snow) yields

185 days where there is no snow cover and no precipitation. Therefore, a proposed soil exposure frequency of 185 days/year will be used in the HHRA for dermal and inhalation exposures. However, a proposed exposure frequency of 350 days/year will be used for the soil ingestion exposure pathway to account for indoor dust exposure.

Age-Adjusted Intake Rate for Residents

The EPA nation-wide default adult and child resident intake rates for soil ingestion, soil dermal contact, and soil inhalation were age-adjusted to account for multiple intake rates, soil-to-skin adherence factors, skin surface areas, inhalation rates, and body weights over an extended time-period (for use in excess lifetime cancer risk [ELCR] estimates). Calculations are presented in **Table 4.1 Supplement of Appendix A.**

Vegetable Intake Rates

A proposed homegrown vegetable ingestion rate of 0.464 kg/day was identified for a RME scenario for an adult in the Midwest (including Minnesota) in EPA's Exposure Factors Handbook (**EPA, 1997**). Over a proposed assumed 4-month growing period, this ingestion rate results in eating 55.68 kg of homegrown vegetables, or an ingestion rate of 1 pound/day for an adult and 0.4 pounds/day for a child. These proposed values seem to be reasonable upper estimates.

The RME and CTE garden vegetable intake rates for a child resident ages 1-6 were calculated using age-specific intake rates presented in the Exposure Factors Handbook (**EPA, 1997**). Calculations are provided in **Table 4.2 Supplement of Appendix A.**

Exposure Durations

A duration of exposure (expressed as years) to arsenic is used when estimating intakes for all exposure scenarios. Based on feedback received at the September 26, 2006 public meeting, 50 years is proposed for the RME scenario and 15 years is proposed for the CTE scenario for residents. In addition, since construction workers may work in the site vicinity over multiple years, exposure durations of 10 years (RME) and one year (CTE) are proposed based on feedback from the September 26, 2006 public meeting. Feedback on, and rationale for, alternate exposure durations are welcome at this time. Recommended site-specific exposure durations will be further evaluated during preparation of the HHRA.

Dermal Absorption

A dermal absorption factor is used when evaluating dermal exposures to arsenic in soil. The arsenic dermal absorption factor of 0.03 was obtained from EPA dermal guidance (**Wester, et al., 1993 as cited in EPA, 2004b**). Although absorption of arsenic by the dermal route has not been well-characterized for humans, reviews of animal studies indicate the absorption through skin is expected be low compared to other exposure routes (**ATSDR, 2005**).

6. Toxicity Assessment

The specific form of arsenic present at the Site is unknown. Therefore, toxicity information for inorganic arsenic will be used in the HHRA. The following hierarchy of sources was used to obtain toxicity data for arsenic:

- Integrated Risk Information System (IRIS) **(EPA, 2006)**;
- Provisional Peer-Reviewed Toxicity Values (PPRTVs); and
- Health Effects Assessment Summary Tables (HEAST; **EPA, 1997**).

Non-cancer toxicity values to be used in the HHRA are presented in **Tables 5.1** and **5.2** of **Appendix A**; non-cancer inhalation toxicity values could not be located for arsenic. Cancer toxicity values for arsenic are provided in **Tables 6.1** and **6.2** of **Appendix A.**

Toxicity values provided by EPA typically reflect doses to study subjects via ingestion or inhalation exposures. However, dermal exposures are expressed as absorbed doses. Therefore, the absorbed-dose intakes for dermal exposure must be used with absorbed-dose toxicity values. The absorbed-dose toxicity values are calculated by applying oral absorption factors to administered-dose toxicity values. The EPA's recommended arsenic oral absorption factor of 95% will be used in the HHRA (**Bettley, 1975 as cited in EPA, 2004b**). This value is consistent with findings in several studies in humans that indicate that arsenates and arsenites are well-absorbed across the gastrointestinal tract (**ATSDR, 2005**). In accordance with EPA dermal guidance (**EPA, 2004b**), oral toxicity values will be used as dermal toxicity values without adjustment in the HHRA because the recommended oral absorption factor is greater than 50%.

7. Risk Characterization

Risk characterization will involve estimating the magnitude of potential adverse health effects from exposure to arsenic. This step of the HHRA combines the estimated intakes (exposure levels) and toxicity values to provide numerical estimates of potential carcinogenic health risks and semi-quantitative estimates of non-carcinogenic health risks. Risk characterization also considers the nature and weight of evidence supporting these estimates, and the magnitude of uncertainty surrounding the estimates.

The risk estimates are intended to provide the basis for management decisions and do not predict actual health outcomes. The estimates will be based on conservative (health-protective) assumptions, and therefore actual site-related risks are likely to be less than these estimates.

7.1 Approach for Assessing Potential Cancer Risks

To characterize potential carcinogenic effects, statistical probabilities are estimated from calculated intakes and toxicity values that a hypothetical receptor group will develop cancer over a lifetime as a result of the assumed exposures.

Using the cancer slope factors (CSFs), estimated daily intakes averaged over a lifetime of exposure will be converted to incremental risks of a hypothetical receptor group developing cancer. The following formula will be used to estimate potential carcinogenic risk ("excess lifetime cancer risk" [ELCR]) from site exposure:

$$ELCR = Intake \times CSF$$

USEPA's target range for carcinogenic risk associated with Comprehensive Environmental Response Compensation, and Liability Act (CERCLA) sites is 1 in 10,000 (1×10^{-4}) to 1 in 1 million (1×10^{-6}). That is, the risk associated with the site should not exceed this target

range. For carcinogens, USEPA guidance defines chemicals that significantly contribute to a cumulative site cancer risk as those with ELCRs that exceed 10^{-6} for an exposure pathway.

7.2 Approach for Assessing Potential Non-carcinogenic Health Effects

Potential non-carcinogenic health risks will be estimated by calculating a hazard quotient (HQ) for arsenic for each exposure route. The HQ will be calculated as the ratio of the estimated intake to the reference dose (RfD) as follows:

$$HQ = \frac{Intake}{RfD}$$

If the estimated daily intake for arsenic exceeds its RfD, the HQ will exceed 1. An HQ above 1 indicates a potential for adverse health effects associated with arsenic exposure, but it does not indicate the actual level of risk.

A hazard index (HI) approach will be used to evaluate non-carcinogenic health risks for a receptor group posed by more than one exposure route. The HI approach assumes that simultaneous subthreshold exposures by several exposure routes are additive. The HI is equal to the sum of the HQs and is calculated as follows:

$$HI = \frac{I_1}{RfD_1} + \frac{I_2}{RfD_2} \cdots \frac{I_i}{RfD_i}$$

Where:

I = intake level (mg/kg-day)
RfD = chronic reference dose (mg/kg-day)
I_i = intake level (intake) for the ith pathway
RfD_i = reference dose for the ith pathway

A cumulative HI above 1 indicates the potential for adverse health effects. The cumulative HI is defined as the sum of the HQs for all media and all pathways of exposure for a particular receptor.

7.3 Uncertainty Analysis

All HHRAs involve assumptions, professional judgments, and imperfect data to varying degrees; these in turn result in uncertainty in the final estimates of risk. The Uncertainty Analysis subsection of the HHRA will describe the likelihood that the approaches incorporated into the HHRA may result in an overestimate or underestimate of actual risks associated with exposure to site-related arsenic concentrations. Risk assessment in general is a highly conservative process and often is based on extremely conservative assumptions and scenarios.

There are several categories of uncertainty associated with risk assessment (e.g., data evaluation). The uncertainties associated with each category will be presented in the HHRA report.

Where background (non-site-related) concentrations of arsenic are available, the potential cancer and noncancer risks associated with background exposures will be presented.

8. References

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Appendix A

RAGS Part D Tables

TABLE 1

SELECTION OF EXPOSURE PATHWAYS

South Minneapolis Site

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Soil	Surface Soil	Surface Soil	Resident	Adult/Child	Ingestion, Dermal Contact	Quant	Residents may contact arsenic in impacted soil.
		Ambient Air	Emissions from Surface Soil			Inhalation	Quant	Residents may inhale ambient air potentially impacted through fugitive dust emissions from impacted soil.
		Indoor Dust	Indoor Dust			Ingestion	Quant	Residents may ingest indoor dust potentially impacted through fugitive dust emissions from impacted soil or from tracking indoors.
		Garden Vegetables	Garden Vegetables			Ingestion	Quant	Residents may consume garden vegetables grown on impacted soil.
		Soil	Soil (0-5 ft)	Construction Worker	Adult	Ingestion, Dermal Contact	Quant	Construction workers may contact arsenic in impacted soil.
		Ambient Air	Emissions from Soil			Inhalation	Quant	Construction workers may inhale ambient air potentially impacted through fugitive dust emissions from impacted soil.
	Groundwater	--	--	--	--	--	-- (1)	No private potable wells are located within the area. The neighborhood over the plume is served by City of Minneapolis water. Municipal wells are not impacted. Future soil sampling (to a depth of 10 feet) will evaluate the potential for off-site soil to impact groundwater via leaching.
	Surface Water, Sediment	--	--	--	--	--	--	No ponds or streams are located within the investigation area. A lake is present to the southwest outside the investigation area.

Note:

(1) Groundwater exposure pathways are being investigated.

Type of Analysis:

Quant - Quantitative Analysis

TABLE 4.1. Supplement
CALCULATION OF AGE-ADJUSTED INTAKE RATES
REASONABLE MAXIMUM EXPOSURE / CENTRAL TENDENCY EXPOSURE
South Minneapolis Site

Age	Mean BW[2] (kg)	Ingestion						Dermal							Inhalation				
		IR-S		ED		IR-S-Adj (IR * ED) / BW		SSAF[3]		SA[3,4,5]	ED		DA-Adj (SSAF*SA*ED)/BW		IN[2]	ED		IN-Adj (IN*ED)/BW	
		RME[1]	CTE[2]	RME	CTE	RME	CTE	RME	CTE		RME	CTE	RME	CTE	RME/CTE	RME	CTE	RME	CTE
6-11 months	9.1	200	100	1	1	22.0	11.0	0.2	0.04	2625	1	1	57.68	11.54	4.5	1	1	0.49	0.49
1 year	11.3	200	100	1	1	17.7	8.8	0.2	0.04	2571	1	1	45.50	9.10	6.8	1	1	0.60	0.60
2 years	13.3	200	100	1	1	15.0	7.5	0.2	0.04	2434	1	1	36.60	7.32	6.8	1	1	0.51	0.51
3 years	15.3	200	100	1	1	13.1	6.5	0.2	0.04	2893	1	1	37.81	7.56	8.3	1	1	0.54	0.54
4 years	17.4	200	100	1	1	11.5	5.7	0.2	0.04	3175	1	1	36.49	7.30	8.3	1	1	0.48	0.48
5 years	19.7	200	100	1	1	10.2	5.1	0.2	0.04	3255	1	1	33.04	6.61	8.3	1	1	0.42	0.42
6 years	22.6	100	50	1	NA	4.4	NA	NA	NA	NA	NA	NA	NA	NA	10.0	1	NA	0.44	NA
7 years	24.9	100	50	1	NA	4.0	NA	NA	NA	NA	NA	NA	NA	NA	10.0	1	NA	0.40	NA
8 years	28.1	100	50	1	NA	3.6	NA	NA	NA	NA	NA	NA	NA	NA	10.0	1	NA	0.36	NA
9 years	31.5	100	50	1	NA	3.2	NA	NA	NA	NA	NA	NA	NA	NA	13.5	1	NA	0.43	NA
10 years	36.3	100	50	1	NA	2.8	NA	NA	NA	NA	NA	NA	NA	NA	13.5	1	NA	0.37	NA
11 years	41.1	100	50	1	NA	2.4	NA	NA	NA	NA	NA	NA	NA	NA	13.5	1	NA	0.33	NA
12 years	45.3	100	50	1	NA	2.2	NA	NA	NA	NA	NA	NA	NA	NA	13.5	1	NA	0.30	NA
13 years	50.4	100	50	1	NA	2.0	NA	NA	NA	NA	NA	NA	NA	NA	13.5	1	NA	0.27	NA
14 years	56.0	100	50	1	NA	1.8	NA	NA	NA	NA	NA	NA	NA	NA	13.5	1	NA	0.24	NA
15 years	58.1	100	50	1	NA	1.7	NA	NA	NA	NA	NA	NA	NA	NA	14.5	1	NA	0.25	NA
16 years	67.1	100	50	1	NA	1.5	NA	NA	NA	NA	NA	NA	NA	NA	14.5	1	NA	0.22	NA
17 years	63.2	100	50	1	NA	1.6	NA	NA	NA	NA	NA	NA	NA	NA	14.5	1	NA	0.23	NA
18 < 25 years	67.2	100	50	7	5	10.4	3.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
25 < 35 years	71.5	100	50	10	4	14.0	2.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
35 < 45 years	74.0	100	50	10	NA	13.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
45 < 55 years	74.5	100	50	5	NA	6.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
<7 to <18	45.6	NA	NA	NA	NA	NA	NA	0.1	0.01	5800	12	NA	106.82	NA	NA	NA	NA	NA	NA
Adult (>18)	69.3	NA	NA	NA	NA	NA	NA	0.1	0.01	5800	32	9	187.41	7.53	13.25	32	9	6.12	1.72
			Total =	50	15	145	51			**Total =**	50	15	541	57	**Total =**	50	15	13.00	4.77

Footnotes:

[1] EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

[2] EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002F.

[3] EPA, 2004: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. EPA/540/R/99/005.

[4] SA for adult includes head, hands, forearms, and lower legs; SA for child includes head, hands, forearms, lower legs, and feet.

[5] SA was calculated for child using Exhibit C-1 of RAGS Part E.

[6] Age-adjusted intake factors using EPA's default values.

BW - body weight (kg)
DA - Adj - adjusted dermal absorption (mg-year/kg-day)
ED - exposure duration (years)
IN - inhalation rate (m^3/day)
IN-Adj - adjusted inhalation rate (m^3/day)
IR-S - soil ingestion rate (mg/day)
IR-S-Adj - adjusted soil ingestion rate (mg-year/kg-day)
SA - skin surface area (cm^2)
SSAF - soil-to-skin adherence factor (mg/cm^2-day)

TABLE 4.2.Supplement
VALUES USED FOR INTAKE OF HOMEGROWN VEGETABLES
South Minneapolis Site

Body Weight (kg)[1]				Body Weight (kg)[2]		Intake of Homegrown Vegetables (g/kg-day)[3]		Intake of Homegrown Vegetables (g/day)[4]	
Age	Boys Mean	Girls Mean	Boys and Girls Mean	Age	Boys and Girls Mean	Median	95th percentile	Median	95th percentile
1 year	11.8	10.8	11.3	1 - 2 years	12.3	3.27	19.6	40.2	241
2 years	13.6	13	13.3						
3 years	15.7	14.9	15.3	3 -5 years	17.5	1.25	7.74	21.8	135
4 years	17.8	17	17.4						
5 years	19.8	19.6	19.7						
							Average[5] =	29.2	178

Sources:

EPA, 1997: Exposure Factors Handbook (EFH). EPA/600/P-95/002F.

Notes:

(1) Body weights were obtained from Table 7-3 of the EFH (EPA, 1997).

(2) Mean Body weights calculated for two child age groups (1-2 years old and 3-5 years old).

(3) Intakes for homegrown vegetables were obtained from Table 13-13 of the EFH (EPA, 1997).

(4) Intakes for homegrown vegetables were calculated by multiplying body weight by intake.

(5) Average intake for homegrown vegetables.

TABLE 5.1

NON-CANCER TOXICITY DATA -- ORAL/DERMAL

South Minneapolis Site

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal (1)	Absorbed RfD for Dermal (2)		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfD:Target Organ(s)	
		Value	Units		Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Arsenic	Chronic	3.0E-04	mg/kg-day	0.95	3.0E-04	mg/kg-day	skin	3/1	IRIS	04/07/2006

Note:

(1) Source: Risk Assessment Guidance for Superfund. Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. Section 4.2 and Exhibit 4-1.

(2) EPA recommends that the oral RfD not be adjusted to estimate the absorbed dose when the absorption efficiency is greater than 50%; therefore, the Oral RfD was used as Absorbed RfD for demal exposure for arsenic.

Definitions: IRIS = Integrated Risk Information System

TABLE 5.2

NON-CANCER TOXICITY DATA -- INHALATION

South Minneapolis Site

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC		Extrapolated RfD (1)		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfC : Target Organ(s)	
		Value	Units	Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Arsenic	Chronic	NA	NA	NA	NA	NA	NA	NA	NA

Definitions: NA = Not Available

TABLE 6.1

CANCER TOXICITY DATA -- ORAL/DERMAL

South Minneapolis Site

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal (1)	Absorbed Cancer Slope Factor for Dermal		Weight of Evidence/ Cancer Guideline Description	Oral Cancer Slope Factor	
	Value	Units		Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Arsenic	1.5E+00	$(mg/kg\text{-}day)^{-1}$	95%	1.5E+00	$(mg/kg\text{-}day)^{-1}$	A	IRIS	04/07/2006

(1) Source: Risk Assessment Guidance for Superfund. Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. Section 4.2 and Exhibit 4-1.

(2) EPA recommends that the oral cancer slope factor not be adjusted to estimate the absorbed dose when the absorption efficiency is greater than 50%; therefore, Oral Cancer Slope Factor is used as Absorbed Cancer Slope Factor for demal exposure for arsenic.

Definitions: IRIS = Integrated Risk Information System

Weight of Evidence definitions:

Group A chemicals (known human carcinogens) are agents for which there is sufficient evidence to support the causal association between exposure to the agents in humans and cancer.

TABLE 6.2

CANCER TOXICITY DATA -- INHALATION

South Minneapolis Site

Chemical of Potential Concern	Unit Risk		Inhalation Cancer Slope Factor		Weight of Evidence/ Cancer Guideline Description	Unit Risk : Inhalation CSF	
	Value	Units	Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Arsenic	4.3E-03	$(ug/m^3)^{-1}$	1.5E+01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	04/07/2006

Definitions: IRIS = Integrated Risk Information System

Weight of Evidence definitions:

Group A chemicals (known human carcinogens) are agents for which there is sufficient evidence to support the causal association between exposure to the agents in humans and cancer.