IERA-RS-BR-TR-2000-0005



UNITED STATES AIR FORCE IERA

Human Health Risk Assessment, Pope Air Force Base, North Carolina (AMC)

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July 2000

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Air Force Institute for Environment, Safety and Occupational Health Risk Analysis Risk Analysis Directorate Risk Assessment Division 2513 Kennedy Circle Brooks Air Force Base TX 78235-5123

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HUMAN HEALTH RISK ASSESSMENT TOTAL TRIHALOMETHANES AT POPE AFB, NORTH CAROLINA (AMC)

EXECUTIVE SUMMARY

A human health risk assessment (HHRA) of total trihalomethanes (TTHM) was completed for Pope Air Force Base (Pope AFB). The purpose of this assessment is to quantify risks to military personnel and their families living on Pope AFB ingesting base supplied water with elevated levels of TTHM. HQ AMC/SGPB supported the base bioenvironmental engineer's request for AFIERA to perform a HHRA.

Pope AFB is located 12 miles northwest of Fayetteville, North Carolina. The base adjoins US Army Fort Bragg and provides intratheater airlift and close air support for airborne forces and other personnel, equipment, and supplies. Pope AFB purchases their drinking water from Fort Bragg. Fort Bragg has responsibility for supplying safe drinking water as defined by the US Environmental Protection Agency (USEPA) Safe Drinking Water Act (SDWA) and monitoring the drinking water for compliance with the SDWA and local and State requirements. Pope AFB is responsible to inform the base populace of any non-compliance status as well as an annual consumer confidence report (CCR) for the purchased water. Fort Bragg sampling data indicated that the TTHM level is currently exceeding the maximum contaminant level of 100 micro-grams per liter of water. The Air Force Institute for Environment, Safety and Occupational Health Risk Analysis (AFIERA) performed a narrow focused risk assessment for TTHM in the water system.

The HHRA reviewed all potential exposure pathways of drinking water by comparing sample results to the USEPA Region 3 established standards. When an analytical result was identified as being above the USEPA Region 3 risk based concentration (RBC), it was identified as a chemical(s) of potential concern (COPC). There are 4 chemicals that sum together for the TTHM value. Of the 4 chemicals, 3 were above the RBC at least 10% of the total sampling history (May 1985- May 2000). Each COPC was statistically reviewed and risk estimates were calculated.

This health risk assessment evaluated both cancer and non-cancer end points. Calculated risk for both cancer and non-cancer indicated that expected exposures are within the EPA guidelines. The risk calculations indicate personnel should not incur adverse health impact due to the TTHM in drinking water.

INTRODUCTION

Purpose

The purpose of this health risk assessment is to quantify risks to military personnel and their families living on Pope AFB from exposures to total trihalomethanes (TTHM) in the drinking water. HQ AMC/SGPB supported the base bioenvironmental engineer's request for a HHRA.

Background

Pope AFB is located 2 miles west of Spring Lake, NC and 12 miles northwest of Fayetteville, North Carolina. The main highways are I-95, Hwy 210, and Hwy 87. The base is surrounded by US Army Fort Bragg and provides intratheater airlift and close air support for airborne forces and other personnel, equipment, and supplies. Pope AFB purchases their drinking water from Fort Bragg.

Fort Bragg is responsible for supplying safe drinking water as defined by the US Environmental Protection Agency (USEPA) Safe Drinking Water Act (SDWA) and monitoring the drinking water for compliance with the SDWA and local and State requirements. Pope AFB is responsible to inform the base populace of non-compliance status with the drinking water. They are required to provide an annual consumer confidence report (CCR) for the purchased water.

Fort Bragg sampling data indicated that the TTHM level exceeds the maximum contaminant level of 100 micro-grams per liter of water (ug/L). The Air Force Institute for Environment, Safety and Occupational Health Risk Analysis (AFIERA) was requested to provide a focused risk assessment for TTHM in the water system.

Based on the report "Air Force Assignment Data Analysis Report" (AFIERA, 2000), the 95th percentile upper confidence level of time on station is 7.67 years for enlisted members and 4.18 years for officers. Based on this, we chose exposure duration of 8 years.

Climate

Pope AFB enjoys a moderate climate without marked seasons. May through September is typically hot and temperatures can reach 100°F accompanied with moderate to high relative humidity levels. Historical averages of the climatic conditions are shown in Table 1.

Average				
Season	High (°F)	Low (°F)	Humidity	Precipitation
Winter	54.3	32.7	61.3	3.5
Spring/Fall	70.7	46.3	56.3	3.3
Summer	85.6	65	64.4	4.7

TABLE 1. Historical Average Climatic Conditions

RISK ASSESSMENT METHODOLOGY

We used existing US EPA risk assessment guidance for superfund (RAGS) as the framework for evaluating data quality, exposure intake, toxicity, and risk characterization. Our analysis is separated into four distinct phases and includes a discussion on the uncertainty and its effect on the risk estimate. Although these guidance documents have been written to address environmental cleanup, the approach is considered valid to assess exposure, toxicity, and risk at non-cleanup sites.

Data Collection and Evaluation

Data collection and evaluation answers the questions of what contaminants are present, where they are present, and in what concentrations. 43 MDOS/SGOAB provided 15 years of TTHM sampling data for Fort Bragg. The data was provided on an Excel spreadsheet with 4 to 5 sample locations per sample period (day). Over all there are 1176 data points with 294 for each of the 4 chemicals. These results were used to calculate excess lifetime cancer risk and non-cancer effects to personnel living on Pope AFB for an 8-year duration.

The results we reviewed were summary in nature and did not include data packages with holding times, chromatograms, quality control information, or practical quantification limits. For the purposes of this assessment, we must assume that prior reviews have documented the data to be of adequate quality. The uncertainty of this data gap on the outcome is unknown.

The sample results were screened to identify contaminants of potential concern (COPC). During the screening process, the results were compared to the United States Environmental Protection Agency (USEPA), Region 3 Risk Based Concentration (RBC) values. Region 3 RBC values were used because US EPA Region 4 recommends using them for risk assessments in their region. This initial screening identified 3 COPC.

Each COPC was queried to determine the frequency (number of times it was sampled compared to the number of times it was above the RBC value). Contaminants with a frequency of less than 5 percent would be eliminated. Arguably, as stated in RAGS, using 5 percent with data sets of less than 20 samples automatically results in the inclusion of all data. All of the COPC were above the five percent threshold.

When a contaminant of potential concern was identified, all sample results for that contaminant were evaluated. Some of the sample results were less than the detection limit. In accordance with RAGS, sample results indicating less than the sample detection limit were modified to half of the detection value, and samples indicating non-detect were given half of the lowest detection level.

The contaminants were sorted by chemical. The results for each contaminant were then statistically analyzed to determine if the data distribution fit better to a normal or log normal distribution. The 95 percentile upper confidence limit (95% UCL) was calculated based on the type of best fit. The 95% UCL value was used as the (RME) concentration to derive risk

numbers. Whenever the 95% UCL exceeded the maximum sample result value, the maximum sample result was used as the RME. The central tendency (CT) values were also calculated to derive comparative risk numbers. The COPC are listed in Table 2.

Num	CAS	СОРС	RBC	Unit	Max	95% UCL	СТ
1	75274	Bromodichloromethane	0.17	μg/L	102	21.6	4.783
2	75252	Bromoform	2.3	µg/L	1.4	Not Ne	cessary
3	124481	Chlorodibromomethane	0.13	μg/L	45.2	4.79	1.068
4	67663	Chloroform	0.15	μg/L	245.9	174.174	76.29

 TABLE 2. Chemicals of Potential Concern.

The data for this risk assessment is well established. TTHM samples were collected at least 4 times a year for the past 15 years. Good data collection increases the confidence of the risk estimation. All of the samples reviewed in this assessment were collected and analyzed by Fort Bragg and their laboratory of choice.

Trihalomethanes are produced from the reaction of chlorinated water with organic and inorganic material in the water. A more detailed discussion is provided under the toxicity section. A brief synopsis of each chemical is provided below.

<u>Bromodichloromethane</u> - Bromodichloromethane (BDCM) is currently used as a chemical intermediate for organic synthesis and as a laboratory reagent. It is commonly found as a by-product of water chlorination and may be found in drinking water and swimming pools. There is no human data for health effects from exposure to BDCM, but animal data suggests it may effect the liver and kidney.

<u>Bromoform</u> - Bromoform is used as a chemical intermediate in the synthesis of organic chemicals and pharmaceuticals. It is also used in polymer reactions in the vulcanization process of rubber and can be used for medicinal purposes. It is also a chlorination by-product and may be an indicator of organic activity in water. Bromoform can be toxic by all routes of exposure. Symptoms of acute exposure include severe irritation of the eyes, lacrimation, salivation, skin and respiratory tract irritation, headache, and dizziness. Chronic exposure may cause liver damage and memory loss.

<u>Chlorodibromomethane</u> - In the USA, chlorodibromomethane (CDBM) is currently produced in small amounts for laboratory use. Another source of CDBM is a by-product of water chlorination (drinking water disinfection). There were no studies on health effects from exposure to CDBM, but animal studies suggest toxicity to the liver and kidney. Inhaling high levels of CDBM can affect CNS activity.

<u>Chloroform</u> - Chloroform is used to manufacture other chemicals. It is released to the air and water through waste streams. Chloroform is also a by-product of water chlorination. Chloroform affects the CNS, liver, and kidneys. Acute exposures may result in fatigue, dizziness, and headache. Chloroform may have a possible link to colon and urinary cancer.

Exposure Assessment

Exposure assessment is the determination or estimation, qualitatively or quantitatively, of the magnitude, frequency, duration, and route of exposure. Exposure is defined as the contact of an organism with a chemical or physical agent.

The exposure assessment is a four-step process:

- Step 1: Characterize the Exposure Setting
- Step 2: Identify Exposure Pathways
- Step 3. Quantify Exposure
- Step 4. Verify Completed Pathway

Step 1. Characterize the Exposure Setting

The exposure setting for this assessment is a typical military installation where military and their dependents reside on base and receive their water from the base. Assumptions made for the exposure assessment include; base population drank 2 liters of plumbed water per day and took one shower/bath per day. Civilian employees (industrial workers) drank 1 liter of plumbed water per day and took one shower per day on base.

Based on the report "Air Force Assignment Data Analysis Report" (AFIERA, 2000), the 95th percentile upper confidence level of time on station is 7.67 years for enlisted members and 4.18 years for officers. Based on this, we chose exposure duration of 8 years. We assumed worst case for 350 days per year exposure, which is the EPA default value (EPA, 1989). Since this HRA is conservative with respect to approach and calculations, the EPA default value of 15 days away from the site is used in-lieu of more site-specific data that may be closer to 335 days accounting for annual leave. For industrial workers, we compared risks for 15, 20, 25, and 30 years of service.

Step 2. Identify Exposure Pathways

This assessment considered possible exposure pathways that included domestic uses of water – consumption and washing. The routes of exposure considered were ingestion, inhalation from showering, and dermal absorption from showering. No other pathways from water were included (washing clothes, flushing, and cooking).

Step 3. Quantify Exposure

A tiered approach to risk assessment was followed as shown in Figure 1. A simple screening was conducted comparing sample results to EPA Region 3 risk based concentration (RBC) values. EPA Region 3 RBC values were used to provide a consistent approach for all Southwest Asia Risk Assessments. Tier I screening indicated that only bromoform is below the RBC. COPC were further evaluated using USEPA Risk Assessment Guidance for Superfund Sites.

In order to quantify exposures, it is necessary to make assumptions and assign values to these assumptions. A USEPA risk assessment usually includes an estimation of intake based on both the average concentration and a concentration correlating to the 95th upper confidence level on the mean. Since the 95th UCL approach is more conservative, it was used to estimate intake. *This likely overestimated the risk.* Attachment 1 presents a summary of all the COPC (includes total number of analytes, frequency, media type, RBC value, max value, best fit determination of sample distribution as being normally or lognormally distributed -- determined by the D'Agostino's test for fit, and sampling information).

In the absence of site-specific data, USEPA recommends default values based on scientific studies and professional judgment. Table 3 provides the values that we used in the evaluation. We have designated each as either a site-specific (SS) value or USEPA default (EPA).

Land Use	Exposure Pathway	Daily Intake Rate	Exposure Frequency	Exposure Duration	Body Weight
Residential	Ingestion of Potable Water	2 liters (USEPA) 5 liters RSRE)	350 days/yr (USEPA)	8 years (SS)	70 kg (A) (USEPA) 15 Kg (C) (USEPA)
	Inhalation of Contaminants (Showering)	20 meters ³ /day (USEPA)	350 days/yr (SS)	8 years (SS)	70 kg (A) (USEPA) 15 Kg (C) (USEPA)

TABLE 3. Exposure Parameters for Inhalation and Ingestion

Note: (A) = Adult, (C) = Child

TABLE 4. Exposure Parameters for Dermal

For dermal absorption in a showering scenario, defaults are somewhat different. We used parameters for skin surface area and bath duration.

		Skin Surface Area			
Residential	Dermal Absorption (Showering)	23000 cm ² (A) (USEPA) 7200 cm ² (C) (USEPA)	350 days/yr (SS)	8 years (SS)	70 kg (A) (USEPA) 15 Kg (C) (USEPA)
		Bath Duration			
		0.2 hr (USEPA)			



Figure 1. Tiered Approach to Risk Assessment.

There are 3 basic equations used to calculate intake and dose: drinking water ingestion, drinking water – shower inhalation, and drinking water – shower dermal. The plumbed water is assumed to be from potable water sources only. The equations are presented below.

Equation 1 is used to calculate the average daily intake from ingestion of contaminants in the drinking water. The exposure assumption values used to calculate the average dose from ingestion of drinking water contaminants are shown in table 2. The central tendency (CT), or average ingestion rate was assumed to be 2 L/day, with a maximum ingestion rate of 5 L/day. The average ingestion rate was selected because it is the default long-term ingestion rate for adults, and is based on the average consumption rate of water for adults performing normal activities. The maximum ingestion rate was selected because it represents an increased consumption of water due to heavy activities/increased temperature during the workday.

Equation 1: Residential Exposure – Drinking Water, Ingestion

$$I = CW \times \left(\frac{CR \times EF \times ED}{BW}\right) \times \frac{1}{AT}$$

where:

Ι	=	intake (mg/kg body weight per day)
CW	=	Chemical concentration in water (ug/L)
CR	=	Contact rate (liters/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (usually expressed in years)
BW	=	Body weight (kg)
AT	=	Averaging time (in days; for carcinogens 70 years x 365 days/year, for non-
		carcinogens ED x 365 days/year)

Equation 2 is used to calculate the average daily intake from inhalation of volatilized airborne contaminants from plumbed water. The exposure assumption values used to calculate the average dose from airborne contaminants are shown in table 2.

Equation 2: Residential Exposure - Non-Potable Water, Showering -- Inhalation

$$I = CA \times \left(\frac{IR \times EF \times ED \times SD}{BW}\right) \times \frac{1}{AT}$$

where:

Ι	=	Intake (mg/kg [body weight] per day)
CA		Chemical concentration in air (mg/m3)
IR	=	Inhalation rate (m3/min)
EF	=	Exposure frequency (days/year)

ED	=	Exposure duration (usually expressed in years)
BW	=	Body weight (kg)
AT	=	Averaging time (in days; for carcinogens 70 years x 365 days/year, for non-
		carcinogens ED x 365 days/year)
SD	=	Shower duration (minutes)

Equation 3 is used to calculate the average daily dose resulting from dermal contact with plumbed water. The exposure assumption values used to calculate the average dose from airborne contaminants are shown in Table 3.

Equation 3: Residential Exposure – Non-Potable Water, Showering -- Dermal

$$AD = CW \times \left(\frac{SA \times pK \times ET \times EF \times ED \times CF}{BW}\right) \times \frac{1}{AT}$$

where:

AD	=	Absorbed Dose (mg/kg body weight per day)
CW	=	Chemical concentration in water (mg/L)
SA	=	Skin surface area available for contact (cm ²)
pК	=	Chemical-specific dermal permeability constant (cm/hr)
ΕT	=	Exposure time (hours/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (usually expressed in years)
CF	=	Volumetric conversion factor for water (1 liter/1000cm ³)
\mathbf{BW}	=	Body weight (kg)
AT	=	Averaging time (in days; for carcinogens 70 years x 365 days/year, for
		carcinogens ED x 365 days/year)

non-

Step 4. Verify Completed Pathway

The evaluation and verification of the pathway is difficult with the limited data provided. For simplicity, our assumption is that personnel living on base are consuming plumbed water and showering on base and therefore the exposure pathway is considered complete.

Toxicity Assessment

Disinfection of drinking water is one of the major public health advances in the 20th century. One hundred years ago, typhoid and cholera epidemics were common throughout American cities and disinfection was a major factor in reducing these epidemics. However, the disinfectants themselves can react with naturally occurring materials in the water to form unintended organic and inorganic byproducts, which may pose health risks. Trihalomethanes (THM) are a group of four chemicals that are formed along with other disinfection byproducts. The trihalomethanes are chloroform, bromodichloromethane, chlorodibromomethane, and bromoform. EPA has published the Stage 1 Disinfectants/Disinfection Byproducts Rule to regulate total trihalomethanes (TTHM) at a maximum allowable annual average level of 80 parts per billion. This standard will replace the current standard of a maximum allowable annual average level of 100 parts per billion in December 2001 for large surface water public water systems. The standard will become effective for the first time in December 2003 for small surface water and all ground water systems such as Pope AFB.

Since the discovery of chlorination byproducts in drinking water in 1974, numerous toxicological studies have been conducted. These studies have shown several disinfection byproducts to be carcinogenic in laboratory. Some disinfection byproducts have also been shown to cause adverse reproductive or developmental effects in laboratory. However, there is considerable uncertainty involved in using the results of high-dose, toxicological studies of some byproducts occurring in disinfected drinking water to estimate the risk to humans from chronic exposure to low doses of these and other byproducts. In the area of epidemiology, a number of studies have been completed investigating the relationship between exposure to chlorinated surface water and cancer. Some have suggested an increased cancer risk to those exposed to chlorinated waters while others have demonstrated none. There remains considerable debate in the scientific community on the significance of these contradictory findings concerning chlorinated water and disinfection byproducts.

Toxicity Values

The toxicity assessment attempts to answer the questions "What are the main health effects?" and "At what concentrations might we see an effect?". The toxicity values are based on oral, dermal, and inhalation exposure pathways. Values for reference doses, reference concentrations, cancer slope and unit risk values have been derived from a variety of sources. The most acceptable and verifiable values are derived from US EPA's Integrated Risk Information System (IRIS).

To be cited in IRIS, there must exist a body of knowledge regarding a given chemical. For noncancer studies, it is important to have chronic, multigenerational, developmental and reproductive studies. The use of established "no observed adverse effect level" (NOAEL) is the preferred method. In the absence of a NOAEL, the "lowest observed adverse effect level" (LOAEL) can be used. Human data usually take precedence over animal bioassay data. Cancer studies include human epidemiology studies, rodent bioassays, and vitro assays that might shed light on the mode of action for carcinogenesis. Non-verifiability in IRIS is usually due to a deficiency in the scientific data required for making quantitative analyses.

Toxicity values represent "safe" levels of exposure to avoid cancer and non-cancer effects. The primary source of for the values used come from IRIS. Where values for chemicals were not

found in IRIS, EPA Region III RBC tables were consulted. These tables are a compilation of both USEPA Health Effects Assessment Summary Table (HEAST) and recent EPA-NCEA (National Center for Environmental Assessment) provisional toxicity values. Table 5 identifies the COPC, the weight of evidence characterization of carcinogenicity, toxicity values used, and the source of value.

Risk Characterization

Risk characterization integrates information from the other components of the risk assessment and forms an overall conclusion about the risk. Steps for quantifying the carcinogenic risk or non-carcinogenic hazard quotient are applied to each exposure pathway and analyzed.

Carcinogenic Effects

For carcinogens, risk estimators are expressed as the excess incremental probability, above background cancer rates, of an individual developing cancer over a lifetime as a result of exposure to the potential carcinogen. US EPA guidance assumes a linear dose-response relationship due to the relatively low exposure levels found at Superfund sites; therefore, the slope factor is a constant, and the risk will be directly related to intake. Under this assumption, the linear low-dose equation for a single chemical is described below.

Equation 4: Carcinogenic Risk

$$\begin{bmatrix} Risk = LADD \times SF \end{bmatrix}$$

Where:

Risk = A unit-less probability LADD = Lifetime average daily dose over 70 years (mg/kg-day) SF = Slope factor, the carcinogenic toxicity value (mg/kg-day)⁻¹

Next, the risk calculated for each chemical of concern is summed together to generate an estimate of total risk per exposure pathway.

Equation 5: Total Risk

Total
$$Risk = Risk_1 + Risk_2 + Risk_3 + ... + Risk_i$$

Where:

Total Risk = the total cancer risk, expressed as a unit-less probability Risk_i = the calculated risk for each chemical of concern

	Referen	ce Doses a	nd Carcinoge	nic .	Potency Slop	e Fa	ctors			
			Sources:				H = HEAST		O = other	
			I = IRIS				A = HEAST Alternate			
			E = EPA-NCEA prov	isional	zalue		W = Withdrawn from I	RIS or H	EAST	
					Oral				Inhalation	
				data	Slope	data		duta	Slope	data
		EPA	Oral	ce of	Factor	ce of	Inhalation	ce of	Factor	Source of data
		Cancer	RfD0	Sour	CSFo	Sour	<i>RfDi</i>	Sour	CSFi	Sour
Contaminant	CAS	Class.	mg/kg/d		kg∙d/mg		mg/kg/d		kg∙d/mg	-
Bromodichloromethane	75274	B2	2.00E-02	I	6.20E-02	Ι				
Chlorodibromomethane	124481	С	2.00E-02	Ι	8.40E-02	Ι				
Chloroform	67663	B2	1.00E-02	I	6.10E-03	Ι	8.60E-05	E	8.10E-02	Ι

TABLE 5. Toxicity Factors for COPC

Values for RfD, RfC, and slope factors derived from a number of sources:

I: US EPA Integrated Risk Information System.

n: US EPA National Center for Environmental Assessment (NCEA)

h: HEAST Tables (Health Effects Assessment Summary Tables

re: Route extrapolation

US EPA Cancer Classification Scheme:

A: Human carcinogen: sufficient evidence from epidemiologic studies to support a causal association between exposure and cancer.

B: Probable Human Carcinogen: weight of evidence of human carcinogenicity based on epidemiologic studies is limited; agents for which weight of evidence of carcinogenicity based on animal studies is sufficient.

Two subgroups:

B1: limited evidence of carcinogenicity from epidemiologic studies.

B2: Sufficient evidence from animal studies; inadequate evidence or no data from epidemiologic studies

C: Possible Human Carcinogen: limited evidence of carcinogenicity in animals in the absence of human data.

D: Not Classifiable as to Human Carcinogenicity: inadequate human and animal evidence of carcinogenicity or no data are available.

E: Evidence of Non-carcinogenicity for Humans: no evidence for carcinogenicity in at lease two adequate animal tests in different species or in both adequate epidemiologic and animal studies.

Reference Concentration (RfC): An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious non-cancer effects during a lifetime.

Reference Dose (RfD): An estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

Cancer Slope Factor (CSF): The slope of the dose-response curve in the low-dose region. When low-dose linearity cannot be assumed, the slope factor is the slope of the straight line from 0 dose (and 0 excess risk) to the dose at 1% excess risk. An upper bound on this slope is usually used instead of the slope itself. The units of the slope factor are usually expressed as 1/(mg/kg-day).

Noncarcinogenic Effects

The measure used to describe the potential for noncarcinogenic toxicity to occur in an individual is not expressed as a probability, but is a comparison of the exposure (intake) with a reference dose. This ratio of exposure to toxicity is called the noncancer hazard quotient.

Equation 6: Noncarcinogenic Hazard Quotient

[Noncancer Hazard Quotient* = E/RfD]

Where:

E = Exposure level or chronic daily dose (CDD) RfD = Reference dose

*E And RfD must be expressed in the same units and represent the same exposure period.

The RfD is the US EPA's preferred oral toxicity value for noncancer effects. It is defined as an estimate of a daily exposure level for the human population, including sensitive subpopulations (with an order of magnitude for uncertainty) that is likely to be without an appreciable risk of deleterious effects during a lifetime. If the exposure level exceeds the toxicity value (ratio greater than 1), there may be some concern for potential adverse health effects. The level of concern does not increase linearly as the RfD is approached or exceeded because RfDs do not have equal accuracy or precision nor are they based on the same severity of toxic effects.

Similar to calculating total risk, the total potential for noncancer effects is determined by summing the hazard quotients for each chemical of concern, resulting in a hazard index (also described in Exposure Assessment, Step 3).

Equation 7: Hazard Index

$$\left[HI^* = E_I/RfD_I + E_2/RfD_2 + \dots + E_i/RfD_I \right]$$

Where:

 E_i = Exposure level (or intake) for the ith toxicant RfD_i = Reference dose for the ith toxicant

*E And RfD must be expressed in the same units and represent the same exposure period.

If the hazard index exceeds unity (1), the analyst must closely examine the target organs involved. If different target organs are affected, the hazard index should be recalculated to group those chemicals that may elicit like responses.

Risk Calculations

Using the principles described above, the carcinogenic risks and non-cancer hazard indices were calculated accounting for exposures to drinking water ingestion, inhalation from showering, and dermal absorption from showering. The calculation for cancer risk is based on an 8-year exposure, but can be extrapolated to any period since the cancer risk is directly related to intake. For non-cancer effects, the hazard quotient is the same, regardless of duration.

In the Superfund program, USEPA tries to manage risks in the one in ten thousand to one in one million range. Below one in one million, the risk is considered negligible; above one in ten thousand, some remediation is usually required. The Agency's preference is for risk numbers to be near the more protective end of the range (one in one million). For Pope AFB, the cancer risk estimates for exposure to water are within the USEPA's target range. The cancer risks associated with exposure medium at Pope AFB, for an 8-year duration, for both 2-L/day and 5-L/Day ingestion of drinking water, and comparison of the RME and CT values are shown in Table 6.

For the purposes of this document, we have located Toxicity Values from the USEPA IRIS, Regional offices, EPA NCEA Health Effects Assessment Summary Tables (HEAST) and ATSDR. For non-cancer effects, the RfD, RfC, and MRLs are all derived in approximately the same way: NOAEL (or LOAEL) is determined (preferably from human data, but more usually from animal studies) and is divided by uncertainty factors. These uncertainty factors represent the uncertainty in extrapolating from animals to humans; from a LOAEL to a NOAEL; from subchronic to chronic studies; and to account for sensitive subpopulations.

Summary of Cancer Risks; Ingesting	g 2 and 5 Liters o	f Drinking Wo	ater per Day	
	R	ME	(CT
	Cancer Risk	Cancer Risk	Cancer Risk	Cancer Risk
Exposure Route	2 Liters/Day	5 Liters/Day	2 Liters/Day	5 Liters/Day
Adult; Drinking Water Ingestion, 2 & 5 Liters per Day	8.78E-06	2.19E-05	2.67E-06	6.67E-06
Adult; Drinking Water Showering, Inhalation	7.61E-08	7.61E-08	2.22E-09	2.22E-09
Adult; Drinking Water Showering, Dermal	3.63E-06	3.63E-06	8.77E-07	8.77E-07
Totals for Adults	1.25E-05	2.57E-05	3.55E-06	7.55E-06

TABLE 6. Associated Cancer	Risk
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Summary of Cancer Risks; Ingest	ing 1 and 2 Liters o	f Drinking Wo	iter per Day	
	R	ME	(2 T
	Cancer Risk	Cancer Risk	Cancer Risk	Cancer Risk
Exposure Route	1 Liters/Day	2 Liters/Day	1 Liters/Day	2 Liters/Day
Child; Drinking Water Ingestion, 2 Liters per Day	2.05E-05	4.10E-05	6.22E-06	1.24E-05
Child; Drinking Water Showering, Dermal	5.08E-06	1.02E-05	1.23E-06	2.46E-06
Totals for Children	2.56E-05	5.11E-05	7.45E-06	1.49E-05

The non-cancer toxicity values for the chemicals of potential concern at Pope AFB are summarized in Table 7 as a Hazard Index value. A Hazard Index (HI) was calculated using the traditionally defined RfDs for each chemical. The HI for each exposure route and summed total are less than unity and therefore would not be evaluated any further within the United States. The HI for each exposure route is shown in Table 7 for adults and children.

Summary of Noncancer Hazard 1	ndices	
	RME	СТ
이는 것이 있는 것이 가지 않는 것은 것도로 방법을 했다. 것이 가지 않는 것이 있는 것이 없는 것이 있는 것이 있는 것이 없는 것이 없는 것이 있는 것이 없는 것이 없는 것이 없는 것이 없는 것이 있는 것이 있는 것이 없는 것이 없는 것이 없는 것이 없는 것이 없 것이 같이 있는 것이 없는 것이 없이 없는 것이 없 않이 없는 것이 없 않이 않이 않이 않이 않이 않이 않아. 않은 것이 없는 것이 없 것이 것 같이 않아, 것이 없는 것이 없이 않이 않이 않이 않이 않이 않이 않이 않아, 것이 없 않이 않이 않이 않이 않아, 않이 않아, 않이 않이 않아, 않이 않아, 않아, 않이 않아, 않이 않이 않이 않이 않아, 않이 않이 않이 않이 않이 않이 않이 않아, 않이 않이 않이 않이 않이 않이 않이 않이 않이	NonCancer	NonCancer
	Systemic	Systemic
	Hazard	Hazard
	Index	Index
Exposure Route	HI	HI
Adult; Drinking Water Ingestion, 2 Liters per Day	6.22E-05	2.41E-05
Adult; Drinking Water Showering, Inhalation	2.34E-08	1.83E-05
Adult; Drinking Water Showering, Dermal	8.18E-06	3.45E-06
Totals	7.04E-05	4.59E-05
Child; Drinking Water Ingestion, 2 Liters per Day	1.45E-04	5.63E-05
Child; Drinking Water Bathing, Dermal	1.15E-05	4.83E-06
Totals	1.57E-04	6.11E-05

 TABLE 7. Systemic Hazard Quotient for Noncancer Risk - Adults

Industrial workers (civilian employees) will likely have a longer exposure duration than that of the military population. In order to account for this longer exposure duration, a separate calculation was performed for the worker scenario on Pope AFB. The calculations are very similar to the resident scenario. The significant differences with the worker scenario are the longer exposure duration (up to 30 years), the decrease in water consumption (from 2 to 1), and the less frequent shower exposures. The cancer and noncancer results are provided in Table 8. All of the calculations are within the acceptable range.

Summaries of Adult Cancer Risk and	d Noncancer Haza	urd Index; Indu	strial Worker	P
	R	ME	(CT
		NonCancer		NonCancer
		Systemi c		Systemic
	Cancer	Hazard	Cancer	Hazard
	Risk	Index	Risk	Index
Exposure Route	yrs	Ш	yrs	Ш
Adult; Drinking Water Ingestion, 1 Liter per Day	3.92E-07	2.22E-05	1.19E-07	8.61E-06
Adult; Drinking Water Showering, Inhalation	6.80E-09	1.86E-10	1.98E-10	1.31E-05
Adult; Drinking Water Showering, Dermal	3.10E-07	5.61E-06	7.51E-08	2.36E-06
Total for 15 years of Exposure	1.06E-05	4.17E-04	2.91E-06	3.61E-04
Total for 20 years of Exposure	1.42E-05	5.56E-04	3.89E-06	4.81E-04
Total for 25 years of Exposure	1.77E-05	6.95E-04	4.86E-06	6.01E-04
Total for 30 years of Exposure	2.13E-05	8.34E-04	5.83E-06	7.22E-04

TABLE 8. Industrial Worker Exposure Calculations

UNCERTAINTY

Risk assessments are estimations of what might occur under certain conditions, provided there is both a hazard present and exposure occurs. These estimations are based on data and assumptions that contain inherent uncertainties. Uncertainties may contribute to an overestimation or underestimation of risk, or the effect on the outcome may be unknown. These will be addressed according to the four-part risk assessment process.

Data Collection and Evaluation

Uncertainty is always an issue with environmental sampling, largely because of the potential for uneven distribution of chemicals in the environmental media over space and time. The sampling data analyzed to accomplish this risk assessment has uncertainties associated with it. There is no background information provided on the sampling data other than a location and a result. The assumption is that the samples taken on Fort Bragg are representative of expected water quality on Pope AFB. The actual numbers can be higher, lower, or the same.

With any risk assessment, the data needs to be representative of the environmental exposures associated with the site. The sample data appears to span the normal 4 quarters of the year and covers a 15 year period. This suggests the data is representative of the actual exposures associated with the sample locations. Data precision and accuracy are unknown.

Many of the sample results are reported as less than the detection limit. When converting the results that were less-than a detection limit value to an actual number (half of the detection limit), all of the sample analytes resulted as being above the RBC. This indicates the analytical detection limit was not low enough to be used in a risk-based analysis for the established RBC. This could result in over estimating the actual risk.

Exposure Assessment

The actual exposure to contaminants from showering and bathing are also unknown since the time and frequencies are assumptions. The actual amount of water ingested will also vary and more people are drinking more bottled water, which could lower the actual risk.

Showering is also a source of uncertainty. We have assumed inhalation of THMs while showering, but do not have measured data to support the concentrations we calculated using Henry's Law constants—the impact on the assessment is unknown. Dermal absorption also introduces uncertainty because we assumed the THMs will remain in the water to contact the skin, and then be absorbed into the body. However, because we have assumed volatilization previously, it is unlikely the concentrations we calculated would be achieved in both media. As a result, the risk is probably overestimated.

Toxicity Assessment

Toxicity values are based primarily on animal studies, where a LOAEL or NOAEL is generated experimentally in response to a known exposure over a defined period of time. Safety factors are then applied to the LOAEL or NOAEL to yield a reference dose (RfD, oral) or reference concentration (RfC, inhalation) that is considered the safe threshold for human exposure. Safety factors can range from 1 to 10,000, so there can be a large degree of uncertainty about the "safe dose" for humans. In general, these safety factors will lead to an overestimation of toxicity in humans, and therefore lead to an overestimation of the true risk or non-cancer hazard potential.

DISCUSSION

Personnel assigned to Pope AFB for up to 8 years should not have negative impact on their health based on TTHM in the drinking water. This HHRA is for both the carcinogenic and non-carcinogenic health risks to military and civilian personnel. The results for both are within the acceptable range considered safe by the USEPA. These risk estimates are based on very conservative estimates of exposure and toxicity and are likely to overestimate the actual risk.

Although the predicted health impact to base personnel is minimal, the data analyzed is at a screening level only. Recommendations for further evaluation are provided under the recommendation section.

It is important to understand that the toxicity values were established to protect the health of the most sensitive populations, for a 30 year exposure duration. This HHRA is for a military population, with a probable maximum duration of 8 years. As with most health impact, the toxicity of chemicals can be highly variable in individuals. Overall physical condition, chemical sensitivities, and diet all play a major role in physiological response to exposure. A more site-specific investigation can be accomplished to determine more realistic risks. As a next step, once site-specific information is obtained, a probabilistic risk assessment can be accomplished.

While showering, volatile chemicals have the potential to volatilize, aerosolize, and remain in the water. Separate calculations were used to estimate exposure for volatilization and dermal contact due to showering, and the aerosolization was ignored. The aerosolized route was ignored because the ingestion route was previously calculated and the droplets from aerosolization are normally large enough to ignore the inhalation route—which is captured for volatiles anyway.

RECOMMENDATIONS

- 1. A complete drinking water analysis should be accomplished to determine actual risks of exposure to the supplied water. The risk to base personnel for drinking the water is complex and TTHM probably represents only a percentage of the overall risk.
- 2. Coordinate with Fort Brag Preventive Medicine personnel for updates to the drinking water system. It is our understanding that Fort Brag has funding for modifying the water system.
- 3. Information in this report that is to be presented to the base population needs to be done in non-technical language. We encourage the advice of trained risk communicators to review your message before presenting it. AFIERA has several trained risk communicators and are willing to assist with finalizing your message.

CONCLUSIONS

The risk calculations indicate personnel should not incur adverse health impact due to the TTHM in drinking water. A tiered approach was utilized to perform this health risk assessment. The purpose was to evaluate potential health threats to personnel from trihalomethanes in the drinking water. The assessment looked at all potential exposure pathways. A more complete analysis of the water should be accomplished in the future to determine actual risk from the drinking water on Pope AFB.

The HRA reviewed all potential exposure pathways by comparing sample results to EPA established standards. When an analytical result was identified as being above the USEPA risk based concentration (RBC), it was identified as a chemical(s) of potential concern (COPC). Each COPC was statistically reviewed and risk estimates were calculated.

This health risk assessment utilized two different approaches for evaluating the risks for resident and industrial worker populations. A cancer and non-cancer risk assessment indicated that exposures are well below the recommended EPA guidelines for both populations.

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Summary of Pope AFB TTHM Sample Results

Assumptions:

Total Number of Results:

1176 549

Total Number Exceeding RBC:

Code	Type	Total	Total > RBC
BK	Blank	0	0
EX	Air-Ambient	0	0
GM	Grab - Bulk Material	0	0
ßN	Grab - Water (Non-Potable)	0	0
GP	Grab - Water (Potable)	1176	549

Analytes:
fCOPC
Number o
Total

0	0	549	
0	0	1176	
	le)		

Adult Population (No Children or Elderly)	
Exposure Duration:	2 yrs
Water Consumption:	2-5L
Body Weight:	70 kgs
Use other EPA Defaults	

		Inclusive Dates	For Sample Collectioin	20-May-85 - 16-May-00	1	20-May-85 - 16-May-00	20-May-85 - 16-May-00
	Unique	Samp	Days	62		62	62
		Best	Fit	L	ssary	Ц	z
	-		ст	4.783	Not Necessary	1.068	76.29
			Media RBC Unit Max 95% UCL	21.6		4.79	0.15 µg/L 245.9 174.174 76.29
	Vater		Max	102	1.4	45.2	245.9
	P = Potable Water	/ater	Unit	μg/L	µg/L	0.13 µg/L 45.2	µg/L
	P=	potable W	RBC	0.17	2.3	0.13	0.15
	A = Air	N = Non-potable Water	Media	Ч	Р	Р	٩
			Freq	84%	0%	10%	92%
			Total > RBC Freq	248	0	30	271
			Total	294	294	294	294
Total Number of COPC Analytes: 1176	Total Number Exceeding RBC: 549		COPC	75274 Bromodichloromethane	75252 Bromoform	124481 Chlorodibromomethane	67663 Chloroform
otal Numb	Total Nu		CAS	75274	75252	124481	67663
T			Num		2	ю	4

Summary of Adult Cancer Risks and Noncancer Hazard Indices; 2 Liters Water ingested per Day	Hazard Indic	es; 2 Liters Wo	tter ingested p	er Day
	RN	RME	C	ст
		NonCancer	- -	NonCancer
		Systemic		Systemic
	Cancer	Hazard	Cancer	Hazard
	Risk	Index	Risk	Index
Exposure Route	8 yrs	Ш	8 yrs	IH
Adult; Drinking Water Ingestion, 2 Liters per Day	8.78E-06	6.22E-05	2.67E-06	2.41E-05
Adult; Drinking Water Showering, Inhalation	7.61E-08	2.34E-08	2.22E-09	1.83E-05
Adult; Drinking Water Showering, Dermal	3.63E-06	8.18E-06	8.77E-07	3.45E-06
Totals	1.25E-05	7.04E-05	3.55E-06	4.59E-05

Summary of Child Cancer Risks and Noncancer Hazard Indices; 2 Liters Water ingested per Day	Hazard Indic	es; 2 Liters Wo	tter ingested p	er Day
	RME	1E	С	CT
,		NonCancer		NonCancer
		Systemic		Systemic
-7	Cancer	Hazard	Cancer	Hazard
	Risk	Index	Risk	Index
Exposure Route	8 yrs -	ΗI	8 yrs	ΗI
Child; Drinking Water Ingestion, 1 Liters per Day	2.05E-05	1.45E-04	6.22E-06	5.63E-05
Child; Drinking Water Showering, Dermal	5.08E-06	1.15E-05	1.23E-06	0.00E+00
Totals	2.56E-05	1.57E-04	7.45E-06	5.63E-05

Summary of Cancer Risks,

Cancer Risks; Ingesting 2 and 5 Liters of Drinking Water per Day RME	Adult: Drinking Water Exposure Route Cancer Cancer Cancer Adult: Drinking Water - Ingestion, 2 & 5 Liters per Day 8 Liters/Day 8 Liters/Day 8 Liters/Day 2 Liters/Day <th>Cancer Cancer Cancer Cancer Child: Drinking Water Ingestion, 2 Liters per Day <i>I Liters/Day I Liters/Day</i> Child: Drinking Water Showering, Dermal 2.05E-05 4.10E-05 Solde-06 1.02E-05 1.1iters/Day 2.1iters/Day Totals for Children 2.56E-05 1.02E-05 1.23E-06 Totals for Children 2.56E-05 5.11E-05 2.46E-05</th>	Cancer Cancer Cancer Cancer Child: Drinking Water Ingestion, 2 Liters per Day <i>I Liters/Day I Liters/Day</i> Child: Drinking Water Showering, Dermal 2.05E-05 4.10E-05 Solde-06 1.02E-05 1.1iters/Day 2.1iters/Day Totals for Children 2.56E-05 1.02E-05 1.23E-06 Totals for Children 2.56E-05 5.11E-05 2.46E-05
	26	

Summary of Noncancer Hazard Indices	ndices	
	RME	CT
	NonCancer	NonCancer
	Systemic	Systemic
	Hazard	Hazard
	Index	Index
Exposure Route	HI	НІ
Adult; Drinking Water Ingestion, 2 Liters per Day	6.22E-05	2.41E-05
Adult; Drinking Water Showering, Inhalation	2.34E-08	1.83E-05
Adult; Drinking Water Showering, Dermal	8.18E-06	3.45E-06
*		
Totals	7.04E-05	4.59E-05

Summary of Noncancer Hazard Indices	ıdices	
	RME	CT
	NonCancer	NonCancer
	Systemic	Systemic
	Hazard	Hazard
	Index	Index
Exposure Route	НІ	Ш
Child; Drinking Water Ingestion, 2 Liters per Day	1.45E-04	5.63E-05
Child; Drinking Water Showering, Dermal	1.15E-05	4.83E-06
Totals	1.57E-04	6.11E-05

	Referenc	e Doses a	Reference Doses and Carcinogenic Potency Slope Factors	nic F	otency Slope	e Fac	tors			
			Sourcae:				H = HEAST		O = other	
			I = IRIS				A = HEAST Alternate			
			E = EPA-NCEA provisional value	isional va	ilue	-	W = Withdrawn from IRIS or HEAST	RIS or HI	EAST	
1					Oral				Inhalation	
				, קסנס	Slope	, קיסניס		קסנס	Slope	qata
-		EPA	Oral	fo əs.	Factor	fo ə	Inhalation	fo ə.	Factor	fo əə
		Cancer	RfDo	mos	CSFo	mos	RfDi	mos	CSFi	inos
Contaminant	CAS	Class.	mg/kg/d		kg.d/mg		mg/kg/d		kg-d/mg	
Bromodichloromethane	75274	B2	2.00E-02	I	6.20E-02	Ι				
Chlorodibromomethane	124481	c	2.00E-02	I	8.40E-02	Ι				
Chloroform	67663	B2	1.00E-02	I	6.10E-03	Ι	8.60E-05	E	8.10E-02	-
			-							

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APPENDIX B

RISK CALCULATION TABLES

The risk calculations used for this HRA are presented in the following tables.

Human Health Risk Assessment Pope Air Force Base (AMC)

	Adult	Resident D	Adult Resident Drinking Water Ingestion	er Ingestion			
Daily Dose (LA Car	Daily Dose (LADD or CDD) = (RME or CT Conc. x l Carcinogenic risk = LADD x Slope Factor Harard Ouotient = CDD / Reference Dos	(RME or CT Conc. x Ih LADD x Slope Factor CDD / Reference Dove	(RME or CT Conc. x IR x EF x ED) / (BW x AT) LADD x Slope Factor CDD / Roference Doce	¢ ED) / (BW x ≀	1 <i>T</i>)		
		Lifetime		Cancer			
	RME	Average Daily	Chronic Daily	Slope Factor	Refernce Dose	Lifetime	Svstemic
Contaminant	Conc. me/L	Dose me/ke/d	Dose mo/ko/d	CSF0 ko·d/mo	RfDo mo/ka/d	Cancer Pist	Hazard
Bromodichloromethane	2.16E-02	6.76E-05	5.92E-04	6.20E-02	2.00E-02	4.19E-06	1.18E-05
Chlorodibromomethane	4.79E-03	1.50E-05	1.31E-04	8.40E-02	2.00E-02	1.26E-06	2.62E-06
Chloroform	1.74E-01	5.45E-04	4.77E-03	6.10E-03	1.00E-02	3.33E-06	4.77E-05
Description	Units	Value		R	Rationale (Source)	e)	
RME Concentration	me/L	listed	95% Upper Co	nfidence Limit	95% Upper Confidence Limit or Maximium Detect Value	Detect Value	
Ingestion rate	Ľ/d	2	Site Specific Parameter	trameter			
Exposure frequency	dy	350	Site Specific Parameter	rameter			
Exposure duration	Ň	8	Site Specific Parameter	rameter			
Body weight	ke	70	Adult body wei	ght, Convention	Adult body weight, Convention; (USEPA 1991)	()	
Averaging time	p	25550	Carcinogenic effects; (USEPA 1989)	ffects; (USEPA	1989)		
Averaging time	<i>d</i>	2920	Noncarcinogenic effects; (USEPA 1989)	ic effects; (USI	EPA 1989)		
		Lifetime		Cancer			
	·	Average	Chronic	Slope	Refernce		
	CT	Daily	Daily	Factor	Dose	Lifetime	Systemic
	Conc.	Dose	Dose	CSF0	RfD_{0}	Cancer	Hazard
Contaminant	mg/L	mv/kv/d	mg/kg/d	ky-dimg	mg/kg/d	Risk	Ouotient
Bromodichloromethane	4.78E-03	1.50E-05	1.31E-04	6.20E-02	2.00E-02	9.29E-07	2.62E-06
Chlorodibromomethane	1.07E-03	3.34E-06	2.93E-05	8.40E-02	2.00E-02	2.81E-07	5.85E-07
Chloroform	7.63E-02	2.39E-04	2.09E-03	6.10E-03	1.00E-02	1.46E-06	2.09E-05

		Adult Resi	Adult Resident Showering Inhalation.	ing Inhalatic)n.		
Daily Dose (LADD (Carcinoe	(LADD or CDD) = (RME or CT Conc. x1 Carcinogenic risk = LADD x Slove Factor	(RME or CT C LADD x Slone	(RME or CT Conc. x IR x EF x ED) / (BW x AT) LADD x Slove Factor	c ED) / (BW x /	IT)		
Hazı	Hazard Ouotient =	CDD / Reference Dose	ice Dose				
	RME	Lifetime					
-	Avg. Air	Average	Chronic				
	Conc.	Daily	Daily	Cancer		Lifetime	Systemic
*	in Shower	Dose	Dose	Slope	Refernce	Cancer	Hazard
Contaminant	me/m3	me/ke/d	me/ke/d	Factor	Dase	Risk	Ouotient
Bromodichloromethane	2.83E-01	9.24E-05	3.01E-08				
Chlorodibromomethane	5.19E-02	1.69E-05	5.52E-09	•			
Chloroform	2.71E+00	8.85E-04	2.89E-07	8.60E-05	8.10E-02	7.61E-08	2.34E-08
Description	Units	Value		R	Rationale (Source)	(9	
RME Concentration	me/L	listed	95% Upper Coi	nfidence Limit	95% Upper Confidence Limit or Maximium Detect Value	etect Value	
Inhalation rate	m3/min	0.01389	Default (USEPA 1991)	A 1991)			
Exposure frequency	d/v	350	Site Specific Parameter	trameter			
Exposure duration	, v	×	Site Specific Parameter	trameter			
Body weight	ķe	70	Adult body weis	eht, Convention	Adult body weight, Convention; (USEPA 1991)	()	
Averaging time carc.	ď	25550	Carcinogenic effects; (USEPA 1989)	ffects; (USEPA	1989)		
Averaping time ncarc.	q	2920	Noncarcinogenic effects; (USEPA 1989)	ic effects; (USI	EPA 1989)		
Shower duration	min/d	15					
	СT	Lifetime					
	Avg. Air	Average	Chronic				
	Conc.	Daily	Daily	Cancer		Lifetime	Systemic
	in Shower	Dose	Dose	Slope	Refernce	Cancer	Hazard
Contaminant	me/m3	me/ke/d	me/ke/d	Factor	Dase	Risk	Ouotient
Bromodichloromethane	6.27E-02	1.36E-06	1.19E-05				
Chlorodibromomethane	1.16E-02	2.51E-07	2.20E-06				
Chloroform	1.19E+00	2.58E-05	2.26E-04	8.60E-05	8.10E-02	2.22E-09	1.83E-05

,		Adult Resi	Adult Resident Drinking Water Dermal Contact	g Water Dei	rmal Contac			
Daily Dose (LADD or CDD) =	DD or CDD) =		(RME or CT Conc. x SA x pK x ET x EF x ED x IE-3 l/ml) / (BW x AT)	x ET x EF x EL) x IE-3 [/ml) /	(BW x AT)		
Care	Carcinogenic risk =		Factor					
Нал	Hazard Ouotient = CDD / Reference Dose	CDD / Referen	ice Dose					
		·	Lifetime					
		Dermal	Average	Chronic	•			
	RME	Permeab.	Daily	Daily	Cancer		Lifetime	Systemic
	Conc.	Coeff.	Dose	Dose	Slope	Refernce	Cancer	Hazard
Contaminant	me/L	cm/h	me/ke/d	me/ke/d	Factor	Dose	Risk	Ouotient
Bromodichloromethane	2.16E-02	2.00E-02	5.35E-06	4.68E-05	6.00E-01	9.00E-03	3.21E-06	4 22E-07
Chlorodibromomethane	4.79E-03	2.00E-02	1.19E-06	1.04E-05	6.20E-02	2.00E-02	7 36E-08	2 08F-07
Chloroform	1.74E-01	2.00E-02	4.32E-05	3.78E-04	7.90E-03	2.00E-02	3 41E-07	7 55F-06
Description	Units	Value			Rationale	Rationale (Source)		
RME Concentration	nıe/I.	listed	95% Upper Co	mfidence Limit	<u>95% Upper Confidence Limit or Maximium Detect Value</u>	Detect Value		
Dermal Perm Coeff	cm/h	listed	Table 5-8, Der	mal Exposure A	Table 5-8. Dermal Exposure Assessment (USEPA 1992)	EPA 1992)		
Surface area	cm3	23000	Adult skin surfe	ace area, Convu	Adult skin surface area, Convention; (USEPA 1991)	(1661)		
Exposure frequency	dУ	365	Site Specific Parameter	arameter				
Exposure duration	Ŋ	×	Site Specific Parameter	<i>trameter</i>				
Body weight	ke	70	Adult body wei	ght, Convention	Adult body weight, Convention; (USEPA 1991)	()		
Averaging time carc.	q	25550	Carcinogenic e	Carcinogenic effects; (USEPA 1989)	1989)			
Averaging time ncarc.	q	2920	Noncarcinogen	Noncarcinogenic effects; (USEPA 1989)	5PA 1989)			
Bath duration	h/d	0.33	(USEPA 1992)					
			Lifetime					
		Dermal	Average	Chronic				
	СТ	Permeab.	Daily	Daily	Cancer		Lifetime	Systemic
	Conc.	Coeff.	Dose	Dose	Slope	Refernce	Cancer	Hazard
Contaminant	me/L	cm/h	me/ke/d	me/ke/d	Factor	Dose	Risk	Ouotient
Bromodichloromethane	4.78E-03	2.00E-02	1.19E-06	1.04E-05	6.00E-01	9.00E-03	7.11E-07	9.34E-08
Chlorodibromomethane	1.07E-03	2.00E-02	2.65E-07	2.32E-06	6.20E-02	2.00E-02	1.64E-08	4 63E-08
Chloroform	7.63E-02	2.00E-02	1.89E-05	1.65E-04	7.90E-03	2.00E-02	1.49E-07	3.31E-06

		ł	Adult Resid	Adult Resident Showering Calculated Air Exposure Concentrations	ring Calc	ulated Air	Exposure C	oncentrati	ons			
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$		RME Conc.	Mol. WI.	Henry's Constant	KI	Ķ8	Overall Trans. Coeff: KL	Temp-adj. Trans. Coeff. KaL	Conc. leaving H2O Cwd	VOC Gener. Rate S	Air Conc. at Shower End	Avg. Air Conc. in Shower
	Contaminant Bromodichloromethane	2.16E-02	9/1001 1.69E+02	aim-m3/mol	<i>cm/h</i> 1 02F±01	9 80F402	9 25E 400	1 24F±01	7 31 8-03	<u>me/m3-min</u>	<i>me/m3</i> 5 495 01	m2/m3
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Chlorodibromomethane	4.79E-03	2.08E+02	9.90E-04	9.19E+00	8.82E+02	7.34E+00	9.83E+00	1.34E-03	9.23E-03	1.00F-01	5 19F-07
n Units Value Rationale (Source) cm/h 20 20 Rationale (Source) cm/h 300 1002 1002 cm/h 318 1 1002 cm/h 1 1 1 mu 1 1 1 num 1 0.0166667 RANGE: STOLS FER HOUR) 12 num 12 0 0.00000 1200000 1200000 num 12 0.00000 1200000 1200000 1200000 1200000 num 12 0.00000 1.000000 1.000000 1.000000 1.000000 1.000000 num 0.00000 0.00000 0.00000 0.00000 1.00000 0.000000 0.00000 <td>Chloroform</td> <td>1.74E-01</td> <td>1.19E402</td> <td>4.60E-03</td> <td>1.21E+01</td> <td>1.16E+03</td> <td>1.15E+01</td> <td>1.54E+01</td> <td>7.00E-02</td> <td>4.83E-01</td> <td>5.25E+00</td> <td>2.71E+00</td>	Chloroform	1.74E-01	1.19E402	4.60E-03	1.21E+01	1.16E+03	1.15E+01	1.54E+01	7.00E-02	4.83E-01	5.25E+00	2.71E+00
n Units Value Rationale (Source) cuu/h 20 20 20 cuu/h 3000 20 20 $ru 1002 318 20 ru 1 0.0596 7 ru 1 0.0596 7 ru 1 0.0596 7 ru 1 0.0596 7 ru 20 7 7 ru<<$												
	Description	Units	Value				Rai	tionale (Sourc	ce)			
	I-vhase Lc. CO2	cm/h	20									
	G-phase t.c. H2O	cm/h	3000									
	Water visc. at 20C	cD	1.002									
K 318 nun 1 0 r 2 0 un 20 0 </td <td>Water visc. at 45C</td> <td>cn</td> <td>0.596</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	Water visc. at 45C	cn	0.596									
nun 1 1/min 20 nin.1 20 nin.1 30 nin.1 0.0166667 nin.1 0.014 nin.1	Shower tenn	Ŕ	318									
vini 20 I/min 20 nii 20 nii 20 nii 20 nii 20 niii 200166667 [RANGE: S TO I.S PER HOUR) Overall Temp-adji. Conc. VOC Air niii-I 0.0166667 [RANGE: S TO I.S PER HOUR) Overall Temp-adji. Conc. VOC Air Conc. Mol. Wi. Constant KI Kai. Coeff. Han, B Genet. Conc. Conc. Mol. Wi. Constant KI Kai. Coeff. Han Bala Ii Conc. Mol. Wi. Constant KI Kai. Coeff. Rod Sond. Sond. Conc. Mol. Wi. Constant KI Kai. Kai.	Dronlet diameter	nım	1									
	Dran tine	S.	2									
min 2.9 min 12 0.0166667 RANGE: S TO LS PER HOUR) Overalt Temp-adj Conc. VOC Air min-L 0.0166667 RANGE: S TO LS PER HOUR) Overalt Temp-adj Conc. VOC Air CT Henry's Coeff Coeff Raving Gener. Conc. VOC Air Conc Mol. Wi. Constant KI KaL KaL Coeff Henry Gener. Conc. VOC Air Not Mol. Wi. Constant KI KaL KaL Coeff Henry Gener. Conc. VOC Air Nor Mol. Wi. Constant KI KaL KaL KaL Gener. Conc. Incr. I	Shower flow rate	I /min	20									
min.1 12 Outefold RANGE. S TO LS PER HOUR) Overall Temp-adj Conc. VOC Air min.1 0.0166667 RANGE. S TO LS PER HOUR) Overall Temp-adj Conc. VOC Air CT Mol. Wi. Constant Rins. Trans. Trans. Trans. Fanya Conc. VOC Air Conc. Mol. Wi. Constant K1 Kal. Conf. Henry Conc. Conc. VOC Air Conc. Mol. Wi. Constant K1 Kal. Conf. Henry Conc. Conc. <td>Shower stall volume</td> <td></td> <td>2.9</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	Shower stall volume		2.9									
min-1 0.0166667 /RANGE 5 TO L5 PER HOUR) Overall Temp-adj. Conc. VOC Air CT Trans. Trans. Trans. Trans. Trans. Conc. VOC Air CT Nol. Wi. Constant Ri Kal. Conc. VOC Air Conc. Mol. Wi. Constant KI Kal. Conc. VOC Air Conc. Mol. Wi. Constant KI Kal. Conf. Henry. Conc. Conc. VOC Air nsolid atmom Conf. KI Kal. Conf. Henry. Conc. Conc	Shower duration	min	12					i				
CT Henry's Trans. Temp-adj. Conc. VOC Air Canc. Mol. Wi. Constants Trans. Trans. Trans. Leaving Gener. Conc. VOC Air Conc. Mol. Wi. Constants KI Trans. Leaving Gener. Conc. Voc Air Conc. Mol. Wi. Constant KI Kal. Conc. Mor. Mon. Min Min Min Mon. Min Min Min Min Min Min	Air exchange rate	min-I	0.0166667	(RANGE: .5 1	TO LS PER H	OUR						
Conc. Mol. Wi. Constant R1 Kg KL Kal. Cwd S. End in ne/L e/mol atm-m3/mol cm/h cm/h me/l send in mol in End in 1 0.01E-03 1.69E+02 2.41E-03 1.02E+01 9.80E+02 9.25E+00 1.24E+01 1.62E-03 1.12E-02 1.21E-01 1 0.07E-03 2.08E+02 9.19E+00 9.83E+00 2.98E+00 2.98E+02 2.24E-01 2.24E-02 1.21E+01 1.65E+03 2.12E-01 2.30E+02 7.24E-02 2.34E+02 7.64E-03 2.06E-03 2.24E-02 7.24E+02 7.64E-02 2.34E+02 7.64E-02 2.30E+02		CT		Henry's			Overall Trans. Cooff	Temp-adj. Trans. Cooft	Conc. leaving HTT	VOC Gener. Poto	Air Conc.	Avg. Air
4.78E-03 1.69E+02 2.41E-03 1.02E+01 9.80E+02 9.25E+00 1.24E+01 1.62E-03 1.12E-02 1.21E-01 1.07E-03 2.08E+02 9.99E+00 8.82E+02 7.34E+00 9.83E+00 2.98E-04 2.06E-03 2.24E-02 7.63E-02 1.19E+02 4.60E-03 1.21E+01 1.15E+01 1.54E+01 3.07E-02 2.12E-01 2.30E+00	Conformation	Conc.	Mol. Wt.	Constant	KI /L	Kg 	KL KL	KaL	Cwd	S	End	in Shower
1.07E-03 2.08E+02 9.90E-04 9.19E+00 8.82E+02 7.34E+00 9.83E+00 2.98E-04 2.06E-03 2.24E-02 7.63E-02 1.19E+02 4.60E-03 1.21E+01 1.16E+03 1.15E+01 1.54E+01 3.07E-02 2.12E-01 2.30E+00	Bromodichloromethane	4.78E-03	1.69E+02	2.41E-03	1.02E+01	9.80E+02	9.25E400	1 24F+01	1 K2E-03	1 12R-02	1 21 E_01	CHIMIN S
7.63E-02 1.19E+02 4.60E-03 1.21E+01 1.16E+03 1.15E+01 3.07E-02 2.12E-01 2.30E+00	Chlorodibromomethane	1.07E-03	2.08E+02	9.90E-04	9.19E+00	8.82E+02	7.34E+00	9.83E+00	2.98E-04	2.06E-03	2.24E-02	1.16E-02
	Chloroform	7.63E-02	1.19E+02	4.60E-03	1.21E+01	1.16E+03	1.15E+01	1.54E+01	3.07E-02	2.12E-01	2.30E+00	1.19E+00
			T	Ī							Ī	

	Adult	Resident D ₁	Adult Resident Drinking Water Ingestion	er Ingestion			
Daily Dose (LA Carc	Daily Dose (LADD or CDD) = (RME or CT Conc. x IR x EF x ED) / (BW x AT) Carcinogenic risk = LADD x Slope Factor	(RME or CT C LADD x Slope	onc. x IR x EF ; Factor	x ED) / (BW x /	1 <i>T</i>)		
Hai	Hazara Uuottent = 1	<u>UDD/Keterence Dose</u> Lifetime	ice Dose	Cancer			
		Average	Chronic	Slope	Refernce		
	KME	Daily	Daily	Factor	Dose	Lifetime	Systemic
Contaminant	Conc. me/L	Dose mp/kp/d	Dose mo/ko/d	CSF0 ko:d/ma	RfDo molbald	Cancer Dist	Hazard
Bromodichloromethane	2.16E-02	1.58E-04	1.38E-03	6.20E-02	2.00E-02	9.78E-06	2.76F-05
Chlorodibromomethane	4.79E-03	3.50E-05	3.06E-04	8.40E-02	2.00E-02	2.94E-06	6.12E-06
Chloroform	1.74E-01	1.27E-03	1.11E-02	6.10E-03	1.00E-02	7.76E-06	1.11E-04
Description	Units	Value		R	Rationale (Source)	(e)	
RME Concentration	me/L	listed	95% Upper Confidence Limit or Maximium Detect Value	nfidence Limit	or Maximium I	Detect Value	
Ingestion rate	1.14	1	Site Specific Parameter	trameter			
Exposure frequency	<i>v/p</i>	350	Site Specific Parameter	ırameter			
Exposure duration	^	8	Site Specific Parameter	ırameter			
Body weight	ke	15	Child body weight, Convention; (USEPA 1991)	ght, Convention	n; (USEPA 199	(1)	
Averaging time	q	25550	Carcinogenic effects; (USEPA 1989)	ffects; (USEPA	1989)		
Averaging time		2920	Noncarcinogenic effects; (USEPA 1989)	ic effects: (USI	EPA 1989)		
		Lifetime		Cancer			
		Average	Chronic	Slope	Refernce		
	CT	Daily	Daily	Factor	Dose	Lifetime	Systemic
	Conc.	Dose	Dose	CSF0	RfDo	Cancer	Hazard
	mgm	mg/kg/d	mg/kg/d	kerdime	me/ke/d	Risk	Ouotient
Bromodichloromethane	4.78E-03	3.49E-05	3.06E-04	6.20E-02	2.00E-02	2.17E-06	6.12E-06
Chlorodibromomethane	1.07E-03	7.80E-06	683E-05	8.40E-02	2.00E-02	6.55E-07	1.37E-06
Chloroform	7.63E-02	5.57E-04	4.88E-03	6.10E-03	1.00E-02	3.40E-06	4.88E-05

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BW x AT) Referace Lifetime S Referace Cancer I Dose Risk 0 2 00E-02 4 50E-06 2 00E-02 4 78E-07 2 00E-02 4 78E-07 2 00E-02 4 78E-07 1992) 1036-07 2 00E-07 2 00E-07			Child Resid	Child Resident Drinking Water Dermal Contact	g Water Der	mal Contact			
LifetimeLifetimeLifetimeDermatLifetimeDermatAureateDermatAureateDermatAureateDermatAureateDermatAureateConc.Conc.Conc.Conc.Conc.Conc.Conc.Conc.Conc.Conc.Conc.LifetimeSigetimeSigetimeSigetimeConcentLineDateConcentLifetimeSigetimeConcentA TSDSidet colsGioBe066.05E-05GioBe07A GioBe07A TSDSidet colspan="2">ConE-02Sidet colspan="2">ConE-07A GioBe07A TSDSidet colspan="2">ConE-02Sidet colspan="2">ConE-02Sidet colspan="2">ConE-07A GioBe07A TSDSidet colspan="2">Colspan="2">ConE-07A GioBe07A Colspan="2">Cone-07A TSDSidet colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="2">Colspan="	Daily Dose (LAI Carci	11 11	(RME or CT C LADD x Slope	onc. x SA x pK. Factor	x ET x EF x EL) x IE-3 [/ml) /	(BW x AT)		
Dermal Average Chronic RME Permeab. Daily Daily Cancer Lifetime S Conc. Coeff: Dose Dose Stope Referace Lifetime S nch. Conc. Coeff: Dose Dose Stope Referace Cancer Lifetime S nch. 2.06E-02 7.80E-06 6.05E-05 6.05E-05 6.05E-07 4.50E-07 Action Bonc-03 4.50E-07 Action P Action P Action P Action P Action Action P Action P Action P Action P Action Action P Action	102	ara Uuoneni =	und kereren	ce Doxe Lifetime					
RME Permeab. Daily Daily Daily Daily Date Date Lifetime S $conc.$ $coeff$ $Dose$ $Dose$ $Dose$ $Slope$ $Referace$ $Cancer$ $Lifetime$ S $neLL$ 2 $coeff$ $Dose$ $Dose$ $Slope$ $Referace$ $Cancer$ $Lifetime$ S 2 $1deL_{CD}$ 2 $0oE-O2$ $1.66E-O5$ $5.29E-O4$ $7.90E-O2$ $4.56E-O5$ $6.0E-O2$ $4.816-O5$ $6.0E-O2$ $4.78E-O2$			Dermal	Average	Chronic				
Conc. Coeff: Dose Note Slope Referator Cancer I me/L $me/kedd$ $me/keddd$ $me/keddddddddddddddddddddddddddddddddddd$		RME	Permeab.	Daily	Daily	Cancer		Lifetime	Systemic
me/L cm/k me/ked me/ked me/ked factor $Dose$ Risk 0 2 16E-02 7.50E-06 6.56E-05 6.20E-02 7.50E-06 6.50E-02 7.50E-07 4.50E-07 1 74E-01 2.00E-02 6.05E-05 5.29E-04 7.90E-03 2.00E-02 4.56E-06 1 74E-01 2.00E-02 6.05E-05 5.29E-04 7.90E-03 2.00E-02 4.56E-05 1 14E-01 2.00E-02 6.05E-05 5.29E-04 7.90E-03 2.00E-02 4.56E-05 1 174E-01 2.00E-02 6.05E-05 5.29E-04 7.90E-03 2.00E-02 4.56E-05 1 14E-01 2.00E-02 7.90E-01 7.90E-02 4.88E-07 1 14E-01 1 isted 2.5% Demail Exposure Assessment UISEPA 1991) 1.00E-02 1.03E-02 1 1 3.6 Stati surface area Convention: (USEPA 1992) 1.03E-02 1.03E-02 1 1 3.6 Stati surface 1.05E-04 1.991 1.00E-02 1.00E-02 1 1 2.5550 Ca		Conc.	Coeff.	Dose	Dose	Slope	Refernce	Cancer	Hazard
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Contaminant	me/L	cm/h	me/ke/d	me/ke/d	Factor	Dose	Risk	Ouotient
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Bromodichloromethane	2.16E-02	2.00E-02	7.50E-06	6.56E-05	6.00E-01	9.00E-03	4.50E-06	5.91E-07
	Chlorodibromomethane	4.79E-03	2.00E-02	1.66E-06	1.46E-05	6.20E-02	2.00E-02	1.03E-07	2.91E-07
initionUnitsValueRationale (Source)itoionUnitsValueRationale (Source)trationmg/Llisted 95% Upper Confidence Limit or Maximium Detect ValueCoeffcm/hlisted 75 Monte areaCoeffcm/hlisted 700 85% Upper Confidence Limit or Maximium Detect ValueCoeffcm/hlisted 700 85% Upper Confidence Limit or Maximium Detect ValueCoeffcm/hlisted 700 85% Control $inim$ yRSite Specific Parameter $inim$ ySite Specific Parameter $inim$ y Site Parameter $inim$ y Site Parameter $inim$ y y $inim$ 0.33 (USEPA 1992) $inim$ 0.33 0.050 $inimeter0.05$	Chloroform	1.74E-01	2.00E-02	6.05E-05	5.29E-04	7.90E-03	2.00E-02	4.78E-07	1.06E-05
iplionUnitsValueRationale (Source)tration $mell$ listed 95% Upper Confidence Limit or Maximium Detect ValueCoeff cm/h listed 55% Upper Confidence Limit or Maximium Detect ValueCoeff cm/h listed 55% Upper Confidence Limit or Maximium Detect ValueCoeff cm/h listed 7200 $Adult skin surface area. Convention: (USEPA 1991)uencydy350Site Specific Parameterutionv_p8Site Specific Varameterutionv_p8Site Specific Varameterutionv_p15Adult body worntion: (USEPA 1991)uencyd_p25550Carcinopenic effects: (USEPA 1989)uencrd2920Noncarcinopenic effects: (USEPA 1989)uencrd2920Noncarcinopenic effects: (USEPA 1989)uencrd2920Noncarcinopenic effects: (USEPA 1989)uencrd2920Noncarcinopenic effects: (USEPA 1989)uencrd0.33(USEPA 1992)uencrdddd2000.000.00ddddddddddddddddddddddddddddddddd<$									
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trationmg/llisted 95% Upper Confidence Limit or Maximium Detect ValueCoeffcmuhlistedTable 5-8. Dermal Exposure Assessment (USEPA 1992) $cm3$ 7200 Adult skin surface area. Convention: (USEPA 1991) $uency$ y 8 Site Specific Parameter $uion$ y 8 Site Specific Parameter $iion$ y 15 Adult body weight. Convention: (USEPA 1991) $ie orcc.d_10.33(USEPA 1992)ie orcc.d_10.33(USEPA 1992)ie orcc.d_10.33(USEPA 1992)ie orcc.d_10.330.33ie orcc.d_10.330.00cordie orcc.d_10.330.00cordie orcc.d_10.330.00cordie orcc.d_10.330.00cordie orcc.0.330.00cord0.00cordie orcc.0.00cord0.00cor$	Description	Units	Value			Rationale	(Source)		
Coeffcm/hlistedTable 5-8. Dermal Exposure Assessment (USEPA 1992)uency dy 350Site Specific Parameterution y 8Site Specific Parameterution y 8Site Specific Parameter $uency$ dy 350Site Specific Parameter $uency$ dy 350Site Specific Parameter $uency$ dy 350Noncarcinogenic effects: (USEPA 1991) d' $2556n$ Carcinogenic effects: (USEPA 1989) $uency$ d' 2920 Noncarcinogenic effects: (USEPA 1989) $uency$ d' $Daily$ $Daily$ $uency$ d' $Daily$ $Daily$ $uenchd'd'Dailyuenchd'DailyDailyuenchd'd'd'uenchd'd'd'uenchd'd'd'uenchd'd'd'uenchd'd'd'uenchd'd'd'uenchd'd'd'uenchd'd'$	RME Concentration	me/L		95% Upper Co.	nfidence Limit	or Maximium L	Detect Value		
cm37200Adult skin surface area, Convention: (USEPA 1991)uency dy 350 Site Specific Parameterution y 8 Site Specific Parameter kg 15 Adult body weight, Convention: (USEPA 1991) kg 15 Adult body weight, Convention: (USEPA 1991) d 25550 Carcinogenic effects: (USEPA 1989) d 2920 Noncarcinogenic effects: (USEPA 1989) d d 2920 d 2920 Noncarcinogenic effects: (USEPA 1989) d d 986 d <td>Dermal Perm Coeff</td> <td>cm/h</td> <td>listed</td> <td>Table 5-8, Den</td> <td>mal Exposure A</td> <td>Issessment (US</td> <td>EPA 1992)</td> <td></td> <td></td>	Dermal Perm Coeff	cm/h	listed	Table 5-8, Den	mal Exposure A	Issessment (US	EPA 1992)		
uencydy350Site Specific Parameterationy8Site Specific Parametertiony15Adult body weight, Convention: (USEPA 1991)te carc d 25550Carcinogenic effects: (USEPA 1989)te varc d 2320Noncarcinogenic effects: (USEPA 1989)te varc d 2320Noncarcinogenic effects: (USEPA 1989)te varc d 2320Noncarcinogenic effects: (USEPA 1989)te varc d 330(USEPA 1992)te narc d 0.33(USEPA 1992)te narc d d d te narc d </td <td>Surface area</td> <td>cm3</td> <td>7200</td> <td>Adult skin surfi</td> <td>uce area. Convi</td> <td>ention; (USEP+</td> <td>1991)</td> <td></td> <td></td>	Surface area	cm3	7200	Adult skin surfi	uce area. Convi	ention; (USEP+	1991)		
uturey8Site Specific Parameterle carc.kg15Adult body weight, Convention: (USEPA 1991)le carc.d25550Carcinogenic effects: (USEPA 1989)le ncarc.d25550Carcinogenic effects: (USEPA 1989)le ncarc.d2330Noncarcinogenic effects: (USEPA 1989)le ncarc.d2330Noncarcinogenic effects: (USEPA 1989)le ncarc.d2330Noncarcinogenic effects: (USEPA 1989)le ncarc.d2330Noncarcinogenic effects: (USEPA 1989)le ncarc.d333(USEPA 1992)le ncarc.d333(USEPA 1992)le ncarc.d333(USEPA 1992)le ncarc.d333(USEPA 1992)le ncarc.d3033(USEPA 1992)le ncarc.d3033(USEPA 1992)le ncarc.DermalAverageChronicLifetimeSSolopeSlopele ncarc.DoseDoseSlopele ncl.ne/Lne/KeidReferancele ncl.ane/L3.24E-05S.00E-022.00E-07le nchname1.07E-022.00E-022.00E-022.00E-07le nchname7.63E-022.00E-022.00E-072.00E-07le nchname7.63E-022.00E-022.00E-022.00E-07le nchname1.07E-022.32E-047.90E-03le nchname1.07E-022.00E-022.00E-07le nchname1.90E-032.00E-02 <td>Exposure frequency</td> <td>vlp</td> <td>350</td> <td>Site Specific Po</td> <td>ırameter</td> <td></td> <td></td> <td></td> <td></td>	Exposure frequency	vlp	350	Site Specific Po	ırameter				
k_{0} 15 Adult body weight, Convention: (USEPA 1991) e carc. d 25560 Carcinogenic effects: (USEPA 1989) e ncarc. d 25560 Carcinogenic effects: (USEPA 1989) h/d 0.33 (USEPA 1992) Lifetime h/d 0.33 USEPA 1992) Lifetime h/d 0.33 Lifetime 0.33 h h/d $Daily$ $Cancer$ $Lifetime$ h/d h/d $Daily$ $Cancer$ $Lifetime$ h/d h/d h/d $Pactor$ $Pactor$ $Lifetime$ h/d h/d h/d	Exposure duration	v	×	Site Specific Po	ırameter				
e carc. d 25560 Carcinogenic effects: (USEPA 1989) e ncarc. d 2920 Noncarcinogenic effects: (USEPA 1989) le ncarc. d 2920 Noncarcinogenic effects: (USEPA 1989) le ncarc. bid 0.33 (USEPA 1992) Lifetime Lifetime Lifetime Lifetime Signe Cancer Lifetime CT Permeab. Daily Cancer Lifetime Conc. Coeff. Dose Slope Refernce Cancer Lifetime ne/L me/L me/L Dose Slope Refernce Cancer Lifetime omethane $4.78E-03$ $3.71E-07$ $3.24E-06$ $6.00E-02$ $2.00E-02$ $2.00E-02$ $2.30E-02$ 2	Body weight	ko	15	Adult body wei	ght. Convention	n: (USEPA 199	(1)	,	
a d 2920 Noncarcinogenic effects; (USEPA 1989) h/d 0.33 (USEPA 1992) $Lifetime$ 1.33 $Lifetime$ 1.33 $Lifetime$ 1.33 CT $Permeab$ $Average$ CT $Permeab$ $Daily$ CT $Permeab$ $Daily$ CT $Permeab$ $Daily$ Cmc $Coeff$ $Dose$ Ne/L $Conc.$ $Coeff$ ne/L cm/h $ne/ke/d$ ne/L cm/h $ne/ke/d$ ne/L cm/h $ne/ke/d$ ne/L $2.00E-02$ $1.66E-06$ $1.07B-03$ $2.00E-02$ $1.45E-05$ $6.00E-01$ $9.00E-02$ $2.00E-02$ <td>Averaping time carc.</td> <td>d</td> <td>25550</td> <td>Carcinogenic e</td> <td>ffects; (USEPA</td> <td>1989)</td> <td></td> <td></td> <td></td>	Averaping time carc.	d	25550	Carcinogenic e	ffects; (USEPA	1989)			
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Averaping time ncarc.	q	Π	Noncarcinogen	vic effects; (USI	<u>5PA 1989)</u>			
LifetimeLifetimeDermalAverageChronicCTPermeab.DailyDailyCancerLifetimeSConc.Coeff.DoseDoseSlopeRefernceCancerIme/Lcm/hme/ke/dFactorDoseSlopeRefernceCancerIomethane $4.78F-03$ $2.00E-02$ $1.66E-06$ $1.45E-05$ $6.00E-01$ $9.00E-03$ $9.96E-07$ $9.00E-02$ $2.00E-02$ $2.00E-02$ $2.16E-05$ $2.32E-04$ $7.90E-02$ $2.00E-02$	Bath duration	h/d	0.33	(USEPA 1992)					
Dermal Average Chronic CT Permeab. Daily Daily Cancer Lifetime S Conc. Coeff. Dose Dose Slope Referance Lifetime S me/L cm/h me/ke/d Dose Slope Referance Cancer I nme/L cm/h me/ke/d me/ke/d Factor Dose Risk O omethane 1<07E-03				Lifetime					
CT Permeab. Daily Daily Cancer Lifetime S Conc. Coeff. Dose Dose Stope Referance Lifetime S mell. cm/h melke/d melke/d melke/d Factor Dose Referance Cancer I methane $4.78F-03$ $2.00E-02$ $1.66E-06$ $1.45E-05$ $6.00E-01$ $9.00E-03$ $9.96E-07$ $0.00E-02$ $3.71E-07$ $3.24E-06$ $6.20E-02$ $2.00E-02$ <td></td> <td></td> <td>Dermal</td> <td>Average</td> <td>Chronic</td> <td></td> <td></td> <td></td> <td></td>			Dermal	Average	Chronic				
Conc. Coeff. Dose Dose Slope Referance Cancer I me/L cm/h $me/ke/d$ $me/ke/d$ $Referance$ $Cancer$ I omethane $4.78E-03$ $2.00E-02$ $1.666E-06$ $1.45E-05$ $6.00E-01$ $9.00E-03$ $9.96E-07$ 0 omethane $1.07E-03$ $2.00E-02$ $3.71E-07$ $3.24E-06$ $6.20E-02$ $2.30E-08$ $0.66E-07$ $0.0methane$ $1.07E-02$ $2.00E-02$ $3.71E-07$ $3.24E-06$ $6.20E-02$ $2.30E-08$ $0.055-02$ $2.00E-02$ 2.00		CT	Permeab.	Daily	Daily	Cancer		Lifetime	Systemic
me/L cm/h me/ke/d ractor Dose Risk 0 omethane $4.78E-03$ $2.00E-02$ $1.66E-06$ $1.45E-05$ $6.00E-01$ $9.00E-03$ $9.96E-07$ $9.06E-07$ $0.05E-03$ $0.07E-03$ $2.00E-02$ $3.71E-07$ $3.24E-06$ $6.20E-02$ $2.30E-08$ $7.63E-07$ $2.30E-08$ $0.96E-07$ $0.06E-02$ $2.00E-02$		Conc.	Coeff.	Dose	Dose	Slope	Refernce	Cancer	Hazard
comethane 4.78E-03 2.00E-02 1.66E-06 1.45E-05 6.00E-01 9.00E-03 9.96E-07 comethane 1.07E-03 2.00E-02 3.71E-07 3.24E-06 6.20E-02 2.30E-08 7.63E-02 2.00E-02 2.65E-05 2.32E-04 7.90E-03 2.09E-02 2.09E-07	Contaminant	me/L	cm/h	me/ke/d	me/ke/d	Factor	Dose	Risk	Ouotient
unomethane 1.07E-03 2.00E-02 3.71E-07 3.24E-06 6.20E-02 2.00E-02 2.30E-08 7.63E-02 2.00E-02 2.00E-02 2.09E-07 2.09E-07 2.09E-07	Bromodichloromethane	4.78E-03	2.00E-02	1.66E-06	1.45E-05	6.00E-01	9.00E-03	9.96E-07	1.31E-07
7.63E-02 2.00E-02 2.65E-05 2.32E-04 7.90E-03 2.00E-02 2.09E-07	Chlorodibromomethane	1.07E-03	2.00E-02	3.71E-07	3.24E-06	6.20E-02	2.00E-02	2.30E-08	6.49E-08
	Chloroform	7.63E-02	2.00E-02	2.65E-05	2.32E-04	7.90E-03	2.00E-02	2.09E-07	4.64E-06
								i	

	Industr	ial Worker	Industrial Worker Drinking Water Ingestion	ater Ingestic	u u		
Daily Dose	Daily Dose (LADD or CDD) = (RME or CT Conc. x IR x EF x ED) / (BW x AT)	(RME or CT (Jone. x IR x EF.	x ED) / (BW x)	AT)		
C	Carcinogenic risk = LADD x Slope Factor <u>Hazard Ouotient = CDD / Reference Dose</u>	LADD x Slope CDD / Refere	: Factor 1ce Dose				
Description	Units	Value		Ľ	Rationale (Source)	ie)	
RME Concentration	mg/L	listed	95% Upper Co	nfidence Limiı	95% Upper Confidence Limit or Maximium Detect Value	Detect Value	
Ingestion rate	1/4		Site Specific Parameter	ırameter			
Exposure frequency	dly	250	Site Specific Parameter	trameter			
Exposure duration	· ^	30	Site Specific Parameter	ırameter			
Body weight	ke	70	Adult body wei	ght, Conventio	Adult body weight, Convention; (USEPA 1991)	(1)	
Averaging time	ď	25550	Carcinogenic effects; (USEPA 1989)	ffects; (USEP,	4 1989)		
Averaging time	q	10950	Noncarcinogenic effects; (USEPA 1989)	ic effects; (US	EPA 1989)		
		Lifetime		Cancer			
		Average	Chronic	Slope	Refernce		
		Daily	Daily	Factor	Dose	Lifetime	Systemic
	Conc.	Dose	Dose	CSF0	RfDo	Cancer	Hazard
Contaminant (CT)	mg/L	mg/kg/d	mg/kg/d	kerd/mg	me/ke/d	Risk	Ouotient
Bromodichloromethane	4.78E-03	2.01E-05	4.68E-05	6.20E-02	2.00E-02	1.24E-06	9.36E-07
Chlorodibromomethane	1.07E-03	4.48E-06	1.05E-05	8.40E-02	2.00E-02	3.76E-07	2.09E-07
Chloroform	7.63E-02	3.20E-04	7.46E-04	6.10E-03	1.00E-02	1.95E-06	7.46E-06
Contaminant (RME)							
Bromodichloromethane	2.16E-02	9.06E-05	2.11E-04	6.20E-02	2.00E-02	5.62E-06	4 73F-06
Chlorodibromomethane	4.79E-03	2.01E-05	4.69E-05	8.40E-02	2.00E-02	1.69E-06	9.37E-07
Chloroform	1.74E-01	7.30E-04	1.70E-03	6.10E-03	1.00E-02	4.46E-06	1.70E-05

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APPENDIX C

STATISTICAL ANALYSIS DATA

A summary of the statistical analysis is presented in the following tables. The tables presented are representative of all the data sets used for this HRA. Complete data sets are available upon request to AFIERA.

Human Health Risk Assessment Pope Air Force Base (AMC)

D'Agostino's Test for Goodness of Fit (Sample Size >50)

Chloroforn

Contammant of Concern

Descriptive Analysis	sis
Mean (M)	76 29037415
Standard Error	3260.725251
Median	2T ET
Mode	0 5
Standard Dewation	48 94156318
Sample Vanance	2395.276606
Kurtosss	0.115740254
Skewness	0.492707273
अध्यक्ष	245.65
Minumum	0 25
Mexanum	542 0
Sum	22429 37
Count	. 294
Confidence Level(95 0%)	E2E489871.0

								0.995383035	2.7
294	0.95	1 645	1 645	1 674	0 063	164.6	164.5	~2/2(n-1))	mma)^2/n)
n :	Camma = (g) =	z(gamma) =	z (P) =	k (g. P. n.) =	t (P,df) = (P,n-1) =	Xp=	X(gamma) =	l - (#(84m)^2/2/2(n-1))	z(P)^2 - (z(gamma)^2/n)
	Camm	म् ह	Ĩ	k (g	(IP'd) 1		X(ga	;	a م

0.95

1

	NORMAL				TYMNONOVA	1
Su	Statistic Name	x	ч	1/la Yi	Statis	Statistic Name
J.B	S = sample Std Dev =	48 942	1 531	4.62	= CS	[unitiess]
en.	Mean = M =	76 290	3816	WUN#	= CM	1,An
5	M · S = X (10%)	27.349	2.285	9.83	= CX (16%)	ug't.
en.	M + S = X (84%)	125.232	5.347	209 88	= GX (84%)	ue/t
e/L	M · t x S / (n'.5) = LCL =	111.92	3.810	45.16	= CLCL	ug/L
¢r.	M + t x S / (m S) = UCL =	76470	3 821	45 67	= CUCL	ugʻL
er.	(%56) X = S X (%56) dZ + W	156 799	6 334	563 32	= GX (95%)	ue/L
g/L	M + k x S = UTL =	158.230	6.379	589.10		ug'L
¢∕L	= 130	0.15	0.15	0.15	= 0EL	ug/L
er.	Median = Me =	73.75	4 30			
8/L	(M · Me) / S =	0 052	-115 0-			
Smaller Test Statistic.	Smaller Test Statistic, (M-Me)/S, implies better distribution Normal or Lognormal	n Normalo	r Lognormal			
	For Normal Distribution, M = Mc = Mo (mean = median = mode)	e = Mo (mea	n = median =	mode)		
	For Lognormal Distribution. mean = median = mode for [in (data) in Nepers]	a = medaan ≃	mode for [hn ((data) in Neperi	-	
	For Lognormal Distribution. We of data = GM of data (in poin or $mg/m^3 \approx ug/L$	of data = GM	ol data (m pp	m or mg/m3 =	1 <mark>8</mark> (1)	
			α/2	0.025		0.975
Using Table A	Using Table A8, determine range base on $\alpha/2$	a/2	Range	-2.31984	-0.54706	1.53004

Conclude the best fit is Normal

offceroted Data (e.g. pern. maj/m.) ugl. Number of Samples 294 Number of Samples 294 Number of Samples 294 Significance Level (u.) 0.05 Pointion 0.01 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.01 0.25 0.02 0.220 0.01 0.2 0.02 0.2 0.01 0.2 0.02 0.2 0.03 0.2 0.04 0.2 0.02 0.2 <tr< th=""><th></th><th></th><th>_</th><th>= 0</th><th>0 28114</th><th></th><th></th></tr<>			_	= 0	0 28114		
Number of Samples Significance Level (a) 294 Significance Level (a) 0.05 Flaming Data Flaming Data Flaming Data Flaming Data Flaming Data (a) 0.05 (a) 0.03 0.25 0.003 0.25 .38.875 0.003 0.25 .38.875 0.003 0.25 .31.739 0.017 0.5 .31.739 0.017 0.5 .31.739 0.017 0.5 .36.135 0.017 0.5 .36.135 0.017 0.5 .36.135 0.017 0.5 .36.135 0.017 0.5 .36.135 0.024 0.5 .36.135 0.017 0.5 .36.135 0.027 0.3 .36.135 0.017 0.5 .47.30 0.017 0.5 .47.30 0.0101 0.5 .47.30	ta (e.g. ppm. mg/m3)			а •	48.85826		
Significance Level (co) 0.05 Alguificance Level (co) 0.05 Penifican 0.01 0.25 Penifican 0.01 0.25 1.8777.735 Penifican 0.01 0.25 1.8777.735 Penifican 0.01 0.25 1.8777.735 Penifican 0.01 0.25 1.8777.735 Penifican 0.01 0.25 1.8737.735 Penifican 0.01 0.25 1.8737.735 Penifican 0.01 0.25 1.8737.735 Penificance 0.01 0.25 1.8737.735 Penificance 0.01 0.25 1.1759 Penificance 0.025 1.1759 1.1759 Penificance 0.024 0.25 1.1759 Penificance 0.024 0.5 1.1759 Penificance 0.024 0.5 1.1759 Penificance 0.024 0.5 1.1759 Penificance 0.024 0.5 1.1759 Penific	Number of Samples			۳ ۲	-0 54706		
23393.57 1187377.335 Funding r/a Duta 1187377.335 Funding r/a Duta 118737.735 Funding r/a Duta 118737.735 Funding r/a Duta 118737.735 Funding r/a Duta 0.5 -36.375 0007 0.255 -36.375 -36.375 0017 0.25 -36.375 -36.375 0017 0.55 -36.175 -36.375 0017 0.55 -36.1750 -36.370 0017 0.55 -36.700 -37.700 0018 0.5 -37.700 -37.700 00197 0.5 -36.700 -36.700 00197 0.5 -67.790 -67.790 00197 0.5 -67.790 -67.790 00197 0.5 -67.790 -67.790 00197 0.5 -67.790 -67.790 00197 0.5 -67.790 -67.790 00197 0.5 -67.790 -67.790	sprificance Level (a)						
Puttang Ionation Data (w)C Data (w)C <thdata (w)C</thdata 	22429.37	1187277.735	701816.0457	-	1121.857989	-2.13607E-13	686.51387
Portician (Q) r/a ug/L (5(+1))%L 0001 0.25 -36.375 00101 0.25 -36.375 00101 0.25 -36.375 00101 0.25 -36.375 0011 0.55 -36.375 0011 0.55 -31.750 0011 0.5 -31.750 0011 0.5 -37.950 0011 0.5 -37.950 0011 0.5 -37.950 0011 0.5 -37.950 0011 0.5 -37.950 0011 0.5 -37.950 0011 0.5 -37.950 0011 0.5 -37.950 0011 0.5 -45.750 0011 0.5 -45.750 0011 0.5 -45.750 0011 0.5 -45.750 0011 0.5 -45.750 0011 0.5 -45.750 0011 0.5 </th <th></th> <th></th> <th></th> <th>Modified</th> <th></th> <th></th> <th></th>				Modified			
0.001 0.255 34.615 0.003 0.255 36.155 0.001 0.25 36.155 0.010 0.25 36.155 0.011 0.5 36.155 0.011 0.5 36.155 0.011 0.5 36.126 0.011 0.5 37.70 0.017 0.5 37.20 0.024 0.5 37.20 0.027 0.5 37.20 0.027 0.5 37.20 0.027 0.5 37.20 0.027 0.5 37.20 0.027 0.5 37.20 0.028 0.5 57.20 0.041 0.5 67.70 0.041 0.5 67.70 0.041 0.5 67.70 0.041 0.5 67.70 0.041 0.5 67.70 0.041 0.5 67.70 0.051 0.5 67.70 0.051 0.5		- 66-11 Mar	5	Plotting	(x) प	22	(AC 1000
0 007 0.25 36 175 0 010 0.25 36 175 0 017 0.5 31 750 0 017 0.5 31 750 0 017 0.5 31 750 0 017 0.5 31 750 0 020 0.5 37 750 0 021 0.5 57 250 0 021 0.5 57 350 0 021 0.5 56 750 0 021 0.5 56 750 0 021 0.5 56 750 0 024 0.5 56 750 0 035 0.5 56 750 0 041 0.5 56 750 0 041 0.5 56 750 0 041 0.5 56 750 0 051 0.5 56 750 0 053 0.5 56 750 0 054 0.5 51 750 0 055 1.3 150 750 0 053 0.5 55 750 0 050 1.1 1100 50 0 050	╀	20, 12	105851 2865	12 IV	1387 1.	11 - 04 (m)	27 0472
0010 0.25 .36125 0014 0.5 .71790 0017 0.5 .71790 0024 0.5 .7120 0024 0.5 .7120 0027 0.5 .7120 0028 0.5 .7120 0027 0.5 .7120 0027 0.5 .67790 0017 0.5 .67790 0017 0.5 .67790 0017 0.5 .67790 0017 0.5 .67790 0014 0.5 .67790 0017 0.5 .67790 0018 0.5 .67790 0019 0.5 .67790 0024 0.5 .67790 0035 0.5 .67790 0036 0.5 .67790 0036 0.5 .67790 0037 0.5 .67790 0038 0.5 .67700 0037 0.5 .67700	╞	STE 05	5782 138501	0 6137	1.3863	-5 202	21.062
0014 0.5 71750 0017 0.5 71260 0020 0.5 71260 0021 0.5 71260 0022 0.5 71250 0021 0.5 71250 0021 0.5 67730 0017 0.5 67730 0011 0.5 67730 0011 0.5 67730 0011 0.5 67730 0011 0.5 67730 0011 0.5 67730 0014 0.5 67730 0014 0.5 67730 0014 0.5 67730 0015 0.5 67730 0024 0.5 67730 0035 0.5 67730 0036 0.5 67730 0036 0.5 67730 0037 0.5 67730 0038 0.5 67730 00391 0.5 67730	\vdash	-36.125	5782 138501	0 6137	1.3863	-5 202	227.062
0117 0.5 71,290 0224 0.5 77200 0224 0.5 77200 021 0.5 77200 021 0.5 77200 021 0.5 77200 021 0.5 67730 021 0.5 64730 021 0.5 64730 021 0.5 64730 021 0.5 64730 021 0.5 64730 021 0.5 64730 021 0.5 64730 021 0.5 64730 0221 0.5 64730 0231 0.5 64730 0232 0.5 64730 0231 0.5 64730 0231 0.5 64730 0232 0.5 64730 0233 0.5 64730 0233 0.5 64730 0234 0.5 64730		-71.750	5744 180814	1.3069	1669.0-	-4 509	20.331
0230 0.3		-71.250	5744 180814	1 3069	1269-0-	4 509	20.331
0024 0,5 -70,2,0 0037 0,5 -69,790 0031 0,5 -69,790 0031 0,5 -69,730 0041 0,5 -69,290 01041 0,5 -69,730 01041 0,5 -68,730 01041 0,5 -68,730 01041 0,5 -68,730 01041 0,5 -67,730 01041 0,5 -67,730 0051 0,5 -67,730 0053 0,5 -67,730 0054 0,5 -67,730 0053 0,5 -67,730 0054 0,5 -67,730 0053 0,5 -64,730 0073 1,25 -15,750 0073 1,25 -64,730 0073 1,25 -15,92,90 0073 1,25 -15,92,90 0074 1,1 -11,05,00 0075 1,1 -11,05,00 0108		-70 750	5744 180814	1 3069	16931	-4 509	166 02
0027 0.0 0.0 0.0 0031 0.5 -69.20 -69.20 0031 0.5 -69.20 -69.20 0031 0.5 -69.20 -69.20 0044 0.5 -69.20 -69.20 0044 0.5 -69.20 -69.20 0044 0.5 -67.70 -67.70 0048 0.5 -67.70 -67.70 0051 0.5 -67.70 -67.70 0054 0.5 -67.70 -67.70 0051 0.5 -67.70 -67.70 0053 0.5 -67.70 -67.70 0054 0.5 -67.70 -67.70 0054 0.5 -67.70 -67.70 007 0.5 -67.70 -67.70 007 0.5 -67.70 -67.70 0084 0.5 -67.70 -67.70 0085 0.5 -1.90.70 -67.70 0085 0.5 -67.70		-70.250	5744 180814	1 3069	-0.6931	-4 509	20.331
011 0.5 -69.20 0014 0.5 64.750 0017 0.5 64.750 0014 0.5 64.750 0044 0.5 64.750 0041 0.5 64.750 0048 0.5 64.750 0049 0.5 64.750 0041 0.5 64.750 0042 0.5 64.750 0043 0.5 64.750 0054 0.5 64.750 0054 0.5 64.750 0054 0.5 64.750 0054 0.5 64.750 0054 0.5 64.750 0054 0.5 64.750 0054 0.5 64.750 0054 0.5 64.750 0054 0.5 64.750 0035 0.5 64.750 0036 0.5 64.750 0037 0.5 64.750 0038 0.5 64.		-69 750	5744 180814	1 3069	1669 0-	-4 509	20 331
0034 0.5 68.730 0017 0.5 68.250 0044 0.5 67.730 0044 0.5 67.730 0046 0.5 67.730 0046 0.5 67.730 0048 0.5 67.730 0049 0.5 67.730 0041 0.5 67.730 0042 0.5 67.730 0043 0.5 67.730 0044 0.5 67.730 0054 0.5 64.750 0054 0.5 64.750 0054 0.5 64.750 0054 0.5 64.750 0054 0.5 64.750 0054 0.5 64.750 007 0.5 64.750 007 0.5 64.750 007 0.5 64.750 0084 1.2 -199.260 0084 1.3 -199.260 0095 5.5 6		-69 250	5744 180814	1 3069	-0 6931	-4 509	20.331
0077 0,5 68.290 0144 0,5 67.790 0144 0,5 67.790 0144 0,5 67.790 0144 0,5 67.790 0144 0,5 67.790 0145 0,5 66.750 0146 0,5 66.750 0147 0,5 66.750 0148 0,5 66.750 0149 0,5 66.750 0105 0,5 66.750 0106 0,5 64.790 0107 0,5 64.790 0107 0,5 64.790 0107 0,5 64.790 0107 0,5 64.790 0107 0,5 64.790 0108 1,2 -199.240 0108 2 -599.4500 0108 5,5 649.510 0108 5,5 -1190.500 0108 9,5 -11305.900 0110 13		-68.750	5744 180814	1 3069	0.6931	-4 509	20.331
104(0.5 67790 0.044 0.5 6720 0.048 0.5 66750 0.051 0.5 66750 0.051 0.5 66750 0.051 0.5 66750 0.051 0.5 66750 0.051 0.5 65750 0.053 0.5 65750 0.054 0.5 65750 0.053 0.5 65750 0.054 0.5 65750 0.053 0.5 64770 0.054 0.5 64750 0.055 0.5 64750 0.054 0.5 64750 0.055 0.5 64750 0.055 0.5 64750 0.052 1.3 -199240 0.053 5.5 -993640 0.053 5.5 -993640 0.053 5.5 -993640 0.055 5.5 -993640 0.055 5.5		68.250	5744 180814	1 3069	-0.7	-4 509	100 02
0044 0.5 67.290 0048 0.5 66.750 0051 0.5 66.750 0054 0.5 66.750 0054 0.5 66.750 0054 0.5 66.750 0054 0.5 65.750 0054 0.5 65.750 0054 0.5 65.750 0055 0.5 65.750 0073 0.5 65.750 0073 1.25 -160.550 0073 1.25 -150.550 0073 1.25 -160.550 0073 1.25 -190.550 0085 1.3 -190.550 0085 1.3 -190.550 0085 2. -290.600 0092 5.57 -695.500 0102 5.57 -695.600 0102 5.57 -1130.500 0105 9.7 -1130.500 0116 12 -142.200	-	-67.750	5744 180814	1 3069	-0.7	-4 509	20 331
0948 0.5 66.79 0.051 0.5 -66.260 0.054 0.5 -66.250 0.054 0.5 -66.250 0.064 0.5 -66.250 0.064 0.5 -66.250 0.064 0.5 -67.30 0.064 0.5 -67.30 0.063 0.5 -67.70 0.064 0.5 -67.70 0.073 0.5 -67.70 0.074 175 -1500 0.075 0.5 -67.70 0.076 13 -190.550 0.078 13 -197.500 0.085 13 -190.550 0.093 2 -599.450 0.093 2 -994.510 0.093 557 -645.10 0.093 557 -645.10 0.093 557 -645.10 0.093 557 -645.10 0.093 57 -1130.500		-67.250	5744 180814	1 3069	-0.7	-4.509	20.331
0.051 0,5 66,230 0054 0.5 66,730 0058 0,5 65,730 0051 0,5 65,730 0053 0,5 55,730 0054 0,5 56,730 0053 0,5 56,730 0054 0,5 56,730 0053 0,5 56,730 0073 0,5 56,750 0073 0,5 56,750 0073 1,35 -155,650 0085 1,3 -159,250 0085 1,3 -159,250 0085 2 -299,450 0095 5,57 -665,150 0095 5,57 -665,150 0095 5,57 -665,150 0195 5,57 -693,150 0195 5,57 -693,150 0195 9,1 -1305,300 0110 13 -142,500		-66.750	5744 180814	69001	-0.7	4 509	20.331
0054 0.5 65 730 0083 0.3 65 380 0001 0.5 64 250 0005 0.5 64 250 0005 0.5 64 250 0055 0.5 64 250 0056 0.5 64 250 0056 0.5 64 250 0056 0.5 65 250 0073 0.5 65 250 0073 1.25 -155 655 0073 1.3 -160 500 0073 1.3 -160 500 0083 1.3 -193 250 0083 2 -390 450 0092 5.9 -665 615 0093 5.9 -994 450 0093 5.9 -1100 650 0109 5.9 -993 150 0105 9.7 -1110 650 0105 9.7 -1130 500 0116 12 -142 500	_	-66.250	5744 180814	1 3069	-0.7	-4 509	20.331
0054 0,3 65 250 0001 0,5 -64 750 0055 0,5 -64 750 0071 0,5 -51 750 0071 0,5 -51 750 0073 0,5 -51 750 0073 0,5 -51 750 0073 0,5 -51 750 0073 1,25 -155 653 0073 1,3 -195 650 0082 1,3 -195 650 0083 2 -31060 0083 2 -31060 0083 2 -390 450 0083 2 -390 450 0092 5,9 -650 450 0093 5,9 -693 150 0093 5,9 -994 500 0105 9,7 -110050 0105 9,7 -11305 300 0115 13 -142 260	_	057 28-	5744 180314	1 3069	.0.7	-4 509	168 02
0.001 0.5 -64.750 0.065 0.5 -64.750 0.068 0.5 -61.750 0.073 0.5 -61.750 0.073 0.5 -61.750 0.073 0.5 -61.750 0.073 1.735 -157623 0.073 1.735 -159230 0.083 2 -3410645 0.083 2 -3410645 0.093 5.57 -665.615 0.093 5.59 -6991100 0.093 5.57 -665.615 0.093 5.59 -6991100 0.093 5.59 -6991100 0.102 7.3 -916.500 0.103 9.7 -11.10.610 0.105 9.7 -11.10.610 0.106 1.1.4 -1305.300 0.116 1.2 -14.22.600	+	-65 250	5744 180814	69001	-0.7	.4 509	105.02
0055 0.5 64.20 0084 0.5 61.760 0071 0.5 61.750 0073 0.5 61.750 0073 0.5 61.750 0073 0.5 61.750 0073 0.5 62.750 0082 13 -159.875 0083 13 -150.879 0083 13 -150.819 0083 2 -341.000 0083 2 -341.000 0083 2 -341.000 0083 2 -341.000 0083 2 -916.610 0093 5.57 -665.615 0093 5.59 -699.100 0102 7.3 -916.500 0103 9.7 -113.0560 0115 11.4 -1805.300 0116 13 -1442.500		-64.750	5744 180814	1.3069	-0.7	-4 509	20.331
0054 0.5 6.1750 0071 0.5 6.120 0073 0.5 6.120 0073 0.5 6.120 0073 0.5 6.120 0073 0.5 6.125 0072 0.5 6.125 0083 13 1.0550 0083 2 -41000 0092 5.9 -69515 0093 5.9 -69516 0092 5.9 -699100 0092 5.9 -699100 0102 7.8 -916500 0102 7.8 -1130500 0110 11.4 -1120500 0119 12 -142500	_	-64 250	5744 180814	690E 1	-0.7	-4 509	20.331
0071 0.5 61250 0073 0.5 62750 0073 1.2 61750 0085 1.3 -195435 0085 1.3 -19050 0093 2 -19050 0085 1.3 -19050 0093 2 -19050 0093 5 -91400 0093 5 -91910 0093 5 -91910 0093 5 -91910 0102 7.8 -914500 0102 7.8 -914500 0102 7.8 -914500 0110 11.4 -113050 0119 11 -110500 0119 13 -1442500	_	-63.750	5744 180814	1 3069	-0.7	-4 509	166.02
0075 0.5 62.730 0028 1.25 -155.645 0082 1.3 -100.550 0085 1.3 -100.550 0085 1.3 -197.250 0085 1.3 -197.250 0085 1.3 -197.250 0082 2 -241.000 0092 5.9 -695.610 0092 5.9 -695.610 0092 5.9 -695.610 0102 7.8 -916.500 0112 1.1 -1270.500 0119 1.1 -113.0530 0119 1.3 -144.2.500		-63 250	5744 180814	1 3069	-0.7	-4 509	166 02
0.07a 1.25 -155.625 0.082 1.3 -160.550 0.085 1.3 -197.210 0.085 1.3 -197.210 0.085 1.3 -197.210 0.085 2 -241.000 0.092 5.57 -665.615 0.093 5.57 -665.615 0.092 5.59 -993.450 0.092 5.57 -665.615 0.092 5.59 -916.500 0.102 7.3 -915.600 0.102 7.4 -112.05.900 0.105 9.1 -142.500 0.119 13 -142.200		-62 750	5744 180814	1 3069	-0.7	-4 509	20.331
0.082 1.3 -160,550 0.085 1.3 -159,250 0.093 2 -290,600 0.092 4.9 -594,600 0.092 5.57 -665,615 0.092 5.57 -665,615 0.092 5.57 -665,615 0.093 5.9 -965,610 0.093 5.9 -916,610 0.093 5.9 -916,610 0.093 5.9 -1130,650 0.102 7.8 -1130,510 0.103 9.1 -1270,500 0.104 12.8 -1442,500 0.119 13 -1442,500		-155 625	5631 057753	1622.2	0.2	165 E-	12 907
0.055 1.3 -159.250 0.033 2 -241000 0.032 4.9 -590.450 0.092 5.57 -665.615 0.095 5.57 -665.615 0.092 5.9 -993.150 0.093 5.57 -665.615 0.093 5.57 -1130.650 0.102 7.8 -91.650 0.103 9.7 -1130.650 0.104 11.4 -1305.300 0.116 128 -1442.500	-	-160.550	5623 556215	2 2624	0.3	-3.553	12.627
0.083 2 -241.000 0.092 4.9 -599.450 0.095 5.57 -665.615 0.099 5.9 -993150 0.099 5.9 -916500 0.0102 7.8 -916500 0.0102 7.8 -916500 0.0103 9.7 -1110050 0.109 11.4 -1120500 0.110 11.4 -1155300 0.110 12.8 -142260 0.119 13 -1442500		-159 250	\$623 \$56215	2 2624	0.3	635 6-	12.627
0.092 4.9 -599.450 0.095 5.57 -695.615 0.099 5.9 -993150 0.099 5.9 -993150 0.0102 7.8 -915.90 0.0102 7.8 -915.00 0.0105 9.7 -111.005.00 0.109 11.4 -1305.300 0.110 11.4 -1305.300 0.110 12.8 -142.200 0.119 13 -142.200	_	-243 000	5519 059691	2 6931	0.7	521 E-	157.6
0.095 5.57 -665.615 0.099 5.9 -93150 0.0102 7.8 -916500 0.0105 9.7 -1130650 0.0195 11 -1220500 0.112 11.4 -1315300 0.116 11.4 -1305300 0.110 12.8 -142260 0.119 13 -142260		-590.450	5096.585521	3 5892	1.6	-2 227	4 958
0.099 5.9 -693150 0.102 7.8 916500 0.105 9.7 -1130650 0.109 1.1 -1270500 0.112 11.4 -1305300 0.112 11.4 -142560 0.116 12.8 -142260 0.119 13 -1442560		-665.615	5001.37132	BTITH	1.7	-2 098	4 403
0 102 7.3 -916 500 0 105 9.7 -1130 500 0 109 11 -1270 500 0 112 11.4 -1305 300 0 116 12.8 -142 500 0 119 13 -1442 500		-699.150	4954.804773	3.7750	1.8	-2 041	4.165
0 105 9.7 .1130 050 0 109 11 .1270 500 0 112 11.4 .1305 300 0 116 12.8 .1422 600 0 119 13 .1402 500		-916.500	4690 931351	4 0541	21	1 762	3 104
0199 11 -1.270 500 0112 11.4 -1.305 300 0116 12.8 -1422 600 0119 13 -1442 500		-1130 050	4434 277929	4 2721	23	-1 54	2 383
0115 11.4 .1305 300 0116 12.8 .1452 800 0119 13 .1462 500		-1270 500	4262 832957	4 3979	24	418 •1	110 2
0116 12.8 .1452 800 0119 13 .1462 500		-1305 300	4210 760657	4 4336	2.4	-1 382	1161
0 119 13 -1462 500		-1452 800	4031 02761	4 5494	25	-1 266	1 604
		-1462 500	4005 67146	4 5649	26	-1 251	1 565
-1471 800	2 13.2	-1471 800	16295 0865	4 5802	2.6	-1 236	1 527

Calculating the Concentration Term (In accordance with EPA Supplemental Guidance to RAGS)

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The concentration term has uncertainity associated with estmating the true average concentration at a site, therefore the 95 percent upper confidence limit (UCL) of the arithmetic mean should be used for this variable. Once calculated, this term will be used to calculate esitmated intake. Obviously, with more data points, the higher the accuracy of the true mean. It is also important to consider transforming the data to the natural log (In). Since our data is already transformed when fitting the data, both UCLs are calculated for us below.

upper confidence Lim it mean of the untransformed data standard deviation of the untransformed data Calculating the UCL of the Arithmetic Mean For a Normal Distribution $UCL = m + 2 \times s$ 174.174 76.29 48.94 95 % UCL E Chloroform UCL = W here: 11 11 **۲** ۵ upper confidence Limit
 e (constant (base of the natural log, equal to 2.718)) raisment
 mean of the transformed data
 standard deviation of the transformed data
 standard Leviation of the transformed data
 Natural Logentihm Calculating the UCL of the Arithmetic Mean ng/ $UCL = exp(ln(_{0}) + (Z_{val} \times S_{y}))$ For a Lognormal Distribution $= y + 0.5 * Sy^{A}2$ 146.550 786 1.53 3.816 1.645 294 1817. number of samples П 95 % UCL = , Z.95 ə đ ഗ് e UCL exp a li Sy u W here:

* Note: The calculated 95% UCL is always the lowest value of the calculated value and max value.

174.174 ug/ L

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95 % UCL

Conclude the best fit is Normal --- Recommend Using the 95%

UCL for a Normal Distributionas shown below:

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D'Agostino's Test for Goodness of Fit (Sample Size >50)

н Д Chloredbromomethane Regulatory Exposure Limit 0.13 Contaminant of Concern Units

- ·			
0.11009	2.74117	98.35507	
= Q		- γ	
0.13	ug/L	294	0.05
Regulatory Exposure Limit	ints of recorded Data (e.g. ppm, mg/m3).	Number of Samples.	Significance Level (a).

Totals		314.15	26084.325	2109.126471	2	-165.7820933	1.04095E-12	289.77484
	Plotting	Date			Modified			
Renk	Position	8		1	Plotting	ц (Х) Ч	:	
	(u)/2	18n	TXC((1+U)C - 1)	XI-MJYZ	la Yi	Ч	Yi - M (h)	CVI-M)72
-	0 003	0.25	-36 625	0 6700035	06137	-1 3863	-0.822	0 676
7	0 007	0.25	-36 375	0 6700035	0 6137	-1 3863	-0 822	0 676
~	0.010	0.25	-36 125	0 6700035	0.6137	-1.3863	-0.822	0.676
-	0.014	0.25	-35 8 75	0 6700035	0 6137	1 3863	-0 822	0 676
~	0 017	0.25	-35 625	0 6700035	0 6137	E98E 1-	-0.822	0 676
8	0 020	0.25	27£ 2£.	0 6708035	16130	-1 3863	0.822	0 676
7	0.024	0.25	-35 125	0 6700035	0 6137	1.3863	-0.822	0.676
8	0 027	0.25	-34 875	0 6700035	0 6137	-1 3863	-0 822	0 676
6	0 031	0.25	· 34 625	0 6700035	0 6137	-1 3863	-0 822	976
10	0.034	0.25	34 375	0 6700035	0 6137	E98E [-	-0 822	0 676
11	0.037	0.25	-34.125	0 6700035	0 6137	-1.4	-0.822	0.676
12	0.041	0.25	33 875	0 6708035	0 6137	-1.4	-0.822	0.676
13	0 044	0.25	-33 625	0.6700035	0 6137	-14	-0 822	0 676
14	0 048	0.25	220 88.	0 6700035	0 6137	-14	-0 822	0 676
15	0 OS1	0.25	33 125	0 6700035	0 6137	-14	-0 822	0 676
16	0.054	0.25	- 32 875	0 6700035	0 6137	-14	-0.822	0 676
17	0 058	0.25	-32 625	0 6700035	0 6137	4	-0.822	0 676
18	190 0	0.25	-32 375	0 6700035	0 6137	4	-0 822	0 676
19	0 065	0.25	-32 125	0.6700035	0 6137	-14	-0.822	0 676
20	0.068	0.25	-31 875	0 6700035	0 6137	-1.4	-0.822	0 676
17	1100	0.25	31 625	0 6700035	0 6137	-14	-0.822	0 676
22	600	0.25	375 16.	0 6700035	0 6137	4 [-	-0 822	0 676
23	0 078	0.25	-31 125	0 6700035	0 6137	-14	-0.822	0 676
24	0.082	0.25	-30 875	0 6700035	0.6137	-14	-0.822	0.676
25	0.085	0.25	- 30 625	0 6700035	16137	-14	-0 822	0 676
26	0 088	0.25	-30 375	0 6700035	0 6137	41.	-0.822	0 676
и	0 092	0.25	-30 125	0 6700035	0 6137	-14	-0.822	0 676
28	0 095	0.25	-29 875	0 6700035	0 6137	41-	-0.822	0.676
62	0.099	0.25	-29.625	0.6700035	0.6137	-1.4	-0.822	0.676
R	0 102	0.25	275 92-	0 6700035	1619.0	-14	-0.822	D 676
31	0 105	0.25	29 125	0 6700035	0.6137	-1 4	-0 \$22	0.676
32	0 109	0.25	-28 875	0 6700035	0 6137	14	-0 822	0 676
E	0.112	0.25	-28 625	0 6700035	0 6137	-14	-0.822	0 676
×	0.116	0.25	-28 375	0 6700035	0 6137	-14	-0.822	0 676
35	0.119	0.25	-28 125	0.6700035	0.6137	-1.4	-0.822	0.676
20	2210	0.25	77 8 77	ATORNEA D				į

Descriptive Analysis	yris
Mean (M)	1.068537415
Standard Error	38 0787558
Median	0.25
Mode	0.25
Standard Deviation	2.745847918
Sample Variance	7.539680789
Kurtosis	229.4332918
Skewaess	14.28646783
Range	44 95
Maamuna	0.25
Maximum	45.2
Sum	314.15
Count	294
Confidence Level(95.0%)	0.010041848

0 995383035

e Analysis	= d.	0.95
1.068537415	11 12	294
38 0787558	Gamma = (g) =	0.95
0.25	z(gamma) =	1.645
0.25	z (P) =	1.645
2.745847918	k(g.P.n) =	1.674
7.539680789	$t(P,df) = (P,n \cdot 1) =$	0.063
229.4332918	_= ¢χ	25
14. 28646783	X(gamma) =	25
44 95		
0.25	a ≕ I (z(gam	1 - (z(gam)^2/2(n-1))
45.2	$b = z(P)^{\gamma 2} \cdot (z(g))^{\gamma 2}$	z(P)^2 - (z(gamma)^2/n)
314.15		
294		

NORMAT					
Statistic Name	×	И	1/b Yi	Stefets	Statitic Name
S = sample Std Dev =	2.746	0.994	14.7	a GS	[undess]
Mcaa = M =	1.069	-0.564	0.57	= GM	ugʻi
M · S = X (16%)	11 677	-1.558	0.21	= GX (16%)	ugr
W + S = X (84%)	3 814	0431	154	= GX (\$4%)	ue/L
W · t × S / (س 5) = LCL =	1 058	-0 S68	0.57	= olcl	1,An
$M + t \ge S / (\pi^{-}.5) = UCL =$	1.079	0.560	0.57	= GUCL	ugt
(%66) X = S X (85%) X = X (85%)	5.585	1 072	2 92	= GX (95%)	ne/L
M + k × S = UTL =	5 666	1 101	301	= GUTL	ug't.
- OEL =	610	013	0.13	= OEL	1)An
Median = Me	0 25	-1.39			
= S / (= W · We) / S =	0 298	0 827			
Smaller Test Statuthe, (M-Me)/S, unplies better distribution. Normal or Lognormal	n. Normal o	r Lognormal			
For Normal Distribution, M = Me = Mo (mean = median = mode)	≂ Mo (mea	n wedaan =	mode)		
For Lognormal Distribution, mean = median = mode for [h (data) in Nepers]	a median =	mode for [h	(data) in Neper	-	
For Lognormal Distribution, Me of data = CM of data [u pom or mg/m3 = ug/L]	f data = GM	of data [un pp	m or mg/m3 =	[J]80	
		د/ ۳	200.0		9000
Istine Table 48 determine range have on 20					

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Conclude the best fit is Lognormal

Calculating the Concentration Term (In accordance with EPA Supplemental Guidance to RAGS) The concentration term has uncertainity associated with estmating the true average concentration at a site, therefore the 95 percent upper confidence limit (UCL) of the arithmetic mean should be used for this variable. Once calculated, this term will be used to calculate estimated intake. Obviously, with more data points, the higher the accuracy of the true mean. It is also important to consider transforming the data to the natural log (In). Since our data is already transformed when fitting the data, both UCLs are calculated for us below.

ug/L upper confidence Limit mean of the untransformed date standard deviation of the untransformed data Calculating the UCL of the Arithmetic Mean For a Normal Distribution $UCL = m + 2 \times s$ Conclude the best fit is Lognormal -- Recommend Using the 95% 6.560 1.07 UCL for a Lognormal Distribution as shown below: 95 % UCL = Chlorodibromomethane III MCL Where: upper contridence Limit
 e (constant (base of the natural log, equal to 2.718)) rasi
 mean of the transformed data
 mean of the transformed data
 Matmal Logenthum
 number of samples ug/I Calculating the UCL of the Arithmetic Mean $UCL = exp(ln(\phi) + Z_{val}(Sy))$ For a Lognormal Distribution $\varphi = y + 0.5 * Sy^{A2}$ -0.564 0.9330 1.645 0.99 4.790 294 Ħ 95 % UCL ¤ ۲ Z.95 r 9 ᅕᆃᆠᅇ^{ᆞᆆ}ᆴ Ŋ Where:

95 % UCL = 4.790 ug/L

* Note: The calculated 95% UCL is always the lowest value of the calculated value and max value.

D'Agostino's Test for Goodness of Fit (Sample Size >50)

Bromodichloromethane

Contaminant of Concern

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uts of record	ded Data (e.g.	uts of recorded Data (e.g. ppm, mg/m3).	Jgu		"	7.12824		•	
	Num	Number of Samples	294			-82 40666			
	Signfice	Significance Level (a):	0.05						
Lotats		1406.25	85014.825	14038.65916	2	353,4111811	-2.55705E-13	234.25093	
	Plotting	Data			Moddfed				
Renk	Position	8			Plotting	(00) म			
-	r/n	Jan	X((1+u)5 i)	(XL-M)^2	for Yi	×	Yi - M (h)	(Yi-M)^2	
-	0 003	0.25	-36.625	20.54956919	0.6137	-1 3863	-2 588	6.700	
2	0 007	0.25	-36 375	20 54956919	0 6137	-1 3863	-2 588	6 700	-
m	0100	0.25	-36.125	20 54956919	D 6137	-1 3863	-2 588	9.700	
4	0.014	0.25	-35 875	20 54956919	0 6137	-1 3863	-2 588	6 700	
۶	0 017	0.25	-35.625	20 54956919	0 6137	-1 3863	-2 588	6 700	
40	0 020	0.25	35.375	20 54956919	0 6137	-1 3863	-2 588	6 700	
٢	0 024	0.25	-35.125	20 54956919	0.6137	-1 3863	-2.588	6.700	•••
8	0 027	0.25	-34 875	20 54956919	0 6137	£98E 1-	-2 588	6 700	
6	0 031	0.25	-34.625	20 54956919	0.6137	-1.3863	-2 588	9.700	
2	0 034	0.25	-34.375	20.54956919	0.6137	-1.3863	-2.588	6.700	
=	0 037	0.25	-34 125	20 54956919	0 61 37	41-	-2 588	6 700	
12	1000	0.25	-33 875	20 54956919	0 6137	-14	2 588	6 700	
9	0 044	0.5	-67 250	18 34548756	1 3069	-0.7	-1 895	3 592	
4	0 048	0.5	-66 750	18 34548756	1 3069	-0.7	-1 895	3 592	
2	0 051	0.5	-66.250	18 34548756	1.3069	-0 7	-1.895	3 592	
91	0 054	0.5	-65.750	18 JASA8756	1 3069	20-	\$68 1-	3 592	
11	0 058	0.5	-65.250	18 34548756	1 3069	-0.7	-1 895	3.592	
81	0 061	0.5	-64 750	18 J4548756	1 3069	-0.7	-1 895	3 592	
61	0 065	0.5	-64 250	18 34548756	1 3069	-0 7	-1 895	3 592	
50	0 068	0.5	-63 750	18 34548756	1 3069	-0.7	-1 895	3 592	
12	0 071	0.5	-63 250	18 24548756	690E 1	-0.2	-1 895	3 592	
2	0 075	0.5	-62 750	18 34548756	1 3069	-0 J	-1 895	3 592	
8	0.078	0.5	-62.250	18 34548756	1 3069	-0 Z	-1.895	3.592	
24	0 082	0.8	-98.800	15.8655896	1 7769	-0.2	-1.425	2 031	
25	0 085	-	-122 500	14 31232429	2 0000	00	-1 202	1 445	-
26	0 088	-	-121 500	14 31232429	2 0000	6.0	-1 202	1 445	
27	0 092	-	-120 500	14 31 2 3 2 4 2 9	2 0000	00	-1 202	1 445	
28	900	-1	-119 500	14 31232429	2 0000	00	-1 202	1.445	
29	660 0		-118 500	14 31 232429	2 8000	00	-1 202	1 445	
90	0 102		-117 500	14 31232429	2 0000	00	-1 202	1 445	
Ē	0.105	1.1	-128.150	13 56569164	2 0953	0.1	-1 107	1.225	
8	0 109	1.25	-144 375	12 48324266	2 2231	0.2	6 <i>L</i> 6 0:	856 0	
8	0 112	1.25	-143 125	12 48324266	2 2231	0.2	-0.979	0 958	
*	0116	1.25	-141 875	12 48324266	1622.2	0.2	61.6 D	856 0	
8	0119	1.25	-140 625	12 48324266	2 2231	0 2	61.610-	0 958	

Descriptive Analysis	فندو
Mean (M)	4.783163265
Standard Error	241.7410676
Median	•
Mode	2.5
Standard Deviation	7.140391085
Semple Vanance	50 98518484
Kurtosis	131.1124332
Skewness	10.4646285
Range	101.75
Minimura	0.25
Maximum	102
Sum	1406.25
Count	294
Confidence Level(95.0%)	0.026113144

									0.995383035	27
0 95	294	0.95	1 645	1 645	1.674	0 063	10.07	10.07	1 - (z(gam)^2/2(n-1))	z(P)^2 - (z(gamma)^2/n)
P =	n=	Gamma = (g) =	r(gamma) =	z (P) =	k (g. P. n) =	t (P,df) = (P,n 1) =	Xe =	X(gamma) =	1 - (z(gam	z(Р)^2 - (д(
		Genter	z(ga	N	k (g	(P,df)		X(ge	28	ا م

NORMAL				LOGNORMAL	L
Steristic Name	х	Yi	1/ Ja Yi	Stetist	Stetistic Name
ug'l. S = sample Std Der =	cv = 7140	0 894	245	= GS	(unitiess)
ug'l. Mean = M =	M = 4783	1 202	1 33	= GM	ug/L
ug'L M · S = X (16%)	6%) -2 357	0 308	1.36	= 0X (16%)	ugʻt
ug'L M + S = X (84%)	4%) 11.924	2 096	8.14	= CIX (84%)	ug/L
$w_{ix} = W_{ix} = V (m' S) = LCL =$	L = 4.757	1.199	3.32	= GLCL	ug/L
$wg(L = M + i \times S / (n^2) = UCL =$	L = 4 809	1.205	3.34	= CUCL	ugʻL
ug'L M + Zp (95%) x S = X (95%)	5%) 16.529	2.673	14.48	= GX (95%)	ugʻL
ugʻi. M + k x S = UTL =	L= 16 738	2 699	14.87	- GUTL	ug/L
10 M	0EL = 017	017	017	= OEL	ug/L
ug'L Median = Me =	te = 4.00	1 39			
ug/L (M · Mc) / S =	S= 0110	-0 206			
Smaller Test Stahstic, (M.Me)/S, emples better distribution. Normal or Lognormal	abutton Normal o	r Lognormal			
For Normal Distribution, M = Mc = Mo (mean = raction = rade)	= Mc = Mo (mea	n = raedian =	mode)		
For Lognormal Distribution, mean = median = mode for [in (data) in Nepers]	mean = median =	mode for [h	(data) in Neper		
For Lognormal Distribution, Me of data = GM of data [in ppm or mg/m1 = ug/L]	Me of data = GM	of data [mp	= Cm/8m 10 md	ug'L]	
		-	_		
		α/2	0.025		0.975
Using Table A8. determine range base on $\alpha/2$	e on <i>a/</i> 2	Rance		-2 31984 -82 40666	1.53004

t Lognormal
the best fit h
Conclude 1

on Term suidance to RAGS)	the true average concentration ne arithmetic mean should be lculate esitmated intake.	ue mean. It is also important to ta is already transformed when	Calculating the UCL of the Arithmetic Mean For a Normal Distribution	$UCL = m + 2 \times s$	· · · · · ·	upper confidence Limit mean of the untransformed data standard deviation of the untransformed data	н к 4,78 4,73 4,73	95 % UCL = 19.064 ug/L		Recommend Using the 95% tion as shown below:
Calculating the Concentration Term (In accordance with EPA Supplemental Guidance to RAGS)	The concentration term has uncertainity associated with estmating the true average concentration at a site, therefore the 95 percent upper confidence limit (UCL) of the arithmetic mean should be used for this variable. Once calculated, this term will be used to calculate esitmated intake.	Obviously, with more data points, the higher the accuracy of the true mean. It is also important to consider transforming the data to the natural log (In). Since our data is already transformed when fitting the data, both UCLs are calculated for us below.	Calculating the UCL of the Arthmetic Mean For a Lognormal Distribution	$UCL = exp(\ln(\phi) + Z_{val}(Sy))$	$\varphi = y + 0.5 * Sy^{\Lambda}2$ Where:	UCL upper contridence Limit exp = constant (hase of the rational log, equal to 2.718)) arei m = Y Y = meen of the transformed data 5 = standard deviation of the transformed data h = Matural Logarithm h = mumber of samples		$Z_{.95} = 1.645$ 95 % UCL = 21.600 ug/L	Bromodichloromethane	Conclude the best fit is Lognormal Recommend Using the 95% UCL for a Lognormal Distribution as shown below:

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