

## 5.2 Monte Carlo Results

Table 5-8 summarizes the Monte Carlo simulation results quantifying lifetime exposure to arsenic in mg/kg-day for the Balmertown study area, the Balmertown control area, and Red Lake. The tables present the arithmetic mean, and the 50th and 90th percentile values for exposure attributable to two sets of pathways: soil and dust; and soil and dust, drinking water, and food. Table 5-9 compares average lifetime exposure for all three geographic areas and quantifies the proportion of exposure attributable of the three pathways considered (soil and dust, water, and food). The results indicate that, on average, the soil and dust pathways account for a larger fraction of arsenic exposure in Balmertown (7.9 percent and 7.5 percent in the Balmertown study area and control area, respectively) than it does in Red Lake (1.7 percent). However, total exposures are comparable in all three locations. Figures 5-1 and 5-2 show the distribution and cumulative frequency, respectively, of total lifetime exposure to arsenic for the three groups.

**Table 5-8**  
**Monte Carlo Results**  
**Lifetime Average Exposure to Arsenic (mg/kg-day)**  
**2000 Interactions per Run**

	Exposure Attributable to Soil and Dust	Exposure Attributable to Soil, Dust, Water, and Food
<b>Balmertown Study Area</b>		
Arithmetic mean	6.81E-06	8.62E-05
50th percentile	2.36E-06	6.84E-05
90th percentile	1.62E-05	1.67E-04
<b>Balmertown Control Area</b>		
Arithmetic mean	6.62E-06	8.81E-05
50th percentile	2.61E-06	6.93E-05
90th percentile	1.58E-05	1.74E-04
<b>Red Lake Control Area</b>		
Arithmetic mean	1.37E-06	8.19E-05
50th percentile	5.42E-07	6.42E-05
90th percentile	3.39E-06	1.62E-04

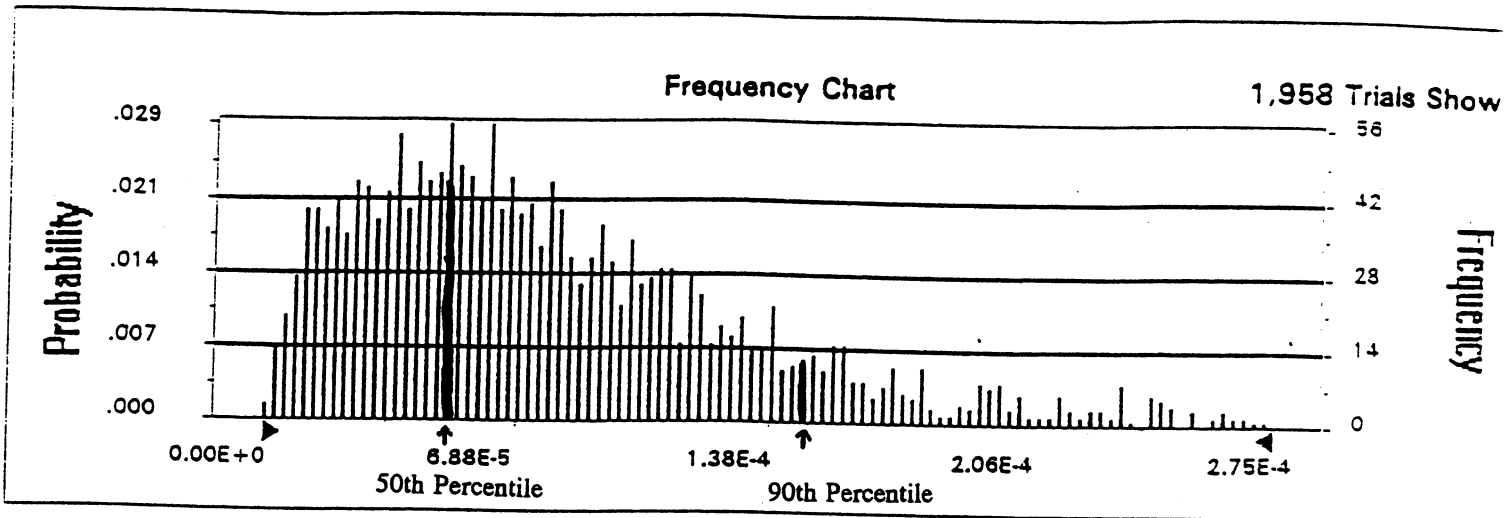
**Table 5-9**  
**Monte Carlo Results**  
**Average Inorganic Arsenic Exposure Attributable to Each Exposure Source**  
**(mg/kg-day)**

	Balmertown Study Area		Balmertown Control Area		Red Lake Control Area	
Soil and Dust	6.81E-06	7.9%	6.62E-06	7.5%	1.37E-06	1.7%
Water	1.65E-05	19.1%	1.65E-05	18.7%	1.66E-05	20.2%
Food	6.29E-05	73.0%	6.50E-05	73.8%	6.39E-05	78.0%
Total	8.62E-05		8.81E-05		8.19E-05	

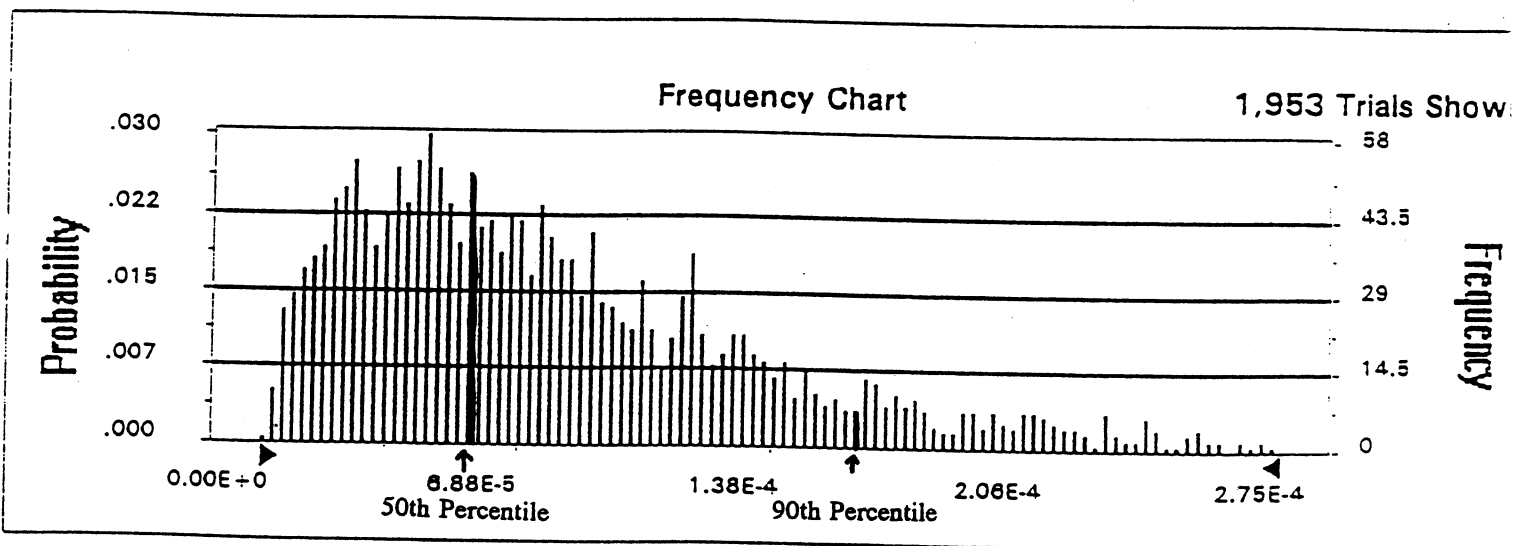
The Monte Carlo results cannot be directly compared as an average to the average of the deterministic individual house results described in Section 5.1. Unlike the Monte Carlo results, which

**Figure 5-1**  
**Distribution of Total Lifetime Exposure to Arsenic**

**Balmertown Study Area**



**Balmertown Control Area**



**Red Lake Control Area**

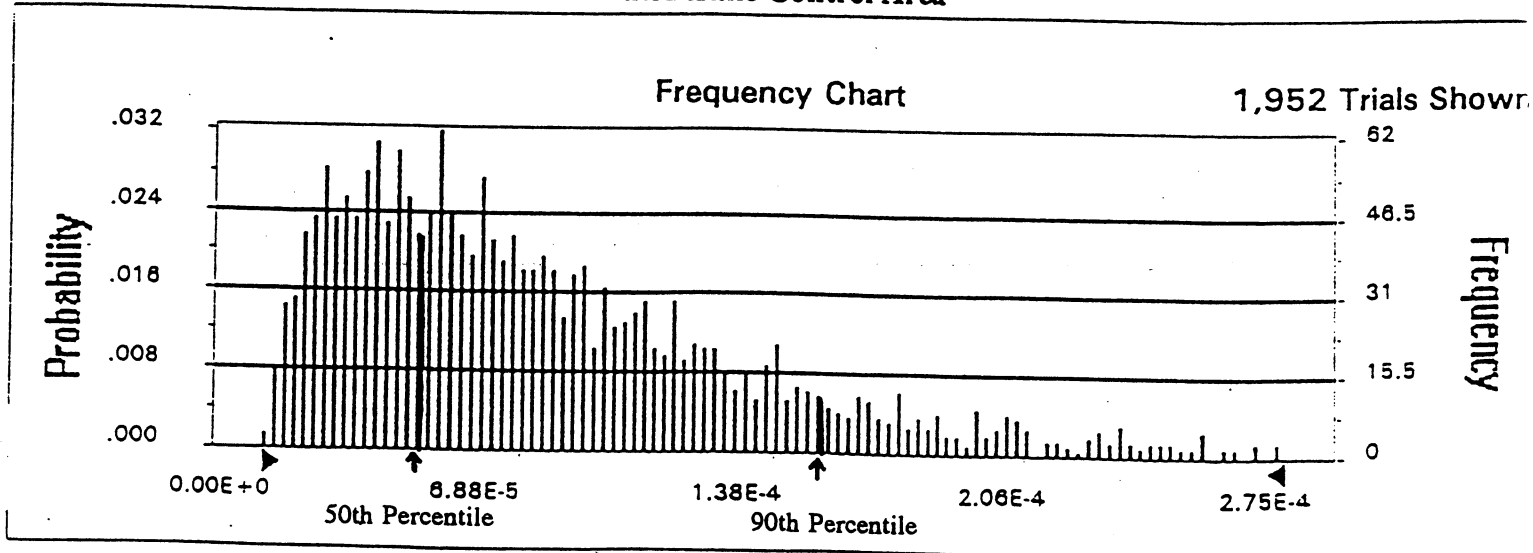
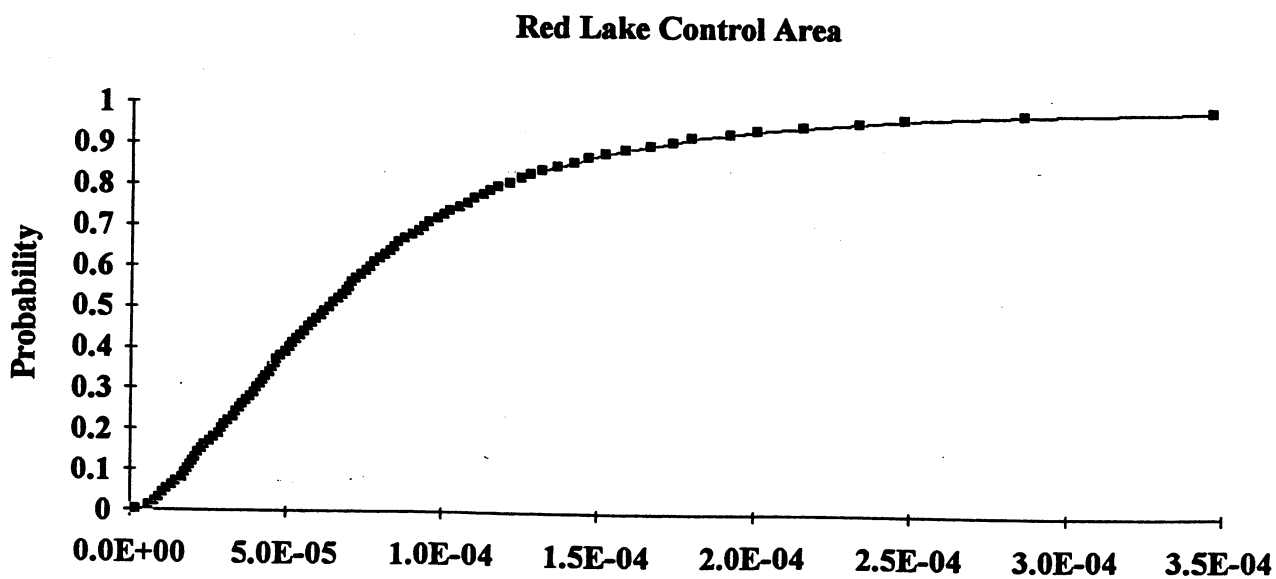
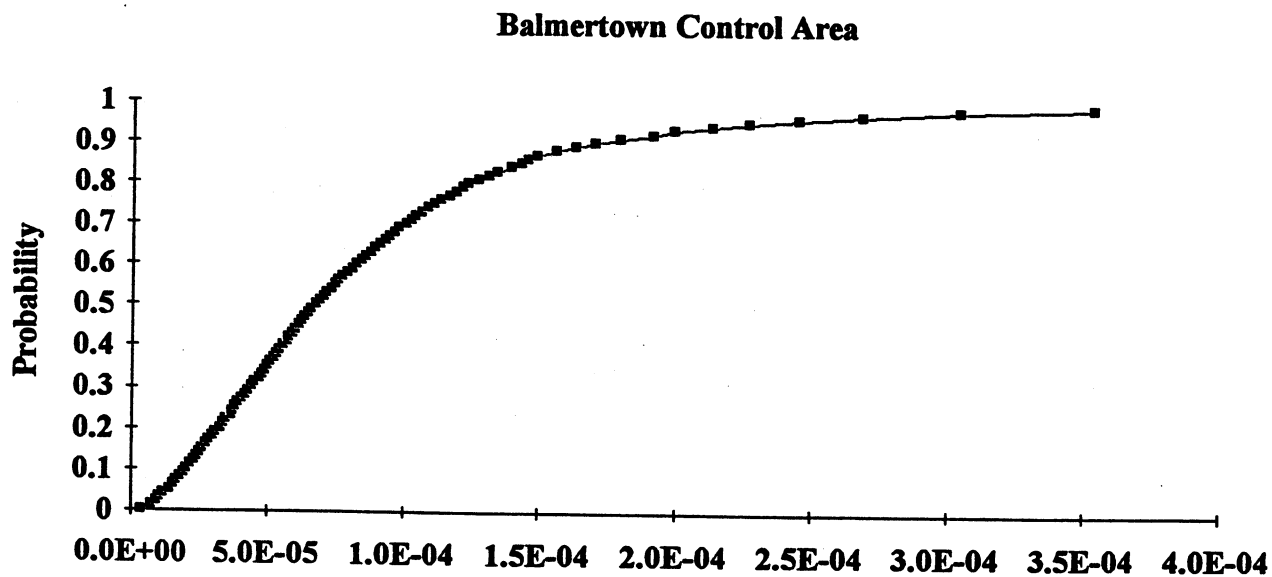
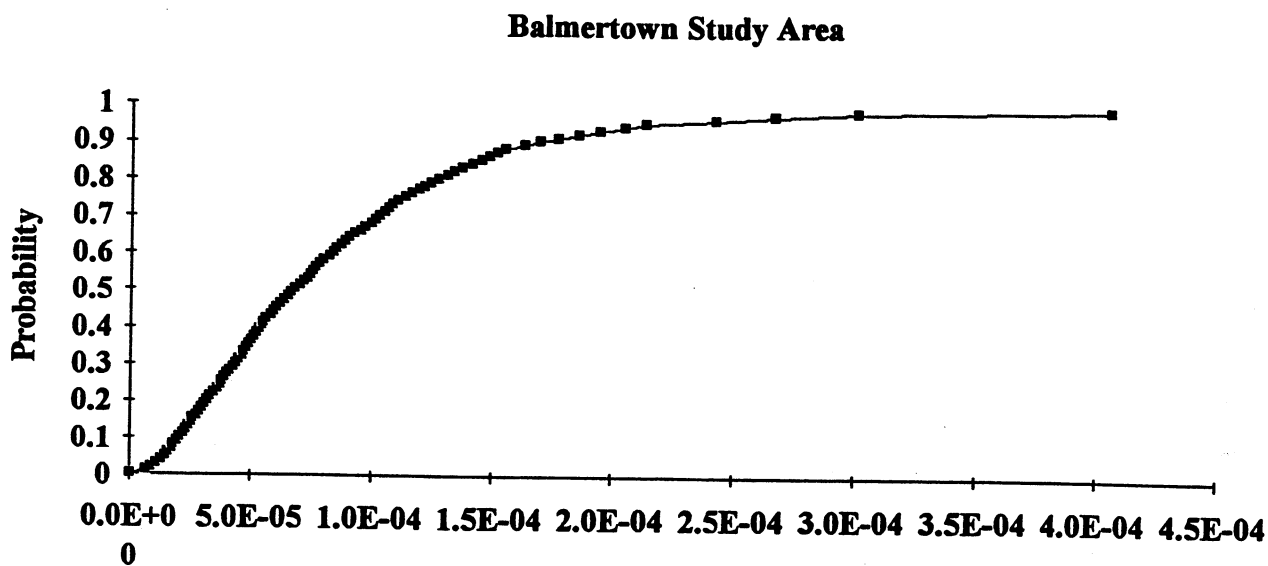


Figure 5-2: Cumulative Frequency of Total Lifetime Exposure to Arsenic (mg/kg-d)



quantify lifetime arsenic exposure assuming individuals live at the site for some subset of their lifetime, the individual house results quantify exposure assuming that individuals live at the site for an entire 70-year lifetime. Moreover, the individual house results break the exposure contribution into a component attributable to exposure during childhood and a component attributable to exposure during adulthood. In order to compare the results from these two sections, we must scale back the implicit 70-year exposure duration used to calculate individual house exposures. Since the arithmetic average of the exposure duration distribution used in the Monte Carlo simulation is approximately 22 years, we assume that exposure consists of two components: 6 years during childhood, and 16 years during adulthood. Hence, the total contribution to average lifetime exposure ( $Exp$ ) in mg/kg-day is:

$$Exp = Exp_C + \left( \frac{16}{64} \times Exp_A \right)$$

where

- $Exp_C$  = Total contribution to average lifetime exposure assuming the individual spends all 6 years of childhood at the site, and
- $Exp_A$  = Total contribution to average lifetime exposure assuming the individual spends all 64 years of adulthood at the site.

Table 5-10 compares Monte Carlo estimates of average lifetime arsenic exposure to the estimates calculated using the results from Section 5.1 and adjusted to an average exposure duration of 22 years. The individual house estimates of average exposure attributable to soil and dust ingestion somewhat exceed the Monte Carlo estimates of average exposure for the Balmertown study and control areas, but are slightly lower for Red Lake. In addition, individual house estimates of exposure attributable to food and water ingestion are consistently higher than the corresponding Monte Carlo estimates.

**Table 5-10**  
**Contribution to Lifetime Arsenic Exposure:**  
**Monte Carlo Results vs. Individual House Results**  
**Adjusted to Average Exposure Duration**  
**(mg/kg-day)**

	Balmertown Study Area		Balmertown Control Area		Red Lake Control Area	
	MC <sup>a</sup>	IH <sup>b</sup>	MC <sup>a</sup>	IH <sup>b</sup>	MC <sup>a</sup>	IH <sup>b</sup>
Soil and Dust	6.81E-06	7.28E-06	6.62E-06	7.88E-06	1.37E-06	1.30E-06
Water	1.65E-05	2.80E-05	1.65E-05	2.80E-05	1.66E-05	2.80E-05
Food	6.29E-05	8.94E-05	6.50E-05	8.94E-05	6.39E-05	8.94E-05
Total	8.62E-05	1.24E-04	8.81E-05	1.24E-04	8.19E-05	1.12E-04

*Notes:*

- (a) *MC = Monte Carlo estimates*
- (b) *IH = Individual House estimates*

In the previous paragraph we compared the average Monte Carlo analysis to the individual house runs by adjusting the individual house runs to the average exposure duration of the Monte Carlo analysis - namely 22 years. Thus, we were able to assess the quality of the exposure intake parameters used in each assessment. The results of the adjusted individual house runs can also be compared to the Monte Carlo distributions to assess what percentile is represented by the individual house run values. Thus, the values from the Monte Carlo runs can be compared to the individual house values as shown in Table 5-11. This comparison indicates that all the soil and dust ingestion values for all the individual house runs were between the 50th and 90th percentile Monte Carlo value. The total values for lifetime exposure in the individual house runs were between the 50th and 90th percentile Monte Carlo values as shown in Table 5-11. The total values for the Balmertown study and control areas and the Red Lake control area corresponded to the 79th, 80th, and 78th percentile Monte Carlo values, respectively.

**Table 5-11**  
**Comparison of Adjusted Total Lifetime Exposure for Individual House Runs**  
**to 50th and 90th Percentile Values for Monte Carlo Results**  
**(mg/kg-day)**

	Total Exposure			Exposure to Soil and Dust		
	Average Value for Individual House Run	Monte Carlo 50th Percentile	Monte Carlo 90th Percentile	Average Value for Individual House Run	Monte Carlo 50th Percentile	Monte Carlo 90th Percentile
Balmertown Study Area	1.24E-04	6.8E-05	1.67E-04	7.28E-06	2.36E-06	1.62E-05
Balmertown Control Area	1.24E-04	6.9E-05	1.70E-04	7.88E-06	2.61E-06	1.58E-05
Red Lake Control Area	1.12E-04	6.4E-05	1.62E-04	1.30E-06	5.42E-07	3.39E-06

This comparison indicates that total exposure for the individual house runs represent a fairly high end exposure.

### 5.3 Comparison of Calculated Intake to Urinalysis Results

As stated in the Introduction, one purpose of the exposure assessment is to compare the arsenic levels in urine predicted from the exposure assessment to observed urine arsenic levels from the urinalysis screening program conducted by Placer Dome in 1993 and 1994. This comparison is useful for determining whether the calculated exposure to arsenic either overpredicts or underestimates exposure when compared to urinary arsenic data. Urinary arsenic is a generally accepted indicator of arsenic exposure because the presence of arsenic in urine reflects arsenic exposure in the last few days, and may be useful in identifying sources of arsenic exposure.

The urinalysis screening involved 65 individuals (63 adults and 2 children aged 1-6). (A total of 47 adults and 1 child comprised the study population, and 16 adults and 1 child comprised the control population). Although the urinalysis survey was conducted in both February and June of 1994, 10 people who participated in February did not participate in June. We analyzed the data for each area (Balmertown study area, Balmertown control area, and Red Lake control area) using paired t-tests and determined that the February and June urinalysis results were not statistically different for either the