February 1994
Publication # 9285.7-15-1
EPA 540-R-93-081

5. APPLICATIONS WITH EXAMPLES

5.1 APPLICATIONS FOR POPULATION ESTIMATES

The purpose of this chapter is to provide concrete examples complete with explanations that can guide the user through specific applications of the model. These examples are taken in part from past applications of the model, but they have been modified for the purposes of illustration and do not represent any specific site or risk management decision. While the user should find some guidance in these examples, they are not meant to be comprehensive of all possible model applications, nor should they be generalized to any particular site.

EXAMPLE 5-1. Default Values

As stated earlier in this manual, the model can predict geometric mean blood lead levels in a population of children with residential and neighborhood exposures, provided that the distribution of environmental lead parameters is not widely dispersed. The following is an example of a simple simulation using only default values.

From the main menu shown in Screen 2-1, enter "2" (Computation), then on the Computation Menu enter "1" (Run). The results shown on the monitor display the average of monthly geometric mean blood lead concentrations in one-year intervals, along with the daily lead uptakes from each medium in Fg Pb/day. These results are the geometric mean blood lead concentrations and lead uptakes within each one-year age interval, assuming constant environmental lead concentrations from birth through each age interval. They can be interpreted as representing the results for a "typical" child in contact with these or similar lead concentrations. See Example 5-4 for an extension of this example to risk estimation.

5.2 APPLICATIONS WHERE ENVIRONMENTAL LEAD CONCENTRATIONS CHANGE OVER TIME

EXAMPLE 5-2. Reductions in Air and Dietary Lead Levels from 1975 to 1981 Decrease Baseline Blood Lead Concentrations

This example illustrates the estimation of historical exposures and baseline U.S. blood lead concentrations from 1975 to 1981.

- Air: The user should first enter the 1975 air lead levels from Figure 2-10.

- Diet: Then the user should enter the dietary lead values for the same time period, as in Table 2-1. However, no dietary lead intake values for children are shown for 1975 to 1977. We estimated the 0-11 month value for 1975 as 80 percent of the 1-year value for the 1978 value, that is 80 percent of 45.80 Fg/d = 36.64 Fg/d, since the 6-11 month dietary lead intake values for 1982-1984 are about 80 percent of the respective 1-year-old values. We then assumed that for a child born in 1975, the 1975 value was 36.64 Fg/d, the 1976 value (age 1 year) was the same as the 1978 1-year-old value of 45.80 Fg/d, the 1977 value (age 2 years) was the same as the 1978 2-year-old value of 52.90 Fg/d, the 1978 value (age 3 years) was 52.70 Fg/d as in Table 2-1, the 1979 value (age 4 years) was 47.30 Fg/d as in Table 2-1, the 1980 value (age 5 years) was 38.70 Fg/d as in Table 2-1. We assumed that the 1981 value (age 6 years) was 110 percent of the 1981 value at age 5 years or 110 percent of 35.80 Fg/d = 39.38 Fg/d, since the 1982-1984 6-year-old values are about 10 percent larger than the respective 5-year-old intake values. The input values for dietary lead intake are shown in Table 5-1.

- Water: Water lead concentrations were kept at the default values.

- Soil: Adjustments should be made for lead in soil and household dust. We assumed that soil lead levels, even in areas not heavily impacted by automobile traffic, would have been somewhat larger in 1975 than in 1981. In the absence of better information, we assumed that soil lead concentrations consist of two components, a genuine baseline of about 200 Fg/g which is the current default, and a small increment from air lead deposition that adds about 100 Fg/g soil lead per Fg/m^3 air lead. This assumption implies a relatively small contribution of 10 Fg/g to soil lead from current air lead levels of 0.1 Fg/m^3. Thus the 1975 soil lead level is about 324 Fg/g, the 1976 level about 322 Fg/g, and so on, as shown in Table 5-2.

TABLE 5-1. USER-SELECTED ENTRIES FOR IEUBK MODEL WORKSHEET FOR EXAMPLE 5-2, CHILD BORN IN 1975

PARAMETER	DEFAULT VALUE	USER SELECTED OPTION	UNITS
DATA ENTRY FOR DIET (by year)			
Dietary lead intake			
Age = 0-1 year (0-11 mo),	5.53	36.64	Fg Pb /day
1-2 years (12-23 mo)	5.78	45.80	
2-3 years (24-35 mo)	6.49	52.90	
3-4 years (36-47 mo)	6.24	52.70	
4-5 years (48-59 mo)	6.01	47.30	
5-6 years (60-71 mo)	6.34	38.70	
6-7 years (72-84 mo)	7.00	39.38	

TABLE 5-2. USER-SELECTED ENTRIES FOR IEUBK MODEL WORKSHEET FOR EXAMPLE 5-2, CHILD BORN IN 1975

PARAMETER	DEFAULT VALUE	USER SELECTED OPTION	UNITS
DATA ENTRY FOR SOIL (by year)			
Soil lead concentration			
Age = 0-1 year (0-11 mo) (1975)	0	324	Fg/g
1-2 years (12-23 mo) (1976)	0	322	
2-3 years (24-35 mo) (1977)	0	320	
3-4 years (36-47 mo) (1978)	0	310	
4-5 years (48-59 mo) (1979)	0	290	
5-6 years (60-71 mo) (1980)	0	256	
6-7 years (72-84 mo) (1981)	0	247	

•Dust: The Multiple Source Analysis method for household dust should be used, since soil lead and air lead levels are changing over time. Since particles from leaded gasoline emission are believed to contribute significantly to surface soil transported into the house during these years, we have assumed that the soil-to-dust coefficient is 0.85 appropriate for this historical example, although the current default is 0.70, and the air-to-dust coefficient is 100. This was shown in Screen 2-10. These changes are reported to the user in the main Data Entry Screen for Soil/Dust.

The model can be run by returning to the Computation Menu and using Option 1, or by pressing the F5 key from any of the main media data entry screens. The results are shown on the display. The results are reasonably consistent with the decrease in child blood lead concentrations in the U.S. from about 15 Fg/dL to 10 Fg/dL found in the 1976-1980 NHANES II survey (U.S. Environmental Protection Agency, 1986). However, this exposure scenario follows a single child born in 1975 for six years through 1981. Direct comparison with NHANES II would require representative blood lead estimates for 1-year-olds in 1976, 2-year-olds in 1977, 3 year-olds in 1978 etc.

The importance of a worksheet in developing and documenting the exposure scenario should be clear to the reader. The worksheets for this example are shown in Tables 5-1 and 5-2. Since the exposure scenario here is for a typical urban child and is not specific to a site or neighborhood, the user should not try to extend these results for risk estimation purposes without incorporating interindividual variability and site-specific information concerning exposure variability.

The IEUBK model is a biokinetic model, and therefore has the ability to estimate changes in blood lead in response to yearly changes in environmental lead exposure for children of different ages. The following examples are presented to encourage the user to explore some of the IEUBK model's capabilities for evaluating age-dependent changes in lead exposure when this exposure changes over time.

EXAMPLE 5-3. Example for Children Moving From a Lower to a Higher Soil Lead Concentration

This example demonstrates the effects of change from a constant environmental lead concentration to a higher constant environmental lead concentration. Assume that a child moved into a housing unit with a soil lead concentration of about 2000 µg/g, from a previous housing unit with a soil lead concentration of about 100 µg/g. Assume also that soil is a significant source of dust in household dust, and that the soil lead contribution to household dust lead is 70 percent of the soil lead concentration. The user can assess the maximum effect of new exposure to elevated soil lead (e.g., moving into a new residence). This assessment is for children of different ages, in an ordered sequence of runs. This sequence studies the effects of new exposure at later ages.

The work sheet for this example is similar to the segment shown in Table 5-2. In fact, a sequence of work sheets is needed to study the effects of moving at different ages. There are two variables to be considered here. The first variable is the age of the child, which is used in the IEUBK Model calculations, and is entered as the left-hand column of the work sheets. The second variable is the age at which the child moves into the new exposure environment. Thus, in Table 5-3(a), if the child moves at age 0 years, the child is exposed to 2000 Fg/g lead in soil and 1400 Fg/g lead in dust derived from soil from birth through age 6 years. However, if the child moves at age one year, the correct work sheet is shown in Table 5-3(b). In the work sheet in Table 5-3(b), the child is exposed to 100 Fg/g lead in soil and 70 Fg/g lead in household dust at age zero years, but to 2000 Fg/g lead in soil and 1400 Fg/g lead in dust from soil at ages 1 through 6 years. Similarly, if the child moves at age two years, the correct work sheet is shown in Table 5-3(c). In the work sheet in Table 5-3(c), the child is exposed to 100 Fg/g lead in soil and 70 Fg/g lead in household dust at ages 0 and 1 years, but to 2000 Fg/g lead in soil and 1400 Fg/g lead in dust from soil at ages 2 through 6 years.

The worksheets for Tables 5-3(a-c) are combined and shown as columns 2 to 4 in Table 5-3(d). The last 4 columns in Table 5-3(d) summarize the soil lead work sheet entries if the hypothetical child moves at ages 3, 4, 5, or 6 years respectively. For example, in the extreme right-hand column, if the child moves at age 6 years, he or she is exposed to 100 Fg/g lead in soil from birth through age 5 years, then to 2000 Fg/g at age 6 years.

The IEUBK Model simulation for this example is run 7 times, each run corresponding to a column in Table 5-3(d) or to a work sheet 5-3(a-c) or analogous work sheets for older children. The results, as annual averages of predicted geometric mean blood lead concentration, are shown in Table 5-4 in exactly the same order as in Table 5-3(d).

TABLE 5-3a. SOIL LEAD DATA ENTRY WORKSHEET FOR CHILD EXPOSED TO 2000 Fg/g SINCE AGE 0 (BIRTH)

PARAMETER	DEFAULT VALUE	USER SELECTED OPTION	UNITS
DATA ENTRY FOR SOIL (by year)			
Soil lead concentration			
Age = 0-1 year (0-11 mo)	0	2000	Fg/g
1-2 years (12-23 mo)	0	2000	
2-3 years (24-35 mo)	0	2000	
3-4 years (36-47 mo)	0	2000	
4-5 years (48-59 mo)	0	2000	
5-6 years (60-71 mo)	0	2000	
6-7 years (72-84 mo)	0	2000	

TABLE 5-3b. SOIL LEAD DATA ENTRY WORKSHEET FOR CHILD EXPOSED TO 2000 Fg/g SINCE AGE 1

PARAMETER	DEFAULT VALUE	USER SELECTED OPTION	UNITS
DATA ENTRY FOR SOIL (by year)			
Soil lead concentration			
Age = 0-1 year (0-11 mo)	0	100	Fg/g
1-2 years (12-23 mo)	0	2000	
2-3 years (24-35 mo)	0	2000	
3-4 years (36-47 mo)	0	2000	
4-5 years (48-59 mo)	0	2000	
5-6 years (60-71 mo)	0	2000	
6-7 years (72-84 mo)	0	2000	

TABLE 5-3c. SOIL LEAD DATA ENTRY WORKSHEET FOR CHILD EXPOSED TO 2000 Fg/g SINCE AGE 2

PARAMETER	DEFAULT VALUE	USER SELECTED OPTION	UNITS
DATA ENTRY FOR SOIL (by year)			
Soil lead concentration			
Age = 0-1 year (0-11 mo)	0	100	Fg/g
1-2 years (12-23 mo)	0	100	
2-3 years (24-35 mo)	0	2000	
3-4 years (36-47 mo)	0	2000	
4-5 years (48-59 mo)	0	2000	
5-6 years (60-71 mo)	0	2000	
6-7 years (72-84 mo)	0	2000	

TABLE 5-3d. WORKSHEET FOR YEARLY SOIL LEAD CONCENTRATION FOR HYPOTHETICAL CHILDREN MOVING FROM A RESIDENCE WHERE SOIL CONCENTRATION IS 100 µg/g TO A RESIDENCE WHERE SOIL CONCENTRATION IS 2000 µg/g

AGE OF CHILD (YEARS)	AGE AT TIME OF NEW EXPOSURE (YEARS)						
	0	1	2	3	4	5	6
0	2000	100	100	100	100	100	100
1	2000	2000	100	100	100	100	100
2	2000	2000	2000	100	100	100	100
3	2000	2000	2000	2000	100	100	100
4	2000	2000	2000	2000	2000	100	100
5	2000	2000	2000	2000	2000	2000	100
6	2000	2000	2000	2000	2000	2000	2000

TABLE 5-4. PREDICTED ANNUAL AVERAGE BLOOD LEAD CONCENTRATIONS (µg/dL) FOR HYPOTHETICAL CHILDREN MOVING FROM A RESIDENCE WHERE SOIL CONCENTRATION IS 100 µg/g TO A RESIDENCE WHERE SOIL CONCENTRATION IS 2000 µg/g

AGE OF CHILD (YEARS)	AGE AT TIME OF NEW EXPOSURE (YEARS)						
	0	1	2	3	4	5	6
0	16.2	2.8	2.8	2.8	2.8	2.8	2.8
1	18.6	16.3	3.0	3.0	3.0	3.0	3.0
2	17.7	17.7	14.5	2.8	2.8	2.8	2.8
3	17.3	17.3	17.2	13.5	2.6	2.6	2.6
4	14.7	14.7	14.7	14.5	10.2	2.3	2.3
5	12.6	12.6	12.6	12.6	12.2	8.6	2.1
6	11.3	11.3	11.3	11.3	11.2	10.8	7.5

The changes in exposure scenario are made by first using the parameter selection menu (Option "1" on the Main Menu), Option "4" on the parameter selection menu, and then entering selection "2" in the soil concentration box of the Soil/Dust menu. This allows the entry of separate values for soil lead exposure concentration at each age. The default value of 200 µg/g for each age may be replaced by

100 or by 2000, as indicated by the scenario on the work sheet. When finished, the user must return to the Soil/Dust menu. In order to change the dust lead exposure from the default, a constant 200 µg/g, the user must move the cursor down to the dust lead entry box in the Soil/Dust Menu and enter selection "3", the multiple source menu. The default soil-to-dust coefficient of 0.70 is activated by entering the Multiple Source Menu, and may be changed as needed. We will not modify either the soil-to-dust coefficient of 0.7, nor the air-to-dust coefficient of 100 µg/g per µg/m^3. The complete input file may be saved by returning to the Soil/Dust Menu and using the F6 key. The model may then be run by using the F5 key.

The results of the seven runs are shown in Table 5-4, which is analogous to Table 5-3(d). The second column shows blood lead concentrations for a typical child exposed to 2000 Fg/g lead in soil since birth. The peak blood lead concentration of 18.6 Fg/dL is reached at age one year. If the initial exposure to 2000 Fg/g occurs later, the peak blood lead concentration is lower.

Most of the blood lead response to a change in exposure or a change in environmental lead concentration occurs in the first 3 months after the change. The change in blood lead during the first three months after changing exposure is at least 50 to 60 percent of the total difference in quasi-state-state blood lead concentration before and after the change. The remaining difference will slowly decrease during the next 2 years. We thus suggest that cross-sectional blood lead studies or baseline blood lead concentrations measured in longitudinal studies require that all children shall have lived at their present address for at least 3 to 6 months prior to the blood lead sample.

EXAMPLE 5-4. Example for Children in a Residence Where the Soil Has Been Abated

This sequence of runs considers soil lead exposure decreased from 2000 to 100 µg/g, and the soil contribution to dust decreased from 1400 to 70 µg/g, at ages 0 (i.e. constant exposure without soil and dust lead after birth), at age 1, age 2, and so on. This assessment studies the effects of abatement on children at different ages. The entries for this example are similar to those of Example 5-3. The summary of seven data entry worksheets is shown in Table 5-5(d), and the results are shown in Table 5-6.

TABLE 5-5a. SOIL LEAD DATA ENTRY WORKSHEET
FOR CHILD WITH SOIL ABATED TO 100 Fg/g SINCE AGE 0 (BIRTH)

PARAMETER	DEFAULT VALUE	USER SELECTED OPTION	UNITS
DATA ENTRY FOR SOIL (by year)			
Soil lead concentration			
Age = 0-1 year (0-11 mo)	0	100	Fg/g
1-2 years (12-23 mo)	0	100	
2-3 years (24-35 mo)	0	100	
3-4 years (36-47 mo)	0	100	
4-5 years (48-59 mo)	0	100	
5-6 years (60-71 mo)	0	100	
6-7 years (72-84 mo)	0	100	

TABLE 5-5b. SOIL LEAD DATA ENTRY WORKSHEET
FOR CHILD WITH SOIL ABATED TO 100 Fg/g SINCE AGE 1

PARAMETER	DEFAULT VALUE	USER SELECTED OPTION	UNITS
DATA ENTRY FOR SOIL (by year)			
Soil lead concentration			
Age = 0-1 year (0-11 mo)	0	2000	Fg/g
1-2 years (12-23 mo)	0	100	
2-3 years (24-35 mo)	0	100	
3-4 years (36-47 mo)	0	100	
4-5 years (48-59 mo)	0	100	
5-6 years (60-71 mo)	0	100	
6-7 years (72-84 mo)	0	100	

TABLE 5-5c. SOIL LEAD DATA ENTRY WORKSHEET FOR CHILD WITH SOIL ABATED TO 100 Fg/g SINCE AGE 2

PARAMETER	DEFAULT VALUE	USER SELECTED OPTION	UNITS
DATA ENTRY FOR SOIL (by year)			
Soil lead concentration			
Age = 0-1 year (0-11 mo)	0	2000	Fg/g
1-2 years (12-23 mo)	0	2000	
2-3 years (24-35 mo)	0	100	
3-4 years (36-47 mo)	0	100	
4-5 years (48-59 mo)	0	100	
5-6 years (60-71 mo)	0	100	
6-7 years (72-84 mo)	0	100	

TABLE 5-5d. WORKSHEET FOR HYPOTHETICAL CHILDREN IN A NEIGHBORHOOD WHERE SOIL CONCENTRATION IS REDUCED FROM 2000 µg/g TO 100 µg/g

AGE OF CHILD (YEARS)	AGE AT TIME OF ABATEMENT (YEARS)						
	0	1	2	3	4	5	6
0	100	2000	2000	2000	2000	2000	2000
1	100	100	2000	2000	2000	2000	2000
2	100	100	100	2000	2000	2000	2000
3	100	100	100	100	2000	2000	2000
4	100	100	100	100	100	2000	2000
5	100	100	100	100	100	100	2000
6	100	100	100	100	100	100	100

TABLE 5-6. PREDICTED BLOOD LEAD CONCENTRATIONS (µg/dL) FOR HYPOTHETICAL CHILDREN IN A NEIGHBORHOOD WHERE SOIL CONCENTRATION IS REDUCED FROM 2000 µg/g TO 100 µg/g

AGE OF CHILD (YEARS)	AGE AT TIME OF ABATEMENT (YEARS)						
	0	1	2	3	4	5	6
0	2.8	16.2	16.2	16.2	16.2	16.2	16.2
1	3.0	5.4	18.6	18.6	18.6	18.6	18.6
2	2.8	2.8	6.1	17.7	17.7	17.7	17.7
3	2.6	2.6	2.7	6.6	17.3	17.3	17.3
4	2.3	2.3	2.3	2.5	6.9	14.7	14.7
5	2.1	2.1	2.1	2.1	2.55	6.2	12.6
6	1.9	1.9	1.9	1.9	2.0	2.4	5.8

A sequence of work sheets is needed to study the effects of abatement at different ages. The two variables to be considered here are the child's age, which is a variable used in the IEUBK Model simulation, and the age of the child when the abatement was carried out, which is different for each run in the sequence of 7 runs. In Table 5-5(a), if the soil is abated at age 0 years, the child is exposed to 100 Fg/g lead in soil and 70 Fg/g lead in dust derived from soil from birth through age 6 years. However, if the soil is abated at age one year, the correct work sheet is shown in Table 5-5(b). In the work sheet in Table 5-5(b), the child is exposed to 2000 Fg/g lead in soil and 1400 Fg/g lead in household dust at age zero years, but to 2000 Fg/g lead in soil and 1400 Fg/g lead in dust from soil at ages 1 through 6 years. Similarly, if the soil is abated at age two years, the correct work sheet is shown in Table 5-5(c). In the work sheet in Table 5-5(c), the child is exposed to 2000 Fg/g lead in soil and 1400 Fg/g lead in household dust at ages 0 and 1 years, but to 100 Fg/g lead in soil and 70 Fg/g lead in dust from soil at ages 2 through 6 years.

The worksheets for Tables 5-5(a-c) are combined and shown as columns 2 to 4 in Table 5-5(d). The last 4 columns in Table 5-5(d) summarize the soil lead work sheet entries for a hypothetical child if the soil is abated at ages 3, 4, 5, or 6 years respectively. For example, in the extreme right-hand column, if the soil is abated at age 6 years, he or she is exposed to 2000 Fg/g lead in soil from birth through age 5 years, then to 100 Fg/g at age 6 years.

The IEUBK Model simulation for this example is run 7 times, each run corresponding to a column in Table 5-5(d) or to a work sheet 5-5(a-c) or analogous work sheets for older children. The results, as annual averages of predicted geometric mean blood lead concentration, are shown in Table 5-6 in exactly the same order as in Table 5-5(d).

Abatement at age 1 reduces blood lead from 16.2 to 5.4 µg/dL in the first year after abatement, a reduction of 10.8 µg/dL or 66.7 percent. The effect at age 2 is a reduction from 18.6 to 6.1 µg/dL, that is 12.5 µg/dL or 67.7 percent. Abatement at age 5 has a reduction of 8.5 µg/dL or 57.8 percent in the first year. It should be noted that blood lead concentrations do not reach the post-abatement quasi-steady state level until two years after the abatement, so that the apparent reduction in blood lead concentration in the first year after abatement will underestimate the effectiveness of abatement.

EXAMPLE 5-5. Historical Exposure Reconstruction for Soil and Dust Lead Concentration and Dietary Lead Intake Around an Unused Lead Smelter

One of the issues that arose in developing validation case studies for the IEUBK model is that many of the earlier data sets were collected at sites where background lead exposure differed greatly from current default values, and where both background exposure and soil/dust exposure were changing substantially during the lifetime of the children in the blood lead study. It was therefore necessary to construct an historical exposure scenario for the children in the blood lead study. The exposure reconstruction for the 1983 East Helena blood lead study was discussed in the initial validation of the UBK model (U.S. Environmental Protection Agency 1989). In this example, we will discuss the more complicated exposure situation for the 1983 companion study in the Silver Valley of Idaho. We rely heavily on the initial report on Kellogg Revisited (Panhandle District Health Department 1986), the Human Health Risk Assessment (Jacobs Engineering, 1989, for US EPA Region X), the Risk Assessment Data Evaluation Report (US EPA 1990), the House Dust Remediation Report (CH2M Hill 1991 for the Idaho Dept. of Health), the Record of Decision for the Bunker Hill site (U.S. Environmental Protection Agency 1991), and personal communications with Dr. Ian Von Lindern of Terragraphics Inc. (1992-1993).

The narrow east-west Silver Valley was divided initially into three residential areas, Area 1 (Smelterville) about 1.2 to 1.5 km northwest of the smelter complex, Area 2 (Kellogg) about 2.6 to 3.3 km east of the smelter complex, and Area 3 (Pinehurst) about 6 km west of the smelter complex. In subsequent studies this area was extended and subdivided into 5 to 11 areas or zones. A list of zones and distances is attached as Table 5-7. The main distinction is that the Page neighborhood which is only 3 km west of the smelter complex has been distinguished from Pinehurst, and that the Wardner neighborhood about 3 km southeast of the smelter complex has been separated from the Kellogg community. The five areas currently defined are closer in size and population to the "neighborhoods" recommended in Chapter 4.

Silver Valley has a complicated history of lead exposure, including significantly elevated air and dust lead exposures in 1974 and 1975, and a cessation of lead smelting activities after December 1991. Therefore, the exposure history reconstruction in Table 5-8 is a mixture of observed values and interpolated values. The observed values were sometimes recorded as geometric means and sometimes as arithmetic means, and as estimates or interpolations enclosed in brackets. The basis for the dust lead interpolation was not described in more detail in (Jacobs Engineering 1989). The soil lead concentrations were held at the last measured value until a new observed value had been achieved.

Soil and dust lead concentrations were only observed in 1974, 1975, 1983, and 1986-1988. Dust lead concentrations have also been observed in these communities since 1990. There are alternatives to estimating neighborhood soil and dust lead concentrations between actual observations, such as by linear interpolation, that may provide somewhat different estimates than the interpolations used in the human risk assessment study.

An alternative assumption is that soil and dust lead concentrations decreased linearly between 1983 and 1986-1988. Thus, in Smelterville the decline in soil lead was 3047 - 2685 = 362 µg/g in 4 years, or 90 µg/g per year, whereas in Kellogg it was 2584 - 1988 = 596 µg/g in 4 years, or about 150 µg/g per year. The dust lead concentrations in Smelterville decreased by 3715 - 1203 = 2512 µg/g in 5 years, or about 250 µg/g per year, whereas the dust lead concentration in Kellogg decreased by 2366 - 1450 = 916 µg/g in 5 years or about 230 µg/g per year. However, the dust lead concentrations in 1990-1992 were still elevated above the Pinehurst concentration. It would be prudent to assume that the dust lead concentration was relatively constant for much of the period around and after 1988. By implication, since soil lead and air lead are sources for dust lead, one might assume that the soil lead and air lead concentrations for 1988-1992 are relatively constant at the 1988 values.

TABLE 5-7. NEIGHBORHOOD IDENTIFIERS AND DISTANCE FROM STACK FOR KELLOGG, ID, STUDY

ZONE	APPROXIMATE DISTANCE FROM ZONE CENTER TO Pb SMELTER STACK (Km)	DESCRIPTION
A	1.50	Smelterville, south of old Highway 110 and west of C street
B	1.15	Smelterville, east of C street
C	2.75	Kellogg, north of I-90 and west of Hill street
D	3.25	Kellogg, north of I-90 and east of Hill street
E	2.60	Kellogg, south of I-90 and west of Division street
F	3.30	Kellogg. south of I-90 and east of Division street
G	3.00	Wardner
H	5.70	Pinehurst
I	3.30	Page
J		Smelterville, (1974-75 only)
K		Kellogg/Page, (1974-75 (only)

The soil and dust lead values for a Kellogg child born in 1983, assuming a linear decrease of 150 µg/g in soil lead from 2584 µg/g and a linear decrease of 230 µg/g in dust lead from 2366 µg/g, is shown on the worksheet in Table 5-9. In this example we have treated soil and dust lead concentrations as typical values for the community. Model results for the distribution of blood lead concentrations using these inputs would be expected to be more narrow than seen in the actual community due to variability of exposure concentrations within the community.

TABLE 5-8. OBSERVED AND ESTIMATED AIR, SOIL, AND DUST LEAD CONCENTRATIONS FOR USE IN HISTORICAL EXPOSURE RECONSTRUCTIONS IN SILVER VALLEY COMMUNITIES

YEAR	SMELTERVILLE			KELLOGG			PINEHURST		
	PbA[1,2]	PbS[1,2]	PbD[1,2]	PbA[1,2]	PbS[1,2]	PbD[1,2]	PbA	PbS	PbD
1971	5.7	[6141]	[3530]	8.2			[6.1]		
1972	11.2	[6141]	[6620]	9.6			[6.1]		
1973	16.5	[6141]	[12500]	15.0			[6.1]		
1974	14.3	6141	10583	14.0	2514	6581	6.1	765	2006
1975	8.9	3991	3533	7.4	2586	4573	3.1	508	1749
1976	9.8	[3991]	[6030]	7.5			3.4		
1977	9.1	[3991]	[5670]	6.8			3.6		
1978	5.4	[3991]	[3530]	5.4			2.7		
1979	6.6	[3991]	[4020]	5.9			3.1		
1980	6.2	[3991]	[3780]	5.9			2.2		
1981	4.6	[3991]	[2830]	4.1			1.2		
1982	0.88	[3991]	[3715]	0.28			0.16		
1983	0.20	3047	[3715	0.19	2584	2366	0.14	472	1155
1984	0.12	[3047]	[3715]	0.12			0.09		
1985	0.19	[3047]	[3715]	0.13			0.10		
1986	0.30	[3047]	[3715]	0.19			0.10		
1987	0.36	2685		0.17	1988		0.08		
1988	0.36	[2685]	1203[4]	0.11		1450[4]	0.08		
1989									
1990			1858[3]			1920[3]			1022[3]
1991			1496[3]			1502[3]			1068[3]
1992			978[3]			1227[3]			944[3]

Data Sources:

1. Jacobs Engineering (1989) for data before 1989, Tables 4-5, 4-7, 4-13. PbA values are arithmetic means of lead in air (Fg/m^3), PbS and PbD values not in brackets are geometric means of lead in soil and dust (Fg/g).
2. Jacobs Engineering (1989) for data before 1989. PbS and PbD values in brackets are estimates from Figure 4-16.
3. I. Von Lindern, personal communication. Arithmetic means of dust lead concentrations.
4. Record of Decision, 1991. Tables 5-1, 5-8.

TABLE 5-9. USER-SELECTED ENTRIES FOR IEUBK MODEL WORKSHEET FOR EXAMPLE 5-5, CHILD BORN IN KELLOGG, IDAHO, IN 1983

PARAMETER	YEAR	DEFAULT VALUE	USER SELECTED OPTION	UNITS
DATA ENTRY FOR SOIL (by year)				
Soil lead concentration				Fg/g
Age = 0-1 year (0-11 mo)	1983	0	2,584	
1-2 years (12-23 mo)	1984	0	2,434	
2-3 years (24-35 mo)	1985	0	2,284	
3-4 years (36-47 mo)	1986	0	2,134	
4-5 years (48-59 mo)	1987	0	1,984	
5-6 years (60-71 mo)	1988	0	1,834	
6-7 years (72-84 mo)	1989	0	1,834	
DATA ENTRY FOR DUST (by year)				
Dust lead concentration				Fg/g
Age = 0-1 year (0-11 mo)	1983	0	2,366	
1-2 years (12-23 mo)	1984	0	2,136	
2-3 years (24-35 mo)	1985	0	1,906	
3-4 years (36-47 mo)	1986	0	1,676	
4-5 years (48-59 mo)	1987	0	1,446	
5-6 years (60-71 mo)	1988	0	1,446	
6-7 years (72-84 mo)	1989	0	1,446	

The dietary lead intake depends on the age of the child and on the year of interest. For a child born in 1983, the dietary lead intake data entry worksheet is shown in Table 5-10, using data from Table 2-1. The two additional dietary exposure scenarios are for children who consume only home-grown vegetables, or only locally-caught fish. From Table 2-3 we calculate a weighted average lead concentration of 5.5 µg/g for leafy and root vegetables grown in Smelterville. The worksheet is shown in Table 5-11. From Table 2-4 we find a lead concentration in locally caught fish of 0.80 Fg/g, over twice the national average level at that time. The data entry for fish is shown in Table 5-11. The assumed percentages for local vegetables and fish consumption are 36 and 5 percent, respectively.

The results for elevated soil and dust lead plus baseline dietary lead intake show that if locally-grown vegetables and fish are consumed in large amounts, there is a modest increase in blood lead concentration at each age.

TABLE 5-10. USER-SELECTED ENTRIES FOR IEUBK MODEL WORKSHEET FOR EXAMPLE 5-5, CHILD BORN IN SMELTERVILLE, IN KELLOGG, IDAHO, IN 1983

PARAMETER	DEFAULT VALUE	USER SELECTED OPTION	UNITS
DATA ENTRY FOR DIET (by year)			
Dietary lead intake			
Age = 0-1 year (0-11 mo),	5.53	14.42	Fg Pb /day
1-2 years (12-23 mo)	5.78	22.67	
2-3 years (24-35 mo)	6.49	12.34	
3-4 years (36-47 mo)	6.24	9.08	
4-5 years (48-59 mo)	6.01	6.01	
5-6 years (60-71 mo)	6.34	6.34	
6-7 years (72-84 mo)	7.00	7.00	

TABLE 5-11. USER-SELECTED ENTRIES FOR IEUBK MODEL WORKSHEET FOR EXAMPLE 5-5

PARAMETER	DEFAULT VALUE	USER SELECTED OPTION	UNITS
DATA ENTRY FOR ALTERNATE DIET SOURCES (by food class)			
Concentration:			
home-grown fruits	0		Fg Pb/g
home-grown vegetables	0	5.5	
fish from fishing	0	0.80	
game animals from hunting	0		
Percent of food class:			
home-grown fruits	0		%
home-grown vegetables	0	36	
fish from fishing	0	50	
game animals from hunting	0		

We will discuss blood lead estimation for this example in the validation studies that will reported separately from this manual. We have included this example in the Guidance Manual to give the reader some "real world" exposure scenarios and to confront the reader with some of the choices that may need to be made in developing historical exposure scenarios for blood lead studies.

5.3 APPLICATIONS FOR PROBABILITY AND RISK ESTIMATION

EXAMPLE 5-6. Default Parameters

For the default parameters in Example 5-1, the estimated geometric mean blood lead for children of ages 24 to 35 months is 4.2 Fg/dL. The user may choose any other age range. If the user next goes into Option 1 from the bottom menu, then "3" from Graphics Selection Menu and selects age range 24-36 months (K), the log-normal probability density should appear on screen. This plot can be printed on a user-specified printer. The user can save the graphics file for additional review using the Multiple Runs Option M with just a single run. No default parameters were changed, except for the GSD, which was changed to 1.42. With GSD = 1.42, there is an estimated 0.68 percent risk that a child with the default exposure scenario will have a blood lead exceeding 10 Fg/dL.

A useful alternative display is shown by selecting the Distribution Probability Percent "2" among the plot options. This shows the risk of a blood lead exceedance for any possible blood lead concentration from 0 to 16 Fg/dL, not just the level of concern of 10 Fg/dL, but the line is too close to zero to be visually distinctive above 12 Fg/dL.

EXAMPLE 5-7. Sensitivity of Risk Estimates to User-Selected Geometric Standard Deviation

One way to carry out sensitivity analyses is to carry out each simulation run individually, but to collect the results for different parameters in cumulative output data sets. The IEUBK model does not currently offer options to do this for any parameters except media concentrations that do not change with age during single simulation run. We will thus fix all of the model parameters at default values, except for the GSD, which in this example will take values from 1.42 to 1.90. After running the model as in the preceding example, we will select "6" in the Graphics Selection Menu. This allows the user to change both the GSD and the blood lead level of concern, while leaving the geometric mean blood lead level at the same value, here 4.2 Fg/dL. The results for different GSD values are shown in Table 5-12, for children of ages 24-35 mos.

TABLE 5-12. EFFECTS OF GSD ON THE PROBABILITY OF EXCEEDING 10 µg/dL, USING ONLY DEFAULT EXPOSURE PARAMETERS, FOR CHILDREN AGES 24 TO 35 MONTHS

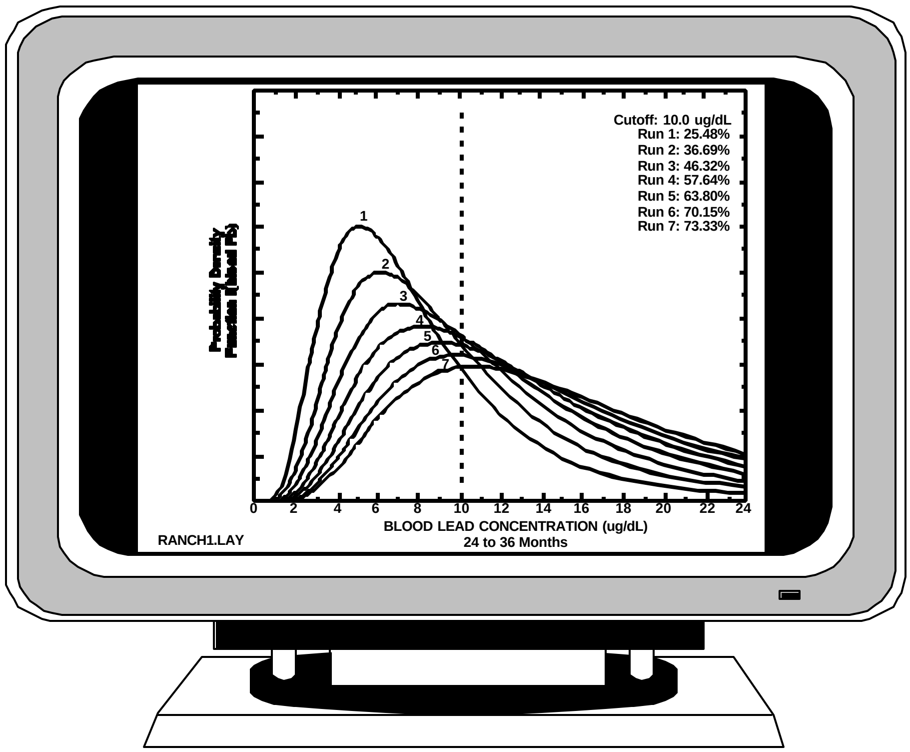
GSD	Probability of Blood Lead > 10 Fg/dL
1.42	0.0068
1.50	0.0157
1.60	0.0324
1.70	0.0513
1.80	0.0696
1.90	0.0870

EXAMPLE 5-8. Effects of Dust Lead Concentration on Risk Estimates for Fixed Soil Lead Concentration

In this example, we can use Option "2" on the Computation Menu to assess the effects of different dust lead levels for a fixed soil lead concentration. We will here assume a soil lead concentration of 1,000 Fg/g, and dust lead concentrations incremented in the Multiple Runs Analysis. The soil lead concentration is not a default and must be reset to 1,000 Fg/g in the Soil/Dust Data Entry Menu (4). We will use 7 levels of dust lead, from 0 to 1,500 Fg/g by steps of 250 Fg/g. These should be changed in the Multiple Runs Analysis, by entering sub-menus 1 (medium = dust), 2 (range set to 0-1500), and 4 (7 levels of dust, results sent to graphics and results save files). All of the other parameters are set to default values except for a GSD of 1.70 to illustrate the effect of a larger GSD. Selection 3 runs the models.

Return to the Output Menu (3), select Plot (2), select Plot Overlay (Density), highlight overlay file, select 24-36 months (K), and the plot will appear on the display. The results are shown in Screen 5-1, which shows the probability density plots for a GSD of 1.70. We are assuming maximum bioavailability (30%). With no lead in dust, the probability that a 2-year-old will exceed 10 Fg/dL is estimated as 25 percent. (Run 1), whereas with dust lead concentration of 1,500 Fg/g (1.5

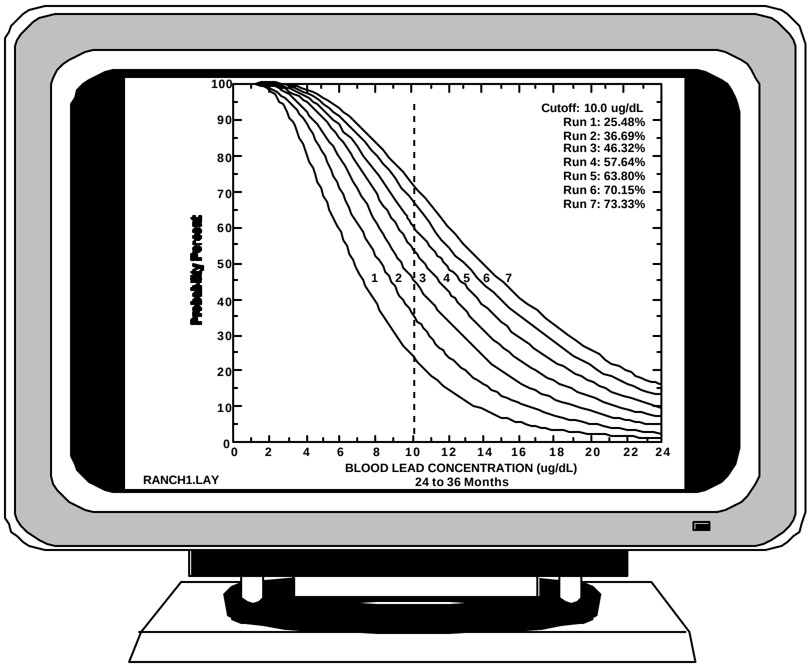
times as large as the soil lead concentration) this probability increases to 73 percent. We see that there is substantial sensitivity to the soil-to-dust coefficient and to additional non-soil sources of dust lead in this example.



**Screen 5-1.	Multiple runs probability density function for soil lead = 1,000 µg/g, dust lead = 0 to 1,500 µg/g, by steps of 250 µg/g (Runs 1 through 7) in Example 5-6.**

The cumulative exceedance probability plots (selection 4 in the Graphics Selection Menu) are shown in Screen 5-2. These plots show a clear increase of risk with increasing dust lead level at all blood lead levels of concern, and offer the user a visual display that may help to separate the risk estimates for different dust lead levels.

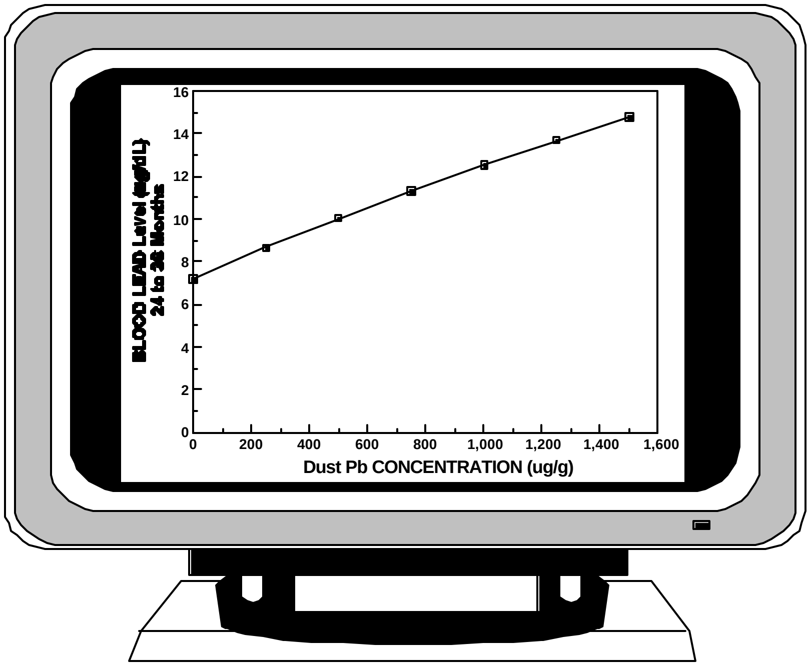
In order to assess the relationship between geometric mean blood lead and dust lead concentration, the user must set soil lead to 1000 in Option 4 of the Parameter Input Menu and then go to Option "2" of the Computation Menu. In Option B, enter sub-menus 1 (medium = dust), 2 (range set to 0-1500), and 4 (7 levels of dust, results sent to graphics and results save files). All of the other parameters are set to default values. Selection 3 runs the models. The results may be plotted immediately, as shown in Screen 5-3, or saved in a *.PBM file for later plotting. Note the slight nonlinearity as dust lead levels exceed 1,000 Fg/g, due to saturable absorption effects.



Screen 5-2. Multiple runs probability of exceedance of blood lead levels for soil lead = 1,000 µg/g, dust lead = 0 to 1,500 µg/g, by steps of 250 µg/g (Runs 1 through 7) in Example 5-6.

5.4 BATCH MODE INPUT AND STATISTICAL ANALYSES OF OUTPUT

This section demonstrates the use of the batch mode analysis method with input data that are typical of the data available to the user in most environmental lead field studies. Assessment of goodness of fit of predicted and observed blood lead levels (when available) requires a statistical analysis of the data using a variety of mathematical and graphical techniques. Output data from the batch mode runs are in ASCII files that can be loaded into almost any statistical analysis package or spreadsheet program that the user may want to use.



Screen 5-3. Relationship of predicted blood lead to dust lead in Example 5-6.

The IEUBK batch mode output files will require little or no editing before being imported into other programs, unless the missing value code (---) is incompatible with the user's package. We have provided a small special-purpose program called PBSTAT that can be used after the batch mode output file is created, by exiting from the IEUBK model and executing PBSTAT, or by Option "5" in the Batch Mode Menu. PBSTAT is provided as a convenience for the user who may not have or wish to use other programs with the IEUBK output file. The statistical and graphical methods in PBSTAT are demonstrated in the following examples. Additional statistical analyses of the batch mode output data files are not possible using PBSTAT, and must be done with other programs.

EXAMPLE 5-9. Complete Data Set for an Old Mining Community

The input data format for a batch mode input file was described in Section 3.3. The data input file for this example is shown in Table 3-2. This data set was produced by a computer simulation and was edited into the format shown in Table 3-2. These are complete data, i.e., there are no missing values for any of the variables.

Let us suppose that these data represent the data for a sample cohort of children, all of whom were 18 months old at the time of blood lead sampling in late October. Let us assume that the data were collected in the community of "Mountain Pass", an old historic town that has been the site of active lead mining, ore processing, and smelting operations for over 100 years. These operations stopped about 25 years ago, and after a period of declining population the town is once more growing as the center of newly developed tourist and outdoor recreation activities. There is now considerable concern about the potential risk of elevated lead concentrations in soil and in the interior dust of the older houses in Mountain Pass. These children were recruited in the first phase of a long-term prospective study on changes in blood lead concentration in Mountain Pass children during a proposed soil lead abatement project.

The data set contains blood lead concentration in children, soil and dust lead concentration in their houses, in four neighborhoods in Mountain Pass. Air lead concentration were measured by a Total Suspended Particulate (TSP) sampler about ten years ago and were found to be less than 0.2 Fg/m^3, so have not been measured since then. First-draw and partially flushed water lead samples were collected at each house, but have not yet been analyzed. Lead-based paint was measured by a portable X-Ray Fluorescence Spectrophotometer (XRF), but there have been some concerns about the instrument calibration during the unseasonably cold weather in which the measurements were made and the site manager has decided not to use the XRF data until the XRF measurements can be replicated next summer. (Even though this is only a hypothetical example, the reasons why some data may not be available are real, and are all too likely to occur in any real field study). The first model run done by the site manager used this data set "as is", with all of the parameters set to their default values in Table 3-1.

The batch mode run is made from Option 4 in the Computation Menu. The user must identify the input data set, known here as EXAMPLE1.DAT. The user also has the option of renaming the data set before running the batch mode analysis. If the user does not rename the data set, then [name].DAT input file results will be saved in data sets [name].TXT and [name].ASC—in this case, EXAMPLE1.TXT and EXAMPLE1.ASC. The output data file EXAMPLE1.TXT may be viewed from Option "2" of the Batch Mode Menu after the batch run is completed.

Option "5" of the Batch Mode Menu, can be used to examine the differences between observed and predicted blood lead levels using a variety of graphical and statistical techniques. The user must leave the main IEUBK model in order to enter the statistical and graphical program PBSTAT.

Selection 1 in the PBSTAT menu allows the user to load the ASCII file denoted [name].ASC. Selection 2 displays a screen full of statistical information. The information on this screen should be useful for many reports. The table includes the geometric and arithmetic mean blood lead concentrations, as well as the 25th, 50th (median), 75th, and 90th percentiles of observed and predicted blood lead levels. This screen reports paired-sample T-tests for the equality of geometric mean observed and predicted blood lead levels in the neighborhood, which is a test of the equality of the mean logarithms (left side of screen). Tests of the equality of the arithmetic mean blood lead concentration are shown on the right-hand side. You should not expect that the statistical tests will report agreement between observed and predicted values (see Section 1.1.5.3). These tests are used to help diagnose problems.

The two-sample Kolmogorov-Smirnov (denoted K-S) test of the equality of the two distribution functions is also reported. This is based on a very simple statistic, the largest absolute difference between the cumulative distribution of the observed blood lead levels and the cumulative distribution function of the predicted values. We have knowingly violated the assumption that these values are independent, thus the null hypothesis distribution will not give valid significance levels. However, we have found that the K-S statistic, together with the percentiles, provides valuable information about the kinds of discrepancies between the neighborhood-scale blood lead distribution and the distribution of predicted blood lead concentration.

Graphical comparisons of observed and predicted blood lead concentrations are very helpful. If the user exits from the statistics screen and then uses Selection 3 in the PBSTAT selection menu, for graphics and plots, there are a number of choices. Option 1 in the PBSTAT graphics selection menu allows plots of cumulative distribution functions, either singly or combined. Either regular or log-transformed blood lead concentrations may be plotted. The empirical cumulative distribution functions (CDF's) differ substantially. Another useful graphical comparison is in Selection 4 of the Graphing Selection menu, "box and whisker" plots. The boxes show the quartiles of the distribution(s), and the whiskers show the range of non-outlier blood lead concentrations. Outliers, by internal criteria, are shown as isolated data points. Observed and predicted values are highly correlated in the example, as shown by Graphing Selection choice 2. Many other plots may be generated by use of Selection 3.

In this example the model has somewhat over-estimated the observed blood lead concentrations. Any one of several factors could explain the difference between observed and predicted blood lead concentrations in these children. Are there adequate quality assurance data for both the blood lead and the environmental lead measurements and do they show satisfactory performance during the study? Because the narrative for this scenario stated that blood lead concentrations were collected in late October, which was described as "unseasonably cold", could the children have been spending much less time playing in soils outside? If so, the blood lead data may reflect lower-than-average intake of soil recently, so that the ingestion rates in the model, which are annual averages, are not representative of the atypical conditions under which these blood lead data were collected. Were most of these children placed in some sort of day-care facility? If so, then the children in the day-care facilities could be analyzed as a separate group with appropriate lead concentration data for the facilities. Other possibilities, such as lower bioavailability of soil lead at some houses or in some neighborhoods, should be investigated. In any event, the answers to these questions are going to be found in site-specific data about child behavior, exposure to soil and dust, and on the chemical and physical properties of the soil and dust at the site, and not in further manipulations of model parameters. An analysis of these data, with additional exposure data, is presented as Example 5-11.

EXAMPLE 5-10. Batch Input Data File with Missing Environmental Lead Data

Some environmental data in a data set may be missing because the samples were not collected, were lost or damaged during transportation, storage, and sample preparation for analysis, or were improperly coded and thus not recorded. In any case, the values for missing data in an IEUBK model batch mode input file may be coded by an isolated decimal point where the variable value would otherwise be placed. Examples are given in the data sets EXAMPLE2.DAT and EXAMPLE3.DAT provided on the program disk. Missing values for water lead, air lead, and paint lead are automatically replaced by default values: 4 Fg/L for water, 0.1 Fg/m^3 for air, and 0 Fg/day for alternative sources. The imputation method for soil and dust lead is different. If soil lead is missing, and dust lead is not missing, then the missing value of soil lead is set to the dust lead value. If dust lead is missing, and soil lead is not missing, then the missing value of dust lead is set to the soil lead value. These cases may be used to estimate or predict blood lead levels. If both soil and dust lead concentrations are missing, then no data are imputed and the blood lead concentration is not calculated for this child. The missing values imputed by the model are earmarked by an asterisk in the [name].TXT output file. The user is responsible for defining an appropriate data imputation process for any site-specific data set that has missing values. The file along with any imputed data should be created before it is submitted to the Batch Mode Option.

One convenient method for imputation of missing dust lead levels is to invoke the Multiple Source menu alternative for dust. The default values in this option (soil-to-dust coefficient of 0.70, air lead contribution of 10 Fg/g to house dust) produce a somewhat different set of dust lead estimates and correspondingly different predicted blood lead concentrations.

Note that missing values of blood lead do not affect the prediction of blood lead from environmental lead data, provided that either a soil lead or a dust lead concentration is present, or that the user has imputed values for soil and dust lead calculated by some other method and inserted in place of the missing value.

EXAMPLE 5-11. Lead Exposure in an Old Mining Community Using Site-Specific Information About Ingestion of Soil and Dust

Suppose that the site manager in Example 5-9 has obtained additional information about the children in this sample, and finds that almost all of them have been enrolled in a day care program in this community. Upon visiting the day care facility, the site manager observes that the facility is modern, with easily cleanable floors, entrance surfaces and window sills. She or he observes that the facility appears to be cleaned often, and that the day care facility operators are aware of the hazard of childhood exposure to lead in dust and are making deliberate efforts to reduce the exposure. She or he also learns that most of the children's parents are employed full-time, and that most of these children spend 8 to 10 hours per day at the facility.

Is there now enough information to change the parameters of the IEUBK model so as to possibly provide a closer description of the data? We would not recommend rerunning the IEUBK Model without additional site-specific data. If predicted blood lead concentrations tend to be somewhat larger than those observed, any one or more of the following possibilities could explain the discrepancy:

(i) The soil lead and dust lead concentrations at the day care center may be much lower than the residential lead concentrations, so that a significant part of the child's daily ingestion of soil and dust includes much less lead than if the same quantity were ingested at home;

(ii) The quantity of soil and dust ingested may be smaller than expected because the child spends a great deal of time away from the home in a relatively clean environment, and frequently interacts with adult caretakers and with other children, thereby reducing both environmental and behavioral magnifiers of soil and dust ingestion;

(iii) The bioavailability of lead in soil and dust at home or elsewhere may be lower than the default values used in the IEUBK Model;

(iv) The children in the sample may represent a non-typical sub-population with respect to ingestion or absorption;

(v) There may be measurement errors in soil lead, dust lead, or blood lead, possibly causing a systematic downward bias in lead measurements.

Any manipulation of the IEUBK Model that reduces lead uptake from a medium would reduce the predicted blood lead concentration and improve the overall fit of the predicted values to the observed values. This does not prove that the manipulation is valid. Lead uptake is the product of ingestion rate and absorption from the medium, so that achieving goodness of fit to the observed values can never prove the correctness of the manipulation of parameters.

We would recommend that some additional site studies be carried out to evaluate these possible causes. These studies include, in the same sequence (i-v):

(i) The soil lead, dust lead, and drinking water lead concentrations at the day care center should be measured;

(ii) The amount of dust in both the residence units and the day care center should be determined by measuring floor dust loadings;

(iii) Methods for child recruitment should be evaluated for possible sampling biases. Socio-demographic factors that may affect soil and dust ingestion should be investigated, including the role of parental awareness and public information programs. Nutritional differences that may affect lead bioavailibility, such as deficiency or repleteness of calcium intake, should be determined where feasible;

(iv) Seasonal biases, biases in sampling locations and in timing of soil and dust sampling studies should be considered as possible measurement errors. QA/QC data for analytical procedures for soil lead, dust lead, blood lead and other media should be reviewed for possible errors, instrument drift or other systematic biases.

For risk assessment applications, it may be preferable to use the default exposure scenario for children who do not spend most of their waking day in a clean environment outside the home. There is no guarantee that other children in this community will not be at higher risk than the children in the sample. We are not suggesting the use of conservative assumptions about ingestion, but rather, the use of realistic assumptions about a plausible alternative exposure scenario (for example, if the day care facility closes down and is not replaced by a similar facility).

5.5 SOIL LEAD ABATEMENT EXAMPLES

Example 5-12. Use of the Multiple Runs Selection to Estimate Soil Lead Abatement Target Levels when Household Dust is Also Allowed to Vary

One of the more frequent applications of the IEUBK model has been to help determine soil lead concentrations for which abatement may be needed in order to reduce the likelihood of exceeding a blood lead level of concern (LOC) to some user-defined risk of exceedance (ROE) of the LOC at the site. These soil lead target concentrations are site-specific variables and reflect to a greater or lesser degree all of the other parameters that determine childhood blood lead levels after abatement. Effective soil lead abatement will often include household dust abatement, both to remove historical reservoirs of contaminated household dust and to help maintain lower household dust lead concentrations after soil abatement. In this situation, the post-abatement environment must be characterized by a site-specific soil-to-dust coefficient so that the soil lead target concentration is connected to a post-abatement dust lead concentration using the Multiple Source Analysis in the Soil/Dust Data Entry Menu. In this example, we will assume that all of the parameters in the model have been set to default values, but even if the default selections in the Multiple Source Analysis for household dust are invoked, they will not be activated without selecting the Multiple Source option. The following steps are used to illustrate soil target levels for a soil-to-dust coefficient of 0.70 and an air-to-dust coefficient of 100 µg Pb/g dust per µg Pb/m^3 air.

1. From the Main Menu, use Option 1: Parameter Menu, then Option 4: Soil/Dust Data Entry Menu, then tab down to Line 2 (Indoor Dust Pb) and use Option 3: Multiple Source Analysis.

2. The user may select the soil-to-dust coefficient other than 0.70 and the air-to-dust coefficient other than 100, but even if the default values are used the user must enter this menu and then Escape back to the Soil/Dust Entry Menu.

3. Escape (exit) from the Soil/Dust Data Entry Menu to the Parameter Menu, then to the Main Menu. Choose Option 2: Computation Menu, then Option 2: Multiple Runs. This will put the user into the RANGE SELECTION MENU.

4. Set up a range-finding run by using Options 1, 2, and 4 in the Range Selection Menu. In Option 1 (Media), choose Soil and return to the Range Selection Menu. In Option 2 (Range), choose Start = 0 (0 µg/g soil lead) and End = 1500 (1500 µg/g soil lead) and return to the Range Selection Menu. In Option 4 (Output Choices), respond "Yes" to the query "Send to Overlay File", respond "7" to the query "Number of Runs for Range". This will produce output runs at 7 equally spaced levels of soil lead from 0 to 1500 µg/g, namely at 0, 250, 500, 750, 1000, 1250, and 1500 µg/g. The user who is not familiar with this option may also wish to respond "Yes" to the query "Display summary outputs". Return to the Range Selection Menu.

5. Run the Multiple Runs Analysis by selecting Option 3 on the Range Selection Menu. The user should see the message that the data sets RANGE#.LAY and RANGE#.TXT have been saved. The data set RANGE#.LAY is needed to obtain the probability plot values. The data set RANGE#.TXT is needed to document the input parameters for the run.

6. In order evaluate the range-finding runs, exit from the Range Selection Menu to the Computation Menu, then to the Main Menu. Select Option 3: Output Menu, then Option 2: Plot menu, then select the GSD and the blood lead level of concern (LOC). The default values GSD = 1.60 and LOC = 10 µg/dl are used here, so no selection is necessary; otherwise, use Option 6. Then use Option 5: Plot Overlay File (probability density functions). Tab down and select the appropriate RANGE#.LAY file, then select the age range "H", ages 0-84 months, or any other range, as needed. The probability of exceeding blood lead 10 µg/dL for each soil lead concentration from 0 to 1500 µg/g by steps of 250 µg/g is shown in Table 5-13.

TABLE 5-13. RANGE FINDING RUN FOR TARGET SOIL LEAD CONCENTRATION

OVERLAY PLOT	SOIL LEAD CONCENTRATION (µg/g)	PROBABILITY OF EXCEEDING 10 µg/dL, percent
1	0	0.285
2	250	2.25
3	500	6.84
4	750	13.64
5	1000	22.39
6	1250	30.26
7	1500	38.16

7. As a result of the range-finding runs shown in Table 5-13, the soil lead target concentration is between 250 µg/g (ROE = 2.25 %) and 500 µg/g(ROE = 6.84%). In order to narrow the list of possible values, repeat steps 4, 5, and 6 with a smaller range of values. We selected Start = 320 µg/g and End = 420 µg/g in Option 2 (Range) of the Range Selection Menu, and selected 6 runs in Option 4 of the Range Selection menu. Run the Multiple Runs Analysis with Option 3. This produces an output data set RANGE#+1.LAY. Plot the results in RANGE#+1.LAY for soil lead concentrations of 320, 340, 360, 380, 400, and 420 µg/g. The results are shown in Table 5-14.

TABLE 5-14. FOCUSED RUN FOR TARGET SOIL LEAD CONCENTRATION

OVERLAY PLOT	SOIL LEAD CONCENTRATION (µg/g)	PROBABILITY OF EXCEEDING 10 µg/dL, percent
1	320	3.24
2	340	3.45
3	360	3.90
4	380	4.15
5	400	4.70
6	420	5.00

8. Table 5-14 shows that the highest value of 420 µg/g appears to produce ROE = 5.00%. To confirm this, repeat Step 7 with a much smaller range of values. We selected Start = 400 µg/g and End = 430 µg/g in Option 2 (Range) of the Range Selection Menu, and selected 4 runs in Option 4 of the Range Selection menu. Run the Multiple Runs Analysis with Option 3. This produces an output data set RANGE#+2.LAY. Plot the results in RANGE#+2.LAY for soil lead concentrations of 400, 410, 420, and 430 µg/g. The results are shown in Table 5-15. **This procedure has identified a soil lead concentration of 410 µg/g as the target level.**

TABLE 5-15. VERIFICATION RUN FOR TARGET SOIL LEAD CONCENTRATION

OVERLAY PLOT	SOIL LEAD CONCENTRATION (µg/g)	PROBABILITY OF EXCEEDING 10 µg/dL, percent	DUST LEAD CONCENTRATION (µg/g)
1	400	4.70	200
2	410	5.00	200
3	420	5.00	200
4	430	5.32	200

9. The user may wish to view the dust lead concentrations corresponding to this procedure. In order to view RANGE#+2.TXT, return to the Main Menu, then the Computation Menu and select Option 4: Batch Mode. Select Batch Mode Option 2: View TXT File, the RANGE#+2.TXT. The dust lead concentrations are shown in the last column of Table 5-15.