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**UPDATED VERSION OF THE CALIFORNIA EPA LEAD RISK ASSESSMENT  
SPREADSHEET MODEL FOR PREDICTING BLOOD LEAD IN CHILDREN AND ADULTS**

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## ABSTRACT

The California Department of Toxic Substances Control has revised and updated its lead risk assessment spreadsheet model (LeadSpread) for predicting distributions of blood lead for adults and for children 1-2 years old. Inputs to LeadSpread are central tendency values; output is converted to a lognormal distribution via an assumed geometric standard deviation. We increased this geometric standard deviation to 1.60, according to White et al. (1998). We decreased food consumption to 1.1 kg/day for children and 1.9 kg/day for adults (Bolger, 1996) and decreased our estimate of lead in the diet to 2.8 µg/kg of food for children and 1.6 µg/kg of food for adults (USFDA, 1996-97). Based on EPA guidance (USEPA, 1997), we increased soil ingestion rates to 100 mg/day for children and 50 mg/day for adults, decreased the ventilation rate for children to 6.8 m<sup>3</sup>/day, and changed exposed skin surface to 2,900 cm<sup>2</sup> for children and 5,800 cm<sup>2</sup> for adults. Using recent guidance on dermal risk assessment (USEPA, 1998), we decreased soil-to-skin adherence from 1 mg/cm<sup>2</sup> for children and adults to 0.2 mg/cm<sup>2</sup> for children and 0.07 mg/cm<sup>2</sup> for adults. Using data from California Air Resource Board (CARB, 1999), we decreased our estimates of lead in air to 0.028 µg/m<sup>3</sup>. Airborne respirable particulates were estimated at 1.5 µg/m<sup>3</sup>, using emission modeling. Assuming 20 mgPb/kg in soil and 15 µgPb/L in drinking water, these revised inputs to LeadSpread predict a geometric mean blood lead concentration of 1.7 µg/dL for children 1-2 years old, with a 99th percentile of 5.2 µg/L. The National Health and Nutrition Examination Survey III, Phase 2 (NHANES III; USDHHS, 1996) found the geometric mean blood lead concentration in the Western U.S. to be 2.2 for children 1-6 years old and 2.6 in children 1-2 years old. Restricting the data from NHANES III to children living in post-1973 housing, geometric mean blood lead concentration decreased to 1.7 and 1.9 µg/L for children 1-6 and 1-2 years old, respectively. Thus, LeadSpread with its revised inputs agrees well with NHANES III data for children either 1-2 or 1-6 years old in post-1973 housing. We also predicted blood lead concentrations using LeadSpread with various combinations of possible site-specific inputs.

## LEADSPREAD REVISIONS

The California Department of Toxic Substances Control maintains a lead risk assessment spreadsheet model (LeadSpread) for predicting distributions of blood lead concentration in adults and in children 1-2 years old. Inputs to LeadSpread are central tendency values; output is converted to a lognormal distribution via an assumed geometric standard deviation. The Department has recently revised the model by reformatting the spreadsheet and by replacing several default input parameters to reflect more recent information. The revised model parameters are shown below.

### DEFAULT INPUT PARAMETER VALUES

General Parameters	Units	Previous	Revised	Reference
Geometric Std. Deviation	Unitless	1.42	1.60	White et al., 1998
Background airborne lead	µg/m <sup>3</sup>	0.18	0.028	CARB, 1999
Source-specific airborne dust	µg/m <sup>3</sup>	50	1.5	Cowherd, 1985
Lead in drinking water	µg/L	15	15	MCL
% Diet home-grown (resident)	%	5.5	7	USEPA, 1997
% Diet home-grown (worker)	%	0	0	

Child Parameters	Units	Previous	Revised	Reference
Daily food consumption	kg/day	1.3	1.1	Bolger, 1996
Dietary lead	µg/kg	10	2.8	USFDA, 1996-97
Soil ingestion	mg/day	55	100	USEPA, 1997
Soil ingestion, pica child	mg/day	790	200	USEPA, 1997
Ventilation rate	m <sup>3</sup> /day	10	6.8	USEPA, 1997
Exposed skin area	cm <sup>2</sup>	2,800	2,900	USEPA, 1997
Soil-to-skin adherence	mg/cm <sup>2</sup>	1	0.2	USEPA, 1998

Adult Parameters	Units	Previous	Revised	Reference
Daily food consumption	kg/day	2.2	1.9	Bolger, 1996
Dietary lead	µg/kg	10	1.6	USFDA, 1996-97
Soil ingestion	mg/day	25	50	USEPA, 1997
Exposed skin area, resid.	cm <sup>2</sup>	3,700	5,800	USEPA, 1997
Soil-to-skin adherence	mg/cm <sup>2</sup>	1	0.07	USEPA, 1998

## RESULTS USING REVISED MODEL

We ran LeadSpread with various combinations of possible site-specific inputs to illustrate its responses to changes in key variables. The following tables illustrate some of these predictions. In each table, the non-default model inputs are highlighted. Poster 342 shows model response to stepwise changes in key input parameters.

### TYPICAL CHILD

INPUTS					OUTPUTS			
Lead in soil (mg/kg)	Home-grown food (% diet)	Lead in water (µg/L)	Airborne Lead (µg/m <sup>3</sup> )	PM <sub>10</sub> (µg/m <sup>3</sup> )	Blood lead (µg/dL)		Soil concentration (mg/kg) Corresponding to 10 µg/dL	
					95 <sup>th</sup> percentile	99 <sup>th</sup> percentile	95 <sup>th</sup> percentile	99 <sup>th</sup> percentile
20	7%	15	0.028	1.5	3.8	5.2	247	146
1000	7%	15	0.028	1.5	30.6	42.3	247	146
20	0%	15	0.028	1.5	3.6	5.0	435	255
20	7%	5	0.028	1.5	2.4	3.3	298	197
20	7%	15	0.1	1.5	4.0	5.5	240	139
20	7%	15	0.028	50	3.8	5.2	246	145

### PICA CHILD

INPUTS					OUTPUTS			
Lead in soil (mg/kg)	Home-grown food (% diet)	Lead in water (µg/L)	Airborne Lead (µg/m <sup>3</sup> )	PM <sub>10</sub> (µg/m <sup>3</sup> )	Blood lead (µg/dL)		Soil concentration (mg/kg) Corresponding to 10 µg/dL	
					95 <sup>th</sup> percentile	99 <sup>th</sup> percentile	95 <sup>th</sup> percentile	99 <sup>th</sup> percentile
20	7%	15	0.028	1.5	4.1	5.7	159	94
1000	7%	15	0.028	1.5	45.8	63.3	159	94
20	0%	15	0.028	1.5	3.9	5.4	218	128
20	7%	5	0.028	1.5	2.4	3.3	191	126
20	7%	15	0.1	1.5	4.3	5.9	154	89
20	7%	15	0.028	50	4.1	5.7	158	94

### ADULT (RESIDENTIAL EXPOSURE)

INPUTS					OUTPUTS			
Lead in soil (mg/kg)	Home-grown food (% diet)	Lead in water (µg/L)	Airborne Lead (µg/m <sup>3</sup> )	PM <sub>10</sub> (µg/m <sup>3</sup> )	Blood lead (µg/dL)		Soil concentration (mg/kg) Corresponding to 10 µg/dL	
					95 <sup>th</sup> percentile	99 <sup>th</sup> percentile	95 <sup>th</sup> percentile	99 <sup>th</sup> percentile
20	7%	15	0.028	1.5	2.5	3.5	1062	676
1000	7%	15	0.028	1.5	9.6	13.2	1062	676
20	0%	15	0.028	1.5	2.5	3.4	3793	2407
20	7%	5	0.028	1.5	1.3	1.8	1230	844
20	7%	15	0.1	1.5	2.8	3.8	1026	640
20	7%	15	0.028	50	2.5	3.5	1037	660

### ADULT (OCCUPATIONAL EXPOSURE)

INPUTS				OUTPUTS			
Lead in soil (mg/kg)	Lead in water (µg/L)	Airborne Lead (µg/m <sup>3</sup> )	PM <sub>10</sub> (µg/m <sup>3</sup> )	Blood lead (µg/dL)		Soil concentration (mg/kg) Corresponding to 10 µg/dL	
				95 <sup>th</sup> percentile	99 <sup>th</sup> percentile	95 <sup>th</sup> percentile	99 <sup>th</sup> percentile
20	15	0.028	1.5	2.4	3.3	5,452	3,468
1000	15	0.028	1.5	3.8	5.2	5,452	3,468
20	5	0.028	1.5	1.2	1.7	6,320	4,335
20	15	0.1	1.5	2.6	3.6	5,322	3,337
20	15	0.028	50	2.4	3.3	5,011	3,187

## VALIDATION

We compared the revised LeadSpread predictions under baseline conditions (20 mg Pb/kg soil; 15 µg/L drinking water) with National Health and Nutrition Examination Survey (NHANES III) regional survey data (USDHHS, 1996). The results, shown below, indicate reasonable agreement between LeadSpread predictions and NHANES III data for children 1-2 or 1-6 years of age living in post-1973 housing in the Western United States.

Indicator	Median Blood lead concentration(µg/dL)
LeadSpread with 20 mg Pb/kg soil and 15 µg/L drinking water	1.7
NHANES III data for the Western United States:	
Children 1-6 years	2.2
Children 1-2 years	2.6
Children 1-6 living in post-1973 housing	1.7
Children 1-2 living in post-1973 housing	1.9

## CONCLUSIONS

The California DTSC has revised its lead risk assessment spreadsheet model (LeadSpread) for predicting distributions of blood lead concentration in adults and in children 1-2 years old. The revised model predicts slightly lower blood lead concentrations with all parameters set at default values. Blood lead predictions using the revised version of LeadSpread agree reasonably well with NHANES III data for children 1-2 or 1-6 years of age living in post-1973 housing in the Western United States.

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