



# Lead Risk Assessment Model Training

Disclaimer: The views expressed are those of the author(s) and do not necessarily reflect the views or policies of the U.S. EPA.

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Day 2: July 24, 2025

# Introductions and Training Overview

- **Training Leaders:**

- EPA TRW Lead Committee Co-chairs
  - Dr. Michele Burgess (OSRTI), Dr. Charlie Partridge (R8), and Ms. Courtney Carroll (R1)
- Dr. James Brown, EPA
- Dr. Mark Follansbee, SRC

- **Training Goals:**

- Overview of the 3 models used to evaluate risk from lead
  - IEUBK, ALM, and AALM
- Exercises and demonstrations of these models

For any questions related to lead evaluation, please contact the Lead TRW by email ([pbhelp@epa.gov](mailto:pbhelp@epa.gov)) or visit the TRW website: <https://www.epa.gov/superfund/lead-superfund-sites-technical-assistance>

# Agenda

## Day 1:

- IEUBK and ALM in Lead Risk Assessment
- Overview of the AALM
- Discussion and Q&A
- IEUBK exercises (1-3): single runs, finding PRG, use of site-specific bioavailability information
- Discussion and Q&A



## Day 2:

- IEUBK exercises (4&5): batch mode and time-weighted averaging for intermittent exposure scenarios
- Discussion and Q&A
- ALM exercise 6
- AALM demonstration and intermittent exposure example
- Discussion and Q&A



# IEUBK- Practice Exercises

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## Exercise 4: Batch Mode

- Used to run multiple properties simultaneously
- Batch mode input file format is required
  - See IEUBK User Guide Appendix A3
- Any inputs not specified in the batch mode input file are set by the IEUBK model at time of the run
- For future scenarios, use 32-month age group. This age result approximates the 12- to 72-month average calculated in single run mode
  - Differences in the results are so small that they are not expected to impact site decisions

# Batch mode run (Exercise Batch Mode file)

Open Excel file and discuss format:

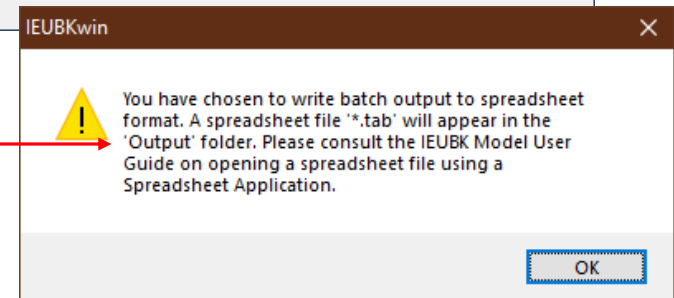
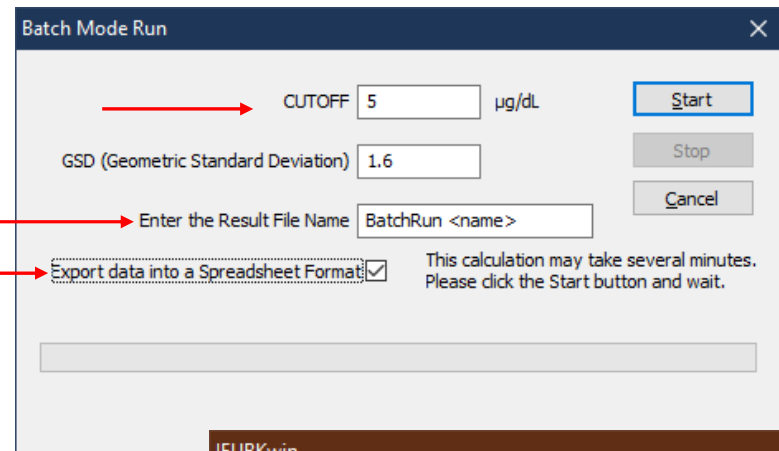
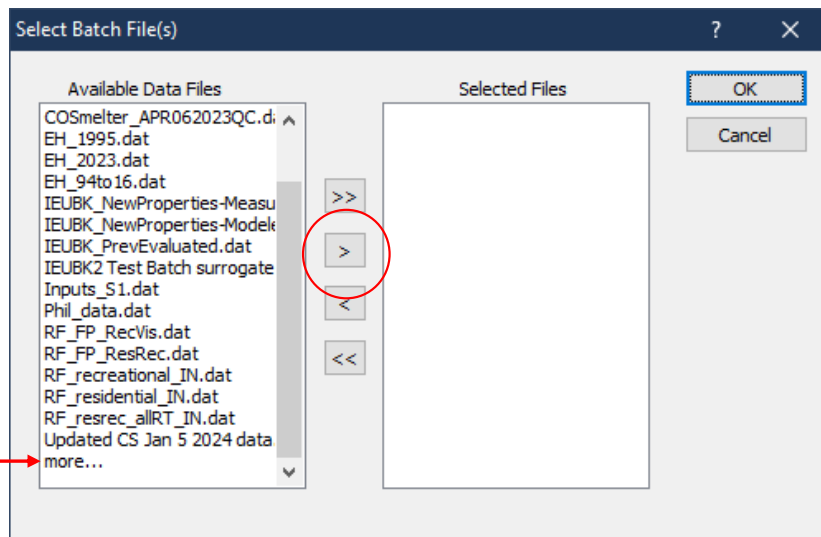
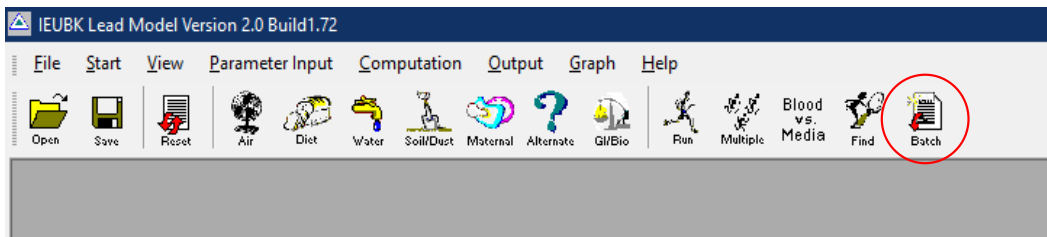
- First 12 columns in your spreadsheet have data (data begins on line 4)
- Format the columns to have a width of 8.0
- Right align all data (including the text descriptions at the top of the worksheet)

Save the file with a Formatted Text (Space delimited) (\*.prn) extension

Manually change the file from \*.prn to \*.dat in your file directory

Run batch mode using the newly created file

# Run the batch mode input file



# Batch mode results

IEUBK Lead Model Version 2.0 Build1 - [BatchRun22.txt]

File Help

Open Save Revert Air Diet Water Soil/Dust Maternal Alternate GI/Bio Run Multiple Blood vs. Media Find Batch

### LEAD BATCH MODE OUTPUT FILE

These IEUBK Model results are valid as long as they were produced with an official, unmodified version of the IEUBK Model with a software certificate.

While IEUBK Model output is generally written with three digits to the right of the decimal point, the true precision of the output is strongly influenced by least precise input values.

=====

Model Version: 2.0 Build1  
 User Name:  
 Date:  
 Site Name:  
 Operable Unit:  
 Run Mode: Research

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\* : signify default values used in place of missing input data.  
 —: signify missing input data.  
 PBB & PRED are the observed and predicted blood Pb levels in µg/dL.

Percent exceedance was calculated using values of GSD and PbB Cutoff as follows:  
 GSD = 1.600  
 PbB Cutoff ( C ) = 5.000 µg/dL

Input File: Updated CS Jan 5 2024 data.dat

ID	FAM	BLK	AGE	SOIL	DUST	WATER	AIR	OTHER	ABSSoil	ABSDust	PBB	PRED	P(PbB>C)
	(mon)	(µg/g)	(µg/g)	(µg/L)	(µg/m <sup>3</sup> )	(µg/day)	(%)	(%)	(µg/dL)	(µg/dL)	(%)		
1	001	001	32	190.0	75.8	0.90*	0.10*	0.000	30.000*	30.000*	0.0	1.99	2.475
2	002	002	32	216.0	120.0	0.90*	0.10*	0.000	30.000*	30.000*	0.0	2.24	4.396
3	003	003	32	238.0	150.0	0.90*	0.10*	0.000	30.000*	30.000*	0.0	2.43	6.213
4	004	004	32	200.0	80.0	0.90*	0.10*	0.000	30.000*	30.000*	0.0	2.03	2.789
5	005	005	32	40.0	68.0	0.90*	0.10*	0.000	30.000*	30.000*	0.0	1.47	0.454
6	006	006	32	190.0	75.8	0.90*	0.10*	0.000	30.000*	30.000*	0.0	1.99	2.475
7	007	007	32	191.0	175.0	0.90*	0.10*	0.000	30.000*	30.000*	0.0	2.38	5.670

# Formatting Batch Mode Output

- Locate your batch mode results (TAB) file in the Output folder of your IEUBK V2 directory and import to Excel
- Adjust column width to read column headers
- Manipulate the data as desired
  - Use conditional formatting to highlight Pred (PbB) > 5%
  - Import to SAS or GIS software to map the results

# Formatted results

Exercise 4 Batch Run Example Output Formatted.xlsx • Saved

File Home Insert Page Layout Formulas Data Review View Help Acrobat

A3 : X ✓ fx

1 LEAD BATCH MODE OUTPUT FILE  
 2 Model Version: 2.0 Build1  
 3  
 4 User Name:  
 5 Date:  
 6 Site Name:  
 7 Operable Unit:  
 8 Run Mode Research  
 9  
 10 \*: signify default values used in place of missing input data.  
 11 #: signify surrogate values entered (determined) by user.  
 12 ---: signify missing input data.  
 13 PBB & PRED are the observed and predicted blood Pb levels in µg/dL.  
 14  
 15 Percent exceedance was calculated using values of GSD and PbB Cutoff as follows:  
 16 GSD = 1.6  
 17 PbB Cutoff ( C ) = 5 µg/dL  
 18  
 19 Input File: Site X Jan 15 2025 data.dat  
 20  
 21 ID FAM BLK AGE (mon) SOIL (µg/g) DUST (µg/g) WATER (µg/L) AIR (µg/m³) Other (µg/day) ABSSoil (%) ABSDust (%) PBB (µg/dL) PRED (µg/dL) P(PbB>C) (%)  
 22  
 23 1 1 1 32 215 107.7 0.90\* 0.10\* 0 30.000\* 30.000\* 0 2.19 3.959  
 24 2 2 2 32 63 33 0.90\* 0.10\* 0 30.000\* 30.000\* 0 1.4 0.34  
 25 3 3 3 32 335 169.2 0.90\* 0.10\* 0 30.000\* 30.000\* 0 2.8 10.925  
 26 4 4 4 32 201 119 0.90\* 0.10\* 0 30.000\* 30.000\* 0 2.19 3.954  
 27 5 5 5 32 185 118 0.90\* 0.10\* 0 30.000\* 30.000\* 0 2.14 3.514  
 28 6 6 6 32 609 74.5 0.90\* 0.10\* 0 30.000\* 30.000\* 0 3.29 18.636  
 29 7 7 7 32 261 258 0.90\* 0.10\* 0 30.000\* 30.000\* 0 2.91 12.485  
 30 8 8 8 32 169 108.5 0.90\* 0.10\* 0 30.000\* 30.000\* 0 2.05 2.872  
 31 9 9 9 32 210 218.4 0.90\* 0.10\* 0 30.000\* 30.000\* 0 2.6 8.235  
 32 10 10 10 32 81 140 0.90\* 0.10\* 0 30.000\* 30.000\* 0 1.89 1.911  
 33 11 11 11 32 187 303 0.90\* 0.10\* 0 30.000\* 30.000\* 0 2.85 11.616  
 34 12 12 12 32 128 28 0.90\* 0.10\* 0 30.000\* 30.000\* 0 1.6 0.754  
 35 13 13 13 32 128 89.5 0.90\* 0.10\* 0 30.000\* 30.000\* 0 1.84 1.672

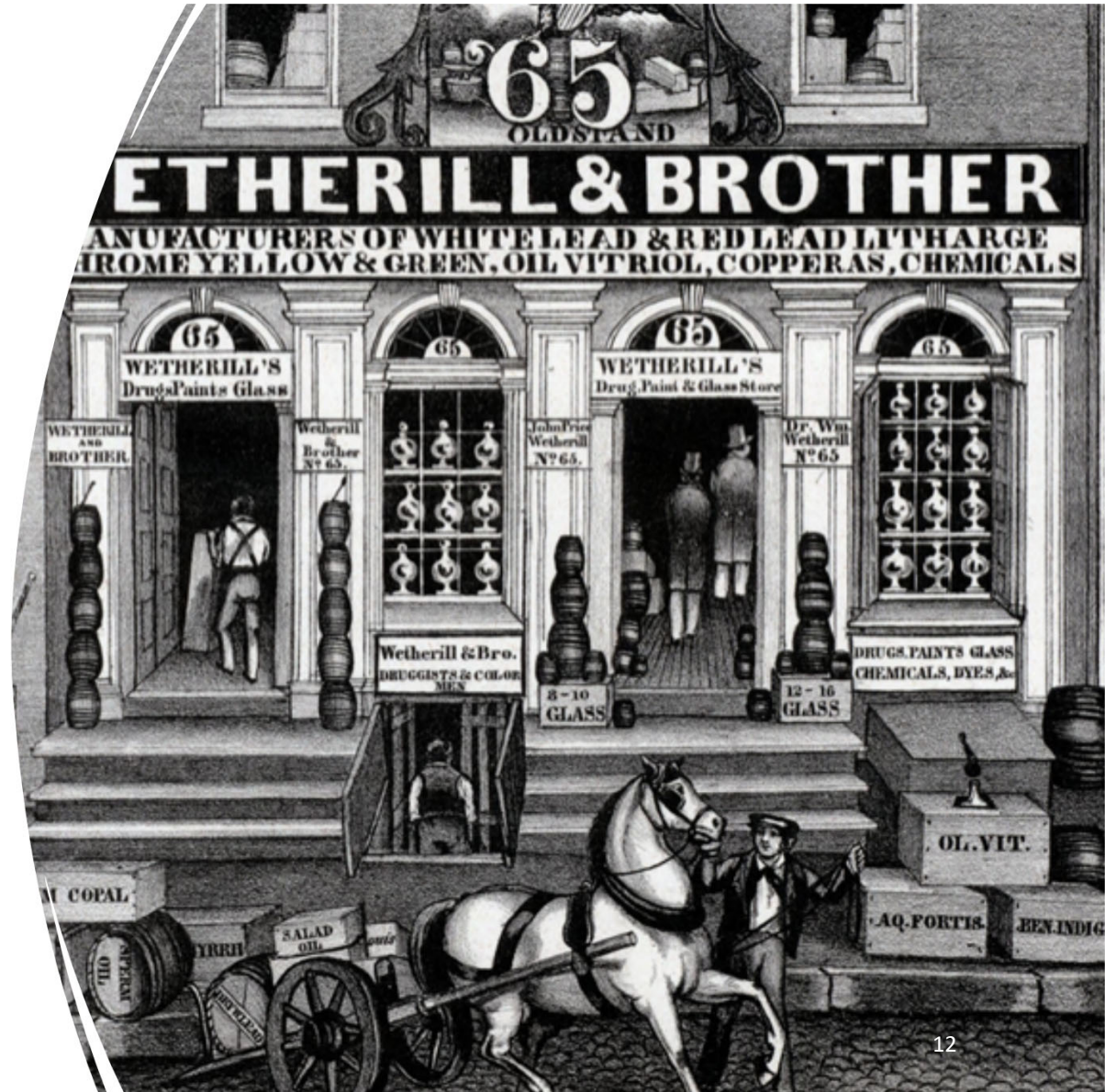
BatchRun Example

Ready Accessibility: Good to go 100%

# Batch Mode Comments

- Change run conditions quickly in the IEUBK model
  - Alternate intake, intake rates for all media, bioavailability (if asterisks are used)
- Allows users to run very large data sets (under the same model conditions set by the user)
- Allows users to calculate a dust lead concentration from outdoor soil lead
- Can queue multiple files and run sequentially
  - Results will be stacked in output file with header identifiers

Please put questions in the Q&A chat



## Exercise 5: Simple Time Weighting and Intermittent Exposure

- Used for exposure scenarios when child receptors are splitting time between multiple locations
  - Day care, second residence
  - Parks, recreation areas
- See US EPA 2024 Intermittent Exposure Guidance
- Minimum exposure frequency and duration
  - No less than 1 day per week for 3 consecutive months

# Risk Assessment for River Park

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- Hypothetical site consists of a small community of homes abutting a river park downstream from an area with sediment contaminated with tailings. Site information indicates local resident children recreate at a local river park **2 days per week** (on average) and children of all ages wade and/or swim for **1 hour/day** from May-August
- Site information:
  - Seven local residences with soil lead concentrations of **50, 75, 100, 125, 150, 175, 200 mg/kg**
  - Beach sediment lead concentration is **310 mg/kg**
  - **No RBA** information for solid media at the site
  - River water lead concentration is 25 µg/L (**0.025 µg/mL**)
- Based on professional judgment (and informed by EFH Table 3-7), you have elected to use **40 mL/hour** as the incidental ingestion rate of surface water while swimming and wading. Intake is (0.025 µg/mL \* 40 mL/hour) or **1 µg Pb/day**. Enter this as an alternate intake
- Assess P5 risk for the site, including site-specific media exposures to soil, sediment, and surface water

# Process for the Intermittent Exposure Assessment

1. Do TWA calculations
2. Batch run file input calculations
3. Create batch input file
  1. Save as PRN
  2. Change to DAT
4. Open IEUBK
5. Set RBA for alternate source (or load from SVD)
  - This is because exposure to water while swimming is being evaluated as an alternate intake in the model (the alternate AF is 50% because water's AF is 50%)
6. Run batch mode and format results

MEDIA	ABSORPTION FRACTION PERCENT	Access alternate bioavailability parameters?	FRACTION PASSIVE/TOTAL ACCESSIBLE	HALF SATURATION Level (µg/day)
Soil	30	<input checked="" type="radio"/> No <input type="radio"/> Yes	0.2	100
Dust	30			
Water	50			
Diet	50			
Alternate	50			

# Weighting Soil Lead Concentration Term

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## Site information

- Residential soil lead concentrations: (A) 50, (B) 75, (C) 100 , (D) 125, (E) 150, (F) 175, (G) 200 mg/kg
- Beach sediment lead concentration is 310 mg/kg

Soil lead concentration is time weighted according to US EPA (2024):

$$PbS_w = (PbS_{home} * time_{home}) + (PbS_{site} * time_{site})$$

Where:

$PbS_w$  = time weighted soil lead concentration; mg/kg

$PbS_{home}$  = residential soil lead concentration; mg/kg

$time_{home}$  = fraction of time at home (e.g., 5 days out of 7 days or 5/7); unitless

$PbS_{site}$  = site soil lead concentration; mg/kg

$time_{site}$  = fraction of time at site (e.g., 2 days out of 7 days or 2/7); unitless

Calculate  $PbS_w$  using the **TWA calculator tool** or your own spreadsheet

# Weighted Soil Lead Concentrations

AutoSave Off DRAFT FINAL TWA Risk Calculation Tool V8\_04'10'202... Search

File Home Insert Page Layout Formulas Data Review View Developer Help Acrobat Comments Share

Clipboard Font Alignment Number Styles Cells Editing Sensitivity Add-ins

M19

TRACK-IN IS TURNED ON  
SEE EPA (2024)

TWA Calculation Inputs\*

Time at Site	2	d
Time at Home	5	d
Total	7	d
Target Risk	5	3.5 and 4-10 µg/dL

Only change data in yellow cells

TWA Soil Inputs to IEUBK

House DU Soil Pb Conc.	Site DU Conc. (ppm)								
	310	200	300	400	500	800	1000	1500	2000
50	124	93	121	150	179	264	321	464	607
75	142	111	139	168	196	282	339	482	625
100	160	129	157	186	214	300	357	500	643

\*Cells E2 and E4 must meet the IEUBK model required minimum exposure frequency and duration of 1 day per week for 13 consecutive weeks may be days/week (minimum is 1 day/7 days), weeks/year (minimum is 52 weeks/52 weeks), days/year (minimum is 52 days/365 days), and months/year (minimum is 3 months/12 months). User sets the numerator and the denominator and changes units accordingly.  
IEUBK V2 (build 1.72)

TWA Dust Inputs to IEUBK Track-in On

House DU Pb Conc. (ppm)	Site DU Conc. (ppm)								
	310	200	300	400	500	800	1000	1500	2000
50	97	75	95	115	135	195	235	335	435
75	110	88	108	128	148	208	248	348	448
100	122	100	120	140	160	220	260	360	460

IEUBK Model Predicted Geomean Blood Lead (µg/dL): Track-in On

House DU Pb Conc.	Site DU Conc. (ppm)								
50	124	93	121	150	179	264	321	464	607
75	142	111	139	168	196	282	339	482	625
100	160	129	157	186	214	300	357	500	643

# Preparing to Run Batch Mode

- Create a batch mode input file
  - Do calculations in one tab and copy this tab as numbers (no formulae) into the batch input file

	A	B	C	D	E	F	G	H	I	J	K	L
1	IEUBK input data file example											
2	NOTE: actual data begins on line 4!!											
3	ID	FAM	BLOCK	AGE	SOIL	DUST	WATER	AIR	OTHER	PbB	ABSSoil	ABSDust
4	A	1	1	32	124	96.8	*	*	1	0	*	*
5	B	2	2	32	142	109.4	*	*	1	0	*	*
6	C	3	3	32	160	122	*	*	1	0	*	*
7	D	4	4	32	178	134.6	*	*	1	0	*	*
8	E	5	5	32	196	147.2	*	*	1	0	*	*
9	F	6	6	32	214	159.8	*	*	1	0	*	*
10	G	7	7	32	231	171.7	*	*	1	0	*	*
11												
12												

- Batch file has PbSw concentrations from TWA calculator, calculated MSA dust (where  $PbDw = [PbSw * 0.7] + [PbA * 100]$ ), and surface water
- Remember to change the Alt Source AF=50%

GI Values/Bioavailability Information

MEDIA	ABSORPTION FRACTION PERCENT	Access alternate bioavailability parameters?	<input checked="" type="radio"/> No <input type="radio"/> Yes
Soil	30	FRACTION PASSIVE/TOTAL ACCESSIBLE	0.2
Dust	30	HALF SATURATION Level (µg/day)	100
Water	50		
Diet	50		
Alternate	50		

Buttons: OK, Cancel, Reset, Help?

# Results

BatchRun Output... • Saved to this PC

File Home Insert Page Layout Formulas Data Review View Developer Help Acrobat

Clipboard Font Alignment Number Styles

15

1 LEAD BATCH MODE OUTPUT FILE  
 2 Model Version: 2.0 Build1  
 3  
 4 User Name:  
 5 Date:  
 6 Site Name:  
 7 Operable Unit:  
 8 Run M Research  
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 10 \*: signify default values used in place of missing input data.  
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 14  
 15 Percent exceedance was calculated using values of GSD and PbB Cutoff as follows:  
 16 GSD = 1.6  
 17 PbB Cutoff ( C ) = 5 µg/dL  
 18  
 19 Input File: Batch Mode input.dat  
 20

ID	FAM	BLK	AGE (mon)	SOIL (µg/g)	DUST (µg/g)	WATER (µg/L)	AIR (µg/m <sup>3</sup> )	Other (µg/day)	ABSSoil (%)	ABSDust (%)	PBB (µg/dL)	PRED (µg/dL)	P(PbB>C) (%)
23 A	1	1	32	124	96.8	0.90*	0.10*	1	30.000*	30.000*	0	2.03	2.74
24 B	2	2	32	142	109.4	0.90*	0.10*	1	30.000*	30.000*	0	2.13	3.506
25 C	3	3	32	160	122	0.90*	0.10*	1	30.000*	30.000*	0	2.24	4.386
26 D	4	4	32	178	134.6	0.90*	0.10*	1	30.000*	30.000*	0	2.35	5.378
27 E	5	5	32	196	147.2	0.90*	0.10*	1	30.000*	30.000*	0	2.45	6.479
28 F	6	6	32	214	159.8	0.90*	0.10*	1	30.000*	30.000*	0	2.56	7.684
29 G	7	7	32	231	171.7	0.90*	0.10*	1	30.000*	30.000*	0	2.66	8.912

# RBA-adjusted Exposure Point Concentration (EPC)

- What if this exercise (#5) had different bioavailability information for lead in the soil and sediment?
- The recommended approach is to incorporate the bioavailability adjustment in the exposure point concentration (EPC) by calculating RBA-adjusted EPCs.
- RBA-adjusted EPC approach is discussed in EPA (2021), *“Guidance for Sample Collection for In Vitro Bioaccessibility Assay for Arsenic and Lead in Soil and Applications of Relative Bioavailability Data in Human Health Risk Assessment.”*
  - See Attachment C Case Study of EPA (2021) for further detail

## Site-specific Bioavailability Information is Incorporated into the Soil Concentration Term

- Instead of updating the bioavailability information in the IEUBK “GI Values/ Bioavailability” window, users can adjust the soil concentration (EPC):

$$RBA_{\text{adjusted}} \text{ EPC} = \text{EPC} * RBA_{\text{fraction}}$$

Where:

$$RBA_{\text{fraction}} = \text{observed } RBA_{\text{media}} \div \text{default } RBA_{\text{media}}$$

For example,  $RBA_{\text{adjusted}} \text{ EPC}$  for 200 mg/kg and observed RBA= 40% (default RBA= 60%)

$$RBA_{\text{adjusted}} \text{ EPC} = 200 * (40/60) = 133.3 \text{ mg/kg}$$

# Use RBA-adjusted Soil EPC and Keep Default Bioavailability Values

Site Specific Soil Dust Data

Soil/Dust Ingestion Weighting Factor (percent soil):

Outdoor Soil Lead Concentration ( $\mu\text{g/g}$ )

Constant Value

Variable Values

Indoor Dust Lead Concentration ( $\mu\text{g/g}$ )

Constant Value

Variable Values

Multiple Source Analysis

Multiple Source Avg:

Soil/Indoor Dust Concentration ( $\mu\text{g/g}$ )

	AGE (Years)						
	0-1	1-2	2-3	3-4	4-5	5-6	6-7
Outdoor Soil Lead Levels:	133.3	133.3	133.3	133.3	133.3	133.3	133.3
Indoor Dust Lead Levels:	103.31	103.31	103.31	103.31	103.31	103.31	103.31

Amount of Soil/Dust Ingested Daily (g/day)

	AGE (Years)						
	0-1	1-2	2-3	3-4	4-5	5-6	6-7
Total Dust + Soil Intake:	0.086	0.094	0.067	0.063	0.067	0.052	0.055

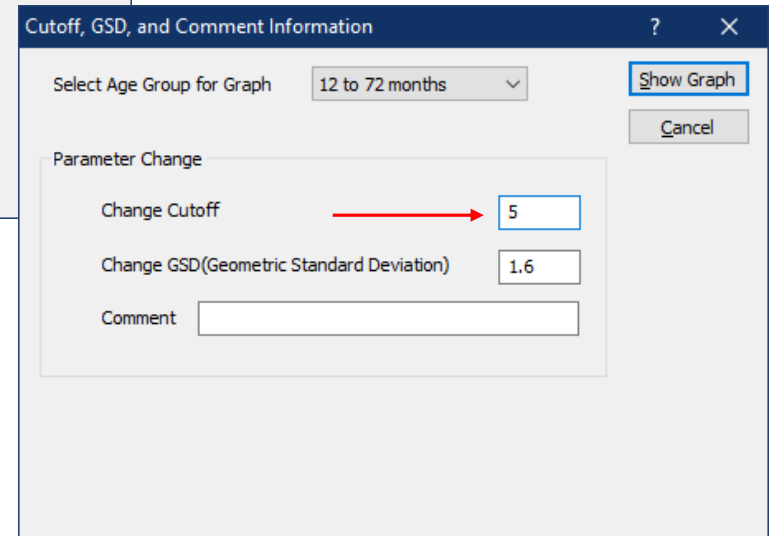
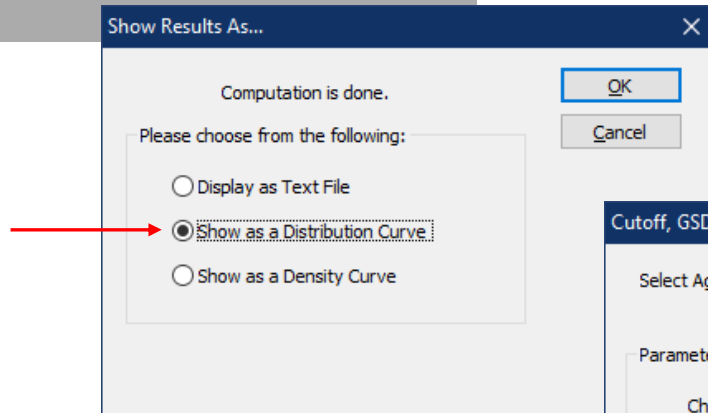
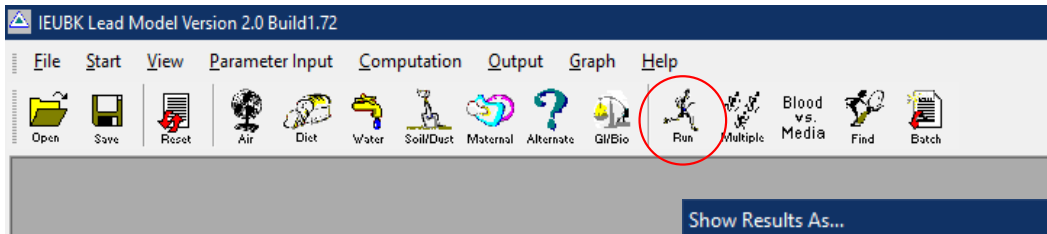
GI Values/Bioavailability

GI Values/Bioavailability Information

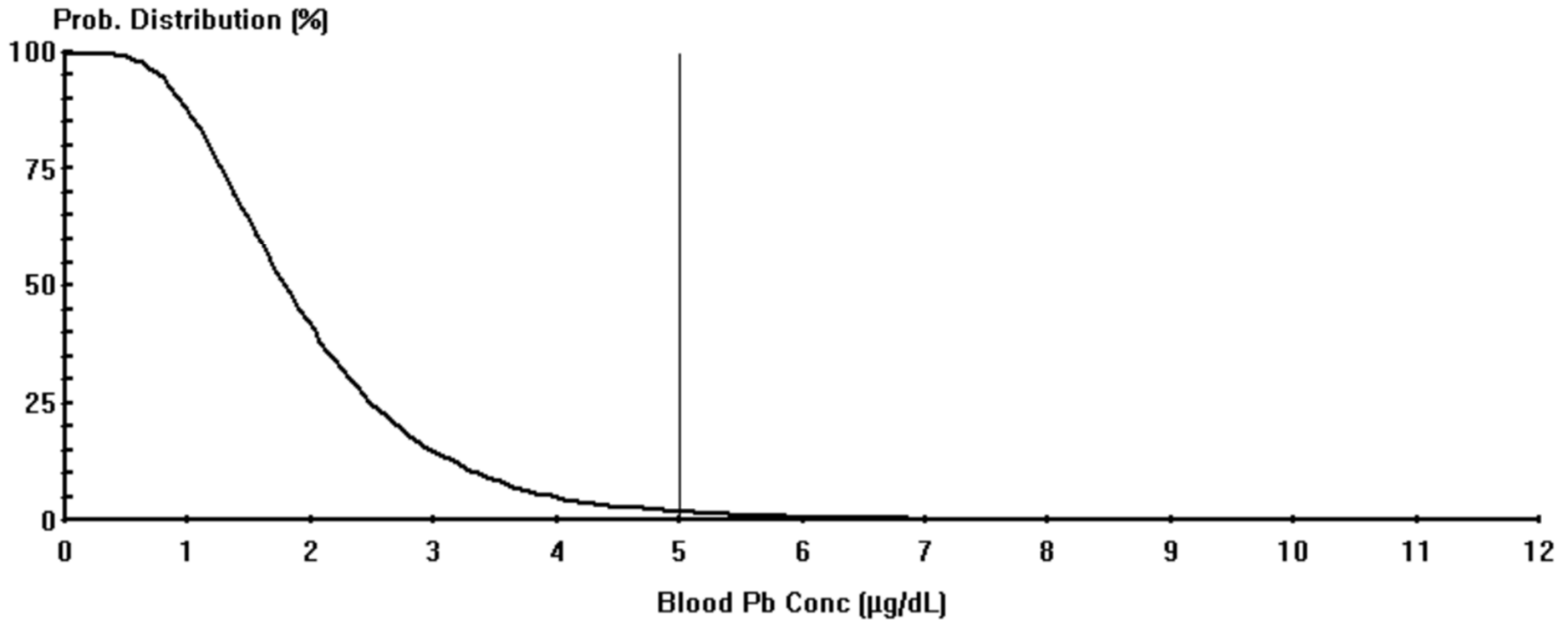
Access alternate bioavailability parameters?  No  Yes

MEDIA	ABSORPTION FRACTION PERCENT	FRACTION PASSIVE/TOTAL ACCESSIBLE	HALF SATURATION Level ( $\mu\text{g/day}$ )
Soil	<input type="text" value="30"/>	<input type="text" value="0.2"/>	<input type="text" value="100"/>
Dust	<input type="text" value="30"/>		
Water	<input type="text" value="50"/>		
Diet	<input type="text" value="50"/>		
Alternate	<input type="text" value="0"/>		

# Run the Model



Using  $RBA = 40\%$  as a  $RBA_{adjusted}$  EPC



Cutoff = 5.000 µg/dl

Geo Mean = 1.893

GSD = 1.600

% Above = 1.938

Age Range = 12 to 72 months

Run Mode = Research

# Discussion and Q&A

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# ALM–Practice Exercise

Disclaimer: The views expressed are those of the author(s) and do not necessarily reflect the views or policies of the U.S. EPA.

# Adult Lead Methodology

Calculation of Preliminary Remediation Goals (PRGs) for Soil in Nonresidential Areas			
U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee			
Version date 06/14/2017			EDIT RED CELLS
Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
$PbB_{fetal, 0.95}$	Target PbB in fetus (e.g., 2-8 $\mu\text{g/dL}$ )	$\mu\text{g/dL}$	5
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	$\mu\text{g/dL}$ per $\mu\text{g/day}$	0.4
$GSD_i$	Geometric standard deviation PbB	--	1.8
$PbB_0$	Baseline PbB	$\mu\text{g/dL}$	0.6
$IR_s$	Soil ingestion rate (including soil-derived indoor dust)	$\text{g/day}$	0.050
$AF_{s, d}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{s, d}$	Exposure frequency (same for soil and dust)	$\text{days/yr}$	219
$AT_{s, d}$	Averaging time (same for soil and dust)	$\text{days/yr}$	365
<b>PRG in Soil for no more than 5% probability that fetal PbB exceeds target PbB</b>		<b>ppm</b>	<b>1,050</b>

# Overview of the Adult Lead Methodology (ALM)

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- ALM is a lead risk spreadsheet tool for Superfund site assessment
- Site-specific conceptual model shows complete exposure pathway for non-residential area
- Soil or sediment exposure to children older than 7 years, adolescents, or adults



# Common Exposure Scenarios for the ALM

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- Utility work
- Construction work
- Youth trespassers (>7 years old)
- Office work
- Landscaping



# Application of the ALM

- In the forward direction, ALM can assess risk
  - Probability (%) of exceeding a user defined target blood lead concentration
- In the backward direction, ALM can derive preliminary remediation goals (PRGs)
  - Maximum soil lead concentration for the exposure scenario that meets the risk goal (no more than 5% probability of exceeding the user-defined target blood lead concentration)

# Minimum Exposure for the ALM

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- Exposure frequency (EF)  $\geq 1$  day/week
- Exposure duration  $\geq 13$  consecutive weeks



# ALM Information Needed to Calculate Risk



- Required
    - Average soil lead concentration
    - Exposure frequency (average)
    - Exposure duration (average)
    - Typical (50 mg soil/day) or contact intensive (100 mg soil/day) exposure to soil (average soil dust ingestion rate)
    - Target blood lead concentration
  - Encouraged
    - Bioavailability information
- 
- ALM output is the probability (%) that fetal blood lead concentration will exceed the user-defined target blood lead concentration.

# ALM Information Needed to Calculate PRG



- Required
    - Exposure frequency
    - Exposure duration
    - Typical or contact intensive exposure to soil (soil dust ingestion rate)
    - Target blood lead concentration
  - Encouraged
    - Bioavailability information
- 
- ALM output is the maximum soil lead concentration that does not exceed 5% probability that fetal blood lead concentration will exceed the user-defined target blood lead concentration

# Hypothetical Example: Utility Corridor Scenario



## Available site information

- Adult workers exposed to contaminated soil at depth 5 d/wk for 20 consecutive weeks
- Soil lead contamination at depth differs for 3 portions of the site
  - Area A = 1500 ppm
  - Area B = 800 ppm
  - Area C = 108 ppm

# Hypothetical Example: Utility Corridor Scenario

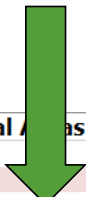


Use the ALM to

1. Calculate risk for the 3 areas
2. Calculate a site-specific PRG

Risk target for this site is no more than 5% probability of exceeding 5  $\mu\text{g}/\text{dL}$  (P5)

# Risk Calculation Steps



**Calculations of Blood Lead Concentrations (PbBs) and Risk in Nonresidential Areas**  
**U.S. EPA Technical Review Workgroup for Lead**  
 Version date 06/14/2017

			Edit Red Cells			
			CURRENT			
Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014	GSDi and PbBo from Analysis of NHANES 2007-2010	GSDi and PbBo from Analysis of NHANES 2004-2007	GSDi and PbBo from Analysis of NHANES III (Phases 1&2)
PbS	Soil lead concentration	µg/g or ppm	1054	←	776	100
R <sub>fetal/maternal</sub>	Fetal/maternal PbB ratio	--	0.9	←	0.9	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4	←	0.4	0.4
GSD <sub>i</sub>	Geometric standard deviation PbB	--	1.8	←	1.7	1.8
PbB <sub>0</sub>	Baseline PbB	µg/dL	0.6	←	0.7	1.0
IR <sub>S</sub>	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050	←	0.050	0.050
IR <sub>S+D</sub>	Total ingestion rate of outdoor soil and indoor dust	g/day	--	←	--	--
W <sub>S</sub>	Weighting factor; fraction of IR <sub>S+D</sub> ingested as outdoor soil	--	--	←	--	--
K <sub>SD</sub>	Mass fraction of soil in dust	--	--	←	--	--
AF <sub>S, D</sub>	Absorption fraction (same for soil and dust)	--	0.12	←	0.12	0.12
EF <sub>S, D</sub>	Exposure frequency (same for soil and dust)	days/yr	219	←	219	219
AT <sub>S, D</sub>	Averaging time (same for soil and dust)	days/yr	365	←	365	365
PbB <sub>adult</sub>	PbB of adult worker, geometric mean	µg/dL	2.1	←	2.3	2.1
PbB <sub>fetal, 0.95</sub>	95th percentile PbB among fetuses of adult workers	µg/dL	5.0	←	5.0	5.0
PbB <sub>t</sub>	Target PbB level of concern (e.g., 2-8 µg/dL)	µg/dL	5.0	←	5.0	5.0
<b>P(PbB<sub>fetal</sub> &gt; PbB<sub>t</sub>)</b>	<b>Probability that fetal PbB exceeds target PbB, assuming lognormal distribution</b>	<b>%</b>	<b>5.0%</b>	<b>←</b>	<b>5.0%</b>	<b>5.0%</b>

## Risk Calculation: Area A

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
PbS	Soil lead concentration	µg/g or ppm	1500
$R_{\text{fetal/maternal}}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD <sub>i</sub>	Geometric standard deviation PbB	--	1.8
PbB <sub>0</sub>	Baseline PbB	µg/dL	0.6
IR <sub>S</sub>	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.100
IR <sub>S+D</sub>	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W <sub>S</sub>	Weighting factor; fraction of IR <sub>S+D</sub> ingested as outdoor soil	--	--
K <sub>SD</sub>	Mass fraction of soil in dust	--	--
AF <sub>S, D</sub>	Absorption fraction (same for soil and dust)	--	0.12
EF <sub>S, D</sub>	Exposure frequency (same for soil and dust)	days/yr	100
AT <sub>S, D</sub>	Averaging time (same for soil and dust)	days/yr	140
PbB <sub>adult</sub>	PbB of adult worker, geometric mean	µg/dL	5.7
PbB <sub>fetal, 0.95</sub>	95th percentile PbB among fetuses of adult workers	µg/dL	13.6
PbB <sub>t</sub>	Target PbB level of concern (e.g., 2-8 µg/dL)	µg/dL	<b>5.0</b>
<b>P(PbB<sub>fetal</sub> &gt; PbB<sub>t</sub>)</b>	<b>Probability that fetal PbB exceeds target PbB, assuming lognormal distribution</b>	<b>%</b>	<b>52.2%</b>

## Risk Calculation: Area B

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
PbS	Soil lead concentration	µg/g or ppm	800
$R_{\text{fetal/maternal}}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD <sub>i</sub>	Geometric standard deviation PbB	--	1.8
PbB <sub>0</sub>	Baseline PbB	µg/dL	0.6
IR <sub>S</sub>	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.100
IR <sub>S+D</sub>	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W <sub>S</sub>	Weighting factor; fraction of IR <sub>S+D</sub> ingested as outdoor soil	--	--
K <sub>SD</sub>	Mass fraction of soil in dust	--	--
AF <sub>S, D</sub>	Absorption fraction (same for soil and dust)	--	0.12
EF <sub>S, D</sub>	Exposure frequency (same for soil and dust)	days/yr	100
AT <sub>S, D</sub>	Averaging time (same for soil and dust)	days/yr	140
PbB <sub>adult</sub>	PbB of adult worker, geometric mean	µg/dL	3.3
PbB <sub>fetal, 0.95</sub>	95th percentile PbB among fetuses of adult workers	µg/dL	7.9
PbB <sub>t</sub>	Target PbB level of concern (e.g., 2-8 µg/dL)	µg/dL	<b>5.0</b>
<b>P(PbB<sub>fetal</sub> &gt; PbB<sub>t</sub>)</b>	<b>Probability that fetal PbB exceeds target PbB, assuming lognormal distribution</b>	<b>%</b>	<b>19.4%</b>

## Risk Calculation: Area C

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
PbS	Soil lead concentration	µg/g or ppm	108
$R_{\text{fetal/maternal}}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4
GSD <sub>i</sub>	Geometric standard deviation PbB	--	1.8
PbB <sub>0</sub>	Baseline PbB	µg/dL	0.6
IR <sub>S</sub>	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.100
IR <sub>S+D</sub>	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W <sub>S</sub>	Weighting factor; fraction of IR <sub>S+D</sub> ingested as outdoor soil	--	--
K <sub>SD</sub>	Mass fraction of soil in dust	--	--
AF <sub>S, D</sub>	Absorption fraction (same for soil and dust)	--	0.12
EF <sub>S, D</sub>	Exposure frequency (same for soil and dust)	days/yr	100
AT <sub>S, D</sub>	Averaging time (same for soil and dust)	days/yr	140
PbB <sub>adult</sub>	PbB of adult worker, geometric mean	µg/dL	1.0
PbB <sub>fetal, 0.95</sub>	95th percentile PbB among fetuses of adult workers	µg/dL	2.3
PbB <sub>t</sub>	Target PbB level of concern (e.g., 2-8 µg/dL)	µg/dL	5.0
<b>P(PbB<sub>fetal</sub> &gt; PbB<sub>t</sub>)</b>	<b>Probability that fetal PbB exceeds target PbB, assuming lognormal distribution</b>	<b>%</b>	<b>0.1%</b>

# PRG Calculation Steps

**Calculations of Preliminary Remediation Goals (PRGs) for Soil in Nonresidential Areas**  
**U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee**  
**Version date 06/14/2017**

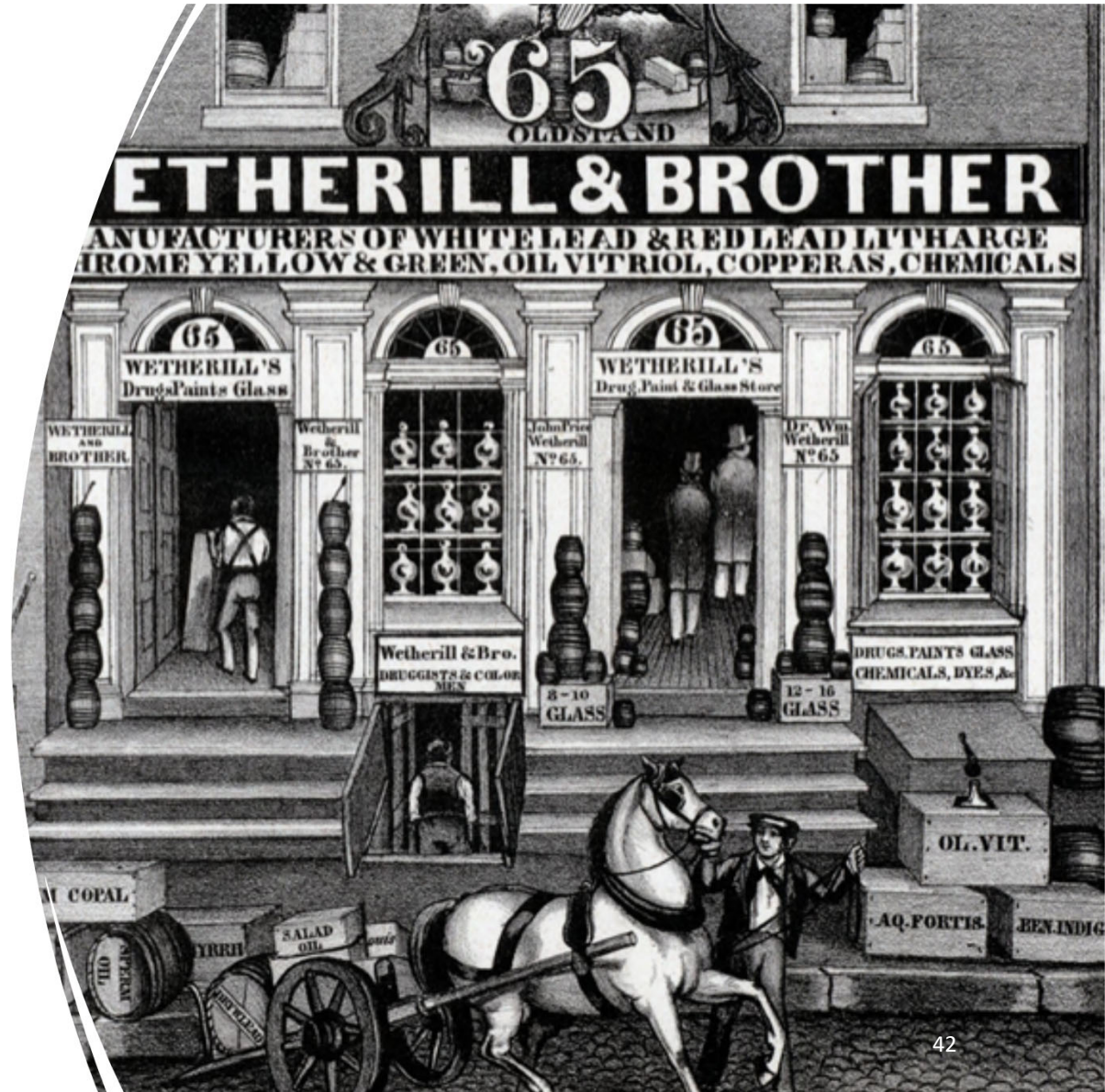
**EDIT RED CELLS**

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014	GSDi and PbBo from Analysis of NHANES 2007-2010	GSDi and PbBo from Analysis of NHANES 1999-2004	GSDi and PbBo from Analysis of NHANES III (Phases 1&2)
$PbB_{fetal, 0.95}$	Target PbB in fetus (e.g., 2-8 $\mu\text{g}/\text{dL}$ )	$\mu\text{g}/\text{dL}$	5	5	5	5
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9
BKSF	Biokinetic Slope Factor	$\mu\text{g}/\text{dL}$ per $\mu\text{g}/\text{day}$	0.4	0.4	0.4	0.4
$GSD_i$	Geometric standard deviation PbB	--	1.8	1.7	1.8	2.1
$PbB_0$	Baseline PbB	$\mu\text{g}/\text{dL}$	0.6	0.7	1.0	1.5
$IR_s$	Soil ingestion rate (including soil-derived indoor dust)	$\text{g}/\text{day}$	0.050	0.050	0.050	0.050
$AF_{s,D}$	Absorption fraction (same for soil and dust)	--	0.12	0.12	0.12	0.12
$EF_{s,D}$	Exposure frequency (same for soil and dust)	days/yr	219	219	219	219
$AT_{s,D}$	Averaging time (same for soil and dust)	days/yr	365	365	365	365
<b>PRG in Soil for no more than 5% probability that fetal PbB exceeds target PbB</b>		<b>ppm</b>	<b>1,050</b>	<b>1,126</b>	<b>773</b>	<b>97</b>

## PRG Calculation for Site

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
$PbB_{fetal, 0.95}$	Target PbB in fetus (e.g., 2-8 $\mu\text{g}/\text{dL}$ )	$\mu\text{g}/\text{dL}$	5
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	$\mu\text{g}/\text{dL}$ per $\mu\text{g}/\text{day}$	0.4
$GSD_i$	Geometric standard deviation PbB	--	1.8
$PbB_0$	Baseline PbB	$\mu\text{g}/\text{dL}$	0.6
$IR_s$	Soil ingestion rate (including soil-derived indoor dust)	$\text{g}/\text{day}$	0.100
$AF_{s, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{s, D}$	Exposure frequency (same for soil and dust)	$\text{days}/\text{yr}$	100
$AT_{s, D}$	Averaging time (same for soil and dust)	$\text{days}/\text{yr}$	140
<b>PRG in Soil for no more than 5% probability that fetal PbB exceeds target PbB</b>		<b>ppm</b>	<b>441</b>

Please put questions in the Q&A chat





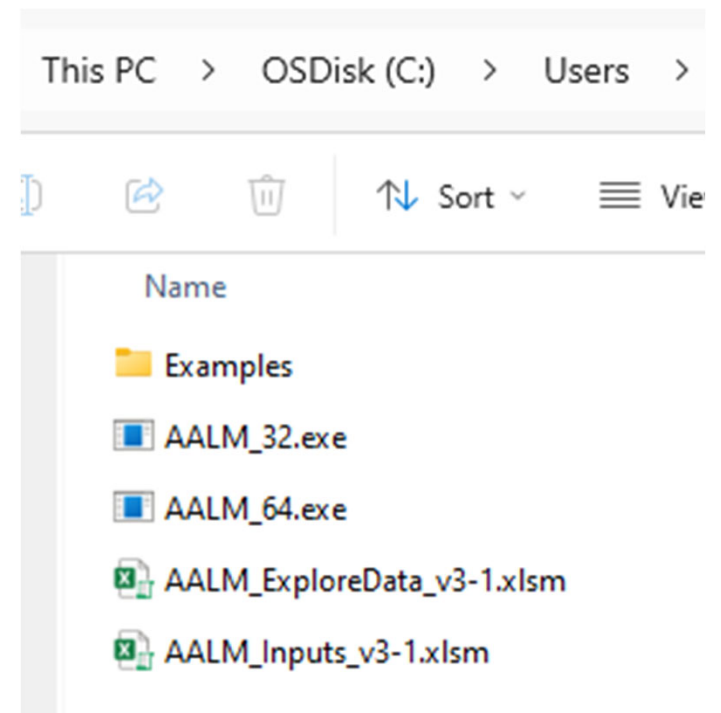
# AALM Demonstration IEUBK Simulation and Intermittent Exposure Example

Disclaimer: The views expressed are those of the author(s) and do not necessarily reflect the views or policies of the U.S. EPA.


# AALM Installation

---


- Run from c: drive area where users have read & write access
- Three primary files
  - AALM\_Inputs\_v3-1.xlsm
    - Setup and run simulations
  - AALM\_ExploreData\_v3-1.xlsm
    - View simulation results
  - AALM\_64.exe
    - Executable that performs calculations
- Examples folder
  - Eight files that can be imported to run AALM simulations discussed in the User's Guide



- AALM\_Inputs\_v3-1.xlsm
  - Setup and run simulations
- Setup
  - Base Parameters
    - Age and Sex
  - Growth and Physiology
    - Should not need to alter
  - Active Media
- Run Simulation

 Import

## All Ages Lead Model (AALM)

 Reset

### Simulation Setup

Simulation Name  
 32-bit exe  
 64-bit exe

**1. Set Base Parameters** Select to see advanced time options:

Age at end (yrs)	<input style="width: 90%;" type="text" value="90"/>	?
Sex	<input style="width: 90%;" type="text" value="Female"/>	?

**2. Set Growth and Physiology**

Adjust growth parameters?	<input style="width: 90%;" type="text" value="No (default)"/>	?
Adjust physiology parameters?	<input style="width: 90%;" type="text" value="No (default)"/>	?



**3. Set Active Media**

	Media	Number of Sources	Number of Periodic "Time Masks"	
Soil	No	0	0	?
Dust	No	0	0	?
Water	No	0	0	?
Air	No	0	0	?
Food	No	0	0	?
Other	No	0	0	?

Solution type	<input style="width: 90%;" type="text" value="Forward"/>	?
Stepwise or Interpolated?	<input style="width: 90%;" type="text" value="Stepwise"/>	?
Linear or Non-linear RBC?	<input style="width: 90%;" type="text" value="Non-linear RBC"/>	?

Run Simulation

# AALM – IEUBK Simulation

 Import
AALM
 Reset

## Simulation Setup

Simulation Name

### 1. Set Base Parameters

Age at end (yrs)  ?

Sex  ?

### 2. Set Growth and Physiology









Adjust growth parameters?  ?

Adjust physiology parameters?  ?

### 3. Set Active Media

	Media	Number of Sources
Soil	No	0
Dust	No	0
Water	No	0
Air	No	0

i Select the AALM Fortran input file you would like to read in.

Name	Date modified	Type	Size
 LeggettInput_Ex1.txt	7/2/2025 12:07 PM	Text Document	8 KB
 LeggettInput_Ex1a.txt	7/2/2025 12:07 PM	Text Document	8 KB
 LeggettInput_Ex2.txt	7/2/2025 12:07 PM	Text Document	6 KB
 LeggettInput_Ex2a.txt	7/2/2025 12:07 PM	Text Document	6 KB
 LeggettInput_Ex3.txt	7/2/2025 12:07 PM	Text Document	7 KB
 LeggettInput_Ex3a.txt	7/2/2025 12:07 PM	Text Document	7 KB
 LeggettInput_Ex4.txt	7/2/2025 12:07 PM	Text Document	6 KB
 LeggettInput_Ex5.txt	7/2/2025 12:07 PM	Text Document	7 KB

File name:  All Files (\*.\*)

Tools ▾



Import

# All Ages Lead Model (AALM)



Reset

## Simulation Setup

Simulation Name

Example1

32-bit exe  
 64-bit exe

Simulation Name changed

### 1. Set Base Parameters

Select to see advanced time options:

Age at end (yrs)

7



Age changed from 90 to 7

Sex

Female



Simulation is for a female

### 2. Set Growth and Physiology

Adjust growth parameters?

No (default)



Adjust physiology parameters?

No (default)



### 3. Set Active Media

	Media	Number of Sources	Number of Periodic "Time Masks"	
Soil	Yes	1	0	
Dust	Yes	1	0	
Water	Yes	1	0	
Air	Yes	1	0	
Food	Yes	1	0	

Media are active with one source  
Buttons appeared

Go to Media

Go to Lung

## Media tab

Imported file applied IEUBK v2.0 default media concentrations, bioavailabilities, and intake rates

- Soil/Dust ingestion
  - 45% from soil
  - 55% from dust
- Air intake is average of IEUBK function (not user accessible) for each year

Soil									
Reset Soil		Clear Soil							
Concentration (ug/g)	Number of Ages	Ages (years)	0						
	1	Source 1	200						
Intake	Number of Ages	Ages (years)	0	1	2	3	4	5	6
	7	Intake (g/day)	0.0387	0.0423	0.03015	0.02835	0.03015	0.0234	0.02475
		Fraction, Source 1	1	1	1	1	1	1	1
RBA	RBA, Source 1	0.6							

Dust									
LTC		Clear Dust		Reset Dust					
Concentration (ug/g)	Number of Ages	Ages (years)	0						
	1	Source 1	150						
Intake	Number of Ages	Ages (years)	0	1	2	3	4	5	6
	7	Intake (g/day)	0.0473	0.0517	0.03685	0.03465	0.03685	0.0286	0.03025
		Fraction, Source 1	1	1	1	1	1	1	1
RBA	RBA, Source 1	0.6							

Water									
Clear Water		Reset Water							
Concentration (ug/L)	Number of Ages	Ages (years)	0						
	1	Source 1	0.9						
Intake	Number of Ages	Ages (years)	0	1	2	3	4	5	6
	7	Intake (L/day)	0.4	0.43	0.51	0.54	0.57	0.6	0.63
		Fraction, Source 1	1	1	1	1	1	1	1
RBA	RBA, Source 1	1							

Air									
Clear Air		Reset Air							
Concentration (ug/m <sup>3</sup> )	Number of Ages	Ages (years)	0						
	1	Source 1	0.1						
Intake	Number of Ages	Ages (years)	0	1	2	3	4	5	6
	7	Intake (m <sup>3</sup> /day)	3.22	4.97	6.09	6.95	7.68	8.32	8.89
		Fraction, Source 1	1	1	1	1	1	1	1
RBA	RBA, Source 1	1							

Food									
Clear Food		Reset Food							
Intake (ug/day)	Number of Ages	Ages (years)	0						
	7	Source 1	2.66	5.03	5.21	5.38	5.64	6.04	5.95
RBA	RBA, Source 1	1							

## Lung tab

Imported file applied 32% deposition and complete absorption of deposited particles consistent with the IEUBK v2.0

Lung Parameters				Reset	Clear All	Done
Variable	Unit	Source 1	Description			
DepFracLET	f	0	Fraction of inhaled aerosol deposited in Extrathoracic region.			
DepFracLTB	f	0	Fraction of inhaled aerosol deposited in Tracheobronchial region.			
DepFracLalv	f	0.32	Fraction of inhaled aerosol deposited in Alveolar region.			
RLETplas	1/day	0.00E+00	Loss rate from Extrathoracic region to plasma.			
RLETstom	1/day	0	Loss rate from Extrathoracic region to GI tract (stomach).			
RLTBplas	1/day	0.00E+00	Loss rate from Tracheobronchial region to plasma.			
RLTBLET	1/day	0	Loss rate from Tracheobronchial region to Extrathoracic region.			
RLalvPlas	1/day	1.00E+00	Loss rate from Alveolar region to plasma.			
RLalvLTB	1/day	0	Loss rate from Alveolar region to Tracheobronchial region.			
RLalvLint	1/day	0	Loss rate from Alveolar region to Interstitial region.			
RLintPlas	1/day	0.00E+00	Loss rate from Interstitial region to plasma.			

32% deposition

Rapid absorption into blood

### Simulation Setup

Simulation Name

#### 1. Set Base Parameters

Age at end (yrs)   
Sex

#### 2. Set Growth and Physiology

Adjust growth parameters?   
Adjust physiology parameters?

#### 3. Set Active Media

	Media
Soil	Yes
Dust	Yes
Water	Yes
Air	Yes
Food	Yes
Other	No

Simulation type   
Stepwise or Interpolated?   
Linear or Non-linear RBC?

From the Simulation Control tab, press Run Simulation button to execute run

Output Selection box indicates the run is complete.

### AALM v3.0

#### Output Selection

Please select the outputs of interest:

- General Run Information
- Detailed Outputs by Timestep
- Daily Intake and Uptake Values
- Explore Data
- Allowable Concentration

Next, press Explore Data button to view results.

### AALM v3.1

#### Output Selection

Please select the outputs of interest:


- General Run Information
- Allowable Concentration

Next, open Explore Data file "AALM\_ExploreData\_v3-1.xlsm" to view results.

AALM v3.1 has been separated into two workbooks to improve model performance.

# AALM – IEUBK Simulation Results


(viewing “AALM\_ExploreData\_v3-1.xlsm” below)



Import

## Explore the Data

Select the update button to update the data to the current simulation run or import previously run data.



Update

### Select Data Summaries to View

- Blood Lead (µg/dL)
- Plasma Lead (µg/dL)
- Cortical Bone Lead (µg/g)
- Trabecular Bone Lead (µg/g)
- Cortical Bone Lead Mass (µg)
- Trabecular Bone Lead Mass (µg)
- Gastrointestinal Lead Intake (µg/day)

### Simulation Parameters

Name Example1

Start Age (yrs) 0

End Age (yrs) 7

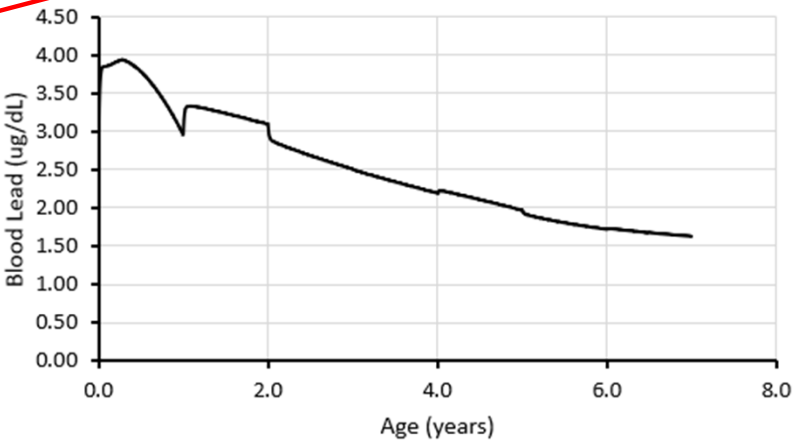
Press Update button

Simulation Name should match name in AALM\_Inputs\_v3-1.xlsm

### Blood Lead (µg/dL)

Y Max: Auto

Y Min: Auto



#### Blood Pb for Age Range

Start (yrs)	End (yrs)
1	6
Average (µg/dL) 2.44	
Minimum (µg/dL) 1.72	
Maximum (µg/dL) 3.33	

#### Blood Pb at a Specific Age

Age (yrs)	Blood Pb (µg/dL)
4	2.19

#### Area Under Blood Pb Curve (AUC)

Age Range		AUC (µg/dL*yr)
Start (yrs)	End (yrs)	
0	7	17.49

		Blood Pb not to exceed (µg/dL)
GSD	1.6	5
	6.3 % exceeding	

		Blood Pb not to exceed (µg/dL)
GSD	1.6	5
	4.0 % exceeding	

Edit pale yellow cells

- Adjust graph axes
- Adjust age range

# AALM – Intermittent Exposure Example

Import

## All Ages Lead Model (AALM)

### Simulation Setup

Simulation Name:   32-bit exe  
 64-bit exe

**1. Set Base Parameters** Select to see advanced

Age at end (yrs)	<input type="text" value="50"/>	?
Sex	<input type="text" value="Female"/>	?

**2. Set Growth and Physiology**

Adjust growth parameters?	<input type="text" value="No (default)"/>	?
Adjust physiology parameters?	<input type="text" value="No (default)"/>	?

**3. Set Active Media**

Media	Number of Sources	Number of Periodic "Time Masks"	
Soil	1	1	?
Dust	0	0	?
Water	0	0	?
Air	0	0	?
Food	0	0	?
Other	1	0	?

Imported "LeggettInput\_Ex3.txt" for Example 3

Simulation runs from birth to 50 years of age

Soil is active with one source and one mask (i.e., when exposure is turned off or blocked)

Other is active with one source

# AALM – Intermittent Exposure Example

## Media Sources, Intakes, and Relative Bioavailabilities <sup>i</sup>

Masking Help

Reset

Done

### Soil

Reset Soil

Clear Soil

Exposed for 3 months starting at 30 years to 1000 µg/g Pb in soil

Concentration (ug/g)	Number of Ages	Ages (years)	0	30	30.25
	3	Source 1	0	1000	0

Mask #	Source	Period (days)	First day blocked	Last day blocked
1	1	7	1	2

No exposure the first 2-days of each week

Intake	Number of Ages	Ages (years)	0	0.274	1	5	10	15
	6	Intake (g/day)	0.018	0.032	0.041	0.036	0.027	0.014
		Fraction, Source 1	1	1	1	1	1	1

RBA RBA, Source 1 0.6 ← 60% RBA (i.e., 30% ABA) assumed

### Other

Clear Other

Intake (ug/day)	Number of Ages	Ages (years)	0
	1	Source 1	5.59
		RBA, Source 1	1

Intake that achieves 0.6 µg/dL blood Pb at 30 years of age

# AALM – Intermittent Exposure Example

(viewing “AALM\_ExploreData\_v3-1.xlsm” below)

Import

## Explore the Data

 Update

Select the update button to update the data to the current simulation run or import previously run data.

### Select Data Summaries to View

- Blood Lead (µg/dL)
- Plasma Lead (µg/dL)
- Cortical Bone Lead (µg/g)
- Trabecular Bone Lead (µg/g)
- Cortical Bone Lead Mass (µg)
- Trabecular Bone Lead Mass (µg)
- Gastrointestinal Lead Intake (µg/day)

### Simulation Parameters

Name	Example3
Start Age (yrs)	0
End Age (yrs)	50

Press Update button

Simulation Name should match name in AALM\_Inputs\_v3-1.xlsm

### Blood Lead (µg/dL)

1
Y Max: 1
0.5
Y Min: 0.5

29.5	X Min: 29.5
31	X Max: 31

Non-numeric value resets axes Auto formatting

#### Blood Pb for Age Range

Start (yrs)	End (yrs)
30	30.25
Average (µg/dL) 0.84	
Minimum (µg/dL) 0.60	
Maximum (µg/dL) 0.94	

#### Blood Pb at a Specific Age

Age (yrs)	Blood Pb (µg/dL)
30.25	0.93

#### Area Under Blood Pb Curve (AUC)

Age Range		AUC (µg/dL*yr)
Start (yrs)	End (yrs)	
0	50	30.96

	Blood Pb not to exceed (µg/dL) ?						
←	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td style="text-align: center;">GSD</td><td style="text-align: center;">5</td></tr> <tr><td style="text-align: center;">1.6</td><td style="text-align: center;">5</td></tr> <tr><td style="text-align: center;">0.0</td><td style="text-align: center;">% exceeding</td></tr> </table>	GSD	5	1.6	5	0.0	% exceeding
GSD	5						
1.6	5						
0.0	% exceeding						

	Blood Pb not to exceed (µg/dL) ?						
←	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td style="text-align: center;">GSD</td><td style="text-align: center;">5</td></tr> <tr><td style="text-align: center;">1.6</td><td style="text-align: center;">5</td></tr> <tr><td style="text-align: center;">0.0</td><td style="text-align: center;">% exceeding</td></tr> </table>	GSD	5	1.6	5	0.0	% exceeding
GSD	5						
1.6	5						
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# Discussion and Q&A

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