

Case Study: Lead Contamination and Local Exposure



RISK ASSESSMENT TRAINING AND EXPERIENCE
Exposure Assessment Course Series – EXA 409

Office of Research and Development
National Center for Environmental Assessment

What You Can Expect to Learn from This Course

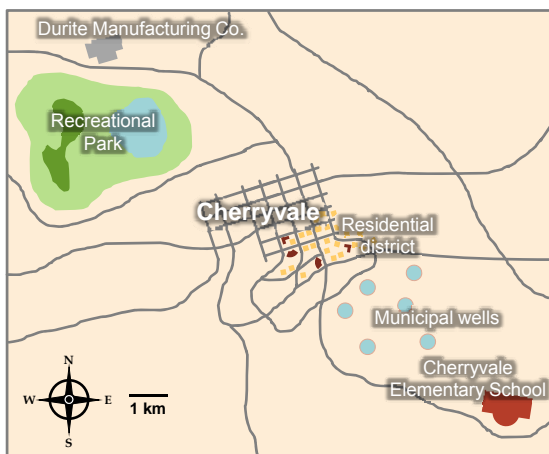
- How to apply exposure assessment concepts in the analysis of a “real-world” chemical exposure scenario
- Background information on factors affecting lead exposures and health effects due to these exposures
- Stakeholder perspectives on application of exposure assessment to risk management decisions

PROBLEM OVERVIEW: LEAD-CONTAMINATED COMMUNITY NEAR MANUFACTURING FACILITY

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Durite Manufacturing and Surrounding Community



- Cherryvale population: 2,386
- Durite Manufacturing located:
 - 5 km NW of Cherryvale
 - 7 km NW of residential district
 - consists of individual dwellings and high-rise apartments
 - 9 km NW of municipal wells
 - public water source for Cherryvale
 - 14 km NW of Cherryvale Elementary
 - Attended by children of Cherryvale
 - Largest elementary school in the area

EXA 409

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THE DAILY NEWS

www.dailynews.com

CHERRYVALE'S FAVORITE NEWSPAPER

- Since 1879

DURITE MANUFACTURING ACCUSED OF POISONING CHILDREN



Local environmental activist finds levels of lead in soil at factor exceed allowable standards.

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THE DAILY NEWS

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CHERRYVALE'S FAVORITE NEWSPAPER

- Since 1879

HOSPITAL FINDS ELEVATED BLOOD- LEAD LEVELS IN LOCAL CHILDREN



Three children show high levels of lead; others show symptoms of exposure.

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- Since 1879

LEAD : CRACK IN CEMENTWORK



- Since 1879



Parents and other concerned citizens

THE DAILY NEWS

www.dailynews.com

CHERRYVALE'S FAVORITE NEWSPAPER

Since 1879

DURITE MANUFACTURING CLAIMS FACILITY IS SAFE

CEO of facility claims factory
uses best available control
technologies




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United States
Environmental Protection
Agency

Problem Overview

- Soil surrounding facility contaminated with lead levels at levels of concern
- Three children with measured elevated blood-lead levels and others show symptoms of lead exposure
- Groundwater contaminated with lead
- Community is concerned
- Durite Manufacturing uses best available control technology

EXA 4099

LEAD BACKGROUND INFORMATION AND DATA

EXA 409

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Lead Characterization and Use

- What is lead?

Lead is a heavy, corrosion-resistant metal that occurs naturally in the environment (primarily found as lead compounds) and can persist for a very long time.

- What has lead been used in?

- Batteries
- Ceramic glazes
- Cable covers
- Dyes
- Weights
- Paints – Banned in 1978*
- Gasoline – Phased out starting in 1973; banned entirely in 1996*
- Solder – Banned if >0.2% lead in 1986; banned in food cans entirely in 1995*
- Plumbing – Restricted lead content of faucets, pipes, and other plumbing materials to 8% in 1986*
- Ammunition – Banned for waterfowl hunting in 1991*



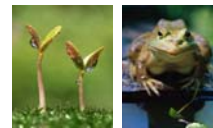
*U.S. regulations only

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Lead Environmental Fate and Transport

- What happens to lead when it enters the environment?
 - Can travel long distances in air before depositing onto soil or water
 - Adsorbs strongly to soil particles. Remains in the upper levels of soil profile, but can also be transported to surface water via erosion and runoff.
 - Unlikely to migrate to groundwater from soil
 - Adsorbs strongly to sediment particles, where it can persist for many years. Can also re-suspend into water column. Fish are exposed via suspended and bottom sediment.
 - Bioconcentrates in plants and animals



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Lead Exposure

- What are the sources of lead exposure?
- **General population:** ingesting dusts, breathing air, drinking water, or eating foods that contain lead

Source	Exposure Media	Origin
Primary:	Lead-contaminated dust	Lead paint, lead emissions
Secondary:	Lead-contaminated drinking water	Lead pipes, erosion of natural deposits
	Food	Plant uptake, atmospheric deposition, formerly from lead-soldered food cans

- **Children:** swallowing paint chips or dust from deteriorated lead-based paints
 - Deteriorated lead paint is number-one cause of severe lead poisoning in U.S. children
 - Particularly vulnerable due to non-adult behavior (e.g., crawling, mouthing)
 - Correlation between lead in soil and lead in blood of children has been studied extensively

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Lead Health Effects

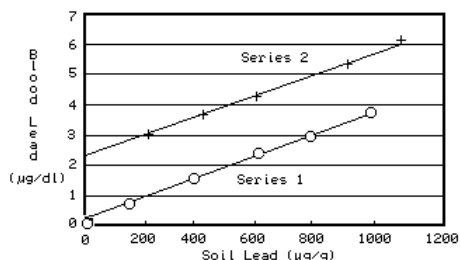
- What are the health effects of lead?
 - **General population:**
 - High blood pressure and hypertension
 - Coronary heart disease
 - Cognitive function decrements, depression and anxiety
 - Reduced kidney function, immune effects
 - **Children:**
 - Damage to brain and nervous system
 - Level of concern: $\geq 5 \mu\text{g/dL}$ -blood
 - Possibly no threshold for effect
 - Behavior and learning problems: IQ, academic performance, learning and memory, inattention, impulsivity, hyperactivity
 - Impaired motor skills
 - Atopic and Inflammatory conditions (e.g., asthma and allergy)

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Correlation between Lead Levels in Soil and in Blood

Figure 3. EPA UPTAKE/BIOKINETIC MODEL FOR LEAD:
BLOOD AND SOIL LEAD CORRELATION



Legend:

	Series 1	Series 2
AIR CONCENTRATION:	0.000 $\mu\text{g Pb}/\text{m}^3$	0.200 $\mu\text{g Pb}/\text{m}^3$
DIET Intake:	0.00 $\mu\text{g}/\text{day}$	6.79 $\mu\text{g}/\text{day}$
DRINKING WATER:	0.000 L/day 0.0 $\mu\text{g}/\text{L}$	0.52 L/day 4 $\mu\text{g}/\text{L}$
SOIL:	0-1000 $\mu\text{g Pb}/\text{g}$	0-1000 $\mu\text{g Pb}/\text{g}$
HOUSE DUST:	0.0 $\mu\text{g Pb}/\text{g}$	200.0 $\mu\text{g Pb}/\text{g}$
PAINT Intake:	0.00 $\mu\text{g Pb}/\text{day}$	0.00 $\mu\text{g Pb}/\text{day}$
MATERNAL CONTRIBUTION:	Infant Model 0.00 $\mu\text{g Pb}/\text{dL}$	Infant Model 7.50 $\mu\text{g Pb}/\text{dL}$
AGE OF CHILDREN:	24-36 months	24-36 months

- Linear correlation between lead in soil and lead in blood
- Introducing exposures via other routes only marginally increases blood-lead levels
 - In this scenario, soil intake is the driving blood-lead levels
 - Note that paint intake is not modeled

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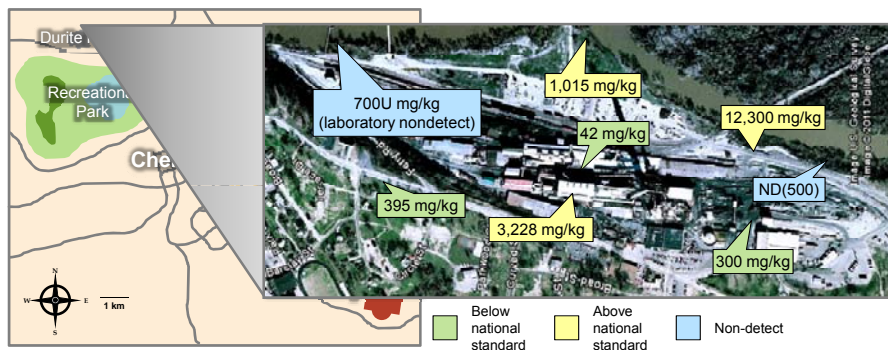
LOCAL MONITORING DATA

EXA 409

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Lead in Soil

• Soil lead standard, children's play areas	400 mg/kg (ppm)	* from TSCA Section 403
• Soil lead standard for other residential soils	1,200 mg/kg*(ppm)	* from TSCA Section 403
• Natural levels of lead in soils:	<50 mg/kg	* from CDC - ATSDR
• Concentrations found at Durite Manufacturing Site (see figure below)		



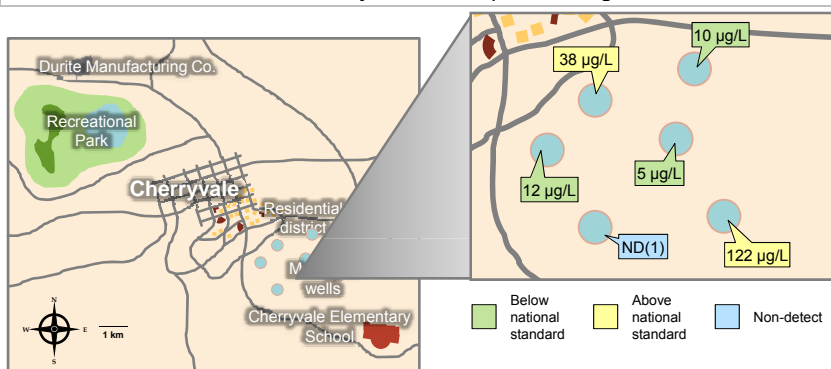
- No data collected on lead in soil in the nearby park or at residences in Cherryvale

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Lead in Ground Water

- EPA Drinking water standard for lead: 15 µg/L (ppb)* * from Safe Drinking Water Act of 1974
- Natural levels of lead in ground water: 1–100 µg/L (average ~3 µg/L)
- Concentrations found in Cherryvale municipal drinking water wells:



- No data collected for ground water wells recently installed at the Durite Manufacturing site.

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Lead Levels in Children's Blood

- CDC levels of concern:
 - ≥5 µg/dL - Community-wide lead poisoning prevention activities are advised
 - ≥20 µg/dL - Medical evaluation and environmental investigations and remediation is advised
 - ≥45 µg/dL - Medical treatment (i.e., chelation therapy) may be necessary
- NHANES levels of lead in blood of children, ranges 1-6, 6-11, and 12-19:
 - Average: 0.8 – 1.6 µg/dL
 - 95th Percentile: 1.8 – 4.0 µg/dL

Concentrations found in blood of children at Cherryvale municipal hospital:	
<1 µg/dL	11 µg/dL
3 µg/dL	15 µg/dL
8 µg/dL	25 µg/dL

- Highest level found in 2 year-old child whose parents worked at Durite and who was rumored to have spent the last year at the on-site Durite Day Care Center.

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STAKEHOLDER PARTICIPATION

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Activity Instructions

- Separate into stakeholder groups representing these perspectives:
 - Manufacturers
 - Local Environmental Agency
 - Local Health Department
 - Citizens/Activists
- ⌚ 30 minutes: Preparation
 - Each group reviews the data in their packet, develops a position, and prepares a presentation.
- ⌚ 20 minutes (5 minutes each):
 - Each group presents its position in 3 minutes, leaving 2 minutes for questions.
- ⌚ 5 minutes: Resolution
 - The local Environmental Agency concludes the meeting with a final resolution.

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Activity Instructions, continued


- Assume you have an unlimited budget.
- Use the knowledge you've picked up from previous EXA courses to develop your presentation.
- Has new information come to light during the past 6 months?

DEVELOPING STAKEHOLDER PERSPECTIVES

(What did you learn in the last
six months?)

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- Since 1879



**Danger:
Contaminated
Area**



Activity Wrap-Up



Were the original data problematic?



How did the municipal wells
become contaminated?



What is the responsibility of
industry in an arena of uncertainty?



How does problem formulation
affect risk management?