

**An interdisciplinary scientist's  
overview of why exposure to  
lead (Pb<sup>2+</sup>) remains an IEQ issue  
for American K-12 schools.**

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# Lead: Part of the History of Environmental Health in our Communities (Homes, Schools)

- Among the issues present even during Ancient Times in Rome, Greece, Europe, etc.:
  - Contamination of water
    - Clean water *necessary for life* (drinking and bathing, cooking).
  - Lead in pottery used to drink wine, hold foods, etc.;
    - Food safety *necessary for life*.
  - Pollution of the air both indoors and outdoors.
    - Breathing clean air *necessary for life*.

# Defining Human Exposure

Contact between a person (*or animal, plant, fish, etc.*) and an **agent**, or the vector of an agent, in one or more **media**, through one or more defined **pathways** and **routes**, at a *specific (acute)* or over a *period (chronic)* of **time**.

Chronic exposure may be intermittent, continuous or episodic.

*Each type is relevant to ongoing issues with lead (Pb<sup>2+</sup>) in our communities, including homes and schools!*

# Exposure Agents

Four categories, classified as carcinogenic or non-carcinogenic:

## 1. Biological

- Bacteria and mold (fungi, mildew, spores), including metabolic products and cell-wall components; pollens from trees, flowers

## 2. Chemical

- Organic: contain C and H, with/without metals
- Non-organic: N, S, H, O and **heavy metals like lead or  $Pb^{2+}$**

## 3. Physical

- Light, noise, ergonomics, weather and climate-related variables (temperature, relative humidity, wind)

## 4. Radiological

- Radon gas, electromagnetic field, ionizing/non-ionizing, nuclear

*Also, an emerging area of research: Psychosocial factors, or social determinants of health*

# Exposure Science Terms *(continued)*

- *Pathways:*

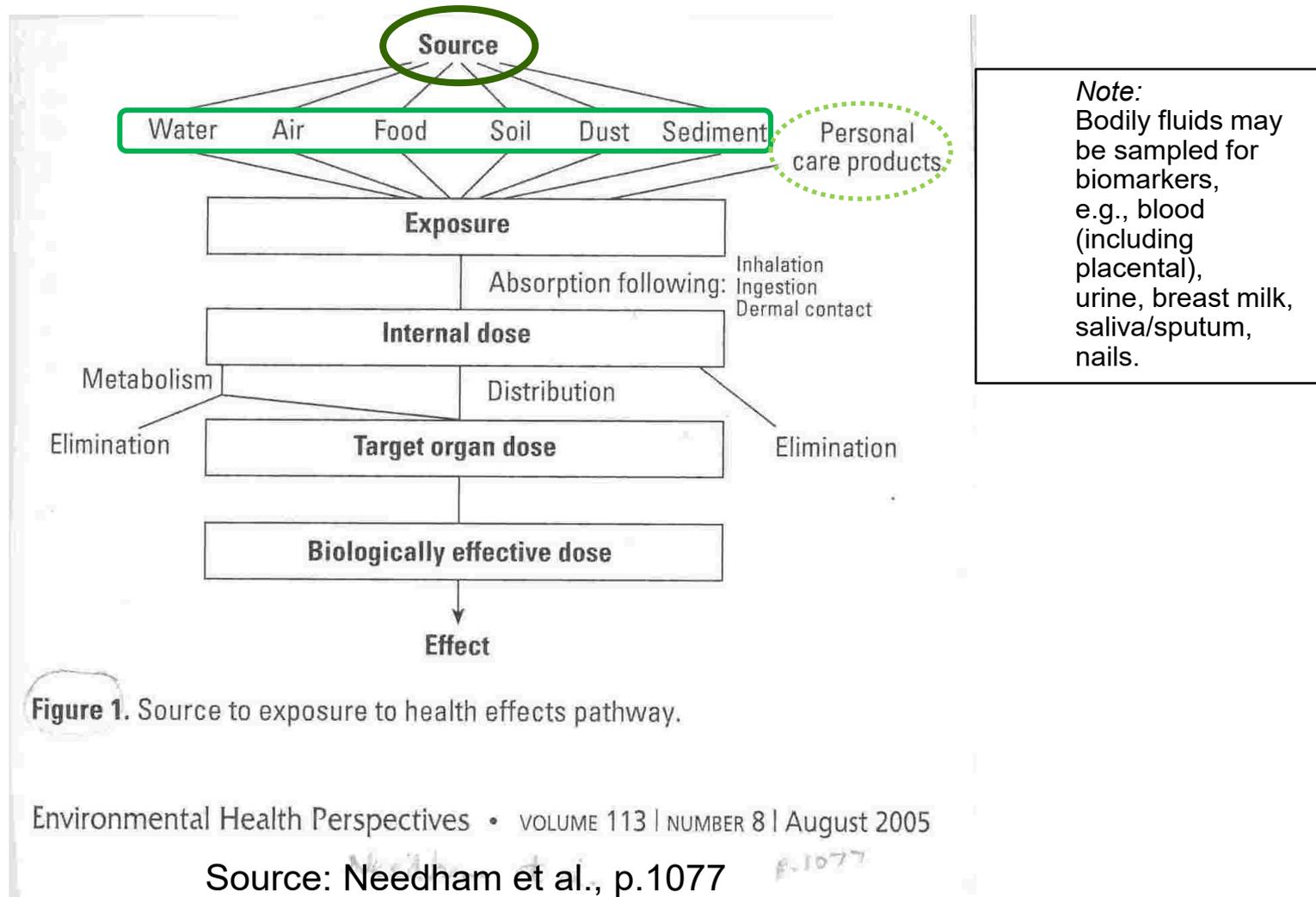
To describe process of the emission(s) of agent(s) from identified source(s)—either natural or human (anthropogenic) or both—to various environmental media.

- *Routes:*

The major *routes* for the general population:

1. Inhalation (nose, mouth)
2. Dermal (skin)
3. Ingestion (food, liquids)

# An Exposure Assessment Flowchart



**Today discuss lead ( $Pb^{2+}$ ) in context of industrial hygiene hierarchy of controls.**

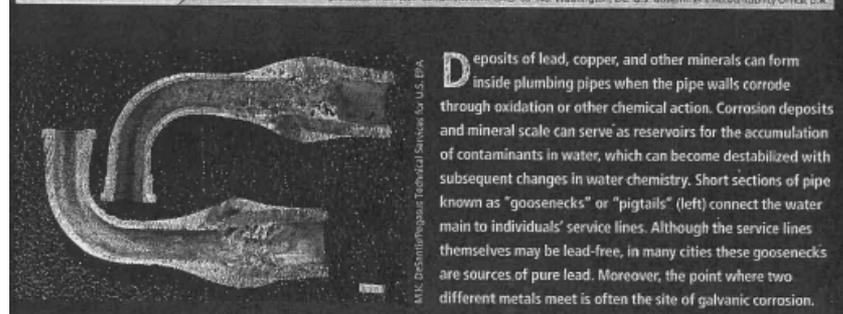
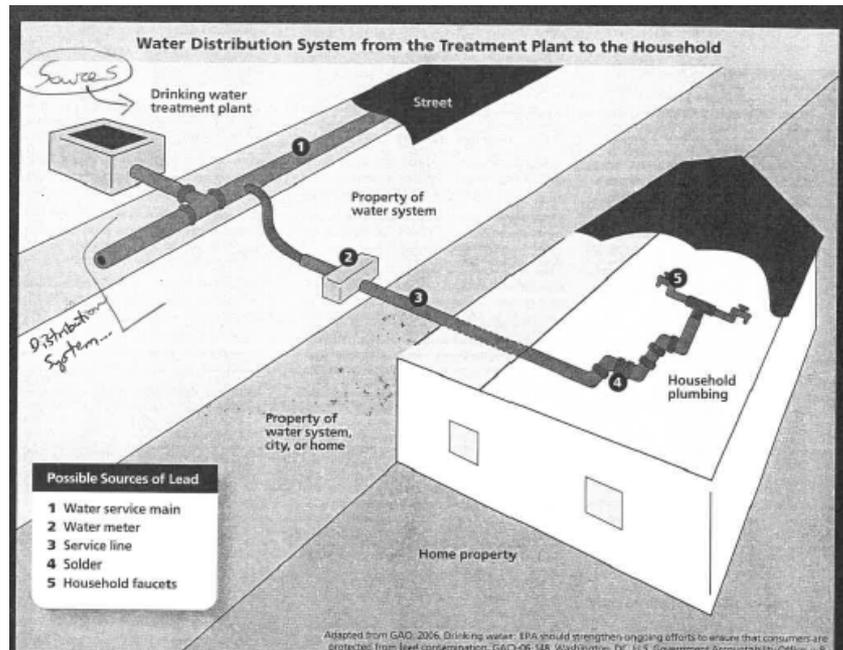
# Ongoing Omnipresent Sources of Lead (Pb<sup>2+</sup>), and Other Pollutants

Note how these could still be at/in a house or at/in a school!  
**Today we discuss why?**

Uses of Lead Past and Present	
Paint	•Lead compounds can add durability, opacity, and pigmentation to paint
Petrol	•Tetraethyl lead used as antiknock agent allows for better engine combustion.
Lead-acid Batteries	•The largest subset of lead-acid batteries are for automotive application
Cosmetics and dyes	•Used as an additive to enhance colour
Ammunition and fishing nets	•Used because of its high density and malleability
Construction and Plumbing	•Used as a material in water distribution pipes, fittings and central distribution networks
Food	•Used as sweetener and colour enhancer for food
Cookware and food storage	•Lead in cookware base material, the glaze or exterior pigments helps melt and fused the silica glaze when fired

Source: Presentation by Monika MacDevette, 7  
WHO-UNICEF et al. 10/28/2020.  
(Infographic: Uses of Lead Past and Present)

# Ongoing Omnipresent Sources of Lead (Pb<sup>2+</sup>) in Water



Note how this could be a house or a school building... serving bathrooms and sinks, classrooms, cafeteria, teacher and staff break room, etc.

*Source: Environmental Health Perspectives, 2009, volume 117, issue 12, p.A545 (in article "Out of Plumb").*

# Extra Points of Information, Part 1 of 2: Complexities in Older School Buildings

[Source: from NASEM webinar 5/27/2020 by Prof. Andrew Whelan, PhD (engineering)]

Zoom Webinar

## Commercial plumbing can be very complex

- Water source
- Service line
- Safety devices including valves
- Water treatment devices
- Water service and distribution piping and faucet connectors
- Hot water heating, recirculation system
- Fixture and fixture fittings
- Pumps, tanks
- Point-of-use devices

**Table 1. Types of building plumbing components**

Components	Description
Water source	Municipal water, onsite well, treated surface water, rainwater.
Service line	Pipe system that carries water from the source to the building water system. Service line materials are variable and may or may not be the same as indoor pipes.
Safety devices including valves	Pressure relief valve, pressure reduction valve, isolation valve, mixing valve, thermostatic mixing valves, backflow prevention device, water hammer arrestors. Materials can include aluminum, brass, copper, lead, plastic, and stainless steel.
Water treatment devices	Fiber, strainer, water softener, chemical addition equipment for disinfection and corrosion control.
Water service and distribution piping and faucet connectors	Various material types have been used to include acrylonitrile butadiene styrene (ABS), brass, cast iron (CI), chlorinated polyvinyl chloride (CPVC), copper, crosslinked polyethylene (PEX), ductile iron (DI), high density polyethylene (HDPE), lead, lead lined steel, multilayer pipe, polyethylene raised temperature (PERT), polypropylene (PP), unplasticized polyvinyl chloride (uPVC), polyvinylidene fluoride (PVDF), black steel, stainless steel.
Hot water recirculation system	Hot water is pumped through primary and secondary water heater loops, which serve different building zones to reduce delivery time of hot water. These have to be hydraulically balanced. Equipment includes master mixing valves, local mixing valves, flow balancing valves, pressure reducing valves, hot water return pumps and water heaters. Multiple temperature loops may exist. Operation of pumps may be intermittent in some systems.
Fixtures and fixture fittings	Aerator, air washers, atomizers, bathtub, bidet, decorative fountains, dishwater, drinking fountain, eyewash station, manual faucet, electric faucet, faucet flow restrictors, hoses, port of use mixing valves, hot tubs, humidifiers, ice machines, microwaves, shower head, shower wand, sink, tub spout, toilet, urinal, washbasin.
Pumps	Pumps are often used for pressure boosting within the building (i.e., for multi-story buildings) where water pressure entering the building is not adequate for water use at distal locations. Pumps are also used for hot water recirculation systems.
Tanks	Standard water heater, pressure tanks, on-demand water heater, hydro-pneumatic tanks, cold water supply storage tank. Water heaters can contain Mg or Al sacrificial anodes and plastic dip tubes.
Point-of-use devices	On-faucet treatment system, under sink treatment system.

<https://doi.org/10.31219/osf.io/qvj3b>

The National Academies of Science, Engineering, and Medicine WSTB

May 27, 2020

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# Highlights from U.S. EPA CHPAC report on charge questions related to K-12 Schools and Child Care

- Source (completed and submitted 7/12/2021, response by EPA via OCHP Director late 2021):  
<https://www.epa.gov/children/chpac-comment-letters>  
<https://www.epa.gov/system/files/documents/2021-11/07-12-21-chpac-schools-charge-response-letter.pdf> [pages 6-9 on lead (Pb2+)]
- Some of the highlighted recommendations appear on the following slides. *Note: ASHA assumes EPA will present about testing for lead in water in K-12 schools in another presentation in today's LEPAC meeting. Re: Revised Lead and Copper Rule, Maximum Contaminant Level (MCL, and MCLG).*

## Highlights: page 7-8

(from pages 7-8):

*“Specifically, schools and child care providers should be informed that detectible lead concentrations below the action level does not equate to the water being “safe” and lead-free, and that there are actions they can take to further reduce levels in drinking water to as close to zero as possible.*

*This communication should include advice on how to achieve further lead reduction....”*

## Highlights: pages 7-8 part 2

(from pages 7-8):

*“...Strengthen public education and risk communication requirements to ensure consistent interpretation, implementation, and enforcement. ... to ensure the communication is understood, including appropriate reading level and languages other than English, as needed. ... The CHPAC 2020 comment letter “Recommendations for improving EPA risk communication for children’s health risks”*

## Highlights: page 9

(page 9):

Currently, EPA's Lead Renovation, Repair, and Painting Rule (RRP) applies only to the portions of pre-1978 buildings where children aged six years and under regularly visit at least two days a week for at least three hours.

*“EPA expand RRP to apply to areas of a school in which elementary school-aged children spend time.”*

## Highlights: Page 9 part 2

(page 9):

In 2012, CDC, in *an acknowledgement of no safe blood lead level (BLL)*, changed the term “level of concern” to “reference level” set at 97.5th percentile of BLL distribution in children (then 5 µg/dL). In 2018, EPA lowered lead dust hazard standards for inspections, risk assessments, and abatement activities in certain school and child care facilities, But, 10 µg/ft<sup>2</sup> for floors and 100 µg/ft<sup>2</sup> for window sills) are based on protection BLL 10 µg/dL.

## Highlights: page 9 part 3

(page 9):

Therefore, the CHPAC...

*“[R]ecommends ... standard[s] be updated to account for the CDC’s most recent blood lead [BLL] reference value and to consider the higher cumulative and aggregate exposures that children may face when attending school or child care in communities with CERCLA or RCRA cleanup sites.”*

Thank you for your efforts to  
protect our children,  
and communities including schools  
and child care centers,  
from **lead (Pb<sup>2+</sup>)!**

Now, transition back to Jeanie Alter, PhD,  
Executive Director of American School Health  
Association (ASHA), or any questions?

# Contacting NJ Safe Schools Program at Rutgers SPH, and Resources



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Questions, Inquiries

**Website:**

[www.njsafeschools.org](http://www.njsafeschools.org)

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# *Appendix: Extra Point of Information, Part 2 of 2:* Complexities of Environmental Toxicology

[Source: Rutgers EOHSI CROM webinar 2/25/2022 by  
Brian C. Buckley, PhD (lab analytical chemistry)]

## Factors Regulating Toxicity of Metals

- Physical State
  - Solid, liquid, vapor
- Atomic Properties
  - Ionic state, oxidation state, ionic radius
- Chemical Properties
  - Binding form, solubility, complex properties, radical formation
- Biological Phenomena
  - PB/PK, bioavailability, biological residence, compartmentalization
  - Organ specificity