# Bioavailability Demonstration — Facilitator Guide

*This demonstration was created to accompany a discussion of bioavailability of arsenic and/or lead at a contaminated Superfund site and to clarify how bioavailability factors into decision making about site remediation.*

## Upon completion of this activity; participants are expected to be able to:

- Define what is meant by the phrase "parts per million"
- Distinguish between 100%, 50% and 25% bioavailability
- Describe why two soils contaminated with arsenic might have different target clean-up concentrations

## Materials Needed

- Copies of 25% and 50% bioavailability worksheets, (see provided PowerPoint slides 27 and 28), one worksheet per group
- Pen or pencil, one per group
- Starlight peppermint candies, at least 38 per 25% bioavailability group
- Starlight Pinwheel peppermint candies, at least 30 per 50% bioavailability group

- Bioavailability demonstration PowerPoint slide set (provided)

## Instructor Preparation

- Prior to conducting this activity assemble required materials (see above) and place one worksheet, along with the minimum number of candies at each table.
- Familiarize yourself with the facilitator PowerPoint.
- [Optional] Insert state specific target concentrations for soil cleanup of arsenic and lead on slide 8.
- Secure access to a screen and projector.

## Instructions

1. Before conducting the candy demonstration, make sure to define what is meant by the phrase "parts per million" so that everyone in the room knows that this phrase is used to reference concentration (see PPT slides 2-5).
2. If known, describe what is known about the concentration of soil arsenic/lead at the site of concern. Describe the concentration of arsenic/lead in native soil and describe how the site of concern has become contaminated with excess arsenic and/or lead through human activities. Discuss state-specific cleanup standards for arsenic and/or lead.
3. Before proceeding ask if there are any questions.
4. Next, explain that scientists know that not all of the arsenic/lead present in soil is available to the human body. Only some forms of arsenic and lead are able to be absorbed if they enter the body; these forms of arsenic or lead are said to be bioavailable and could be harmful to human health[1]. Arsenic and lead that enters the body but that is not bioavailable will be excreted from the body and therefore will not cause harm. Note that bioavailable concentrations of arsenic and lead are going to be less than the total concentration in the soil.
5. Introduce the candy demonstration by stating that participants are going to work with a candy model to examine the concept of bioavailability by comparing two different bioavailability scenarios.

[1] Note: Oral bioavailability of arsenic and lead in soils can vary depending on the lead or arsenic chemical species(s) present, the soil pH, the presence of other organic or inorganic elements/compounds and soil mineralogy.

6. Divide participants into small groups (3-5 ppl per group). Give each group one bioavailability scenario – either the 25% or 50% bioavailability scenario.
7. Tell the groups that each Starlight peppermint candy provided represents 10ppm of arsenic with 25% of that arsenic being bioavailable. Tell the groups that each Pinwheel peppermint candy provided represents 10ppm of arsenic with 50% of that arsenic being bioavailable (show PPT slide 19).
8. Project slide 20 and task each group with figuring out how many candies should be placed into each soil sample: a native soil sample, a contaminated soil sample and a remediated soil sample. Direct each group to the worksheet and candies at their table.

   **The math for these calculations is as follows:**

| Soil Sample | Candy Model | Number of Candies | Total Concentration [soil] |
|---|---|---|---|
| Native soil sample | 10ppm arsenic/candy | × 2 | 20 ppm arsenic |
| Contaminated soil sample | 10ppm arsenic/candy | × 20 | 200 ppm arsenic |
| Remediated soil sample<br>50% bioavailability | 10ppm arsenic/candy<br>w/ 10ppm bioavailable | × 8 | 40 ppm bioavailable<br>80 ppm total arsenic |
| Remediated soil sample<br>25% bioavailability | 10ppm arsenic/candy<br>w/ 5ppm bioavailable | × 16 | 40 ppm bioavailable<br>160 ppm total arsenic |

9. Provide time for participants to determine the number of candies that should be placed into the box for each soil sample represented on their worksheet.
10. Debrief the activity by asking one group with the 50% bioavailability scenario to report their calculations. Check their answers by projecting slide 22. Ask one group with the 25% bioavailability scenario to report their calculations. Check their answers by projecting slide 23.
11. Project slide 24 to compare the results of the two scenarios. Emphasize that both samples have the SAME amount of bioavailable arsenic (40ppm) but different concentrations of total arsenic.
12. Project slide 25 to put these findings into perspective. Describe the target clean-up standards for your state or you can use the example standard provided. Describe how knowing the bioavailability of soil arsenic and/or lead at a site can inform clean-up and result in a target clean-up concentration that appears to be higher than the state standard but actually results in the same level of clean-up due to the fact that bioavailable concentrations of arsenic and/or lead are less than the total soil concentration. This also explains why the target clean-up levels at two different sites can be different.
13. Before proceeding, ask if there are any questions.
14. Describe what is being planned for the site of concern based on what is known about total vs bioavailable concentration of arsenic and/or lead.

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