Activity Overview

Participants make statements about the toxicity of an unfamiliar contaminant by comparing its health-based standard (MCL, RSSL, RfC, or RfD) with the same standards for more familiar contaminants like lead, mercury, arsenic, and cyanide.

When to Use It

When you are trying to call attention to a dangerous contaminant that is not widely known. It is particularly useful when there are reports of tests finding the contaminant, but little detail about where and how much.

Suggested companion activities:

- Use with other activities in Pieces of the Risk Puzzle and the fact sheet from Limits & Levels for the health-based standard you're comparing.
- Follow up with activities in Communicating with Numbers

Steps

1. **Launch the activity**: Who'd heard of [example contaminant of concern] before it was found here? Is it really toxic, or not a big deal? One way to find out: compare it to other toxic substances. The EPA and state agencies set health-based standards for contaminants in [as fits: water, soil, air, our bodies]. If the 'safe' level of a contaminant is very small, that means even a small amount could be harmful. You might know that mercury, arsenic, lead, and cyanide are very toxic. So we're going to compare the [as fits: MCL, RSSL, RfC, RfD] for our contaminants to those toxic substances to see what's most toxic.
2. **In pairs:** Hand out the *Worksheet*, and ToxFAQs on the contaminants of concern. Participants compare using the worksheet.
3. **Debrief:** When people seem ready, ask,

- Which contaminants were the most toxic?
- How did different people compare the standards?
- Which comparisons will best help our campaign? (If applicable)

Worth Noting

Toxicity is just one factor professionals use in assessing risk. See the resource Pieces of the Risk Puzzle for other risk factors.

Different health based-standards have different health and legal implications. See the resource Limits & Levels for more information.

Smart Moves

- Compare it
- Play with different ways to say it

Skill: Describe toxicity by comparing unfamiliar contaminants to familiar toxins

Time: 15 minutes, plus 5 minutes per contaminant.

Preparation

Review the *Facilitator Supplement* for more context

List the community's contaminants of concern. Choose the appropriate health-based standard. Find that standard for each contaminant. Review the *Limits & Levels* fact sheet about the standard.

If there's no single community situation, use either Data Set: *VOCs in Water* or *PCBs in Soil*

Find the ToxFAQ for each contaminant www.atsdr.cdc.gov/toxfaqs/

Materials Needed

List of community's contaminants and standards, or one of the data sets (one per participant)

Worksheet for the standard that is relevant to your situation (one per participant, more if there are many contaminants)

ToxFAQs for the contaminants of concern

Calculators & pens

Fact sheet from *Limits and Levels* about the health-based standard

Health-Based Standards

You can compare the toxicity of two different contaminants using health-based standards:

- Maximum Contaminant Levels (MCLs) for water, especially drinking water
  water.epa.gov/drink/contaminants
- Residential Soil Screening Levels (RSSLs) for soil, especially soil near people's homes
  epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/
- Reference Concentrations (RfCs) for inhalation of air, or similar state air standards
  epa.gov/iris/subst or oehha.ca.gov/air/allrels.html for California's air standards
- The Reference Dose (RfD) for a contaminant that goes into the body in any form
  epa.gov/iris/subst

There are other standards, but these are the most common. For information on each standard, see the resource *Limits and Levels.* Many states have their own standards for water, soil, and air contamination.

Comparing Like to Like

Compare contaminants using the same kind of standard, published by the same people. Don't use a federal standard for one contaminant and a state standard for another other.

Be sure you're using the same units. One MCL may be in mg/L and another in µg/L. Make the conversions yourself before giving to a group, unless you want your group to practice the conversions.

Which one is more toxic?

People have a hard time understanding how a smaller standard can mean more toxic. If people seem confused, make an analogy using coffee, or alcoholic drinks: if the drink is very strong, it only takes a small amount to have an effect. There are other analogies: Concentrated laundry detergent, higher-fat food where a small amount has more calories, etc. Choose one that works for your group.

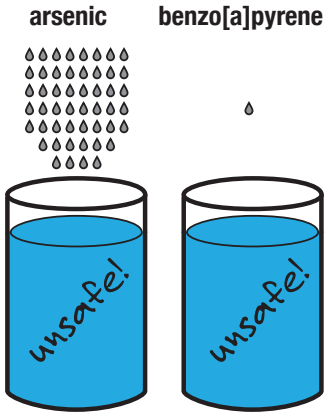
The instructions suggest dividing, but to compare toxicity, but participants may have other ways of finding the answer (like multiplying up).

Example

The MCL for arsenic (10 µg/L) is 50 times bigger than the MCL for benzo[a]pyrene (0.2 µg/L).

That means if it takes *fifty* drops of arsenic to make some amount of water unsafe to drink, it would take only *one* drop of benzo[a]pyrene to make the same amount of water unsafe to drink.

So you can say, "benzo[a]pyrene is 50 times more toxic than arsenic in water!"



MCLs and GWOs

I'd never heard of benzo[a]pyrene, so I looked it up. The MCL for benzo[a]pyrene is 0.2 µg/L. For arsenic, it's 10 µg/L. 10 µg/L is fifty times bigger than 0.2 µg/L. **That means benzo[a]pyrene is 50 times as toxic as arsenic in water!**

1. Choose an unfamiliar contaminant.
2. Compare the MCL for the contaminant to the MCL for mercury, arsenic, lead, or cyanide. One way to compare is to divide the larger MCL by the smaller one. The answer will tell you how much more toxic one is than the other is in water.
3. Fill out one of the sentences below with that information. The one with the smaller MCL is more toxic. You may want to round your number up or down.
4. Repeat for other contaminants. Which statements seem most impressive?

_____ is _____ times as toxic as _____ in drinking water.

_____ is _____ times as toxic as _____ in drinking water.

_____ is _____ times as toxic as _____ in drinking water.

_____ is _____ times as toxic as _____ in drinking water.

_____ is _____ times as toxic as _____ in drinking water.

_____ is _____ times as toxic as _____ in drinking water.

_____ is _____ times as toxic as _____ in drinking water.

_____ is _____ times as toxic as _____ in drinking water.

EPA Maximum Contaminant Level (MCL) & Ground Water Objectives (GWO) for GW-1		
Mercury	**2 µg/L**	The EPA's MCLs are legal limits for any kind of drinking water. GW-1 is a category for underground water that might be used for drinking water. The two levels are the same; both are meant to be health-protective and should not be exceeded. MCLs are measured in micrograms (µg) of the toxin per liter of water. http://water.epa.gov/drink/contaminants
Arsenic	**10 µg/L**	
Lead	**15 µg/L**	
Cyanide	**200 µg/L**	

RSSLs

I'd never heard of indenopyrene, so I looked it up. The RSSL for indenopyrene is 150 mg/kg. For lead, it's 1600 mg/kg. 1600 mg/kg is 10.7 times bigger than 150 mg/kg. **That means indenopyrene is over 10 ten times as toxic as cyanide in soil!**

1. Choose an unfamiliar contaminant.
2. Compare the RSSL for the contaminant to the RSSL for mercury, arsenic, lead, or cyanide. One way to compare is to divide the larger RSSL by the smaller one. The answer will tell you how much more toxic one is than the other is in water.
3. Fill out one of the sentences below with that information. The one with the smaller RSSL is more toxic. You may want to round your number up or down.
4. Repeat for other contaminants. Which statements seem most impressive?

_____ is _____ times as toxic as _____ in soil.

_____ is _____ times as toxic as _____ in soil.

_____ is _____ times as toxic as _____ in soil.

_____ is _____ times as toxic as _____ in soil.

_____ is _____ times as toxic as _____ in soil.

_____ is _____ times as toxic as _____ in soil.

_____ is _____ times as toxic as _____ in soil.

_____ is _____ times as toxic as _____ in soil.

EPA Residential Soil Screening Levels (RSSLs)		
Mercury	**5.6 mg/kg**	The EPA Region III Soil Screening Levels are widely used for comparison purposes. If a tested level exceeds a screening level, it's not necessarily dangerous, it just signals a need for more testing. RSSLs are measured in mg of the toxin per kg of soil.
Arsenic	**0.39 mg/kg**	
Lead	**400 mg/kg**	
Cyanide	**1600 mg/kg**	epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/

Reference Concentration (RfC) for Inhalation

I'd never heard of phosphine, so I looked it up. The RfC for phosphine is 0.3 µg/m^3. For cyanide, it's the same. That means phosphine is as toxic as cyanide to breathe!

1. Choose an unfamiliar contaminant.
2. Compare the RfC for the contaminant to the RfC for mercury, arsenic, lead, or cyanide. One way to compare is to divide the larger RfC by the smaller one. The answer will tell you how much more toxic one is than the other is in water.
3. Fill out one of the sentences below with that information. The one with the smaller RfC is more toxic. You may want to round your number up or down.
4. Repeat for other contaminants. Which statements seem most impressive?

_____ is _____ times as toxic as _____ to breathe.

_____ is _____ times as toxic as _____ to breathe.

_____ is _____ times as toxic as _____ to breathe.

_____ is _____ times as toxic as _____ to breathe.

_____ is _____ times as toxic as _____ to breathe.

_____ is _____ times as toxic as _____ to breathe.

_____ is _____ times as toxic as _____ to breathe.

_____ is _____ times as toxic as _____ to breathe.

Reference Concentration (RfC) for Inhalation		
Mercury	**0.03 µg/m^3 (EPA RfC)**	RfC is a concentration of a toxin in the air that is unlikely to cause non-cancer health problems, even if a person breathes that concentration their entire life. In different states, it's known by different names. It is usually measured in mg/m^3 or µg/m^3. epa.gov/iris/subst State also make their own. See oehha.ca.gov/air/allrels.html
Arsenic	**0.015 µg/m^3 (California REL)**	
Lead	**0.15 µg/m^3 (NAAQS)**	
Cyanide	**0.3 µg/m^3 (Mass. DEP AAL)**	

Reference Dose (RfD)

I'd never heard of chlorpyrifos, so I looked it up. Chlorpyrifos's RfD is 0.00003 mg/kg. For arsenic, it's 0.0003 mg/kg. 0.0003 mg/kg is ten times bigger than 0.00003 mg/kg. **That means chlorpyrifos is 10 times as toxic as arsenic in the human body!**

1. Choose an unfamiliar contaminant.
2. Compare the RfD for the contaminant to the RfD for mercury, arsenic, lead, or cyanide. One way to compare is to divide the larger RfD by the smaller one. The answer will tell you how much more toxic one is than the other is in water.
3. Fill out one of the sentences below with that information. The one with the smaller RfD is more toxic. You may want to round your number up or down.
4. Repeat for other contaminants. Which statements seem most impressive?

_____ is _____ times as toxic as _____ in the body.

_____ is _____ times as toxic as _____ in the body.

_____ is _____ times as toxic as _____ in the body.

_____ is _____ times as toxic as _____ in the body.

_____ is _____ times as toxic as _____ in the body.

_____ is _____ times as toxic as _____ in the body.

_____ is _____ times as toxic as _____ in the body.

_____ is _____ times as toxic as _____ in the body.

EPA Reference Dose (RfD)		
Mercuric Chloride	**0.0003 mg/kg/day**	The RfD for a substance is set to be the most of a toxin that a person can consume every day for their whole life without any ill effects. It is an estimate, based on animal studies. It's measured in mg of the toxin per kg of body weight, because larger people are less affected by the same amount of toxin. epa.gov/iris/subst
Inorganic Arsenic	**0.0003 mg/kg/day**	
Lead	**No Safe Level**	
Cyanide	**0.0006 mg/kg/day**	

VOCs in Water

In this example, "Groundwater Objectives" are equivalent to Maximum Contaminant Levels.

GP-26 Shallow Aquifer Monitoring Well Screen From 4'-16' BGS		RIDEM GA Groundwater Objectives	RIDEM Groundwater Quality PALs	Units	
EPA 8260					
	Vinyl Chloride	2	1	ug/L	
	1,1-Dichloroethene	7	3.5	ug/L	< 2
	trans-1,2-Dichloroethene	100	50	ug/L	
	cis-1,2-Dichloroethene	70	35	ug/L	
	Trichloroethene	5	2.5	ug/L	
	Tetrachloroethene	5	2.5	ug/L	

Notes:
PAL = RIDEMs Preventative Action Limit

PCBs in Soil

TABLE 5

SUMMARY OF POLYCHLORINATED BIPHENYL RESULTS
SOIL SAMPLES
RHOADES SALVAGE
MILTON, VERMONT

SAMPLE LOCATION SAMPLE NUMBER DEPTH	SS-15 R01-081020GL-0028 6 inches	SS-16 R01-081020GL-0029 6 inches	SS-17 R01-081020GL-0030 6 inches	EPA R3 Residential Soil Screening Levels	EPA R3 Industrial Soil Screening Levels
COMPOUND					
Aroclor-1242	ND	0.20	ND	0.22	0.74
Aroclor-1254	0.15	0.16	0.17	0.22	0.74
Aroclor-1260	0.14	0.10	ND	0.22	0.74

NOTES:

1) Samples analyzed by U.S. EPA Office of Environmental Measurement and Evaluation (OEME) using EPA Region I SOP, PESTSOIL2.SOP, PCBs Medium Level in Soils and Sediments.
2) All Results in Milligrams per Kilogram (mg/Kg).
3) EPA R3 = U.S. EPA Region III
4) EPA R3 Residential and Industrial Screening Standards are used for comparison purposes only.
5) ND = Not Detected.
6) Note that summary tables do not include samples in which no analytes were detected. Refer to Appendix E for all analytical data results.