



Contaminant Concentrations

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- How small is 1 ppb?

Glossary

media: also called “environmental media” means soil, water or air

mg/kg: milligrams per kilogram

mg/L: milligram per liter

ml: milliliter, volume equivalent to a cubic centimeter

ppb: parts per billion
1/1,000,000,000

ppm: parts per million 1/1,000,000

µg/L: microgram per liter.
1 microgram is 1/1,000 of a milligram

Percentages and parts per million

Concentrations often are reported as ppm or ppb, because it is very difficult to visualize these very low concentrations as percentages.

1,000,000 ppm	=	100%
100,000 ppm	=	10%
10,000 ppm	=	1%
1,000 ppm	=	0.1%
1 ppm	=	0.001%
1 ppb	=	0.000001%

How are Contaminant Concentrations Expressed?

Parts per million: The amount of a contaminant in water is often measured in **milligrams per liter** (abbreviated as mg/L). This also is referred to as **parts per million**. A liter of water weighs 1000 grams, and a milligram is 1/1,000th of a gram. Therefore, a milligram of a substance dissolved in a liter of water represents one millionth (1,000 divided by 1/1,000) of the weight, or one part per million (1 ppm).

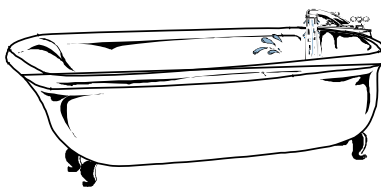
In soils, contaminants are measured in **milligrams per kilogram** (mg/kg). A kilogram is 1,000 grams, so one milligram of contaminant mixed in one kilogram of soil represents one millionth of the total weight.

Parts per billion: For both soil and water, one **part per billion** (ppb) is when a microgram (µg or ug), or 1/1,000,000th of a gram, of a contaminant is present in one liter of water or one kilogram of soil.

Although a ppm or a ppb is a small amount of material to detect by taste or smell, depending on what it is, it could still be harmful to you if you drink it, eat it, or breathe it. That’s why maximum limits are set on the concentration of many substances that can remain in the soil on a site or be present in drinking water.

How Small is 1 part per million?

One ppm of a year is about half a minute. Assuming that the population of Alaska is 550,000, then 1 ppm of Alaska’s population is about half a person. That makes you 2 ppm of Alaska’s population.



One drop of water is 2 ppm of a bathtub full of water

Labs that perform environmental analyses have highly sensitive and sophisticated equipment and tests capable of detecting tiny amounts of many contaminants. In this example, if the laboratory found more than 2 ppm of barium in the samples, this would be higher than the maximum concentration for drinking water.

But how much barium is 1 ppm? To get an idea, pretend that the groundwater is in a bathtub. An average bathtub holds about 200 liters (about 53 gallons) of water. One ppm of barium in the bathtub would be roughly ¼ ml of barium, which would be less than one drop of water. So, ½ ml of barium (1 drop) in

Consider how this works with groundwater contamination. For example, the maximum allowable level for barium in drinking water is 2 ppm. If groundwater at a site was thought to be contaminated with barium, samples of the water would be collected and sent to a laboratory to be analyzed.

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Conversions

To convert from ppm to ppb:

Multiply the ppm concentration by 1,000. The resulting concentration is in ppb.

Example: 3 ppm x 1,000 ppm/ppb = 3,000 ppb

To convert from ppb to ppm:

Divide the ppb concentration by 1,000. The resulting concentration is in ppm.

Example: 3,000 ppb ÷ 1,000 ppb/ppm = 3 ppm



Reference List

Alaska Department of Environmental Conservation. *Cleanup Standards, Public Review Draft.* November 12, 1997.

United States Environmental Protection Agency. *HAZ-ED, Classroom Activities for Understanding Hazardous Waste.* April 1996.

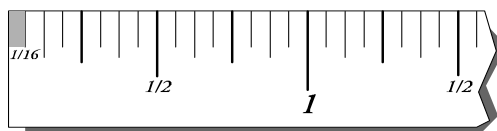
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www.dec.state.ak.us/spar/faq.htm#csp

the 200-liter tub is approximately equal to the maximum drinking water contaminant concentration of 2 ppm.

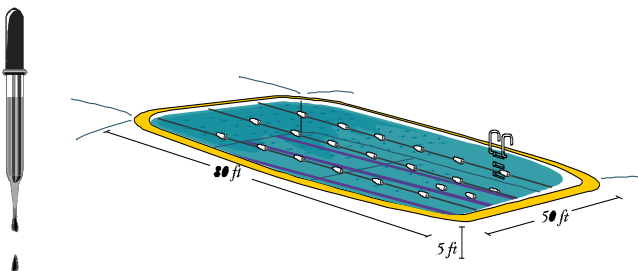
How Small is 1 ppb?

Sometimes contaminant concentrations are given in micrograms per liter ($\mu\text{g/L}$), which is equivalent to ppb. As we've already seen, a ppm is a very small proportion, so a ppb must be extremely tiny. One ppb of one year is $1/32$ of a second. Conversely, one minute is 1 ppb of 1,903 years. One millionth of a mile is $1/16$ of an inch, so one ppb of a mile is one thousandth of $1/16$ th of an inch. One $1/16$ th of an inch is generally the smallest interval shown on most rulers divided by inches.



1/16 inch is 1 ppm of a mile: one-thousandth of that is 1 ppb of a mile

Again, consider how this works with contaminant concentrations in water. The maximum drinking water contaminant level for benzene, 0.005 mg/L (ppm), is



One drop of water is 1 ppb of a swimming pool full of water

equivalent to $5 \mu\text{g/L}$ or 5 ppb. Using the 200-liter bathtub from the earlier example for ppb will result in such a small amount it is hard to picture. Instead of the bathtub, consider an Olympic-size swimming pool. The pool holds about 500,000 liters (about 130,000 gallons). One ppb of 500,000 liters is approximately $1/2$ ml (one drop of water), so five drops of benzene in the pool would be close to the 5 ppb contaminant limit.

For More Information

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