DONALA
WATER & SANITATION DISTRICT

TO OUR CUSTOMERS: Most of us know very little about the naturally occurring background radiation that is present all around us. We thought you would find this to be of interest.

QUESTIONS AND ANSWERS ABOUT NATURAL RADIATION BACKGROUND AND ITS VARIABILITY

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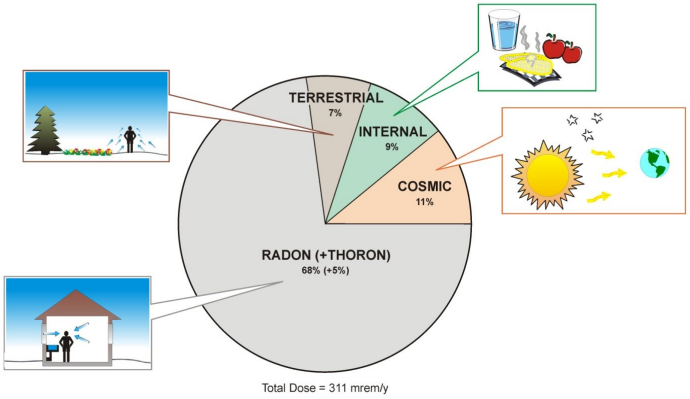
What is Natural Background Radiation?

The magnitude and variability of natural background radiation can be used as a benchmark to provide some perspective on the radiation doses received from Naturally Occurring Radioactive Material (NORM) associated with water treatment facilities. People are exposed to cosmic radiation from the sun and outer space constantly bombarding the earth's atmosphere. Humans are immersed in a field of cosmic radiation that varies with elevation (higher doses are found at higher elevations, like in Colorado's mountains). Naturally occurring radioactive materials are present in the rocks and soil in the earth, in the houses we live in and in the buildings where we work, as well as in the food and drink we consume every day. Figure 1 depicts the major sources of natural background radiation exposure in the United States. Terrestrial radiation includes exposure from naturally occurring uranium, radium, and other naturally occurring radioactive elements in the soil and rocks under our feet. Internal exposure results from these same naturally occurring radioactive elements in the air we breath and in the food and drink we consume every day. Radon and thoron are radioactive gases that are emitted from the natural radium in soils; they enter our homes and places where we work and, via inhalation, usually result in the largest component of our annual natural background radiation dose.

Figure 1: Natural Background Radiation in the United



How Much Natural Background Radiation Do We Receive Each Year in Colorado Compared To Other States?

Natural background radiation typically results in a dose rate of roughly 200 to 400 millirem per year although some places in the world, including parts of the U.S., experience much higher exposure rates. A millirem (mrem) is the unit of measure used to quantify the effective radiation dose. It is related to the amount of energy absorbed by human tissue and other factors. The average annual exposure from natural background radiation in the U.S. is approximately 300 millirem per year and is shown in Table 1, which depicts the major components of natural background radiation. This includes terrestrial radiation (uranium, radium, thorium and a naturally occurring radioactive form (isotope) of potassium (K-40) in soil, rocks and water), cosmic radiation (high energy gamma rays from space) and internal radiation (from food, as well as water and radon gas from natural uranium and radium decaying in the ground).

Based on Table 2, where a person chooses to live can affect their background radiation exposure by several hundred millirem per year.

Table 1: Exposure to Natural Background Radiation in the U.S.

Sources of Exposure	Average in U.S. (millirem per year)
Internal, inhalation (radon and thoron)	228
External, cosmic (space and sun)	33
Internal, ingestion (food and water)	29
External, terrestrial (rocks and soil)	21
Total	**311**

Table 2: Comparison of Average Radiation Backgrounds In U.S. vs. Colorado (millirem per year)

Source	Colorado	Florida	Illinois	Leadville, CO
Cosmic Radiation	**49**	27	28	**85**
Terrestrial Radiation	**39**	13	24	**97**
Internal Radiation -Radon	**300**	54	181	**344**
Internal Radiation -Food and Water	**29**	29	29	**29**
Totals	**417**	123	262	**555**

As you can clearly see in Table 2, higher elevation combined with greater levels of naturally occurring radioactive elements in soil and water in mineralized areas (e.g., igneous formations in Rocky Mountains) and other factors like local geology and geochemistry, result in much greater natural radiation exposure. For example, note that the difference in someone's average annual background radiation exposure if they choose to live e.g., in Florida vs. Colorado can be almost 300 millirem per year, every year!

How Much Naturally Occurring Radioactivity Is In The Food We Eat?

Radioactive elements are inherent in all foods. Naturally occurring radioactive isotopes of potassium (K-40), carbon (C-14), hydrogen (H-3), uranium, thorium and radium and various other radioactive elements are part of our food chain. Plants assimilate radionuclides into their structure through respiration, transpiration, and soil uptake. A picocurie (pCi) is a measure of the amount of radioactivity in a substance. It is the amount of radioactivity where approximately two atoms decay per minute. This is a very small amount of radioactivity. A handful of soil from your backyard will have 5-10 or more pCi in it from naturally occurring radioactivity, including uranium, thorium and radium.

Uranium Annual Intake from Food

- **Whole-grain products: 10 pCi**
- **Meat: 50-70 pCi**
- **Fresh fruit: 30-51 pCi**
- **Potatoes: 67-74 pCi**
- **Bakery products: 39-44 pCi**

How Much Naturally Occurring Radioactivity Is In Our Drinking Water?

The *average* concentration of natural uranium in groundwater in the United States is about 2 pCi per liter (NCRP 1984). However, concentrations can vary considerably from place to place depending on local geology and other environmental factors. A number of studies of uranium content in U.S. domestic water sources indicate levels in groundwater that are used for domestic purposes, including drinking water, can be many times higher than the EPA's standard discussed below. Similarly, it is not uncommon for naturally occurring radium concentrations in domestic groundwater wells to exceed the EPA's drinking water criteria. As we might imagine, the EPA's standards are very conservative.

What Are EPA's Criteria For Radioactivity in Drinking Water?

The EPA has four primary drinking water criteria for radionuclides (USEPA, 2001), which are:

- ≤ 15 pCi / liter gross alpha*
- ≤ 4 millirem per year from beta particle and gamma ray emitters
- ≤ 5 pCi / liter combined radium 226 and radium 228
- ≤ 20 picocuries per liter total uranium (expressed on a mass basis as 30 micrograms per liter)

**Note: Many of the natural uranium and thorium series decay products emit alpha particles*

How Do EPA's Limits For Radioactivity in Drinking Water Compare To Our Typical Annual Exposure From Other Sources of Natural Background Radiation?

It is reasonable to assume that each of EPA's four primary criteria for radionuclides in drinking water involve approximately equivalent levels of radiological health risk. For example, consuming drinking water continuously at the 5 pCi per liter radium criteria would be approximately equivalent to a 4 millirem per year of radiation dose. To put this in perspective, note that Table 2 above indicated the annual average radiation background dose from all sources in Colorado is over 400 millirem per year and the difference between Colorado and Florida is about 300 millirem per year. So even at twice the EPA drinking water criteria for radium (i.e., 10 pCi per liter), this would add about 2% (8 millirem / 400 millirem) to your annual natural background dose. Similarly, it would be about 3% of the difference between us Coloradans and our relatives in Florida. **The obvious conclusion: the additional dose we could get from consuming drinking water continuously at the 5 pCi per liter radium criteria would be indistinguishable from the large variations in our annual dose from naturally occurring radiation**, depending on where we choose to live and what we choose to eat.

We have made great progress in our country in medicine and the sciences. But as is with many chemical constituents occurring in our environment, just because we can measure something, does not make it hazardous.

Donala has hired Radiation Pros to independently support them in making sure your drinking water is safe and that their workers are fully protected. Thank you for your support as we endeavor to serve you. For a more detailed version of the above including the references used from peer reviewed professional publications and the scientific literature go to: www.radpros.com/literature.