Radionuclides
&
Your Well Water:
A Homeowner's Guide

Prepared by

Baltimore County
The Department of Environmental Protection & Sustainability
in Coordination with the
Maryland Department of Environment

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Dear Well-owner,

If you own and operate a domestic well in certain parts of Baltimore County, the Baltimore Department of Environmental Protection and Sustainability (EPS) recommends that you test your well for naturally occurring radiation. This fact sheet has been prepared to help answer your questions about testing and treating your domestic well water supply.

EPS, May 2020

What are radionuclides?

Radionuclides occur naturally as trace elements in rocks, soils, and ground water as a consequence of the radioactive decay of uranium, and thorium. This decay occurs because these elements are unstable; they continually release energy into the environment until a stable, non-radioactive substance is formed. This energy is part of the natural radiation to which all living creatures are exposed. Radon, radium, and uranium are the most common radioactive elements found in ground water. Other naturally occurring radionuclides tend to be environmentally immobile, or have short half-lives, meaning they are far less likely to be found in significant amounts in ground water.

What is radioactivity and how is it measured?

Radioactivity is a measure of the energy that is released during the decay process. The energy or radiation can be in the form of a wave (for example, gamma rays) or a particle (for example, alpha and beta particles) or both. Scientists can identify the different types of radioactive elements by measuring the characteristics of this energy.

In the U.S., radioactivity is measured in units called “curies.” The level of radioactivity in water is very low and is measured in picocuries per liter, written pCi/l (one picocurie equals one-trillionth of a curie or 10^{-12}).

To assess the level of radionuclides in drinking water, the water supply is typically first tested prior to any treatment for short-term gross alpha (also referred to as gross alpha particle activity (GAPA)) and gross beta (gross beta particle activity (GBPA)). These tests are used as cost-effective screening tools used to determine whether further isotope-specific testing for radium and uranium is warranted.

What are the standards for radionuclides in drinking water?

The U.S. Environmental Protection Agency (EPA) sets standards for public drinking water supplies (Table 1). The same standards are usually recommended for private well owners.

Table 1. Standards for radioactive substances in drinking water and recommended treatment methods.

Contaminant	Primary type of radiation	EPA standard	Best Available Treatment Technology[1]
Gross alpha[2] (GAPA)	alpha particles	15 pCi/L [3] (not including uranium)	Reverse Osmosis
Gross beta (GBPA)	beta particles	4 mrem/yr [4]	Ion Exchange Reverse Osmosis
Radium-224	alpha particles	No standard	Ion Exchange Lime Softening Reverse Osmosis
Radium-226	alpha particles	5 pCi/L [3] (combined Ra-226/228)	Ion Exchange Lime Softening Reverse Osmosis
Radium-228	beta particles	5 pCi/L [3] (combined Ra-226/228)	Ion Exchange Lime Softening Reverse Osmosis
Total Uranium	alpha particles	30 micrograms/L [5]	Anion Exchange Reverse Osmosis

[1] Source: EPA 40 Code of Federal Regulations 142.65

[2] The EPA test method for GAPA does not include contributions from radon.

[3] Radioactive decay is measured in units of picocuries per liter (pCi/L).

[4] The standard for gross beta is expressed as an annual dose in millirems per year (mrem/yr). According to the EPA 4mrem/yr is roughly equal to a GBPA of 50 pCi/L minus the naturally occurring potassium-40 activity.

[5] The standard for total uranium is expressed in micrograms per liter (ug/l). According to EPA's Implementation Guidance for Radionuclides, (pg. I-16), 1 ug/l uranium is equal 0.67 pCi/l .

What are the health risks for exposure to radionuclides?

Gross Alpha Particle Activity (GAPA). GAPA is the total measured alpha particle activity in a water sample. It may be due to radium-224, radium-226, uranium, or any combination of alpha-emitting elements. Alpha particles do not penetrate the skin but enter the body when alpha-emitters are in food, water, or air.

Gross Beta Particle Activity (GBPA). GBPA is the total measured beta particle activity in a water sample. It may be due to radium-228 or any combination of beta-emitting elements. Some beta particles are capable of penetrating the skin, however, as with alpha emitters, beta emitters are more hazardous when they enter the body through food or water.

Radium-224, -226, and -228. The isotopes of radium can enter the body through food or water. Most of the radium is eliminated from the body, but some may be deposited in the bones. Some people who drink water containing radium in excess of the standard over many years may have an increased risk of getting cancer.

Total uranium. Like radium, uranium also enters the body through eating and drinking and is then eliminated. Exposure to uranium in drinking water may result in toxic effects to the kidney. Some people who drink water containing uranium in excess of the standard over many years may have an increased risk of getting cancer.

Radon. Radon exists predominantly as a gas that can enter the body through inhalation. Nationally, radon in indoor air is recognized as the second leading cause of lung cancer. The EPA recommends testing of indoor air, and remedial action is recommended if the airborne level exceeds 4 pCi per liter of air. Radon enters the house predominantly from surrounding soil and rock; the contribution of radon from ground water is considered minimal in most instances (< 2%). The EPA estimates that for every 10,000 pCi/L radon that is dissolved in a drinking water supply, approximately 1 pCi/L contributes to the indoor air. To date, the EPA has not established drinking water standards for radon. A more complete discussion of radon can be found at the following website: http://www.nsc.org/issues/radon/faq.htm#water

Natural levels of radiation in drinking water are generally not considered to be a health emergency. Short-term exposures pose very little risk.

What is known about the distribution and occurrence of radionuclides in this area?

Studies by Maryland Geologic Survey and EPS have found elevated levels of natural radioactive elements in groundwater from several geologic formations in Baltimore County: **Baltimore Gneiss; Setters Gneiss and Slaughterhouse Gneiss** (see map). Testing data available indicates that GAPA was above the recommended drinking water standard in 10-15% of the wells in these areas. Approximately 5% of the wells also contain elevated levels of GBPA. All instances of elevated levels of GBPA correlated with elevated GAPA. Isotope-specific tests indicate that radium and, in rare cases, uranium, are primarily responsible for these elevated readings.

There is currently no pattern in well depth, yield, or age of the affected wells, and the elevated concentrations appear to be random within these formations. A pattern may become apparent as more tests are completed. Based on the information available, only wells completed in the Baltimore Gneiss Setters Gneiss and Slaughterhouse Gneiss are considered at risk. Multiple tests conducted on the same well have indicated that GAPA and GBPA levels may vary by as much as 2 to 3 times between readings. This variability may be affected by seasonal changes, water usage, and the relative error that is inherent in the analytical method.

I have an <u>existing</u> domestic supply well, what should I do?

Private well owners who are interested in having their well tested should first contact EPS to find out which aquifer is serving their property. If the well is located within or very near a geologic formation of concern, the owners should next contact a qualified laboratory to arrange for a sample to be collected <u>prior to treatment</u> and analyzed for short-term GAPA, and GBPA. This screening test is less expensive than direct analysis for specific radionuclides. Testing for GAPA and GBPA may cost between $150 and $250, while testing for radium isotopes may cost between $200 and $30. Testing for total uranium may cost between $100 and $200.

Table 2. (below) should be used to assess the GAPA and GBPA tests results and help to determine if treatment or additional testing is needed:

Table 2. Decision Guide for Short-Term GAPA and GBPA Test Results.

If short-term Gross Alpha is…	Then…	Notes
< 5 pCi/l	… no additional tests are needed.	A result in this range indicates that the water meets recommended health standards. Based on data available, gross beta levels will be low if short-term gross alpha levels are low.
5-15 pCi/l	… test for radium 226/228.	Install treatment for radium if the result for combined radium 226/228 is greater than 5 pCi/L. Retest after treatment is installed to ensure that the contaminants are removed.
> 15 pCi/l	… test for radium 226/228 and uranium and install treatment.	If combined radium 226/228 < 5 pCi/l, Uranium < 30 ug/l, and GAPA – Uranium < 15 pCi/l, treatment will not be required. If treatment is installed, the water supply should be retested after treatment for short-term GAPA and GBPA to ensure that contaminants are being removed.

I am having a new well drilled. What type of water testing will be required?

In accordance with the Code of Maryland Regulations (COMAR) 26.04.04.09, a Certificate of Potability (COP) is required prior to putting a new well into potable use; every new well must be tested for bacteria, nitrates, sand, and turbidity. Other parameters may be required if there is reason to suspect contaminants are present that significantly impact human health, safety or comfort. In areas underlain by Baltimore Gneiss, Setters Gneiss and Slaughterhouse Gneiss, Baltimore County requires that new and replacement wells be tested for short-term GAPA and GBPA. It is suggested that you call EPS at 410-887-2762 to determine if testing for radionuclides is required. As per Table 2 (above), testing and treatment may be required prior to issuance of COP.

Elevated levels of radionuclides have been found in my well water. What should I do?

As per Table 1 (above), radium can be effectively removed by a cation exchange (water softener) or reverse osmosis treatment system. Uranium can be removed by anion exchange or reverse osmosis. Other treatment technologies may also be effective (see EPA 40 CFR 142.65 for further information). Before choosing a water treatment system, contact a water treatment company listed under water filtration and purification equipment in the yellow pages or contact EPS.

Depending on other needs to address other water quality parameters, you may consider installing a whole-house unit or a point of use (at the tap) unit. Homeowners using water treatment systems to reduce radionuclides should maintain the unit according to manufacturer's instructions. After installing a water treatment system, the system should be tested for effectiveness by sending another sample to the laboratory post-treatment. Be advised that water softeners typically increase sodium intake between 200-400 mg/day. This may be a concern for persons with sodium-restricted diets.

How can I get more information?

County:	Baltimore County Department of Environmental Protection & Sustainability – 410-887-2762 https://www.baltimorecountymd.gov/Agencies/environment/groundwatermgt/
State:	Maryland Department of the Health – 410-767- 6500 https://phpa.health.maryland.gov/OEHFP/EH/Pages/Radon.aspx
	Maryland Department of the Environment – 410-537-3000 https://mde.state.md.us/programs/Water/water_supply/Pages/radium.aspx
	Department of Natural Resources, Maryland Geological Survey http://www.mgs.md.gov/groundwater/radioactivity.html
Federal:	USEPA Safe Drinking Water Hotline – 800-426-4791
	Radionuclides in Drinking Water https://www.epa.gov/radon#

Radium Risk Areas

in Baltimore County, Maryland