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Groundwater as Drinking Water

The United States has one of the safest water supplies in the world. Yet, drinking water quality varies from place to place, depending on the condition of the source water from which it is drawn and the treatment it receives. The National Ground Water Association has determined that 49% of the U.S. population depends on ground water for its drinking water supply from either a public source or private well. Groundwater from a properly constructed and maintained well is usually high quality water and safe for drinking.

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Drinking Water Standards

Based on the federal Safe Drinking Water Act, the US Environmental Protection Agency (EPA) has established drinking water standards for 20 health-related contaminants including arsenic, nitrate, bacteria, radioactivity, heavy metals such as lead and mercury, and several pesticides. The standards do not presently include many other contaminants sometimes found in drinking water. Drinking water standards and guidelines place a ceiling on contaminant levels in the drinking water supplied by the public water systems, regardless of whether the source is groundwater or surface water. When a standard or guideline is exceeded in a municipal or community water system, the state requires the operator of the system to take corrective steps. These steps can include treating the water through filtration or aeration, blending water from several sources to reduce contaminant levels in the system, or constructing a new well. There is no regulation for ensuring that private wells meet safe drinking water standards. However, private well owners can have their wells tested and use federal drinking water standards as a guide for assessing water quality.

- EPA's Ground Water and Drinking Water
- Texas Commission on Environmental Quality's (TCEQ) "Standards and Reporting Requirements for Public Water Systems" (PDF. Help with PDF.)

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Drinking Water from a Public Supplier

If your water comes from a public supplier, you have two ways to assess the quality of the water coming from your tap:

1.) Consumer Confidence Reports

Consumer Confidence Reports (CCRs) are annual reports provided by every community water supplier and provide information about the quality of drinking water from that particular supplier. The report includes the water's source, contaminants found in the water, and how consumers can get involved in protecting drinking water.

2.) Source Water Assessment Program

The Source Water Assessment Program (SWAP) has two components: assessment and protection. Source water assessment is mandatory and aims to gather valuable information about a community's source of drinking water. Assessment information should tell residents exactly where their water supply comes from and what conditions and/or practices may pose threats to its quality.

Source water protection is a voluntary program that aims to use assessment information to develop a plan or strategy to protect a water supply. Source water protection uses the assessment information to manage contaminants and do contingency planning.

- Texas Commission on Environmental Quality (TCEQ) regulates Texas community water systems through its Public Drinking Water Section.
- TCEQ's Consumer Confidence Reports (CCR) Page. CCR's are annual water reports from utilities that are community water supplies.

Source Water Protection Sites

- The Groundwater Foundation's "Source Water Assessment and Protection Workshop Guide" can be found on their Tools & Resources webpage
- TCEQ's Source Water Assessment Program
- EPA's Source Water Protection Site
- The Source Water Collaborative, 25 national organizations united to protect America's sources of drinking water.

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Drinking Water from a Private Well

Private well owners are responsible for the quality of their water, and no regulatory oversight exists to ensure water quality. However, there are numerous governmental and nonprofit resources for private well owners to assist them in maintaining high quality drinking water.

- EPA's Ground Water & Drinking Water Page
- EPA's Publication (PDF) "Drinking Water from Household Wells" (PDF. Help with PDF.)
- TGPC's Water Well webpage contains information on well maintenance, contamination, testing private wells and more.
- The Source Water Collaborative, 25 national organizations united to protect America's sources of drinking water.

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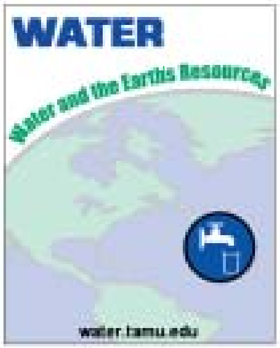

Drinking Water Problems: Radionuclides

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Radionuclides are types of atoms that are radioactive. The most common radionuclides in drinking water are radium, radon and uranium.

Most of the radionuclides in drinking water occur naturally at very low levels and are not considered a public health concern. However, radionuclides can also be discharged into drinking water from human activity, such as from active nuclear power plants or other facilities that make or use radioactive substances.

People who are exposed to relatively high levels of radionuclides in drinking water for long periods may develop serious health problems, such as cancer, anemia, osteoporosis, cataracts, bone growths, kidney disease, liver disease and impaired immune systems.

What are the Sources of Radionuclides in Water?

Radiation comes from outer space, from the ground and even from within our own bodies. Radiation is all around us and has been present since the birth of this planet.

Most of the radionuclides present in drinking water are from natural sources. Naturally occurring radionuclides are created in the upper atmosphere and are found in the Earth's crust. They are found in certain types of rocks that contain trace amounts of the radioactive isotopes (forms) of uranium, thorium and/or actinium. As these rocks weather, the resulting clays and other materials may transmit radionuclides into drinking water. Higher levels of radionuclides tend to be found more often in groundwater, such as from wells, than in surface water, such as lakes and streams.

Many human-made devices and processes result in radioactivity. The list includes, but is not limited to, color television, medical instruments (x-rays and chemotherapy), coal/lignite power plants, industrial processes and cigarette smoking. Radionuclides in water are more likely to be from naturally occurring sources than manmade sources.

Over time, radionuclides decay. As they decay, they produce daughter products that are shorter lived, and "more radioactive." Of particular concern are naturally occurring uranium and radium, which can accumulate to harmful levels in drinking water.

As radionuclides decay, they emit radioactive particles such as alpha particles, beta particles and gamma rays. Each type of particle produces different effects on humans.

Alpha particles are the least penetrating type of radioactive particles; they can be stopped by a sheet of paper or the skin. However, they are still harmful if inhaled or ingested, because then they come into contact with internal organs. Even though they are the least penetrating, alpha particles cause more damage per unit volume than do beta particles or gamma rays.

Beta particles and **gamma rays** deposit their energy over longer distances. Beta particles can be stopped by a piece of wood or a thin sheet of metal such as aluminum foil. Gamma rays, like x-rays, can pass through the human body and are best shielded by dense materials such as lead or thick concrete.

Most of the naturally occurring radionuclides (such as some forms of uranium and radium) emit alpha particles, but some (such as radium-228) emit beta particles.

One of the naturally occurring radionuclides that emit beta particles is tritium. Tritium forms in the upper atmosphere and can be deposited onto surface waters via rain or snow. It can also seep into and accumulate in groundwater. Although natural tritium tends not to occur at levels of concern, contamination from human activities can result in relatively high levels of this radionuclide.

Although most water systems have no detectable radionuclide activities, some areas of the United States have significantly higher levels than the national averages. For example, some areas of the Midwest have elevated radium-226 levels and some Western states have elevated uranium levels compared to the rest of the United States.

Who Regulates Drinking Water Safety?

In 1974, the United States Congress passed the Safe Drinking Water Act. This law requires the U.S. Environmental Protection Agency (EPA) to determine the safe levels of contaminants in U.S. drinking water.

The EPA conducts research of drinking water to determine the level of a contaminant that is safe for a person to consume over a lifetime and that a water system can reasonably be required to remove from it, given present technology and resources. This safe level is called the maximum contaminant level (MCL).

Maximum contaminant levels in drinking water have been established for a variety of radionuclides. For radium, the MCL has been set at 5 pCi/L (picocuries per liter, a unit of measure for levels of radiation). The MCL for gross alpha radiation is 15 pCi/L, and the maximum limit for gross beta radiation is 50 pCi/L.

In addition to causing cancer, exposure to uranium in drinking water may cause toxic effects to the kidney. Based on human kidney toxicity data, the MCL for uranium is 4 millirems per year. The EPA says that a treatment system would be considered vulnerable if it contained 50 pCi/L of uranium.

Although the MCL applies only to public drinking water sources, it can give those who use private wells an idea of what an appropriate level of a contaminant should be for private wells.

There is no current MCL for radon. However, the EPA is proposing two options for states wanting to regulate concentrations of radon in drinking water:

- The first option would require community water suppliers to provide water with radon levels no higher than 4,000 pCi/L. Because about 1/10,000th of radon in water transfers to air, this would contribute about 0.4 pCi/L of radon to the air in a home. This level will be permitted if the state also takes action to reduce radon levels in indoor air by developing EPA-approved, enhanced state radon indoor air programs (called Multimedia Mitigation Programs). This is important, because most of the radon you breathe comes from the soil under the house. This option gives states the flexibility to focus on the greatest problems, encouraging the public to fix indoor air problems and to build homes that keep radon from entering.
- A second option is provided for states that choose not to develop enhanced indoor air programs. Community water systems in those states would be required to reduce radon levels in drinking water to 300 pCi/L. This amount of radon in water contributes about 0.03 pCi/L of radon to the air in your home.

Even if a state does not develop an enhanced indoor air program, water systems may choose to develop their own local indoor radon programs. This option would require them to meet a radon standard for drinking water of 4,000 pCi/L. This option would enable the reduction of overall risks from exposure to radon from both air and water.

Where have Wells with High Levels of Radioactivity been Found in Texas?

To monitor the quality of our water, the Texas Water Development Board (TWDB) collects groundwater samples in the state through its Groundwater Quality Sampling Program. From 1988 to 2004, the board collected 5,471 samples from 4,941 wells to test for gross alpha radiation (Fig. 1). Of the total number of samples, 29 percent contained no detectable amounts of alpha radiation.

The studies found 3,864 samples in Texas containing detectable amounts of gross alpha radiation. Of those, about 11 percent contained gross alpha radiation above the primary MCL of 15 pCi/L.

High levels of gross alpha radioactivity (over the MCL) were found in 22 of the 31 major and minor aquifers in Texas. One stock well in the Queen City aquifer in Frio County contained gross alpha detected at 302 pCi/L; the two aquifers with the most wells with gross alpha over the MCL were the Dockum and the Hickory aquifers, with 129 and 86 wells, respectively. The wells with the high-

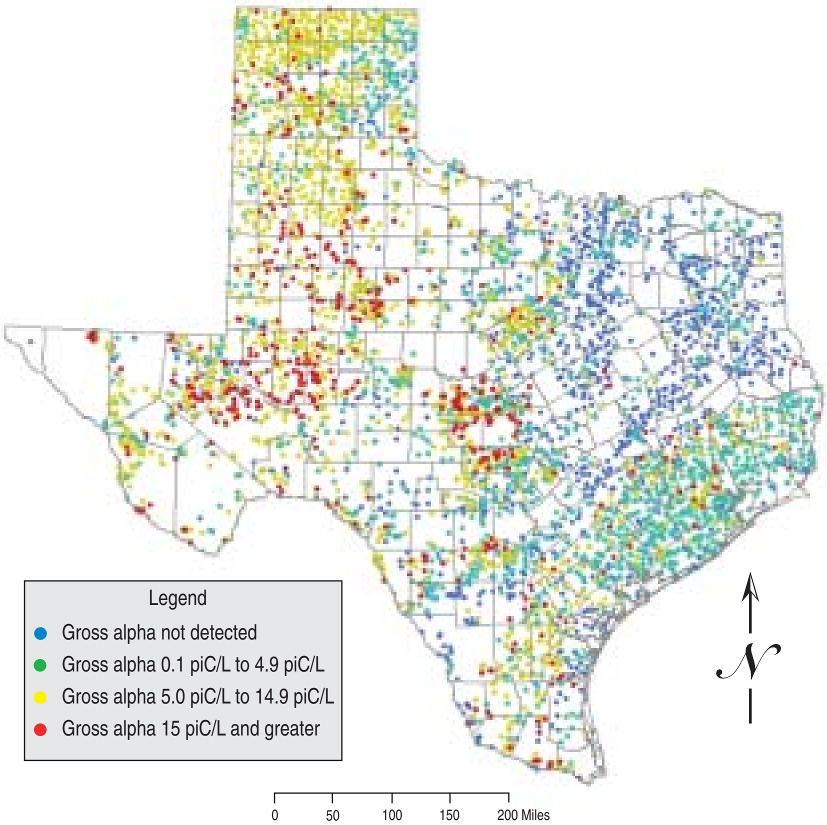

Figure 1. Gross alpha particle concentrations in Texas groundwater, 1988-2004.

est gross alpha values were found in the Carrizo and Gulf Coast aquifers, which contained 1,120 and 835 pCi/L, respectively.

Other aquifers that contained significant numbers of wells with excessive alpha were the Edwards-Trinity Plateau (74 wells), the Gulf Coast (64 wells), and the Ogallala (53 wells). Of the 610 water wells with concentrations above the maximum limit, about 28 percent supplied water to households, 24 percent to livestock, 19 percent to public supply facilities, 17 percent to irrigation wells, 6 percent to industrial facilities and 3 percent to other uses. Five percent of those wells were unused.

The TWDB also collected 5,327 samples from 4,698 Texas wells and analyzed them for gross beta activity. The maximum limit for gross beta activity is 50 pCi/L.

Of the samples analyzed, 34 percent were below detection (Fig. 2). In the samples where detectable levels of gross beta activity were found, the median (midpoint) value was 8.1 pCi/L. Of the 87 samples with detectable gross beta levels, or 1.6 percent, were over the EPA's maximum limit.

Wells in 15 of the designated major and minor aquifers in Texas were found to have high levels of gross beta activity. The number of wells with high gross beta levels ranged from one well each in the Queen City, Yegua, Trinity and West Texas Bolson aquifers, to 15 and 21 wells in the Dockum and Hickory aquifers, respectively.

Of the 87 water wells with concentrations over the maximum limit, about 29 percent supplied water to stock wells, 17 percent to households, 17 percent to irrigation wells, 16 percent to public supply facilities, and 14 percent to industrial facilities. Seven percent were unused.

The TWDB has also analyzed for radon and radium-226 and radium-228, although not throughout the state. The Texas Commission on Environmental Quality (TCEQ) has collected more of these data from its public supply wells. Using the data collected up until 1999, the commission has identified several public water supply sites where there are projected radon violations (Fig. 3).

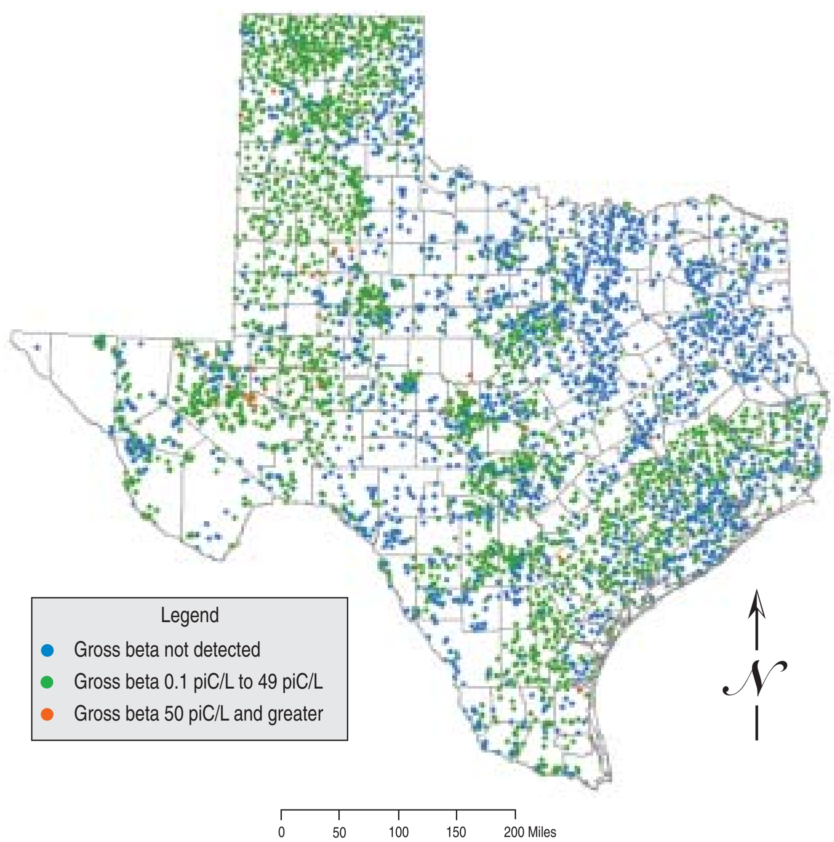

Figure 2. Gross beta particle concentrations in Texas groundwater, 1988-2004.

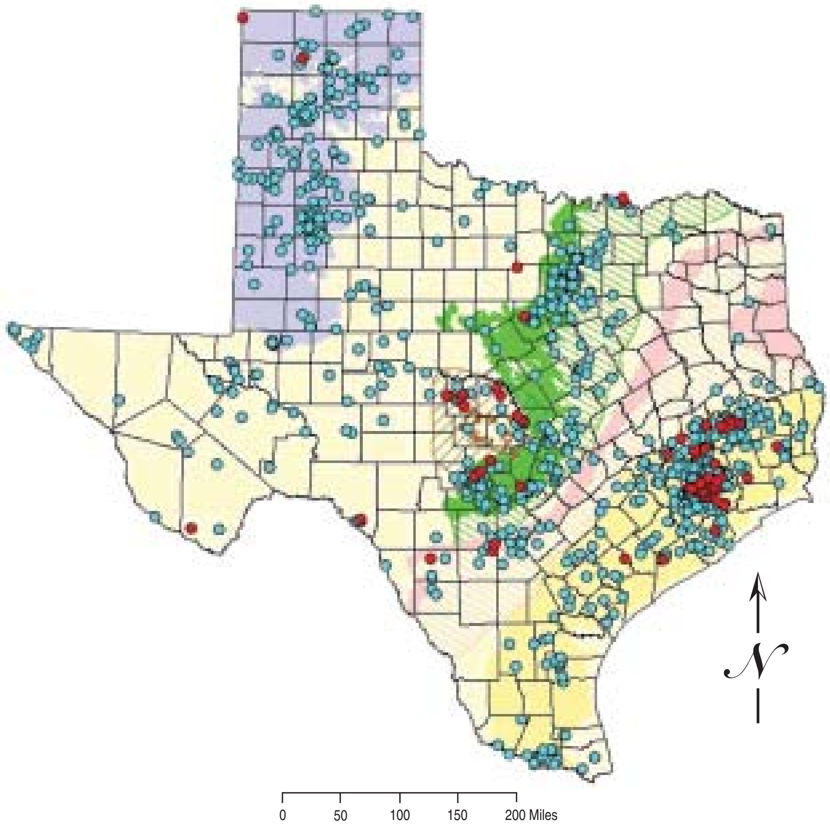

Figure 3. Public water well sites with the potential for high levels of radon.

Although the sites indicated in red do indicate geographic areas where consumers might be more concerned about radon, consumers also need to take into account the amount of radon they are exposed to in the air in their homes as well as in their well water.

How do Radionuclides affect Health?

People ingest radionuclides by either drinking contaminated water or eating food that has been washed with contaminated water. Once ingested, the radioactive particles ionize (destabilize) nearby atoms in the body as they travel through a cell or other material. This ionization process can damage chromosomes or other parts of the cell and can lead to the death or unnatural reproduction (cancer) of the cell.

Uranium: For uranium, the concern is not only that its radioactive decay can cause cancer, but also that exposure to the uranium itself can damage the kidneys. When people are exposed to high levels of uranium in drinking water, changes occur in their kidney functions that can indicate potential kidney failure in the future.

Radium: In the 1920s, the numbers on some watch dials were hand-painted by workers using paint that contained radium. These workers later suffered noncancerous health problems such as benign bone growths, osteoporosis, severe growth retardation, tooth breakage, kidney disease, liver disease, tissue and bone necrosis (death), cataracts, anemia and immunological suppression. Many of these health problems caused death of the dial painters.

These workers also had higher rates of two rare types of cancer: bone sarcomas and carcinomas of head sinuses and mastoids. Patients medically treated with radium-224 also showed an increase in bone sarcomas but not head carcinomas.

However, the levels of exposure that people experience from naturally occurring radium are much lower than those of the watch painters or the people medically treated with radium-224. Therefore, the noncancerous health effects have not been of concern in setting a limit for radium in drinking water.

Radon: Radon is a naturally occurring, odorless and invisible radioactive gas that emits radiation. Inhaling radon increases a person's chance of developing lung cancer. This risk is associated primarily with inhaling radon and its decay products when they are released from water. Levels of radon are generally higher in groundwater than in surface water.

Although not of major concern, ingesting drinking water that contains radon also presents a risk of cancer of the internal organs, primarily the stomach.

Gross alpha emitters (uranium and radium-226): Uranium and radium-226 emit alpha particles. These and other alpha emitters occur naturally as radioactive contaminants, but several also come from manmade sources. They may occur in either groundwater or surface water.

At high exposure levels, alpha emitters may cause cancer.

Beta and photon emitters (radium-228 and tritium): Beta and photon emitters are primarily manmade radioactive contaminants associated with operating nuclear power plants, facilities that use radioactive material for research or manufacturing, or facilities that dispose of radioactive material. Some beta emitters occur naturally. Beta and photon emitters primarily occur in surface water.

At high exposure levels, beta and photon emitters are believed to cause cancer in humans.

Treatment Units for Radionuclides

Whether or not a particular treatment technology can effectively remove a specific radionuclide from drinking water depends on the contaminant's chemical and physical characteristics.

Some treatment options can successfully remove a particular group of radionuclides, yet allow other radionuclides to pass through untreated (Table 1). The effectiveness of most drinking water treatment systems depends on the water quality of the source as well as the size of the water system.

Table 1. Technologies used for the treatment of radionuclides.

Contaminant	Treatment Technology
Radium (-226 and-228)	Ion exchange (IE)-cation, reverse osmosis (RO), distillation (D)
Radon-222	Aeration, granular activated carbon (GAC)
Uranium	IE-anion, RO, D
Adjusted gross alpha emitters	RO, D
Gross beta and photon emitters	IE-mixed bed, RO, D

Reverse Osmosis

One treatment available for a wide range of radionuclides is reverse osmosis (RO). RO can remove 87 to 98 percent of radium from water. It can also reduce the levels of uranium, alpha particle, beta and photon emitter activity.

RO operates by subjecting pressurized water to a special semipermeable membrane (Fig. 4). The membrane allows the water to flow through it but prevents the radionuclides from passing through.

The effectiveness of the process depends on the pH, total suspended solids (TSS, which are materials in water that can be trapped by a filter), pressure and iron and manganese content of the water and the type of membrane used in the system. The water may need to be pretreated to prevent the membrane from degrading. The TSS need to be removed to prevent fouling and to extend the life of the membrane. Some water sources also contain dissolved solids; removing them will prevent scaling in the unit.

The disadvantage of an RO unit is its relatively poor water recovery. Most units are designed to achieve 20 to 30 percent recovery, which means if 100 gallons are treated, only 20 to 30 gallons are usable, and the rest of the water is sent to the wastewater treatment system. Homeowners using on-site wastewater treatment should consider the effect that the additional loading may have on their septic systems.

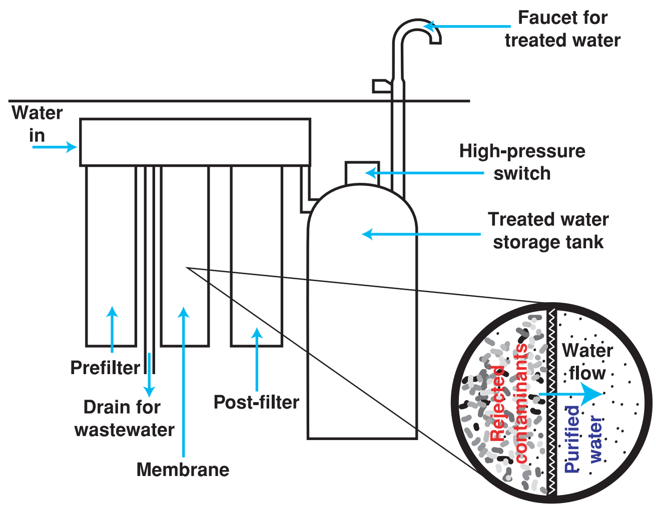

Figure 4. Reverse osmosis treatment unit (adapted from Kneen et al., 1995 and US EPA, 2003).

Because of the RO system's inefficiency, it is typically used to treat only drinking and cooking water. The size of the system should be based on the number of gallons that will be used for these purposes each day.

Typical treatment units produce from 5 to 15 gallons of usable water per day. If large amounts of water are needed, a better option may be another method of treatment, such as ion exchange.

Costs

RO devices usually cost from $300 to $1,000. If no significant plumbing modifications are needed, installing the device should take 30 to 60 minutes. The RO membrane will need to be replaced according to the manufacturer's recommended schedule. New membranes cost about $150.

Depending on the system and based on a 10-year life of the system, the cost of water production ranges from 5 to 10 cents a gallon. This estimate does not take into account the cost of the wasted water or the cost, if any, of treating the wastewater.

Ion Exchange

Ion exchange (IE) is a residential water treatment option that can remove about 90 percent of radionuclides from drinking water.

In the IE process, contaminated water is sent through a resin that contains charged particles. As the water flows through the resin, the contaminant is exchanged with the charged particles in the resin (Fig. 5). The contaminant stays in the resin, and

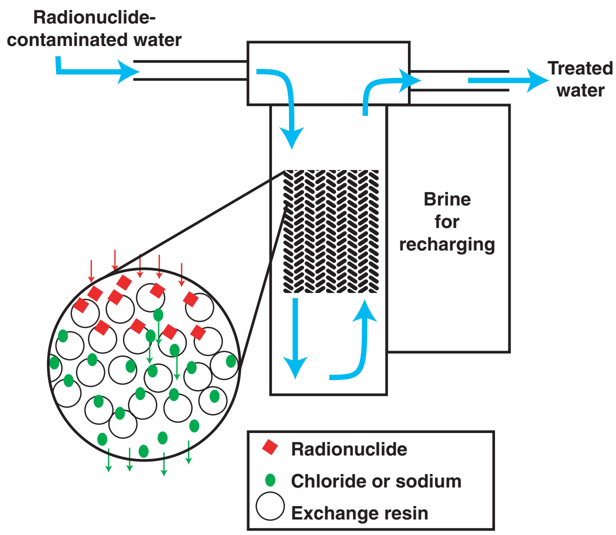

Figure 5. Ion exchange process (adapted from Robillard et al., 2001b).

charged particles from the resin flow out with the treated water.

IE systems can contain different types of resin, depending on the charge of the contaminant intended for removal. Ion exchange units may have cation (positively charged), anion (negatively charged) or mixed bed (a combination of positive and negative ions) resins. Cation exchange is often referred to as water softening.

For example: In a cation exchange unit, radium in the water will replace what is usually sodium or potassium cations on the resin. The radium stays in the unit attached to the resin, and the cations it replaced flow out with the treated water.

Anion exchange units have a similar process, in which uranium replaces chloride or hydroxide anions on the resin. If the water contains both uranium (negative) and radium (positive), a mixed bed ion exchange media can be used.

Anion exchange systems have been found to effectively remove 85 to 95 percent of alpha emitters, depending on the quality of the source water and the kind of alpha emitters in it.

A mixed bed system can also effectively remove gross beta and photon emitters from drinking water. However, keep in mind that other ions present in the water, such as nitrate or sulfate, may compete with the radionuclides for exchange sites on the resin.

When all of the original ions on the resin have all been replaced with contaminants, the resin must be replaced or regenerated to prevent the radionuclide from passing through the resin untreated. An IE unit is regenerated by flushing the resin with a strong solution, usually a sodium chloride or potassium chloride solution. This displaces the positively or negatively charged radionuclides with sodium (positive) or chlorine (negative) ions.

The waste from the regeneration process, which may be radioactive, must be disposed of in accordance with local and federal regulations.

The effectiveness of an IE system may be compromised by excessive amounts of TSS. If the source water is high in solids, a pretreatment filter should be installed.

Costs

Ion exchange units cost from $400 to $1,500 each. Operation and maintenance costs have been estimated to be 2 cents per gallon of treated water.

Distillation

A process that can remove all common types of radionuclides, except radon, from drinking water is distillation.

In the distillation process, water is heated to boiling in an enclosed container (Fig. 6). As the water evaporates, the impurities in the water are left behind in the container. The steam passes over coils that deliver the cooler untreated water to the unit, causing the steam to cool and condense back into a liquid.

Some of the dissolved gases and compounds in the water volatilize (evaporate) near the temperature at which water boils. These will be carried with the

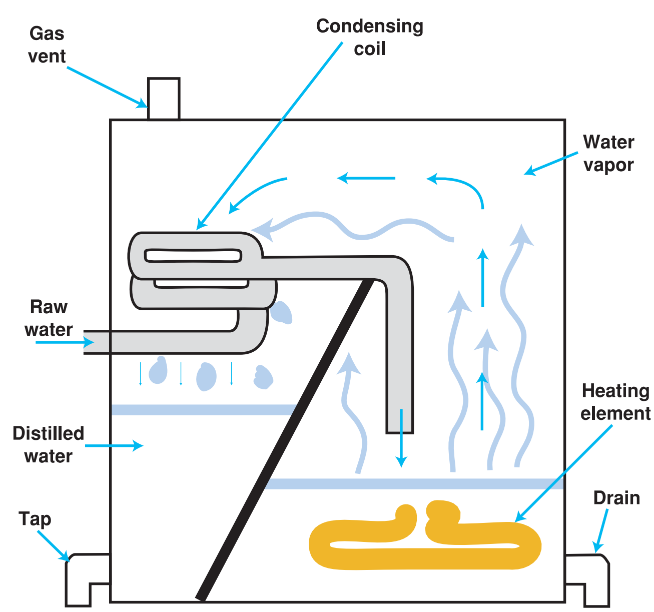

Figure 6. Distillation process (adapted from Kocher, et. al., 2003).

steam and therefore end up in the treated water. These contaminants can be removed by passing the distilled water through a post-filter.

Most distillation units can treat 5 to 11 gallons of water a day.

Costs

Distillation units can be purchased for $300 to $1,200. The operating costs for distillation systems may be higher than for other treatment methods because of the amount of electricity required to operate the distiller. Use this formula to estimate the cost of the energy:

$$\text{Cost/gallon} = 0.024 \times \frac{\text{Wattage of unit}}{\text{Production (gallons/day)}} \times \text{Cost of electricity (\$/k Wh)}$$

Aeration

One technology available for removing radon is aeration. By exposing the water to enough air, up to 99.9 percent of the radon can be removed before the water reaches your tap.

Aeration units have not been tested or certified by the National Sanitation Foundation or the Water Quality Association. However, radon can be removed by three main types of home aeration units: spray aeration, packed column, and a unit that uses a shallow tray.

For all types of aeration units, the water may need to be pretreated if it is high in total suspended solids. Also, after the water is treated for radon, the contaminated air may need to be treated with a granular activated carbon (GAC) system to lower the concentration of radon being discharged through the outside vent.

Spray Aeration

In a spray aeration system, contaminated water is sprayed through a nozzle into a holding tank (Fig. 7). When the water is sprayed, the radon in it evaporates. Then an air blower carries the volatilized gas to a vent outside the house.

With the initial spray, 50 percent of the radon is removed. As the water is sprayed multiple times, even more radon is removed.

To work properly, a spray aeration system needs to include a holding tank of at least 100 gallons.

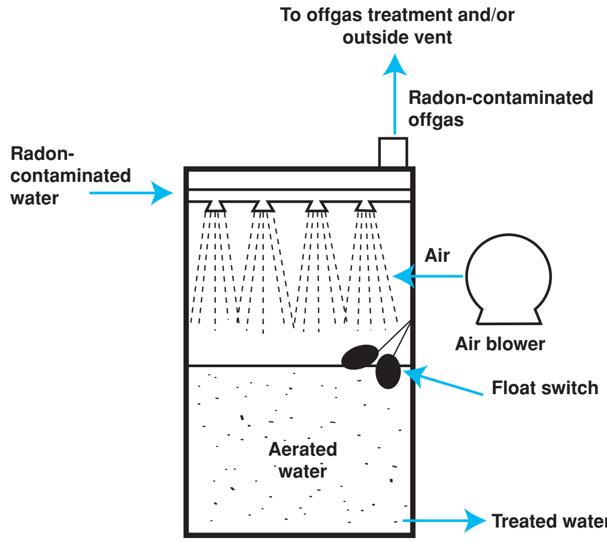

Figure 7. Spray aeration system (adapted from Robillard, 2001a).

Packed Column Aeration

In a packed column aeration system, radon is removed from contaminated water as it is sprayed into the top of a column filled with packing material (Fig. 8). The thin layer of water is exposed to air being blown from the bottom of the column. The air then carries the radon gas out of the column to an outdoor vent.

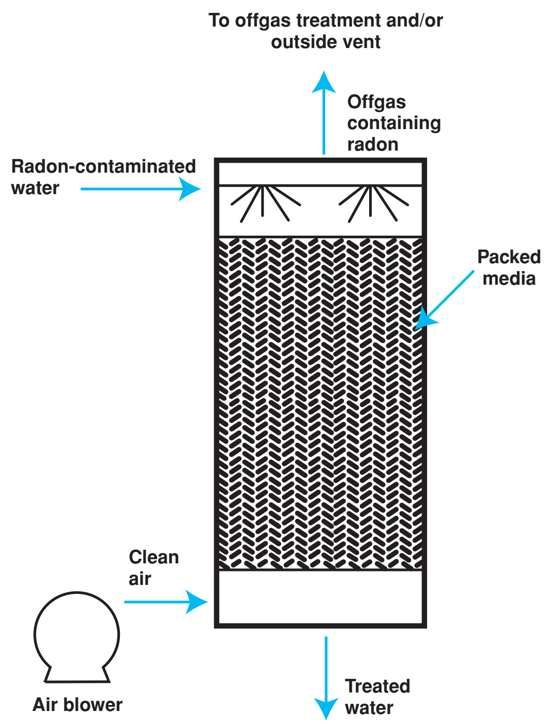

Figure 8. Packed column aeration system (adapted from Robillard 2001a).

Depending on the height of the column, a packed column aeration system can remove 90 to 95 percent of the radon in the water.

This treatment option is not practical for water having radon concentrations higher than 20,000 pCi/L.

Another drawback to this type of system is that over time, biological growth on the packing material or hardness in the water may cause scaling of the equipment.

Shallow Tray Aeration

Shallow tray aeration systems can remove more than 99.9 percent of the radon in water. In this type of system, contaminated water is sprayed onto a tray with tiny holes in it (Fig. 9). As the water flows across the tray, air is blown up through the holes.

The water collects on the bottom of the tank and is then pumped to a water pressure tank. As with the other aeration systems, the radon-contaminated air escapes through an outside vent.

This type of unit is traditionally smaller than other types and uses low-pressure air blowers. Unlike the packed column, the tray is not subject to fouling.

A drawback to this type of system is that it uses more air per minute than the other systems; its air flow rate is so high that it can even depressurize the area where it is stored.

Costs

The cost of home aeration units starts at about $3,000. There will be additional installation and maintenance costs, such as energy requirements for blowers and filter replacement if GAC air filters are used.

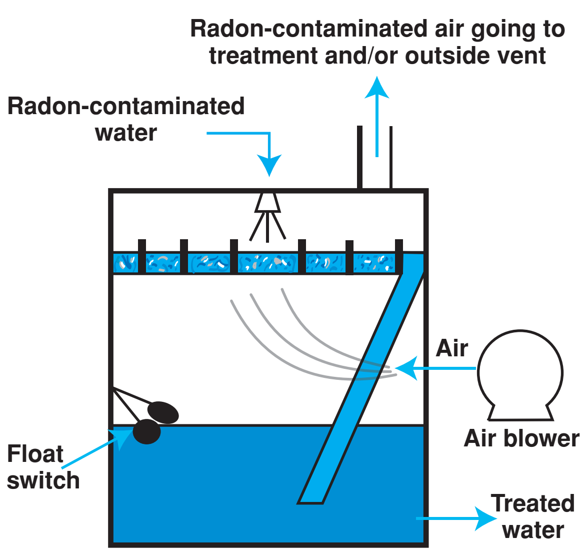

Figure 9. Shallow tray aeration system (adapted from Twitchell, 2000).

Granular Activated Carbon

Another way to remove radon gas from water is to use granular activated carbon. GAC systems remove radon from water through adsorption—that is, when water is passed through the carbon material in the unit, radon collects on the surface of the material and is removed from the water.

The effectiveness of the adsorption process depends on factors such as the pH and temperature of the water; the chemical composition and concentration of the contaminants; and the system's water flow rate and exposure time to the carbon. As the temperature and pH levels drop, the rate of adsorption usually increases.

Granular activated carbon lasts longer when the water has low concentrations of contaminants and when flow rates through the unit are low. The type of carbon used in the system should be determined by the system manufacturer's recommendations.

If the source water contains bacteria or high levels of total suspended solids, the water may need to be prefiltered. Bacteria and suspended solids can disrupt a GAC system. If microorganisms collect and grow on the filter, the water treated by the filter may end up with a higher bacteria concentration than what was in the source water. Also, if TSS are not removed, the solids may clog the pore spaces, making the system ineffective.

A range of GAC systems is available for home use, including:

- Point-of-entry (POE) devices, which treat all the water entering a home. They include pour-though filters and faucet-mounted units.
- Point-of-use (POU) devices, which are used to treat water for drinking and cooking.

When a GAC system is used to remove radon, the filter eventually becomes radioactive as it picks up the radon gas. For this reason, the treatment unit must be placed outside of the home or in an isolated area. This makes GAC point-of-use systems impractical for radon treatment.

The disposal of spent filters may pose a problem. All waste needs to be disposed of in accordance with local and state laws. The contractor providing the media replacement may offer disposal of the spent GAC.

Costs

Point-of-entry GAC systems usually cost from $300 to $3,000. Depending on the unit's size and the manufacturer's recommendations, the GAC can treat about 100,000 gallons of water before needing replacement. Replacing the media costs $80 to $100 per cubic foot. The media will need to be replaced rather than backwashed because backwashing with hot water can release the captured radon.

Selecting a Treatment Unit

No single technology can treat all water contaminants. Before selecting a treatment option, you should have your water source tested by a qualified third-party laboratory to determine the water quality. For a list of labs certified by the Texas Commission on Environmental Quality (TCEQ) to test drinking water, see http://www.tnrcc.state.tx.us/permitting/waterperm/pdw/chemlabs.pdf.

Once you have established what is in the water, research the different products on the market and find one suitable for treating that contaminant. If more than one contaminant is to be treated, check the systems' co-treatment compatibility. For example, an ion exchange unit can remove multiple types of radionuclides, but to do so, an appropriate resin must be chosen.

When comparing treatment units, consider the initial cost, operation and maintenance costs and requirements, the contaminant removal efficiency, warranties, the system's life expectancy and the reputation of the manufacturer. Before making a final decision, consider the wastewater or solid waste that the system will generate and whether or not you will be able to dispose of the waste.

It is important to note that home treatment systems are not regulated by federal or state laws. There are, however, national organizations that offer certification of products. The Water Quality Association (WQA) offers a validation program and advertising guidelines. Products that receive a Gold Seal Product Validation from the WQA are certified in their mechanical performance, but not in their ability to remove harmful contaminants.

The National Sanitation Foundation (NSF) provides certification of a product's ability to remove contaminants that affect health. For a list of drinking water treatment units with NSF certification, see http://www.nsf.org/Certified/DWTU/.

If you have questions about whether a particular product is certified, contact the NSF by calling 877-8-NSF-HELP (877-867-3435), e-mailing to info@nsf.org, or writing NSF International, NSF International, P.O. Box 130140, 789 N. Dixboro Road, Ann Arbor, MI 48113-0140.

If a product has an EPA registration number, this merely indicates that the unit is registered with the EPA; it does not imply EPA approval or certification.

Keeping the System Working

No matter what treatment technology is being used, the system must be maintained to keep operating properly. The first step to proper operation and maintenance is proper installation. Qualified installers:

- Carry liability insurance for property damage during installation
- Are accessible for service calls
- Accept responsibility for minor adjustments after installation
- Give a valid estimate of the cost of installation

After the system is installed, the unit must be maintained properly. RO membranes must be replaced as needed. The resin in ion exchange units must be replaced or recharged. Distillation units must be periodically cleaned to remove scaling and solid buildup. Any filters used in the system should be replaced according to the manufacturer's recommendations. All wastes should be disposed of properly.

Every system should be operated according to the manufacturer's specifications. If you treat more water than the system is designed for in a certain period, the treatment may be less effective and quality of the treated may be diminished.

To make sure your system is working properly, have the treated water tested regularly by a certified lab.

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Have Radionuclides Been Detected in Texas Groundwater?

Radionuclides are types of atoms that are radioactive. The most common radionuclides in drinking water are radium, radon, and uranium. Most of the naturally occurring radionuclides emit alpha particles as they decay, so the overall amount of radioactivity is typically measured as gross alpha radiation.

In 1974, the United States Congress passed the Safe Drinking Water Act. This law requires the U.S. Environmental Protection Agency (EPA) to determine the safe levels of contaminants in U.S. drinking water. EPA conducts research of drinking water to determine the level of a contaminant that is safe for a person to consume over a lifetime and the amount that a water system can reasonably be required to remove from it given present technology and resources. This safe level is called the maximum contaminant level (MCL). Some treatment technologies include reverse osmosis, ion exchange, and aeration.

Radionuclides have been found in some Texas aquifers. The U.S. EPA has set the MCL of gross alpha radiation in drinking water at 15 picocuries per liter (pCi/L). From 2004 through 2023, the Texas Water Development Board collected 3,787 samples from 2,415 unique sites for gross alpha radiation. Concentrations of gross alpha radiation above the MCL were found in 23 of the 31 major and minor aquifers in Texas. The highest numbers of unique sites with detections above the MCL are in the Gulf Coast, Ogallala, and Edwards-Trinity (Plateau) aquifers. The highest gross alpha concentrations were found in the Ogallala, Gulf Coast, and Hickory aquifers, with concentrations greater than 100 pCi/L. Other aquifers that contained significant numbers of wells with gross alpha detections above the MCL were the Hickory, Dockum, and Seymour aquifers. Although contamination from human activity can be a source of radionuclides, most of the radionuclides found in Texas groundwater occur naturally within the aquifer's geologic formation.

Resources and Useful Links

- *Water for Texas 2007*, *State Water Plan,* Texas Water Development Board, pages 228 – 229, https://www.twdb.texas.gov/waterplanning/swp/2007/

- Major and Minor Aquifers of Texas maps, https://www.twdb.texas.gov/groundwater/aquifer/index.asp

- *Drinking Water Problems: Radionuclides*, Texas AgriLife Extension Service, B-6192 (English), https://twon.tamu.edu/wp-content/uploads/sites/3/2021/06/drinking-water-problems-radionuclides.pdf

    - *Problemas del agua potable: Los radion clidos*, Texas A&M AgriLife Extension Service, B-6192S (Spanish), https://agrilifelearn.tamu.edu/s/product/problemas-del-agua-potable-los-radion-clidos/01t4x000004OUhKAAW

- *Radionuclides,* U.S. EPA, https://www.epa.gov/radiation/radionuclides
- *Radionuclides,* USGS, https://www.usgs.gov/mission-areas/water-resources/science/radionuclides
- *Safe Drinking Water Act,* U.S. EPA, https://www.epa.gov/sdwa
- *Radiochemicals and Drinking Water,* Texas Commission on Environmental Quality, https://www.tceq.texas.gov/drinkingwater/chemicals/radionuclides

Other Frequently Asked Questions (FAQs)

To find additional FAQs visit the Texas Groundwater Protection Committee's FAQ webpage at https://tgpc.texas.gov/frequently-asked-questions-faqs.

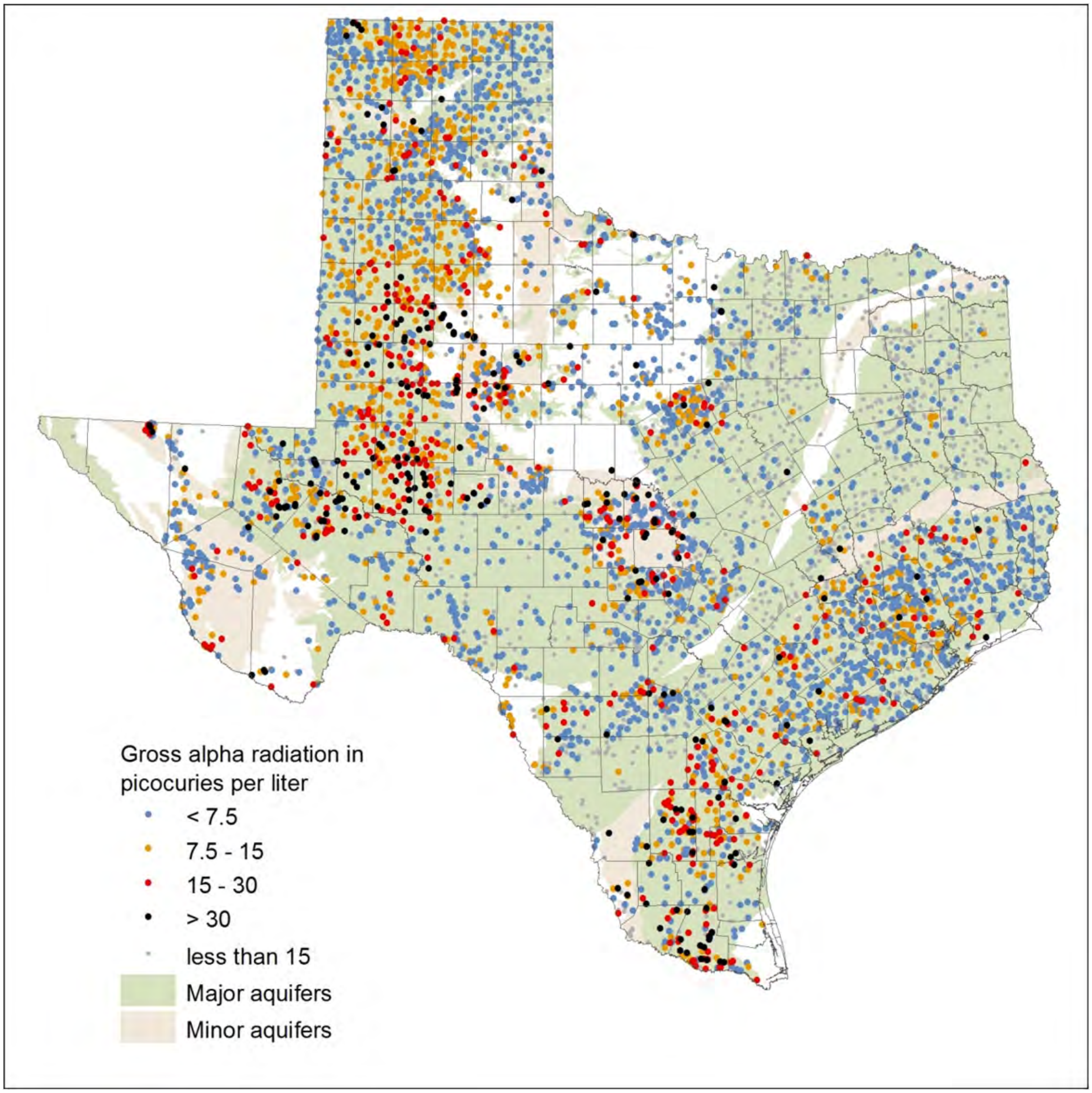


Figure 17. Gross alpha radiation activity in Texas groundwater. Colored symbols indicate detected concentrations within indicated ranges. Smaller gray symbols and associated less than values indicate non-detects below the indicated detection limit concentration. Prepared by BEG for TWDB contract #1004831125, with data from TWDB, 2011.

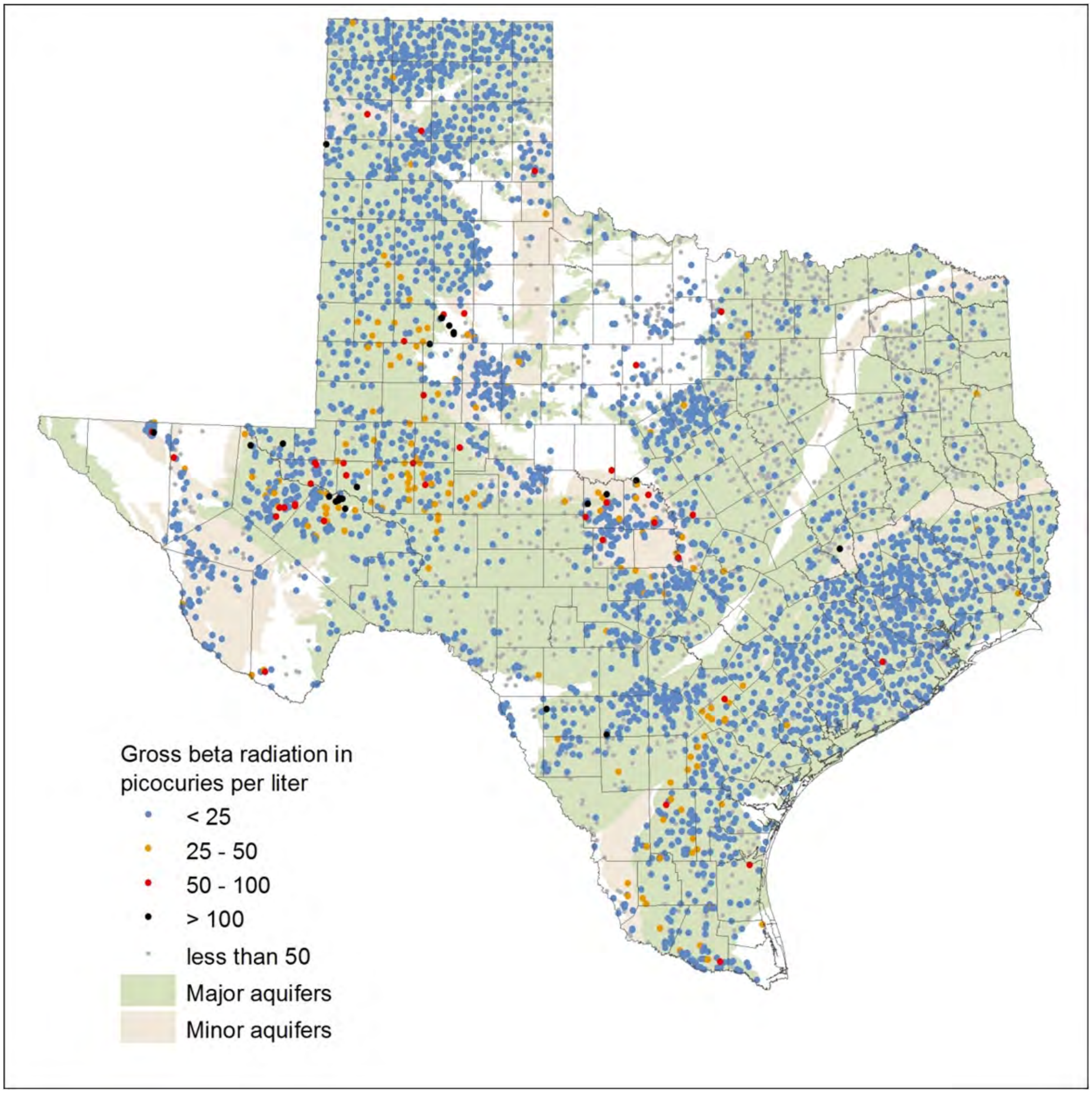


Figure 18. Gross beta radiation activity in Texas groundwater. Colored symbols indicate detected concentrations within indicated ranges. Smaller gray symbols and associated less than values indicate non-detects below the indicated detection limit concentration. Prepared by BEG for TWDB contract #1004831125, with data from TWDB, 2011.

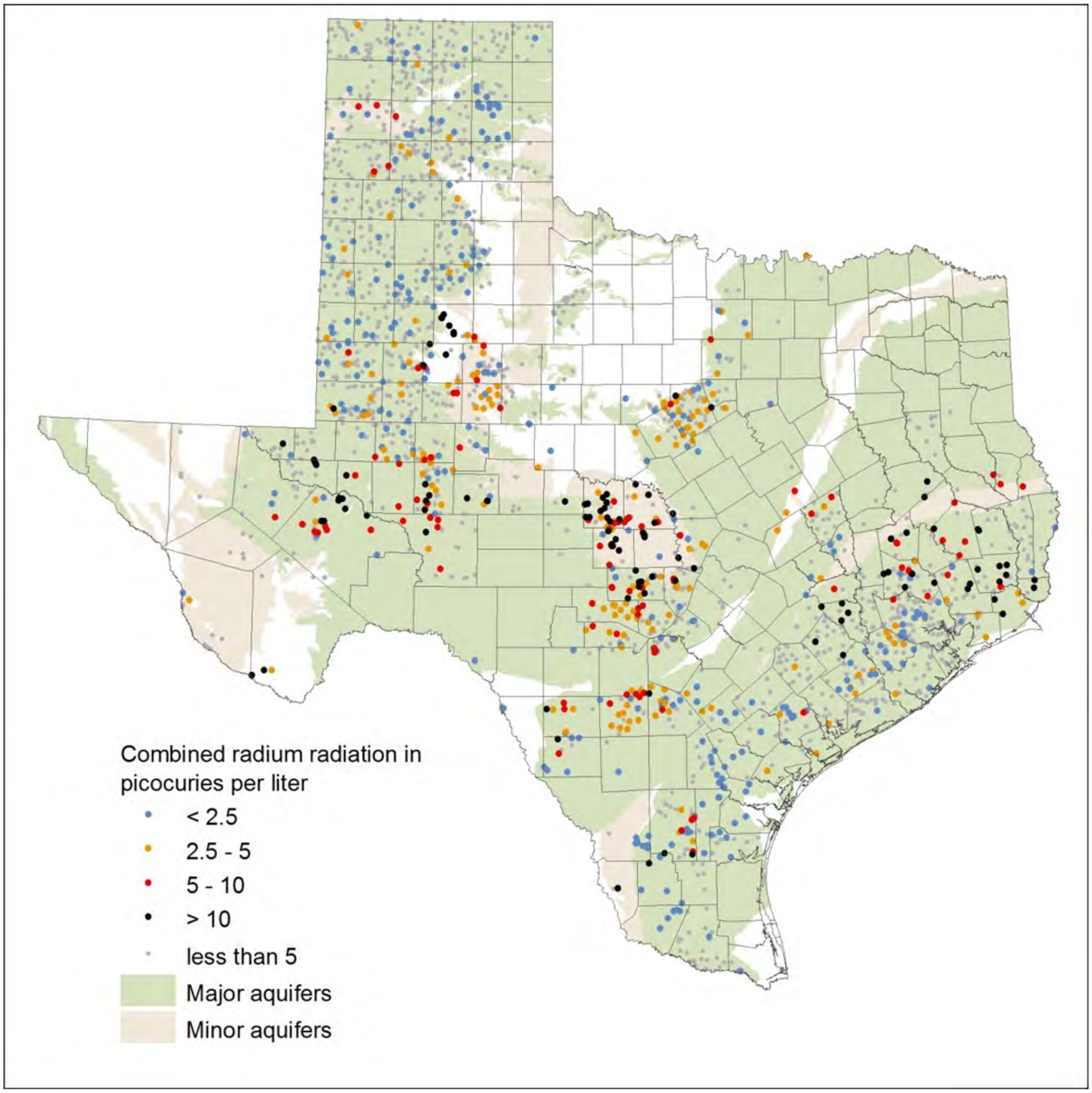


Figure 19. Combined radium radiation activity in Texas groundwater. Colored symbols indicate detected concentrations within indicated ranges. Smaller gray symbols and associated less than values indicate non-detects below the indicated detection limit concentration. Prepared by BEG for TWDB contract #1004831125, with data from TWDB, 2011.

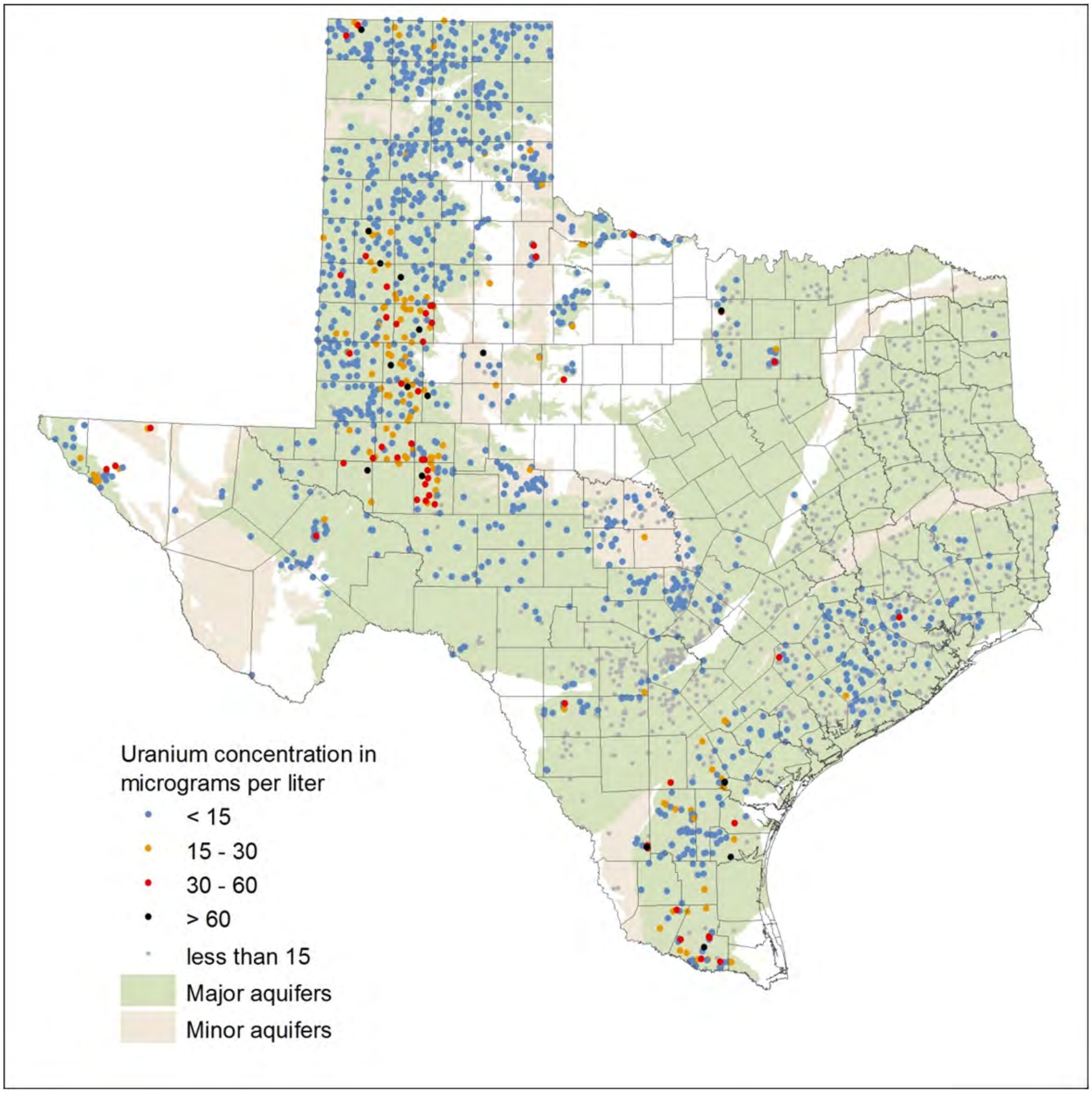


Figure 20. Uranium concentrations in Texas groundwater. Colored symbols indicate detected concentrations within indicated ranges. Smaller gray symbols and associated less than values indicate non-detects below the indicated detection limit concentration. Prepared by BEG for TWDB contract #1004831125, with data from TWDB, 2011.

EPA

Radiation Basics

Radiation is energy. It can come from unstable atoms that undergo radioactive decay <https://epa.gov/radiation/radioactive-decay>, or it can be produced by machines. Radiation travels from its source in the form of energy waves or energized particles. There are different forms of radiation and they have different properties and effects.

Related information in Spanish (Información relacionada en español) <https://espanol.epa.gov/espanol/informacion-basica-sobre-la-radiacion>

On this page:

Dose Calculator

Estimate your yearly dose <https://epa.gov/radiation/calculate-your-radiation-dose> from the most common sources of ionizing radiation with this interactive online dose calculator.

Non-Ionizing and Ionizing Radiation

There are two kinds of radiation: non-ionizing radiation and ionizing radiation.

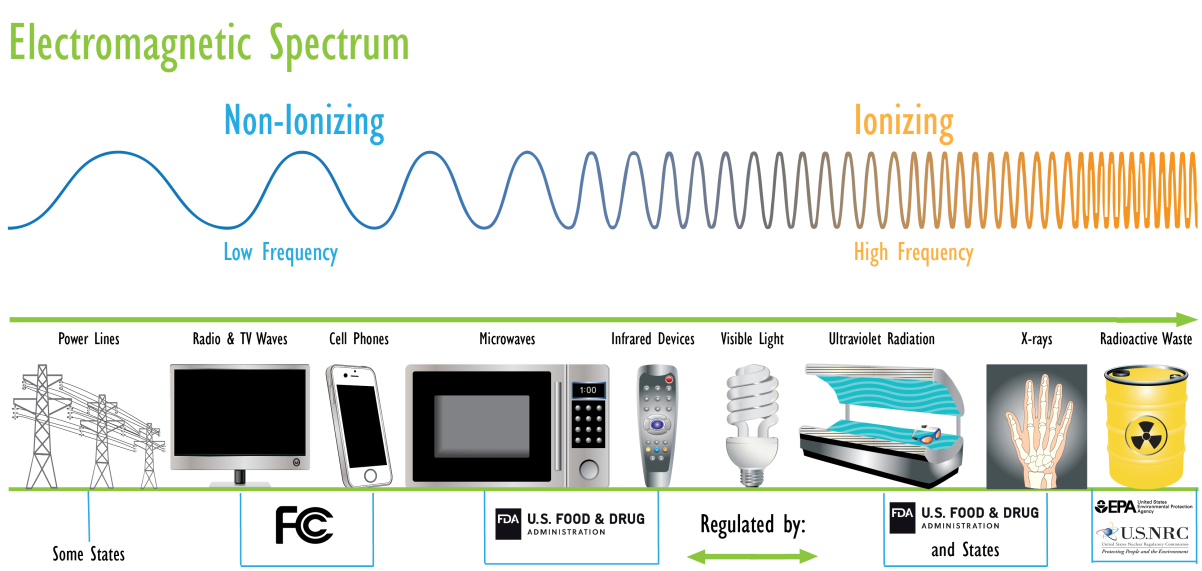
Non-ionizing radiation has enough energy to move atoms in a molecule around or cause them to vibrate, but not enough to remove electrons from atoms. Examples of this kind of radiation are radio waves, visible light and microwaves.

Ionizing radiation has so much energy it can knock electrons out of atoms, a process known as ionization. Ionizing radiation can affect the atoms in living things, so it poses a health risk by damaging tissue and DNA in genes. Ionizing radiation comes from x-ray machines, cosmic particles from outer space and radioactive elements. Radioactive elements emit ionizing radiation as their atoms undergo radioactive decay.

Radioactive decay <https://epa.gov/radiation/radioactive-decay>is the emission of energy in the form of ionizing radiation. The ionizing radiation that is emitted can include alpha particles, beta particles and/or gamma rays. Radioactive decay occurs in unstable atoms called radionuclides <https://epa.gov/radiation/radionuclides>.

Electromagnetic Spectrum

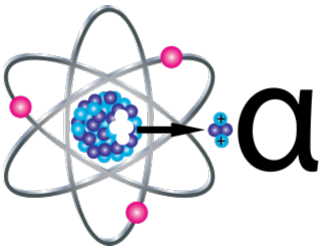
The energy of the radiation shown on the spectrum below increases from left to right as the frequency rises.



EPA's mission in radiation protection is to protect human health and the environment from the ionizing radiation that comes from human use of radioactive elements. Other agencies regulate the non-ionizing radiation that is emitted by electrical devices such as radio transmitters or cell phones (See: Radiation Resources Outside of EPA <https://epa.gov/radiation/radiation-resources-outside-epa>).

Types of Ionizing Radiation

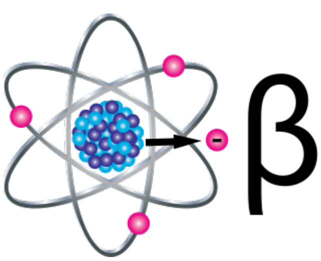
Alpha Particles



Alpha particles (α) are positively charged and made up of two protons and two neutrons from the atom's nucleus. Alpha particles come from the decay of the heaviest radioactive elements, such as uranium <https://epa.gov/radiation/radionuclide-basics-uranium>, radium <https://epa.gov/radiation/radionuclide-basics-radium> and polonium. Even though alpha particles are very energetic, they are so heavy that they use up their energy over short distances and are unable to travel very far from the atom.

The health effect from exposure to alpha particles depends greatly on how a person is exposed. Alpha particles lack the energy to penetrate even the outer layer of skin, so exposure to the outside of the body is not a major concern. Inside the body, however, they can be very harmful. If alpha-emitters are inhaled, swallowed, or get into the body through a cut, the alpha particles can damage sensitive living tissue. The way these large, heavy particles cause damage makes them more dangerous than other types of radiation. The ionizations they cause are very close together - they can release all their energy in a few cells. This results in more severe damage to cells and DNA.

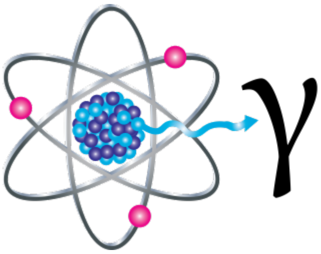
Beta Particles



Beta particles (β) are small, fast-moving particles with a negative electrical charge that are emitted from an atom's nucleus during radioactive decay. These particles are emitted by certain unstable atoms such as hydrogen-3 (tritium <https://epa.gov/radiation/radionuclide-basics-tritium>), carbon-14 and strontium-90 <https://epa.gov/radiation/radionuclide-basics-strontium-90>.

Beta particles are more penetrating than alpha particles, but are less damaging to living tissue and DNA because the ionizations they produce are more widely spaced. They travel farther in air than alpha particles, but can be stopped by a layer of clothing or by a thin layer of a substance such as aluminum. Some beta particles are capable of penetrating the skin and causing damage such as skin burns. However, as with alpha-emitters, beta-emitters are most hazardous when they are inhaled or swallowed.

Gamma Rays



Gamma rays (γ) are weightless packets of energy called photons. Unlike alpha and beta particles, which have both energy and mass, gamma rays are pure energy. Gamma rays are similar to visible light, but have much higher energy. Gamma rays are often emitted along with alpha or beta particles during radioactive decay.

Gamma rays are a radiation hazard for the entire body. They can easily penetrate barriers that can stop alpha and beta particles, such as skin and clothing. Gamma rays have so much penetrating power that several inches of a dense material like lead, or even a few feet of concrete may be required to stop them. Gamma rays can pass completely through the human body; as they pass through, they can cause ionizations that damage tissue and DNA.

X-Rays

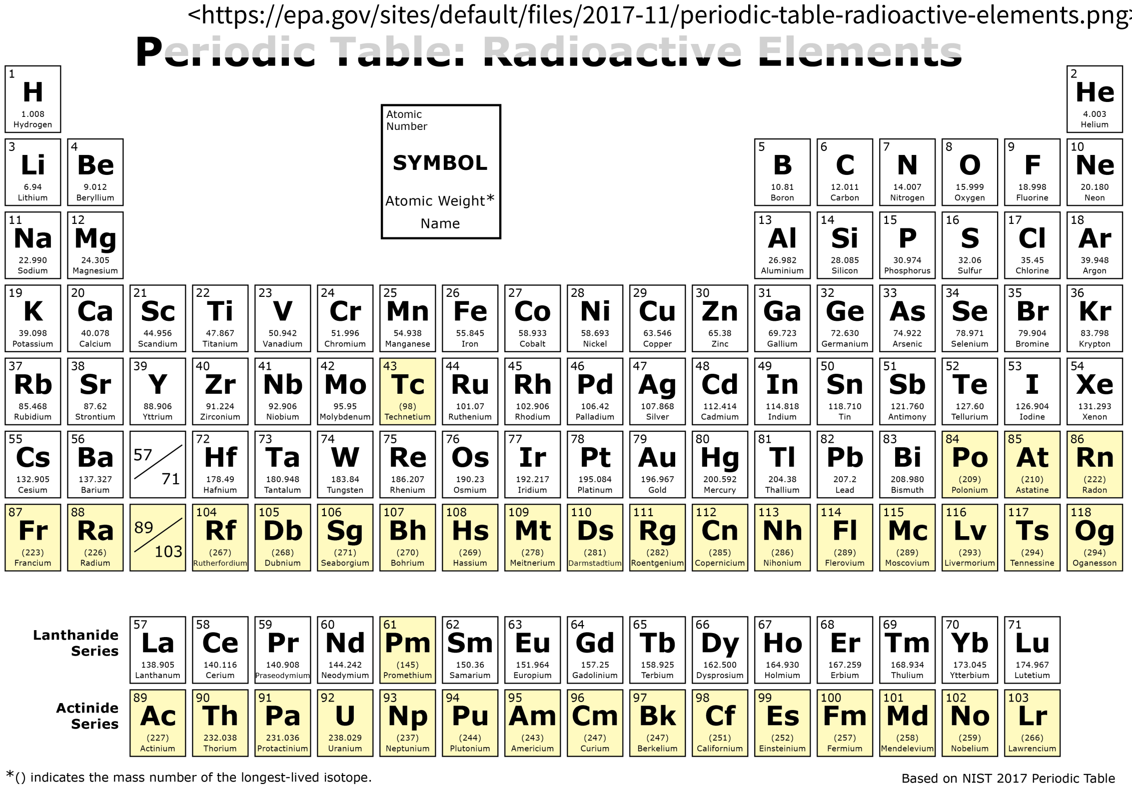
Because of their use in medicine, almost everyone has heard of x-rays. X-rays are similar to gamma rays in that they are photons of pure energy. X-rays and gamma rays have the same basic properties but come from different parts of the atom. X-rays are emitted from processes outside the nucleus, but gamma rays originate inside the nucleus. They also are generally lower in energy and, therefore less penetrating than gamma rays. X-rays can be produced naturally or by machines using electricity.

Literally thousands of x-ray machines are used daily in medicine. Computerized tomography, commonly known as a CT or CAT scan, uses special x-ray equipment to make detailed images of bones and soft tissue in the body. Medical x-rays are the single largest source of man-made radiation exposure. Learn more about radiation sources and doses. <https://epa.gov/radiation/radiation-sources-and-doses> X-rays are also used in industry for inspections and process controls.

Periodic Table

Elements in the periodic table can take on several forms. Some of these forms are stable; other forms are unstable. Typically, the most stable form of an element is the most common in nature. However, all elements have an unstable form. Unstable forms emit ionizing radiation and are radioactive. There are some elements with no stable form that are always radioactive, such as uranium. Elements that emit ionizing radiation are called radionuclides.

<https://epa.gov/sites/default/files/2017-11/periodic-table-radioactive-elements.png>



Last updated on October 1, 2024

Home <https://epa.gov/> / Radiation Protection <https://epa.gov/radiation>

Radionuclide Basics: Uranium

Uranium (chemical symbol U) is a naturally occurring radioactive element. When refined, uranium is a silvery-white metal. Uranium has three primary naturally occurring isotopes: U-238, U-235 and U-234.

Uranium is weakly radioactive and contributes to low levels of natural background radiation in the environment. Uranium is used in nuclear power generation. Specifically, U-235 can be concentrated in a process called “enrichment,” making it "fissile" and suitable for use in nuclear reactors or weapons.

On this page:

Uranium

Type of Radiation Emitted:

- Alpha Particles <https://epa.gov/radiation/radiation-basics#alpha>

- Gamma Rays <https://epa.gov/radiation/radiation-basics#gamma>

Half-life:

Uranium-238: 4.47 billion years
Uranium-235: 700 million years
Uranium-234: 244,000 years

Uranium in the Environment

Uranium is present naturally in virtually all soil, rock and water. Rocks break down to form soil. Soil can be moved by water and blown by wind, which moves uranium into streams, lakes and surface water. More than 99 percent of the uranium found in the environment is in the form of U-238. Uranium-234 is less than one percent of all forms of natural uranium, but is much more radioactive. It gives off almost half of the radioactivity from all forms of uranium found in the environment.

The U.S. mining industry can retrieve uranium in two ways. The first is to mine rock that contains uranium. The second is to use strong chemicals to dissolve uranium from underground rocks into ground water, and then pump the water to the surface. The waste from these processes <https://epa.gov/radiation/tenorm-uranium-mining-residuals> is more radioactive than the natural rock because the natural radioactive material in the earth is now exposed and concentrated. This waste can contaminate water, soil and air if it is not disposed of properly. Uranium eventually decays to radium <https://epa.gov/radiation/radionuclide-basics-radium>. Radium decays to release a radioactive gas called radon <https://epa.gov/radiation/radionuclide-basics-radon>. Radon in underground uranium mines is a greater radiation hazard to miners than uranium. Without precautions (i.e. ventilation) radon can collect in the mine shafts where it is inhaled by miners. Learn more about uranium mines and mills. <https://epa.gov/radtown/radioactive-waste-uranium-mining-and-milling>

Uranium Sources

A person can be exposed to uranium by inhaling dust in air, or ingesting water and food. The general population is exposed to trace levels of uranium primarily through food and water. Learn about background radiation. <https://epa.gov/radtown/background-radiation>

People who live near federal government facilities that made or tested nuclear weapons, or facilities that mine or process uranium ore or enrich uranium for reactor fuel, may have increased exposure to uranium. Uranium that is depleted <https://epa.gov/radtown/depleted-uranium> (U-235) is used in industrial settings (i.e. counterweights).

School science labs <https://epa.gov/radtown/radiation-sources-schools> may keep small quantities of uranium of varying enrichment levels to demonstrate radioactive properties. These sources have low levels of radioactivity and are not harmful to people when handled properly.

Ingestion of uranium is a hazard because of its chemical properties.

Uranium and Health

Uranium decays by alpha particles. External exposure to uranium is therefore not as dangerous as exposure to other radioactive elements because the skin will block the alpha particles. Ingestion of high concentrations of uranium can cause health effects <https://epa.gov/radiation/radiation-health-effects>, such as cancer of the bone or liver. Inhaling large concentrations of uranium can cause lung cancer from the exposure to alpha particles.

Last updated on February 5, 2024

Home <https://epa.gov/> / Radiation Protection <https://epa.gov/radiation> / Radiation Basics <https://epa.gov/radiation/radiation-basics>

Radiation Health Effects

Ionizing radiation has sufficient energy to affect the atoms in living cells and thereby damage their genetic material (DNA). Fortunately, the cells in our bodies are extremely efficient at repairing this damage. However, if the damage is not repaired correctly, a cell may die or eventually become cancerous. Related information in Spanish (Información relacionada en español) <https://espanol.epa.gov/espanol/efectos-de-la-radiacion-sobre-la-salud>.

Exposure to very high levels of radiation, such as being close to an atomic blast, can cause acute health effects such as skin burns and acute radiation syndrome (“radiation sickness"). It can also result in long-term health effects such as cancer and cardiovascular disease. Exposure to low levels of radiation encountered in the environment does not cause immediate health effects, but is a minor contributor to our overall cancer risk.

Visit the U.S. Centers for Disease Control and Prevention (CDC) for more information about possible health effects of radiation exposure and contamination. <https://www.cdc.gov/radiation-emergencies/signs-symptoms/possible-health-effects.html>

On this page:

- Acute radiation syndrome from large exposures
- Radiation exposure and cancer risk
  - Limiting cancer risk from radiation in the environment
- Exposure pathways
- Sensitive populations

Acute Radiation Syndrome from Large Exposures

A very high level of radiation exposure delivered over a short period of time can cause symptoms such as nausea and vomiting within hours and can sometimes result in death over the following days or weeks. This is known as acute radiation syndrome, commonly known as “radiation sickness.”

It takes a very high radiation exposure to cause acute radiation syndrome—more than 0.75 gray (75 rad) in a short time span (minutes to hours). This level of radiation would be like getting the radiation from 18,000 chest x-rays distributed over your entire body in this short period. Acute radiation syndrome is rare, and comes from extreme events like a nuclear explosion or accidental handling or rupture of a highly radioactive source.

View CDC Fact Sheet: Acute Radiation Syndrome (ARS). <https://www.cdc.gov/radiation-emergencies/signs-symptoms/acute-radiation-syndrome.html>

Learn about protecting yourself from radiation. <https://epa.gov/radiation/protecting-yourself-radiation>

Learn about radiation sources and doses. <https://epa.gov/radiation/radiation-sources-and-doses>

Radiation Exposure and Cancer Risk

Exposure to low-levels of radiation does not cause immediate health effects, but can cause a small increase in the risk of cancer over a lifetime. There are studies that keep track of groups of people who have been exposed to radiation, including atomic bomb survivors and radiation industry workers. These studies show that radiation exposure increases the chance of getting cancer, and the risk increases as the dose increases: the higher the dose, the greater the risk. Conversely, cancer risk from radiation exposure declines as the dose falls: the lower the dose, the lower the risk.

Radiation doses are commonly expressed in millisieverts (international units) or rem (U.S. units). A dose can be determined from a one-time radiation exposure, or from accumulated exposures over time. About 99 percent of individuals would not get cancer as a result of a one-time uniform whole-body exposure of 100 millisieverts (10 rem) or lower.[1] At this dose, it would be extremely difficult to identify an excess in cancers caused by radiation when about 40 percent of men and women in the U.S. will be diagnosed with cancer at some point during their lifetime.

Risks that are low for an individual could still result in unacceptable numbers of additional cancers in a large population over time. For example, in a population of one million people, an average one-percent increase in lifetime cancer risk for individuals could result in 10,000 additional cancers. The EPA sets regulatory limits and recommends emergency response guidelines well below 100 millisieverts (10 rem) to protect the U.S. population, including sensitive groups such as children, from increased cancer risks from accumulated radiation dose over a lifetime.

Calculate your radiation dose <https://epa.gov/radiation/calculate-your-radiation-dose>.

Learn about radiation sources and doses <https://epa.gov/radiation/radiation-sources-and-doses>.

Learn more about cancer risk in the U.S. at the National Cancer Institute <https://www.cancer.gov/about-cancer/understanding/statistics>.

Learn more about how EPA estimates cancer risk in, *EPA Radiogenic Cancer Risk Models and Projections for the U.S. Population <https://epa.gov/radiation/blue-book-epa-radiogenic-cancer-risk-models-and-projections-us-population>*, also known as the Blue Book.

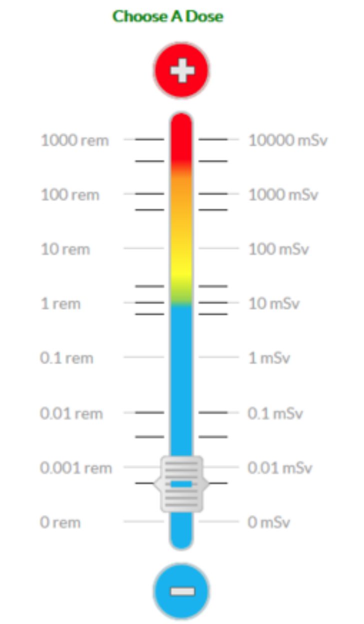
Radiation Thermometer

See radiation doses in perspective with the interactive Radiation Thermometer from the Centers for Disease Control and Prevention (CDC) <https://www.cdc.gov/radiation-emergencies/causes/radiation-thermometer.html>

Limiting Cancer Risk from Radiation in the Environment

EPA bases its regulatory limits and nonregulatory guidelines for public exposure to low level ionizing radiation on the linear no-threshold (LNT) model. The LNT model assumes that the risk of cancer due to a low-dose exposure is proportional to dose, with no threshold. In other words, cutting the dose in half cuts the risk in half.

The use of the LNT model for radiation protection purposes has been repeatedly recommended by authoritative scientific advisory bodies, including the National Academy of Sciences <http://www.nasonline.org/> and the National Council on Radiation Protection and Measurements <https://ncrponline.org/>. There is evidence to support LNT from laboratory data and from studies of cancer in people exposed to radiation. [2,3,4,5]



Source: CDC

Exposure Pathways

Understanding the type of radiation received, the way a person is exposed (external vs. internal), and for how long a person is exposed are all important in estimating health effects.

The risk from exposure to a particular radionuclide depends on:

- The energy of the radiation it emits.
- The type of radiation (alpha, beta, gamma, x-rays <https://epa.gov/radiation/radiation-basics>).
- Its activity (how often it emits radiation).
- Whether exposure is external or internal:
  - External exposure is when the radioactive source is outside of your body. X-rays and gamma rays can pass through your body, depositing energy as they go.
  - Internal exposure is when radioactive material gets inside the body by eating, drinking, breathing or injection (from certain medical procedures). Radionuclides may pose a serious health threat if significant quantities are inhaled or ingested.
- The rate at which the body metabolizes and eliminates the radionuclide following ingestion or inhalation.
- Where the radionuclide concentrates in the body and how long it stays there.

Learn more about alpha particles, beta particles, gamma rays and x-rays. <https://epa.gov/radiation/radiation-basics>

Sensitive Populations

Children and fetuses are especially sensitive to radiation exposure. The cells in children and fetuses divide rapidly, providing more opportunity for radiation to disrupt the process and cause cell damage. EPA considers differences in sensitivity due to age and sex when revising radiation protection standards.

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1 National Research Council, 2006. *Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII Phase 2*. Washington, DC: The National Academies Press (p. 7).

[2] *Brenner, David J. et al., 2003 "Cancer risks attributable to low doses of ionizing radiation: assessing what we really know." Proceedings of the National Academy of Sciences 100, no. 24, (pp. 13761-13766).*

[3] *National Council on Radiation Protection and Measurements, 2018. Implications of Recent Epidemiologic Studies for the Linear Nonthreshold Model and Radiation Protection, NCRP Commentary 27. Bethesda, Maryland: National Council on Radiation Protection and Measurements.*

[4] *Shore, R.E. et al., 2018. "Implications of recent epidemiologic studies for the linear nonthreshold model and radiation protection." Journal of Radiological Protection, no 38,(pp. 1217-1233)*

[5] *U.S. Environmental Protection Agency, 2011. "EPA Radiogenic Cancer Risk Models and Projections for the U.S. Population." EPA Report 402-R-11-001 <https://epa.gov/radiation/blue-book-epa-radiogenic-cancer-risk-models-and-projections-us-population>.*

Last updated on October 2, 2024

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Natural Radionuclides in Private Wells

About 15% of Americans use private wells as their main source of drinking water. Unlike public water systems, wells are usually not regulated or routinely inspected for radionuclides, though some states and cities do regulate private wells. As a result, well owners are responsible for making sure their drinking water is safe to drink. Well water should be tested on a regular schedule. Each year, well owners should test for contaminants such as bacteria, nitrates and viruses. Every three years, well owners should test for radionuclides.

Radiation Facts

More than 15 million Americans use private wells as their main source of drinking water. Those who use private wells should:

- Test for radionuclides every three years.
- Take appropriate steps if radionuclide levels are higher than the EPA's limits.

On this page:

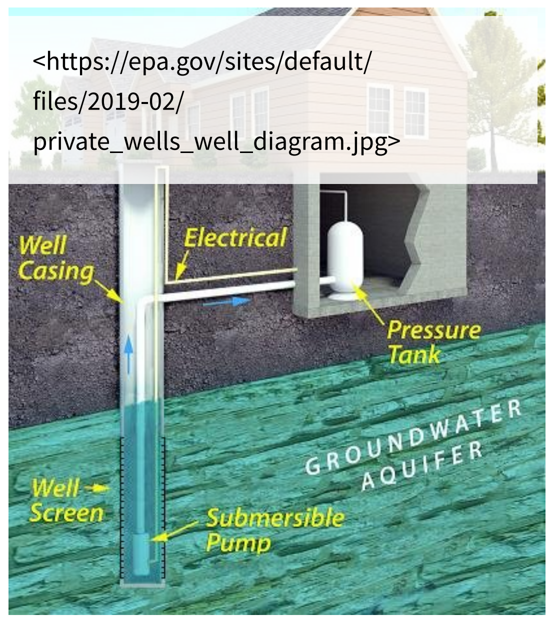
About Natural Radionuclides in Private Wells

Uranium <https://epa.gov/radiation/radionuclide-basics-uranium> is a naturally-occurring radionuclide that decays over time and forms radium. Both elements are naturally present in rocks and soils. Radium <https://epa.gov/radiation/radionuclide-basics-radium> breaks down further to form the radioactive gas radon <https://epa.gov/radiation/radionuclide-basics-radon>. All three of these elements can dissolve in water, which means they can accumulate in wells. If the soil and rocks surrounding a well have high enough concentrations of radionuclides, the well water may contain levels that exceed the EPA's standards.

Image of water flowing from an outdoor faucet.
Source: U.S. Centers for Disease Control and Prevention

Well water should be tested every three years for radionuclides. Kits for testing well water are available online, in hardware stores, and from many state governments.

There are different kinds of tests for different radionuclides in well water. Ask your local drinking water office or your local radiation control program for the tests that are most useful to your area. You can find contact information for your state's radiation control program on the Conference of Radiation Control Program Directors (CRCPD) <https://www.crcpd.org/mpage/map> website.



This picture shows how a private well at a home pumps water from the groundwater aquifer into a pressure tank, which provides the water to a household or building.

If you discover that you need a treatment system, radionuclides can be removed from water by installing a treatment system at the tap. These filtration systems are called Point of Use (POU) systems. Several types of POU systems are available. Two types that the EPA has found to work well are ion exchange and reverse osmosis. Often, they collect too much radiation to be disposed of with ordinary trash. The company that installs the POU system or state radiation and solid waste offices will be able to help well owners with proper disposal guidelines.

What You Can Do

- **Treat your drinking well water if necessary.** If your well water needs to be treated, there are several organizations that can help you pick the best treatment:
  - Water Quality Association <https://wqa.org/>
  - The National Groundwater Association <http://www.ngwa.org/pages/default.aspx>
  - Wellowners.org <http://wellowner.org/>

Where to Learn More

The U.S. Environmental Protection Agency (EPA)

The EPA is the United States' regulatory agency for clean water. While the Agency does not regulate private wells, it maintains many resources that are available to better understand how different drinking water programs work.

Private Drinking Water Wells <https://epa.gov/privatewells>
This webpage provides information about private drinking water well issues like water safety, health risks, and where can you go for additional information.

Summary of the Clean Water Act <https://epa.gov/laws-regulations/summary-clean-water-act>
This webpage shows a summary and the history of the Clean Water Act (CWA) and provides links to information about the EPA's role in CWA enforcement.

Basic Information about Radionuclides in Drinking Water <https://epa.gov/dwreginfo/radionuclides-rule>
This webpage shows basic information about radionuclides in drinking water, including possible health risks of radionuclides and other contaminants.

Safe Drinking Water Act <https://epa.gov/laws-regulations/summary-safe-drinking-water-act>

This webpage contains links to basic information and fact sheets on the Safe Drinking Water Act.

Radon <https://epa.gov/radon>
This webpage provides links to resources, information, and the EPA guidance on radon in homes and businesses.

Radionuclide Basics: Radon <https://epa.gov/radiation/radionuclide-basics-radon>
This webpage provides information about radon in the environment.

The U.S. Department of Health and Human Services (HHS), the Centers for Disease Control and Prevention (CDC)

Because of its role as a public health agency, the CDC maintains resources related to radon in drinking water on their website.

Radon and Drinking Water from Private Wells <https://www.cdc.gov/drinking-water/safety/index.html>
This webpage provides health-related information about radon and drinking water.

The U.S. Department of the Interior (DOI), the U.S. Geological Survey (USGS), National Water-Quality Assessment (NAWQA) Program

In 1991, Congress established the NAWQA to address where, when, why, and how the Nation's water quality has changed, or is likely to change in the future, in response to human activities and natural factors. This includes studies on natural radionuclides in groundwater.

Quality of Water from Domestic Wells in the United States <http://water.usgs.gov/nawqa/studies/domestic_wells/>
This webpage provides information about the NAWQA program's water quality assessments.

Radium Frequently Asked Questions <http://water.usgs.gov/nawqa/trace/radium/ra_faq.html>

This webpage shares answers to frequently asked questions about radium in well water and discusses health effects, drinking water limits, testing for and how to remove radionuclides from well water.

The States

Each state has different policies on well water quality. Some states do not regulate private wells. Check with your local or state office of environmental protection to learn more.

Facts: Private Well Testing (PDF) <http://www.atlantic-county.org/documents/health-topics/well_testing_facts.pdf>(896.73 K)
New Jersey Department of Health and Senior Services
This document offers information on contaminated private well water in the state of New Jersey and lists how to reduce contaminants if they are discovered.

Radium in Drinking Water <https://www.idph.state.il.us/envhealth/factsheets/radium.htm>
Illinois Department of Public Health
This webpage provides an overview of radium and drinking water concerns regarding radium.

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Natural Radionuclides in Public Drinking Water

Public drinking water systems in the United States must ensure that the water they provide to their customers meet all federal, state, and local drinking water standards. Natural radionuclides are a potential hazard.

On this page:

Radiation Facts

- Public drinking water systems test and filter out contaminants, including radionuclides.
- The EPA sets limits, called Maximum Contaminant Levels (MCLs), for radionuclides in public drinking water under the Safe Drinking Water Act <https://epa.gov/sdwa>.

About Natural Radionuclides in Public Drinking Water

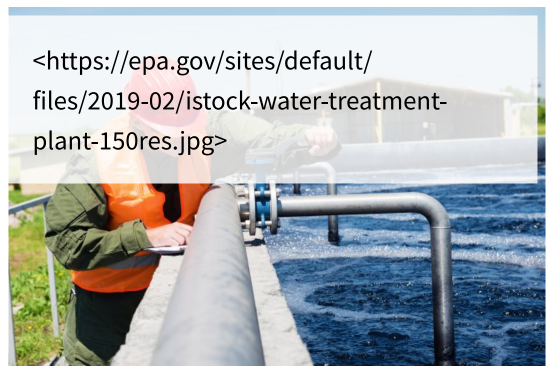
Public drinking water suppliers make sure that the water they deliver to the public is safe for consumption. They regularly test the water and use filters or other methods to remove chemicals and natural radionuclides that can get into water from the soil.

Many of the contaminants found in public drinking water sources occur naturally. For example, radioactive radium and uranium are found in small amounts in almost all rock and soil, and can dissolve in water. Radon, a radioactive gas, created through the decay of radium, can also naturally occur in groundwater. If it is not removed, radon in water can be released into the air as you shower or use water for other tasks like washing dishes or doing laundry.

This picture shows a large red building behind a large rectangular pond of water, called a flocculation tank. Flocculation tanks are used to help filter drinking water.

Drinking water suppliers prevent water sources from becoming contaminated by:

- Identifying the path that water travels to reach the drinking water system to determine areas where drinking water could become contaminated.
- Preparing for emergencies, such as a flood or spill that could threaten the drinking water supply.
- Participating in voluntary programs that help keep contaminants out of drinking water. These programs include educating the public and helping businesses understand how to properly dispose of wastes that could contaminate water.



Water treatment plant worker.

What You Can Do

- **Stay informed.** Public water systems follow laws that protect the public from radionuclides in drinking water. Stay informed by reading your public water system's annual Consumer Confidence Reports. These reports will help you understand where your water comes from. In addition, it should explain whether radionuclides have been detected in your water and how the water supplier treats and delivers water to your household.

Where to Learn More

The U.S. Environmental Protection Agency (EPA)

The EPA is the United States' regulatory agency for clean water. Many resources are available to better understand how different drinking water programs work.

Public Drinking Water Systems Programs <https://epa.gov/dwreginfo/information-about-public-water-systems>
This webpage provides information and links to additional resources regarding drinking water safety standards.

Summary of the Clean Water Act <https://epa.gov/laws-regulations/summary-clean-water-act>
This webpage shows the history and a summary of the Clean Water Act (CWA) and provides links to information regarding the EPA's role in CWA enforcement.

Drinking Water Contaminants: Radionuclides <https://epa.gov/dwreginfo/drinking-water-regulations>
This webpage shows basic information about contaminants in drinking water, including possible health risks of radionuclides.

Safe Drinking Water Act <https://epa.gov/sdwa>
This webpage contains links to basic information and fact sheets on the Safe Drinking Water Act.

Radon <https://epa.gov/radon>
This webpage provides information about radon and provides answers to frequently asked questions about radon, including what you can do about high radon levels in your home.

The Conference of Radiation Control Program Directors (CRCPD)

CRCPD is a nonprofit non-governmental professional organization dedicated to radiation protection.

State Radiation Protection Programs <https://www.crcpd.org/mpage/map>
This webpage provides links and contact information for each state's Radiation Control Program office.

The National Radon Safety Board (NRSB)

The NRSB certification program offers independent certification, accreditation, and approval for various categories of radon service providers.

Welcome to the National Radon Safety Board <http://www.nrsb.org/>
This webpage links to radon-related websites, including information on radon detecting services and devices.

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