



Know the Facts:
Coal Ash

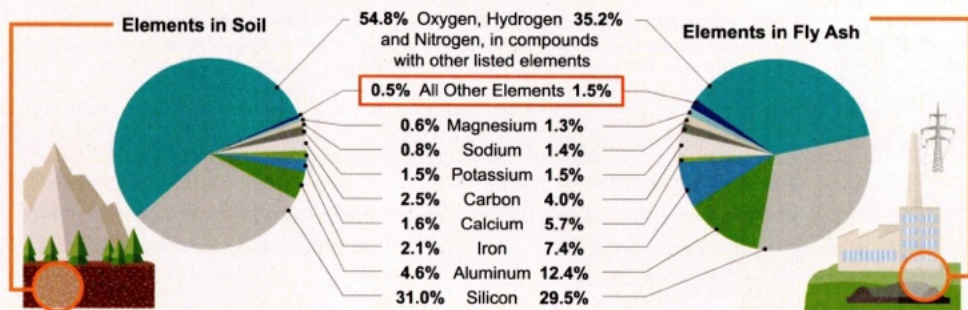
Coal Ash is Not Hazardous

We are all familiar with soil and rocks in our environment. Coal is one type of rock. When we burn coal to produce electricity, the ash that remains is made up of the parts of the coal that do not burn, in the same way that ash remains after burning a campfire.

The utility industry's commitment to our communities includes the safe, responsible management of coal combustion residuals (CCR), or what is commonly referred to as coal ash. The EPA classified coal ash as non-hazardous solid waste. This designation is based on extensive review and detailed studies of the components of coal ash over many years by regulatory agencies, academic institutions, and expert third parties.¹ This designation is also backed up by rigorous toxicity testing, as discussed on the next page. Further, as illustrated on this fact sheet, the constituents of coal ash are nearly identical to common soil.

Coal Ash and Soil

The constituents that make up coal ash are the same as soils and rocks. These constituents are naturally occurring and consist mainly of oxygen, hydrogen, and nitrogen that together with carbon make up the building blocks of all life. Other major components in soil and coal ash are silicon (in the form of silicon oxides, or sand), aluminum, iron, calcium, and other common minerals, as shown in the chart below.²



Regulatory Oversight of Coal Ash Management

There is extensive regulatory oversight of coal ash sites because of the volume of material to manage and monitor. Regulatory agencies such as the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), the Nuclear Regulatory Commission (NRC), state environmental agencies and departments of health and others are responsible for implementing laws passed by Congress and the States to manage health and environmental risks associated with air emissions, wastewater discharges, solid waste disposal, and potential exposure from commercial, industrial, and government operations. Constituents of coal ash and the management of coal ash are regulated to protect the environment, public health, and worker health.

¹ EPA designated coal ash as a non-hazardous waste in its Reports to Congress in 1988 and 1999, www.epa.gov/coalash/reports-congress-wastes-combustion-coal-and-fossil-fuels; in Regulatory Determinations in 1993, www.epa.gov/sites/production/files/2015-08/documents/080993.pdf, and 2000, www.federalregister.gov/documents/2000/05/22/00-11138/notice-of-regulatory-determination-on-wastes-from-the-combustion-of-fossil-fuels; and in the 2015 Final Rule: www.federalregister.gov/documents/2015/04/17/2015-00257/hazardous-and-solid-waste-management-system-disposal-of-coal-combustion-residuals-from-electric.

² Chart modified from: Electric Power Research Institute (EPRI). Report #3002018059, available at: www.epri.com/research/products/000000003002018059

Coal Ash and People

Everything present in coal ash is also naturally present in the soils we encounter at our homes and parks and schools. We're exposed to these constituents every day in our lawns and gardens and in the foods we eat.

Coal ash is maintained and managed on access-controlled industrial sites. The chance of anyone from the community coming into contact with the coal ash is remote and, thus, the chance of receiving a significant exposure to any constituents present in coal ash is also remote. Modern air pollution control technologies capture coal ash particulates and reduce the potential human exposure to background levels.

Decades of Studies Have Demonstrated That Coal Ash is Not Hazardous

The news media frequently describes coal ash as "toxic," but this demonstrates a misunderstanding of toxicology, risk assessment, the roles of regulatory agencies, and the processes those agencies follow in developing and implementing policies and regulations.

When subjected to toxicity testing, coal ash is not considered toxic because the constituents within it are not present at high enough levels, alone or in combination, to be toxic. We know this from available published studies that assess the overall risks of coal ash to humans and the environment.

The U.S. Approach to Chemical Evaluation

In the U.S., EPA evaluates a material based on the constituents present in the material. Thus, the EPA's national risk assessment for coal ash evaluated the constituents present in coal ash. The Toxic Substances and Control Act (TSCA) administered by the EPA also regulates on a per chemical basis. This per-constituent approach has led to questions about whether there is a risk if someone is exposed to all of these constituents in coal ash (or soil) at once. The U.S. does not have a program to conduct testing on coal ash as a whole product, however, Europe does. It is a program called REACH, and such testing has been conducted on coal ash.

REACH: Registration, Evaluation, Authorisation and Restriction of Chemicals



The European Chemical Agency's REACH program regulates a comprehensive program of toxicity testing of materials and has registered coal ash for commerce in Europe. That registration is based on testing whole coal ash using a variety of 47 different human health-based toxicity tests and 39 different aquatic toxicity tests. All of those 86 test results support characterizing coal ash as non-hazardous.³

These toxicity studies have been conducted on coal ash as a whole material. All of the constituents present in ash are present together, thus, these studies answer the question of what additive effects the constituents may have on health.

REACH Coal Ash Human Health-Based Toxicity Studies

Toxicity Test	Publications and Reports	Conclusion
Acute Oral Toxicity	3	No Hazard
Acute Inhalation Toxicity	1	No Hazard
Acute Dermal Toxicity	2	No Hazard
Skin Irritation	12	No Hazard (11) Inconclusive (1)
Eye Irritation	6	No Hazard (5) Inconclusive (1)
Skin Sensitization	4	No Hazard
Repeated Dose Inhalation Toxicity	3	No Hazard
Repeated Dose Oral Toxicity	2	No Hazard
Genetic Toxicity	7	No Hazard
Reproductive Toxicity	2	No Hazard
Worker Epidemiology	5	No Hazard



47 toxicity studies relevant to humans

No adverse effects were identified in any of the studies for both short-term and long-term exposure durations for:

Inhalation, ingestion, and dermal contact

REACH Coal Ash Aquatic Toxicity Studies

Toxicity Test	Publications and Reports	Conclusion
Acute Toxicity to Fish	4	No Hazard
Acute Toxicity to Aquatic Invertebrates	8	No Hazard
Toxicity to Aquatic Algae and Cyanobacteria	16	No Hazard
Toxicity to Microorganisms	8	No Hazard
Chronic Toxicity to Fish	1	No Hazard
Chronic Toxicity to Aquatic Invertebrates	2	No Hazard



39 aquatic toxicity studies

No adverse effects were identified in any of the studies for both short-term and long-term exposure durations for:
Fish, invertebrates, and micro-organisms

All of the 86 studies concluded "no hazard"

³ "Ashes (residues), coal," registration number EC# 931-322-8, is available on-line: www.echa.europa.eu/brief-profile/-/briefprofile/100.151.318

CCR Beneficial Use

For 8 years in a row, more than half of the coal combustion residuals (CCR) produced each year have been put into beneficial use.¹ That's millions of tons of coal ash that does not have to be stored and managed in landfills.

The Environmental Protection Agency encourages the use of coal ash because the practice:

- Reduces the use of virgin resources
- Lowers greenhouse gas emissions
- Reduces the cost of coal ash disposal
- Improves strength and durability of materials

Coal ash improves the performance and sustainability of building products like cement, wall board, and roofing shingles.



Coal ash is used by companies that recycle it into products like cement and concrete.



For every ton of fly ash used as a replacement for Portland cement, approximately one ton of greenhouse gas emissions are avoided. Annually, this reduces carbon emissions by 13 million tons—the equivalent to taking 2.5 million cars off the road.

American Coal Ash Association

"Applications, Science, and Sustainability of Coal Ash, Issue 1, 2023. ASH at Work - Coal Ash 101"

Available at: acaa-usa.org/wp-content/uploads/2023/06/ASH-2023-1.pdf



The cost to build roads, runways, and bridges would increase by an estimated \$104.6 billion over the next 20 years if fly ash were not available.

American Road and Transportation Builders Association

"The Economic Impacts of Prohibiting Coal Fly Ash Use in Transportation Infrastructure Construction, September 2011"

Available at: acaa-usa.org/publications/free-publications/



The many benefits of incorporating fly ash into Portland concrete cement have been demonstrated through extensive research and countless highway and bridge construction projects... Some of the benefits of fly ash in concrete [include] higher ultimate strength, improved workability...lowered costs, [and] increased durability.

Federal Highway Administration

"Highway Applications - Fly Ash Facts for Highway Engineers - Recycling - Sustainability - Pavements - Federal Highway Administration, June 2017"

Available at: www.fhwa.dot.gov/pavement/recycling/fach02.cfm

Built with Coal Ash

Notable national monuments and infrastructure all across the country are built with coal ash.



Oakland Bay Bridge



Hoover Dam



One World Trade Center

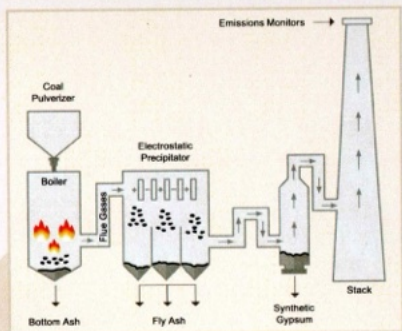
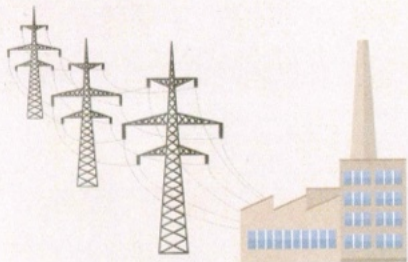


Washington, D.C. Metro

¹ acaa-usa.org/publications/production-use-reports/
"News Release Coal Ash Production and Use 2022"

Coal Ash

When power plants burn coal to produce electricity, coal combustion residuals (CCR), commonly known as coal ash, are created. More than half of CCR is beneficially used.¹



These residuals include fly ash, bottom ash/slag, and synthetic gypsum.



Synthetic gypsum conserves natural resources by replacing natural mined gypsum



Fly ash is used in airport runways



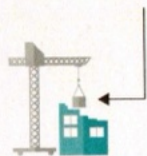
Fly ash is used to replace Portland Cement in the production of concrete



Concrete with **fly ash** is stronger, more durable, lower cost, and environmentally friendly

Fly ash is used in precast concrete products

Every ton of **fly ash** that replaces Portland Cement reduces carbon emissions by 1 ton



Fly ash is used in roads and driveways

Synthetic gypsum is used in wallboard

Fly ash is used in concrete siding materials



Fly ash is used in bridges

Fly ash is used in dams

Some **CCR** have properties suitable for metal castings in the aerospace and automotive industries



¹ [aca-a-usa.org/publications/production-use-reports/](https://www.acaa-usa.org/publications/production-use-reports/)
"News Release Coal Ash Production and Use 2022"

Radiation in Our Environment

Radiation Is a Part of Our Daily Lives

Regardless of where we live, everyone is exposed to small amounts of naturally occurring radiation every day. Our most common exposures are cosmic radiation from the sun and other celestial bodies, terrestrial radiation from the earth's soils and minerals, and even the foods we eat.



Radiation and People



Natural radiation such as cosmic radiation from the sun can enter our bodies through our skin and clothing. Other sources, like radon gas, are inhaled when we breathe.



We ingest other, smaller amounts of radiation because they are present in food and beverages such as certain kinds of nuts or milk.

We can receive doses of radiation from medical treatments such as X-rays, CT scans and other procedures.

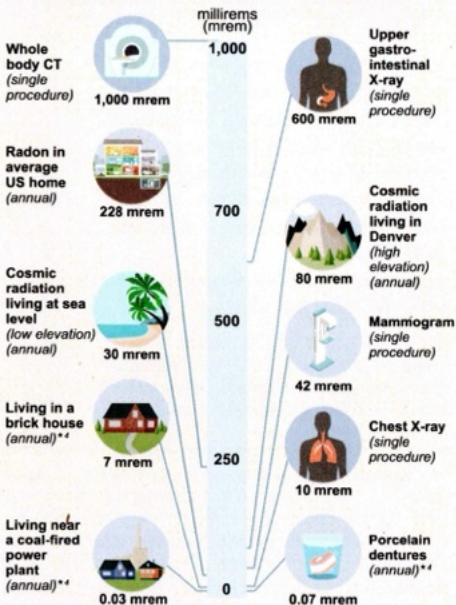


Other factors that contribute to our daily dose of radiation include how high above sea level we live, flying in airplanes, and the types of soils and minerals present where we live.



The types of work we do and the workplace environment can also affect our exposure to radiation, but this makes up less than 1% of most people's annual radiation dose.

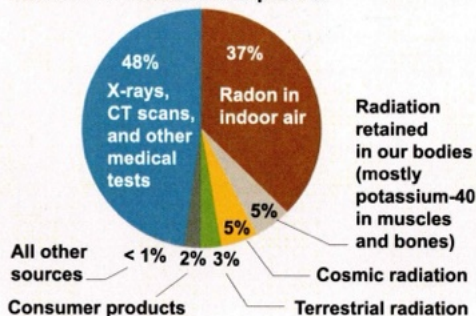
Relative Doses from Radiation Sources¹



Measuring and Understanding Radiation Levels

The chart above shows levels of radiation exposure from various sources. According to the National Council on Radiation Protection and Measurements (NCRP), the average radiation exposure of a person living in the United States is about 620 millirems/year (mrem/yr). As shown in the chart to the right, about half is due to background radiation (with radon inhalation being the biggest part) and medical exposures account for nearly all the rest. Consumer products and all other sources combined are small in comparison to background and medical radiation.

Sources of Radiation Exposure²



¹ Adapted from U.S. Environmental Protection Agency's (EPA) Relative Doses from Radiation Sources, www.epa.gov/radiation/radiation-sources-and-doses

^{*} Source and related dose was added to the original EPA graphic

² Data Source: National Council on Radiation Protection and Measurement, Report No. 160, 2009, <https://ncrponline.org/publications/reports/ncrp-report-160-2/>

Coal Ash and Radiation

Coal Ash

When we burn coal to produce electricity, the ash that remains is made up of the parts of the coal that do not burn, in the same way that ash remains after burning a campfire. Rocks, soils and minerals like coal contain small amounts of naturally occurring radiation.

Federal agencies (U.S. Geological Survey, U.S. Environmental Protection Agency [EPA]) agree that the trace levels of radiation in coal ash are not significantly greater than in common soils and rocks.

"Radioactive elements in coal and fly ash should not be sources of alarm. The vast majority of coal and the majority of fly ash are not significantly enriched in radioactive elements, or in associated radioactivity, compared to common soils or rocks."³

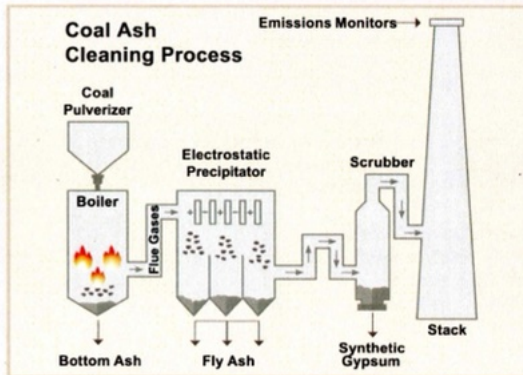
Groundwater Monitoring

The EPA requires electric utilities to measure levels of radium in groundwater from wells next to coal combustion residuals (CCR) management units.

Coal Ash and People

Coal ash is maintained and managed on access-controlled industrial sites. The chance of anyone from the community coming into contact with the coal ash is remote, and thus, the chance of receiving a significant radiation dose from coal ash is also remote.

For example, the Nuclear Regulatory Commission dose calculator⁴ estimates that someone living near a coal-fired power plant receives an additional radiation dose (0.03 mrem) that is about half the dose from having a porcelain dental crown or wearing dentures (0.07 mrem). See the graphic on page 1 of this fact sheet.



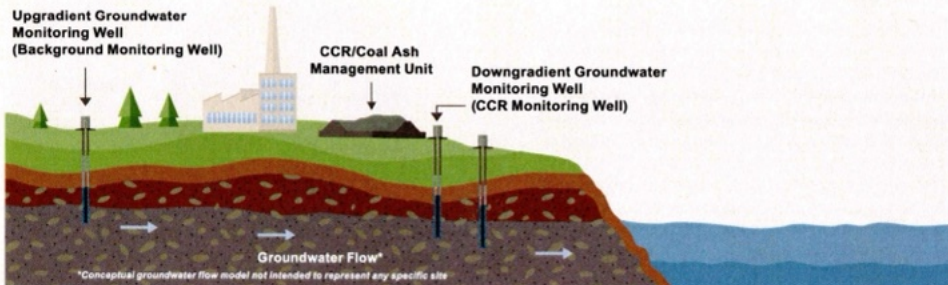
This publication provides information on constituents present in coal ash in the context of exposure from coal ash and other sources in our lives. This publication is for informational purposes only and should not be considered public health or professional medical advice. For more information on the potential health effects of radium please see information from:

EPA Radiation Sources and Doses: Includes links to dose calculator, fact sheet on types of radiation, pie chart from NCRP Report 160, and other useful information. www.epa.gov/radiation/radiation-sources-and-doses#dosescommon

EPA RadTown site: General information for teachers; includes links to other information sources. www.epa.gov/radtown

Radiologyinfo.com: Chart on X-ray exposures from medical procedures. www.radiologyinfo.org/en/info.cfm?pg=safety-xray

Center for Disease Control, Toxicological Profile for Radium: www.atsdr.cdc.gov/ToxProfiles/tp144.pdf



3 U.S. Geological Survey, 1997, Fact sheet FS-163-97: Radioactive elements in coal and fly ash. <https://pubs.usgs.gov/fs/1997/fs163-97/FS-163-97.pdf>

4 U.S. Nuclear Regulatory Commission Personal Radiation Dose Calculator. www.nrc.gov/about-nrc/radiation/around-us/calculator.html

Antimony in Our Environment

Antimony Is Naturally Occurring



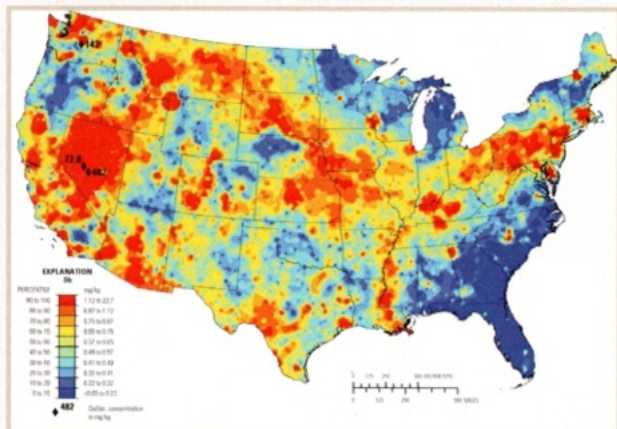
Antimony occurs widely in nature as a very low-level component of rocks, soils, and minerals. Antimony sulfide (stibnite, common name "kohl") was used in ancient Egypt as a form of eyeliner.



Antimony's primary use is as an alloy in storage batteries. It also is used in solder, sheet and pipe metals, ball and roller bearings, fire retardants, pigments, and infrared detectors and diodes.¹



Antimony in Soil



More than a hundred different antimony minerals occur in the earth's crust.² Soils usually contain less than 1 part per million (ppm, or mg/kg) of antimony.

This map, adapted from a U.S. Geological Survey (USGS) report,³ shows relative amounts of naturally occurring antimony in surface soils across the United States. The USGS data shows that national average antimony concentration in surface soils in the U.S. is approximately 0.31 mg/kg³ but can range much higher in some areas of the country.

Antimony and Food

Because it is found naturally in the environment and in many foods and in drinking water, we are exposed to very low levels of antimony every day.⁴ Antimony levels in meats, vegetables, and seafood are quite low, ranging from about 0.2 to 1.1 parts per billion (ppb).⁵

It is present at trace levels in cereals, fruits, vegetables, freshwater fish, meat and poultry, eggs, and dairy products. Beverages such as vegetable juice, soda and electrolyte drinks may have antimony concentrations of up to 6 ppb, which has been deemed acceptable for consumption by the FDA.⁶



1 www.cdc.gov/TSP/ToxProfiles/ToxProfiles.aspx?id=332&tid=58

2 www.usgs.gov/centers/national-minerals-information-center/antimony-statistics-and-information

3 USGS Scientific Investigations Report 2017-5118: Geochemical and Mineralogical Maps, with Interpretation, for Soils of the Conterminous United States, https://pubs.usgs.gov/sir/2017/5118/sir20175118_element.php?el=51

4 www.cdc.gov/TSP/ToxFAQs/ToxFAQsDetails.aspx?faqid=331&toxid=58

5 www.atsdr.cdc.gov/ToxProfiles/tp23-c1-b.pdf

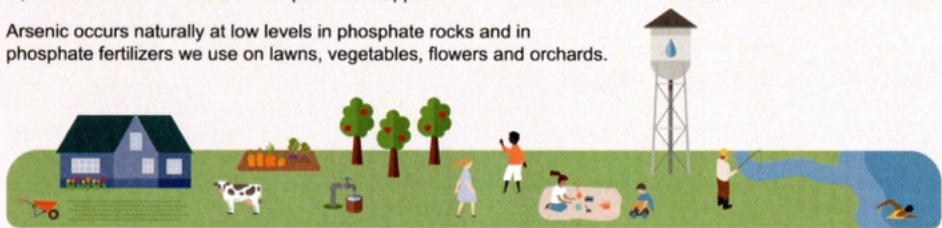
6 www.ecfr.gov/current/title-21/chapter-I/subchapter-B/part-165/subpart-B

Arsenic in Our Environment

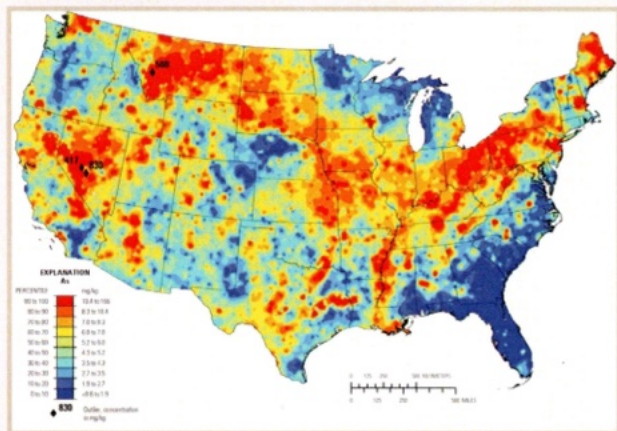
Arsenic Is Naturally Occurring

Nearly everyone is exposed to small amounts of arsenic every day without adverse health effects. Arsenic is a naturally occurring element that is widely distributed in the Earth's crust. Small amounts of arsenic are all around us, in the soils we walk on; the dusts we breathe; the groundwater we drink; and the streams and lakes we swim in, eat fish from and use for municipal water supplies.

Arsenic occurs naturally at low levels in phosphate rocks and in phosphate fertilizers we use on lawns, vegetables, flowers and orchards.



Arsenic in Soil



This map, adapted from a U.S. Geological Survey (USGS) report,¹ shows relative amounts of naturally occurring arsenic in surface soils across the United States. The USGS data shows that national average arsenic concentration in surface soils in the U.S. is approximately 6.4 mg/kg² but can range much higher in some areas of the country.

Arsenic in Food

Arsenic in soils and water is taken up by plants, crops and livestock and gets incorporated into our diets. Seafood, rice, mushrooms and chicken are some of the foods with the highest levels of arsenic. Beer, wine and some fruit juices can contain significant amounts of arsenic as well.

According to the Centers for Disease Control (CDC), "Since arsenic is found naturally in the environment, you will be exposed to some arsenic by eating food, drinking water, or breathing air."³



- 1 USGS, 2014, Geochemical and mineralogical maps for soils of the conterminous United States: U.S. Geological Survey Open-File Report 2014-1082, page 386, <http://dx.doi.org/10.3133/ofr20141082>.
- 2 USGS, 2013, Geochemical and mineralogical data for soils of the conterminous United States: U.S. Geological Survey Data Series 801, Table 2, <http://pubs.usgs.gov/ds/801/>
- 3 www.atsdr.cdc.gov/ToxProfiles/tp2-c1-b.pdf, page 3.

Coal Ash and Arsenic

Coal Ash

When we burn coal to produce electricity, the ash that remains is made up of the parts of the coal that do not burn, in the same way that ash remains after burning a campfire. Rocks, soils and minerals like coal contain small amounts of naturally occurring arsenic.

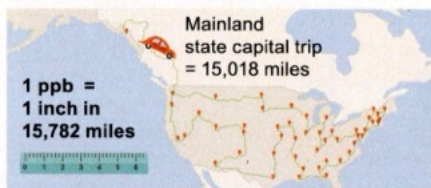


Groundwater Monitoring

The EPA requires electric utilities to measure levels of arsenic in groundwater from wells next to coal combustion residuals (CCR) management units.

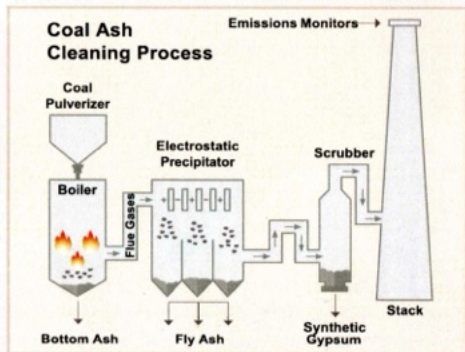
The groundwater sample results are compared to the EPA drinking water standard of 10 µg/L (parts per billion). For comparison, the CDC reports that wine can contain up to 33 µg/L arsenic, and juices and instant cocoa can contain up to 13 µg/L arsenic.⁴

One part per billion, or ppb, is like traveling in your car just 1 inch versus traveling more than 15,018 miles in your car to every state capital in the continental U.S.



Coal Ash and People

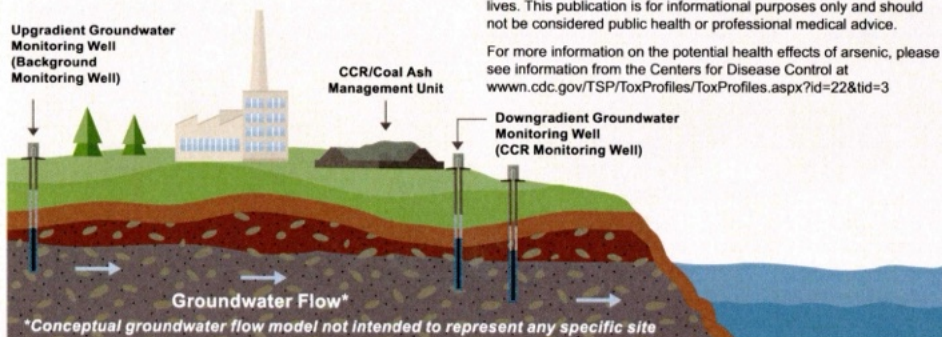
Coal ash is maintained and managed on access-controlled industrial sites. The chance of anyone from the community coming into contact with the coal ash is remote, and thus, the chance of receiving a significant exposure to arsenic from coal ash is also remote. Modern air pollution control technologies capture coal ash particulates and reduce the potential human exposure to background levels.⁴



⁴ www.atsdr.cdc.gov/ToxProfiles/tp2.pdf, p. 352

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For more information on the potential health effects of arsenic, please see information from the Centers for Disease Control at www.cdc.gov/TSP/ToxProfiles/ToxProfiles.aspx?id=22&tid=3



Barium in Our Environment

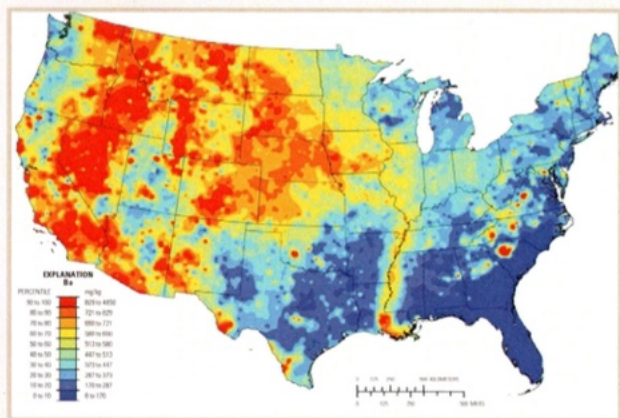
Barium Is Naturally Occurring

Barium occurs widely in nature as a low-level component of rocks, soils and minerals such as coal.¹

Barium compounds are used in weighting agents in oil drilling fluids, contrast agents for colonoscopies, printer paper, paints, bricks, ceramics, glass, rubber, and to produce the green colors in fireworks.^{2,3}



Barium in Soil



This map, adapted from a U.S. Geological Survey (USGS) report⁴, shows relative amounts of naturally occurring barium in surface soils across the United States. The USGS data shows that national average barium concentration in surface soils in the U.S. is approximately 262 mg/kg⁴ but can range much higher in some areas of the country.

Barium and Food

The greatest potential source of barium exposure is through food and drinking water, but the amount of barium in foods and drinking water typically is too low to be of concern.⁵ Some foods, such as Brazil nuts, seaweed, and fish, may contain higher amounts of barium.⁵



1 www.periodic-table.org/Barium-discoverer/

2 www.livescience.com/37581-barium.html

3 www.cdc.gov/TSP/PHS/PHS.aspx?phsid=325&toxid=57

4 https://pubs.usgs.gov/sir/2017/5118/sir20175118_element.php?el=56

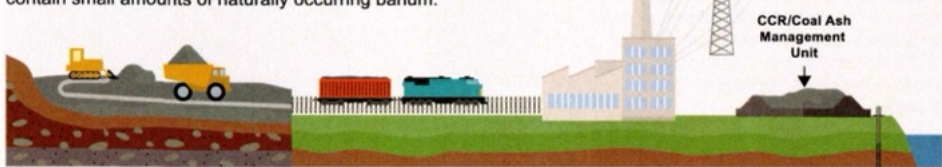
5 www.atsdr.cdc.gov/toxprofiles/tp24-c1.pdf

6 www.cdc.gov/TSP/ToxFAQs/ToxFAQsDetails.aspx?faqid=326&toxid=57

Coal Ash and Barium

Coal Ash

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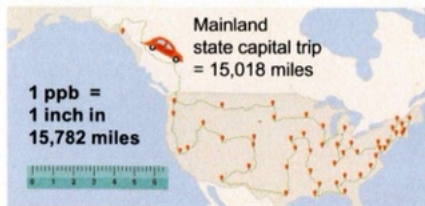


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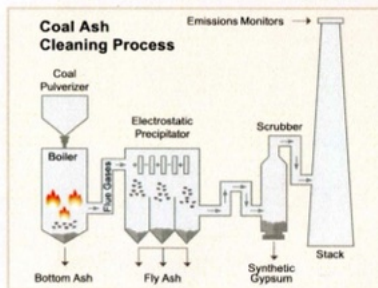
The groundwater sample results are compared to the EPA drinking water standard of 2,000 µg/L (parts per billion). For comparison, one serving of Brazil nuts (1 oz, or 4-5 nuts) has 12 to 14-times as much barium⁵ as is consumed in drinking 2 liters of drinking water with barium at the EPA drinking water standard.

One part per billion, or ppb, is like traveling in your car just 1 inch versus traveling more than 15,018 miles in your car to every state capital in the continental U.S.



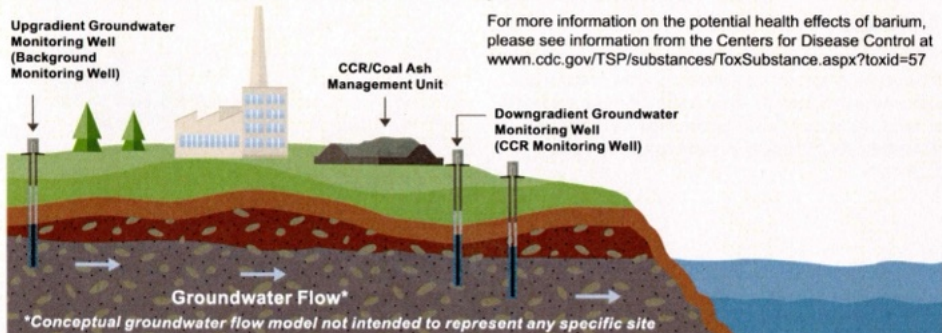
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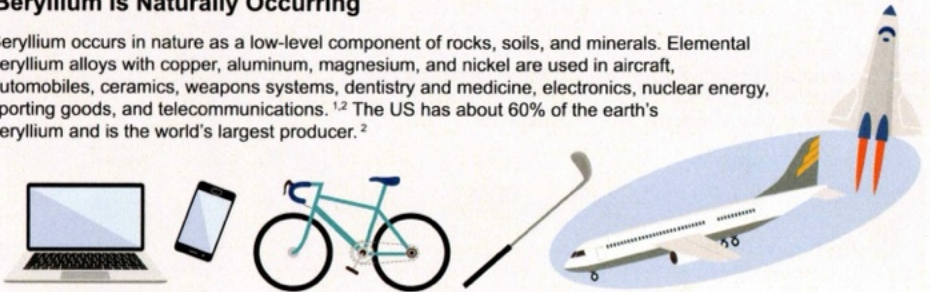
For more information on the potential health effects of barium, please see information from the Centers for Disease Control at www.cdc.gov/TSP/substances/ToxSubstance.aspx?toxid=57



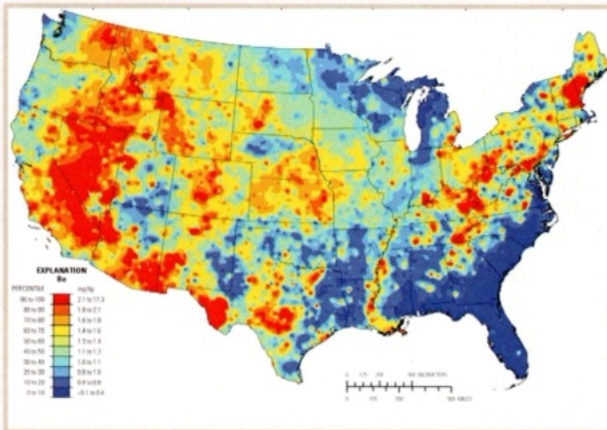
Beryllium in Our Environment

Beryllium Is Naturally Occurring

Beryllium occurs in nature as a low-level component of rocks, soils, and minerals. Elemental beryllium alloys with copper, aluminum, magnesium, and nickel are used in aircraft, automobiles, ceramics, weapons systems, dentistry and medicine, electronics, nuclear energy, sporting goods, and telecommunications.^{1,2} The US has about 60% of the earth's beryllium and is the world's largest producer.²



Beryllium in Soil



This map, adapted from a U.S. Geological Survey (USGS) report³, shows relative amounts of naturally occurring beryllium in surface soils across the United States. The USGS data shows that national average beryllium concentration in surface soils in the U.S. is approximately 0.59 mg/kg³ but can range much higher in some areas of the country.

Beryllium in Food

Kidney beans may contain up to about 2.2 parts per million, or ppm, beryllium. Peas, carrots, lettuce, and pears may contain beryllium up to 0.3 ppm, but all of these levels, even in kidney beans, are too low to cause significant beryllium exposure.⁴



The greatest potential human exposure to beryllium is for workers in areas where beryllium ores are mined and milled, and for metallurgical workers exposed to alloys that contain beryllium.



1 www.osha.gov/beryllium/

2 www.usgs.gov/centers/national-minerals-information-center/beryllium-statistics-and-information

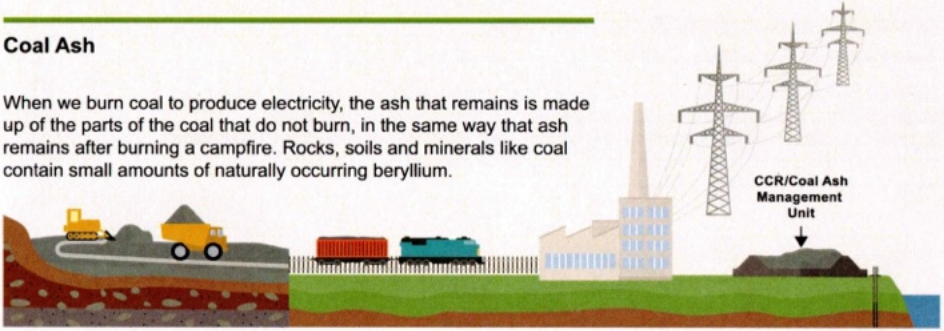
3 https://pubs.usgs.gov/sir/2017/5118/sir20175118_element.php?el=4

4 www.atsdr.cdc.gov/ToxProfiles/tp4-c1-b.pdf

Coal Ash and Beryllium

Coal Ash

When we burn coal to produce electricity, the ash that remains is made up of the parts of the coal that do not burn, in the same way that ash remains after burning a campfire. Rocks, soils and minerals like coal contain small amounts of naturally occurring beryllium.

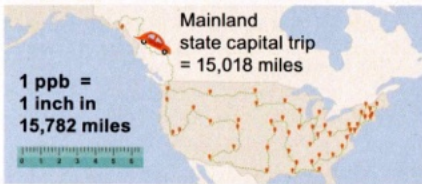


Groundwater Monitoring

The EPA requires electric utilities to measure levels of beryllium in groundwater from wells next to coal combustion residuals (CCR) management units.

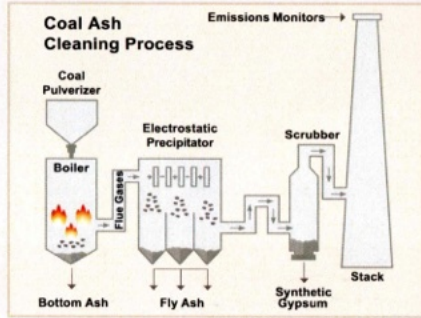
The groundwater sample results are compared to the EPA drinking water standard of 4 µg/L (parts per billion).

One part per billion, or ppb, is like traveling in your car just 1 inch versus traveling more than 15,018 miles in your car to every state capital in the continental U.S.



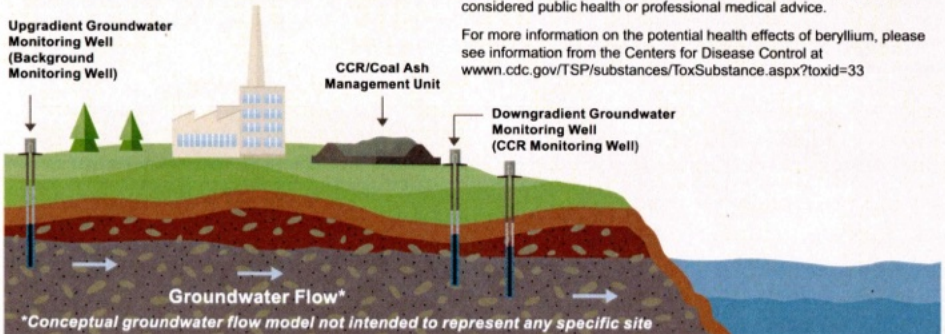
Coal Ash and People

Coal ash is maintained and managed on access-controlled industrial sites. The chance of anyone from the community coming into contact with the coal ash is remote, and thus, the chance of receiving a significant exposure to beryllium from coal ash is also remote. Modern air pollution control technologies capture coal ash particulates and reduce the potential human exposure to background levels that meet applicable regulatory requirements.



This publication provides information on constituents present in coal ash in the context of exposure from coal ash and other sources in our lives. This publication is for informational purposes only and should not be considered public health or professional medical advice.

For more information on the potential health effects of beryllium, please see information from the Centers for Disease Control at www.cdc.gov/TSP/substances/ToxSubstance.aspx?toxid=33



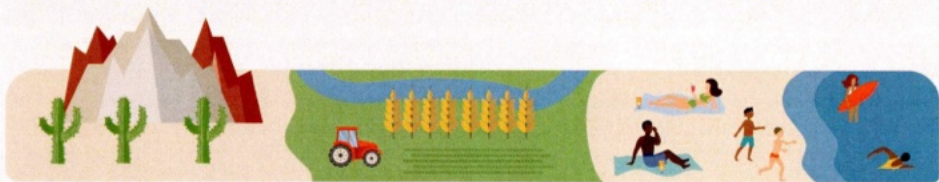
Boron in Our Environment

Boron Is Naturally Occurring

Most of the world's boron is present in our oceans. Seawater contains about 4,600 micrograms per liter ($\mu\text{g/L}$)¹ of boron. Boron levels in freshwater streams and in groundwater are lower (35 to 100 $\mu\text{g/L}$).

Boron levels generally are higher in western U.S. surface soils, up to 300 milligrams per kilogram (mg/kg)² in desert soils, while boron levels average about 31 mg/kg in soils east of the Mississippi River.

Boron is an essential nutrient for plants and is an ingredient in plant fertilizers that you use on your lawn and farmers use for their crops. However, like other essential nutrients, having too much boron in the soil can harm plants.



Boron Abundance and Uses

Boron is present in over 200 different naturally-occurring minerals. Boron is used in soaps, cosmetics, and pharmaceuticals, including most eyewashes. Some detergents, including 20 Mule Team Borax™, are mostly sodium borate. It is also present in some dietary supplements. Boron is used in manufacturing glassware and ceramics — Pyrex™ bakeware owes its heat strength to boron.³



Boron in Food

Because boron is present in soils and water, it also is present in plants and the foods we eat. The highest boron content is in foods such as raisins, peanut butter, peanuts, dried fruits and avocados. Vegetarians tend to consume more boron than non-vegetarians because of their plant-based diet. Coffee is considered to be the largest source of boron to the adult diet, owing mostly to how much we drink!⁴



The Centers for Disease Control (CDC) does not consider boron to be an essential element for humans nor a carcinogen. EPA has not developed a drinking water standard for boron, but does have a screening level of 4,000 $\mu\text{g/L}$ (parts per billion).

One part per billion, or ppb, is like traveling in your car just 1 inch versus traveling more than 15,018 miles in your car to every state capital in the continental U.S.



1 <https://pubs.usgs.gov/wsp/wsp2254/>

2 <https://pubs.usgs.gov/pp/1270/>

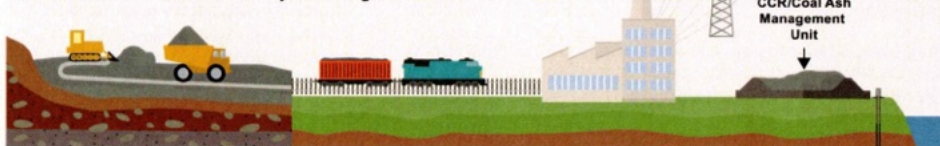
3 www.atsdr.cdc.gov/toxprofiles/tp26.pdf

4 www.atsdr.cdc.gov/toxprofiles/tp26.pdf, pages 148-150.

Coal Ash and Boron

Coal Ash

When we burn coal to produce electricity, the ash that remains is made up of the parts of the coal that do not burn, in the same way that ash remains after burning a campfire. Rocks, soils and minerals like coal contain small amounts of naturally occurring boron.



Groundwater Monitoring

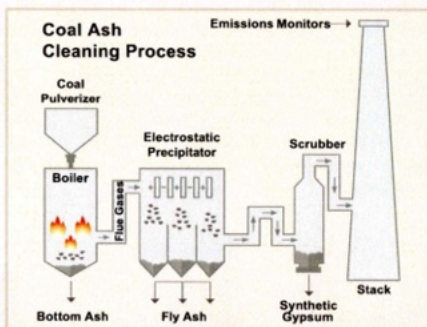
The EPA requires electric utilities to measure levels of boron in groundwater from wells next to coal combustion residuals (CCR) management units.

Coal comes from ancient plant-filled swamps, and because all plants need boron, boron is present in the coal, and in coal ash. Boron dissolves easily in water and typically moves with the flow of groundwater. Boron is generally not a constituent of concern for human health risk, however, sampling groundwater for boron can be a good indicator of whether groundwater has come into contact with CCR.

The EPA drinking water screening level for boron is 4,000 µg/L (parts per billion). For comparison, seawater contains about 4,600 µg/L boron. The CDC reports that wine can often contain up to 2,500 µg/L boron, and coffee can contain up to 290 µg/L boron.⁵

Coal Ash and People

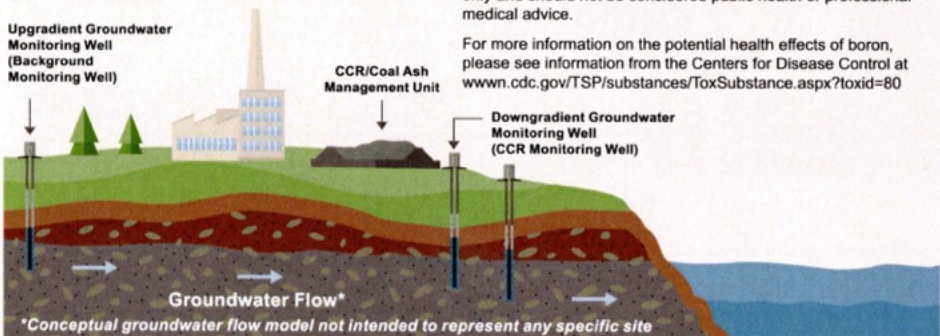
Coal ash is maintained and managed on access-controlled industrial sites. The chance of anyone from the community coming into contact with the coal ash is remote, and thus, the chance of receiving a significant exposure to boron from coal ash is also remote. Modern air pollution control technologies capture coal ash particulates and reduce the potential human exposure to background levels.



⁵ www.atsdr.cdc.gov/toxprofiles/tp26.pdf, pages 148-150.

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For more information on the potential health effects of boron, please see information from the Centers for Disease Control at www.cdc.gov/TSP/substances/ToxSubstance.aspx?toxid=80



Cadmium in Our Environment

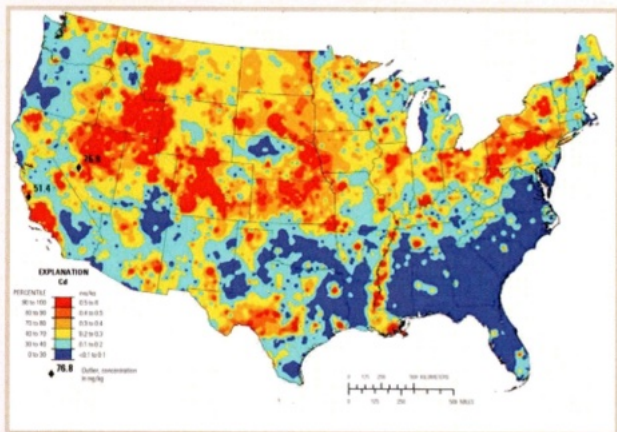
Cadmium Is Naturally Occurring

Cadmium is present in rocks, soils, and in minerals such as coal. Nearly everyone is exposed to cadmium every day through our contact with soils, the food we eat, water we drink and the air we breathe.

The dominant use of cadmium is in the manufacture of nickel-cadmium batteries. Cadmium is also used in making the popular oil painting colors, cadmium yellow and cadmium red. Cadmium chloride is used in photography, photocopying, dyeing and calico fabric printing.¹



Cadmium in Soil



This map, adapted from a U.S. Geological Survey (USGS) report,² shows relative amounts of naturally occurring cadmium in surface soils across the United States. The USGS data shows that national average cadmium concentration in surface soils in the U.S. is approximately 0.3 mg/kg³ but can range much higher in some areas of the country.

Cadmium in Food

Cadmium is naturally present in some foods; levels in food can vary greatly. In general, leafy vegetables such as lettuce and spinach contain relatively high levels of cadmium, as do potatoes and grains.

Peanuts, soybeans and sunflower seeds also may have naturally high levels of cadmium. Meat and fish tend to contain lower amounts of cadmium, except for organ meats such as kidney and liver.¹



1 www.atsdr.cdc.gov/toxprofiles/tp5.pdf

2 USGS, 2014, Geochemical and mineralogical maps for soils of the conterminous United States: U.S. Geological Survey Open-File Report 2014-1082, page 386, <http://dx.doi.org/10.3133/ofr20141082>

3 USGS, 2013, Geochemical and mineralogical data for soils of the conterminous United States: U.S. Geological Survey Data Series 801, Table 2, <http://pubs.usgs.gov/ds/801/>

Coal Ash and Cadmium

Coal Ash

When we burn coal to produce electricity, the ash that remains is made up of the parts of the coal that do not burn, in the same way that ash remains after burning a campfire. Rocks, soils and minerals like coal contain small amounts of naturally occurring cadmium.

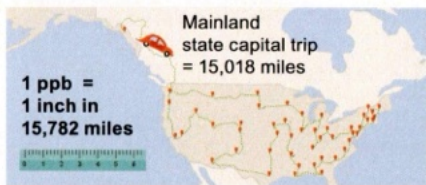


Groundwater Monitoring

The EPA requires electric utilities to measure levels of cadmium in groundwater from wells next to coal combustion residuals (CCR) management units.

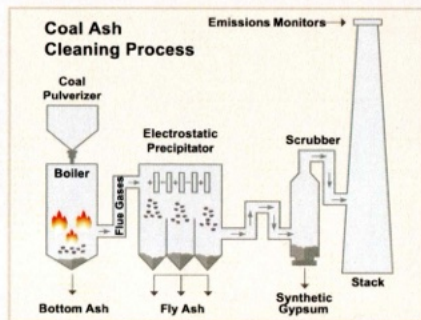
The EPA drinking water screening level for cadmium is 5 µg/L (parts per billion). For comparison, ½ cup of shelled sunflower seeds contains 21 µg cadmium⁴ – more than the amount in a whole day's consumption of drinking water containing cadmium at EPA's 5 µg/L drinking water standard.

One part per billion, or ppb, is like traveling in your car just 1 inch versus traveling more than 15,018 miles in your car to every state capital in the continental U.S.



Coal Ash and People

Coal ash is maintained and managed on access-controlled industrial sites. The chance of anyone from the community coming into contact with the coal ash is remote, and thus, the chance of receiving a significant exposure to cadmium from coal ash is also remote. Modern air pollution control technologies capture coal ash particulates and reduce the potential human exposure to background levels.



4 FDA. Total Diet Study Statistics on Element Results - 2006-2011. www.fda.gov/food/science-research-food/total-diet-study, page 21.

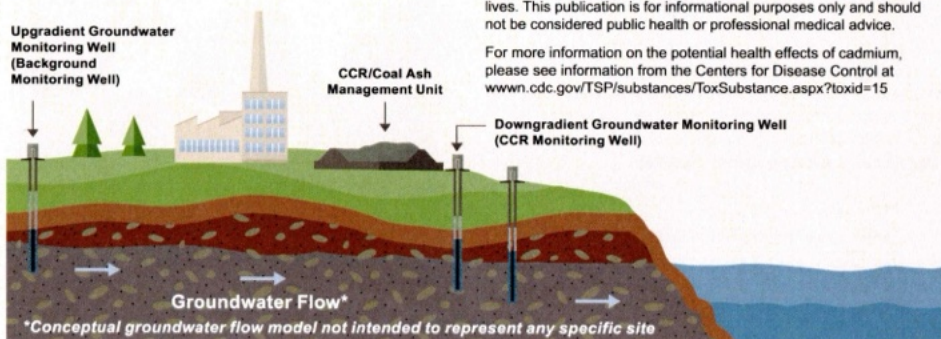
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For more information on the potential health effects of cadmium, please see information from the Centers for Disease Control at www.cdc.gov/TSP/substances/ToxSubstance.aspx?toxid=15

Upgradient Groundwater Monitoring Well (Background Monitoring Well)

CCR/Coal Ash Management Unit

Downgradient Groundwater Monitoring Well (CCR Monitoring Well)



Cobalt in Our Environment

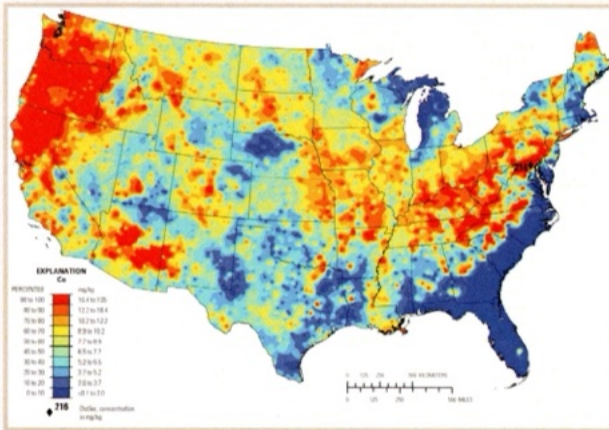
Cobalt Is Naturally Occurring

Cobalt is present in rocks, soils and minerals such as coal. Everyone is exposed to low levels of cobalt daily through the food we eat, the beverages and water we drink, and the air we breathe. Cobalt is an important part of alloys used in artificial hip and knee joints.¹ Cobalt is a critical component of lithium-ion batteries in cellphones, power tools and, more recently, electric vehicles. In fact, in the short and medium terms, cobalt is considered the highest material supply chain risk for electric vehicles.²

Cobalt blue is a well-known color in the art world. It was used in ancient Chinese blue and white porcelains. Cobalt became common in paintings in the 1800s by the impressionists, most notably Renoir, and in Van Gogh's "Starry Night", and is used still today.³



Cobalt in Soil

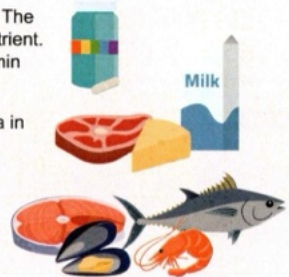


This map, adapted from a U.S. Geological Survey (USGS) report,⁴ shows relative amounts of naturally occurring cobalt in surface soils across the United States. The USGS data shows that national average cobalt concentration in surface soils in the U.S. is approximately 8.9 mg/kg⁵ but can range much higher in some areas of the country.

Cobalt and Health

Cobalt is beneficial for humans because it is an important part of vitamin B12. The human body cannot make vitamin B12; thus, it is classified as an essential nutrient. In fact, only bacteria and certain other single-celled organisms can make vitamin B12, using inorganic cobalt in the environment.¹

Beef and dairy products are good sources of vitamin B12 because the bacteria in the cow's stomach make vitamin B12 that is taken up into the cow. Fish and shellfish are also important sources of vitamin B12 because they eat plankton, which in turn have consumed bacteria that make vitamin B12.¹



1 ATSDR, www.atsdr.cdc.gov/toxfaqs/tfacts33.pdf

2 DOE, 2021, Reducing Reliance on Cobalt in Lithium-Ion Batteries, www.energy.gov/eere/vehicles/articles/reducing-reliance-cobalt-lithium-ion-batteries

3 www.invaluable.com/blog/blue-color/

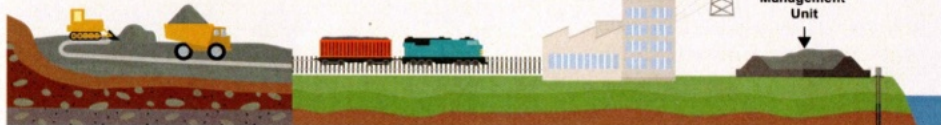
4 USGS, 2014, Geochemical and mineralogical maps for soils of the conterminous United States: U.S. Geological Survey Open-File Report 2014-1082, page 386, <http://dx.doi.org/10.3133/ofr20141082>

5 USGS, 2013, Geochemical and mineralogical data for soils of the conterminous United States: U.S. Geological Survey Data Series 801, Table 2, <http://pubs.usgs.gov/ds/801/>

Coal Ash and Cobalt

Coal Ash

When we burn coal to produce electricity, the ash that remains is made up of the parts of the coal that do not burn, in the same way that ash remains after burning a campfire. Rocks, soils and minerals like coal contain small amounts of naturally occurring cobalt.



Groundwater Monitoring

The EPA requires electric utilities to measure levels of cobalt in groundwater from wells next to coal combustion residuals (CCR) management units.

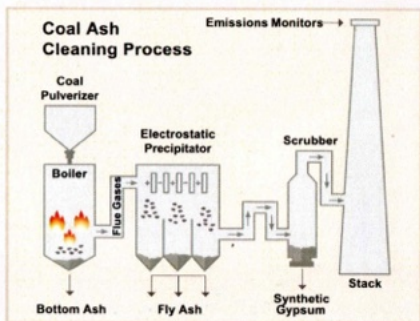
The EPA drinking water screening level for cobalt is 6 µg/L (parts per billion). For comparison, we consume an average of 11 µg of cobalt through the food we eat each day⁶ – approximately the same amount of cobalt in a whole day's consumption of drinking water with cobalt at EPA's 6 µg/L screening level.

One part per billion, or ppb, is like traveling in your car just 1 inch versus traveling more than 15,018 miles in your car to every state capital in the continental U.S.



Coal Ash and People

Coal ash is maintained and managed on access-controlled industrial sites. The chance of anyone from the community coming into contact with the coal ash is remote, and thus, the chance of receiving a significant exposure to cobalt from coal ash is also remote. Modern air pollution control technologies capture coal ash particulates and reduce the potential human exposure to background levels.



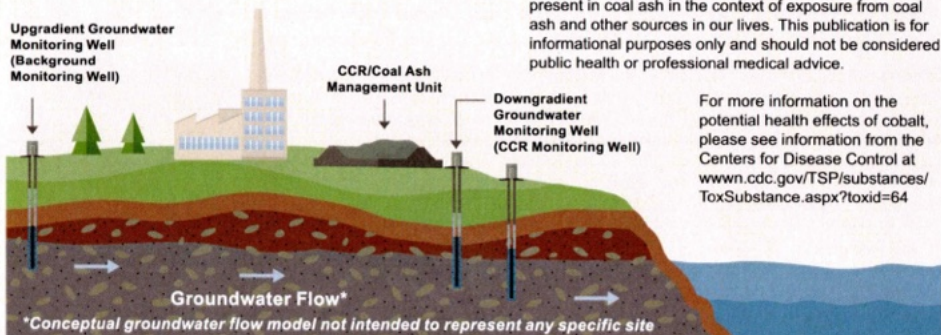
6 www.mdpi.com/2304-8158/9/6/795

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Upgradient Groundwater Monitoring Well (Background Monitoring Well)

CCR/Coal Ash Management Unit

Downgradient Groundwater Monitoring Well (CCR Monitoring Well)



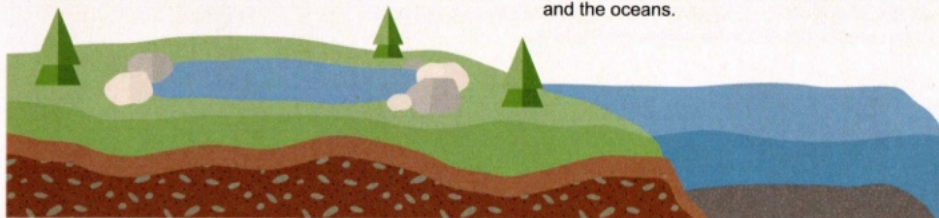
For more information on the potential health effects of cobalt, please see information from the Centers for Disease Control at www.cdc.gov/TSP/substances/ToxSubstance.aspx?toxid=64

Lead in Our Environment

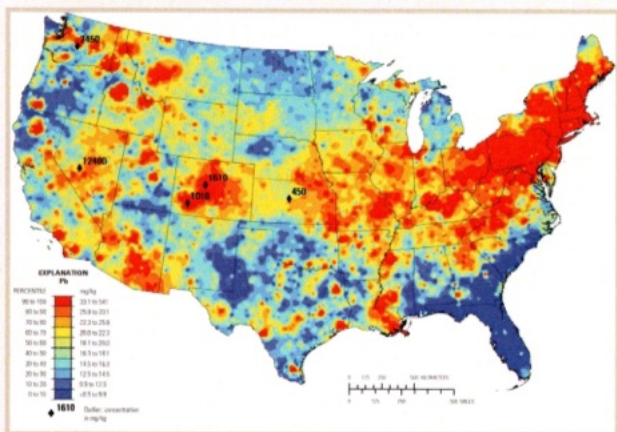
Lead Is Naturally Occurring

Lead is a naturally occurring bluish-gray metal found in the earth's crust.

Small amounts of lead are present in rocks, soils, and sediments and in streams, lakes and the oceans.



Lead in Soil



This map, adapted from a U.S. Geological Survey (USGS) report,¹ shows relative amounts of naturally occurring lead in surface soils across the United States. The USGS data shows that national average lead concentration in surface soils in the U.S. is approximately 26 mg/kg² but can range much higher in some areas of the country.

Exposure to Lead

We are exposed to lead in a variety of ways. While small amounts of lead are present in foods, we are also exposed to lead through everyday activities. Lead is used in batteries, fishing lures and sinkers, gun ammunition, stained glass, ceramics and even some jewelry. Older homes may have lead-based paints and lead plumbing. Many older crystal products, such as wine glasses and decanters, contained lead in the glass. Leaded gasoline was a main source of lead exposure until it was banned in 1996.³



1 USGS, 2014, Geochemical and mineralogical maps for soils of the conterminous United States: U.S. Geological Survey Open-File Report 2014-1082, page 386, <http://dx.doi.org/10.3133/ofr20141082>.

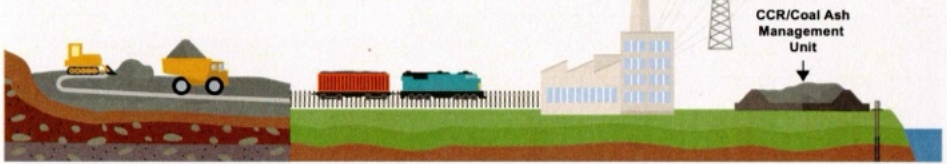
2 USGS, 2013, Geochemical and mineralogical data for soils of the conterminous United States: U.S. Geological Survey Data Series 801, Table 2, <http://pubs.usgs.gov/ds/801/>

3 www.atsdr.cdc.gov/toxprofiles/tp13.pdf, page 1.

Coal Ash and Lead

Coal Ash

When we burn coal to produce electricity, the ash that remains is made up of the parts of the coal that do not burn, in the same way that ash remains after burning a campfire. Rocks, soils, and minerals like coal contain small amounts of naturally occurring lead.



Groundwater Monitoring

The EPA requires electric utilities to measure levels of lead in groundwater from wells next to coal combustion residuals (CCR) management units.

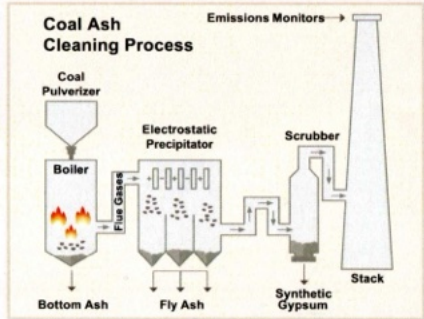
The EPA drinking water screening level for lead is 15 µg/L (parts per billion).

One part per billion, or ppb, is like traveling in your car just 1 inch versus traveling more than 15,018 miles in your car to every state capital in the continental U.S.

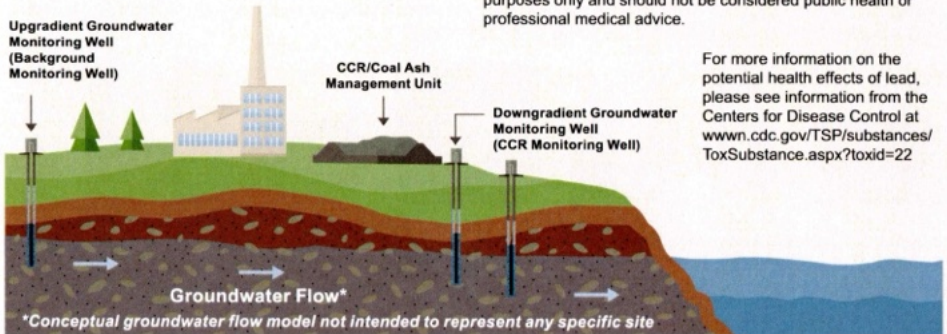


Coal Ash and People

Coal ash is maintained and managed on access-controlled industrial sites. The chance of anyone from the community coming into contact with the coal ash is remote, and thus, the chance of receiving a significant exposure to lead from coal ash is also remote. Modern air pollution control technologies capture coal ash particulates and reduce the potential human exposure to background levels.



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For more information on the potential health effects of lead, please see information from the Centers for Disease Control at www.cdc.gov/TSP/substances/ToxSubstance.aspx?toxid=22

Lithium in Our Environment

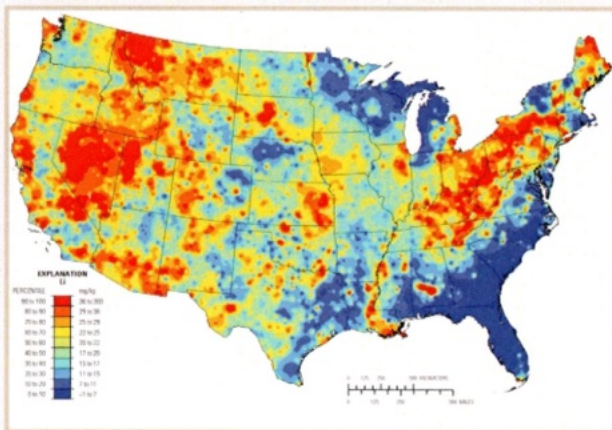
Lithium Is Naturally Occurring

Lithium is present in rocks, soils and minerals such as coal. Nearly everyone is exposed to small amounts of lithium every day through our contact with soils, the food we eat, water we drink and the air we breathe.

Lithium is the critical component of lithium-ion batteries in cellphones, power tools and, more recently, electric vehicles. It is the component in glass-topped stoves that prevents the glass from shattering when heated. It is also used as a sanitizing agent in pools, hot tubs and spas; however, with the demand for lithium in batteries, lithium products for pools are no longer available.¹



Lithium in Soil

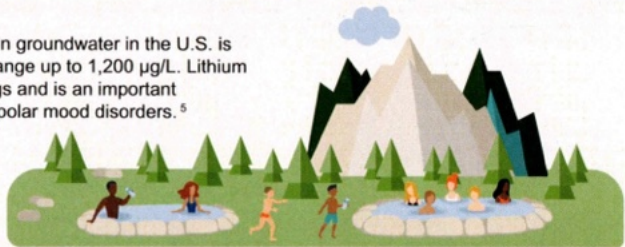


This map, adapted from a U.S. Geological Survey (USGS) report,² shows relative amounts of naturally occurring lithium in surface soils across the United States. The USGS data shows that national average lithium concentration in surface soils in the U.S. is approximately 21 mg/kg³ but can range much higher in some areas of the country.

Lithium and Health

The average concentration of lithium in groundwater in the U.S. is 6 µg/L (or parts per billion)⁴ but can range up to 1,200 µg/L. Lithium is commonly present in mineral springs and is an important long-term therapeutic treatment for bipolar mood disorders.⁵

Some studies suggest that areas where drinking water concentrations of lithium are naturally high have lower rates of violent crimes and suicide.⁶



1 <https://cfpub.epa.gov/ncea/pprtv/documents/Lithium.pdf>

2 USGS, 2014, Geochemical and mineralogical maps for soils of the conterminous United States: U.S. Geological Survey Open-File Report 2014-1082, page 386, <http://dx.doi.org/10.3133/ofr20141082>

3 USGS, 2013, Geochemical and mineralogical data for soils of the conterminous United States: U.S. Geological Survey Data Series 801, Table 2, <http://pubs.usgs.gov/ds/801/>

4 <http://pubs.usgs.gov/sir/2011/5059>

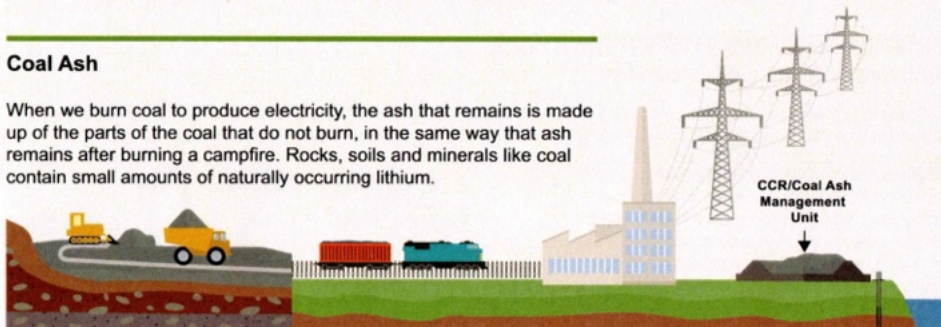
5 Therapeutic doses range from 147 to 343 mg lithium per day; <https://cfpub.epa.gov/ncea/pprtv/documents/Lithium.pdf>

6 <https://link.springer.com/content/pdf/10.1007/s12011-018-1455-2.pdf>, www.cambridge.org/core/journals/the-british-journal-of-psychiatry/article/association-between-naturally-occurring-lithium-in-drinking-water-and-suicide-rates-systematic-review-and-metaanalysis-of-ecological-studies/B7DDAF6E2A818C45EA64F3424E12D67A

Coal Ash and Lithium

Coal Ash

When we burn coal to produce electricity, the ash that remains is made up of the parts of the coal that do not burn, in the same way that ash remains after burning a campfire. Rocks, soils and minerals like coal contain small amounts of naturally occurring lithium.

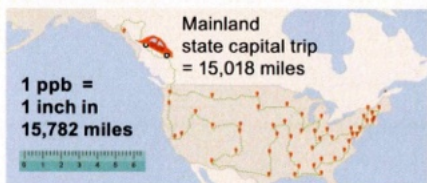


Groundwater Monitoring

The EPA requires electric utilities to measure levels of lithium in groundwater from wells next to coal combustion residuals (CCR) management units.

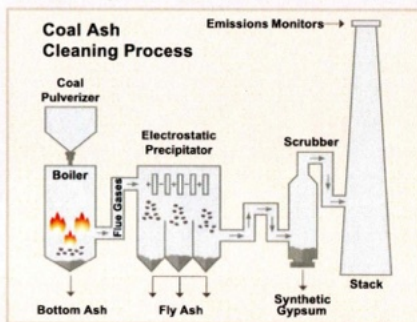
The EPA drinking water screening level for lithium is 40 µg/L (parts per billion). For comparison, concentrations of lithium in red wines, white wines and energy drinks average between 8 and 11 µg/L.⁷ Some bottled mineral waters have over 1,000 µg/L lithium.⁸ Bottled water is available from a mineral spring in the state of Georgia that contains 500 µg/L lithium.⁹

One part per billion, or ppb, is like traveling in your car just 1 inch versus traveling more than 15,018 miles in your car to every state capital in the continental U.S.



Coal Ash and People

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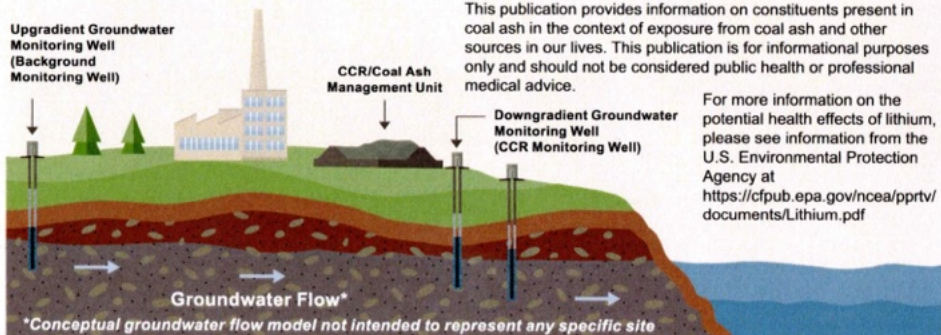
7 www.mdpi.com/2304-8158/9/6/795

8 www.mdpi.com/1660-4601/17/22/8369

9 www.lithiaspringwater.com/index.html

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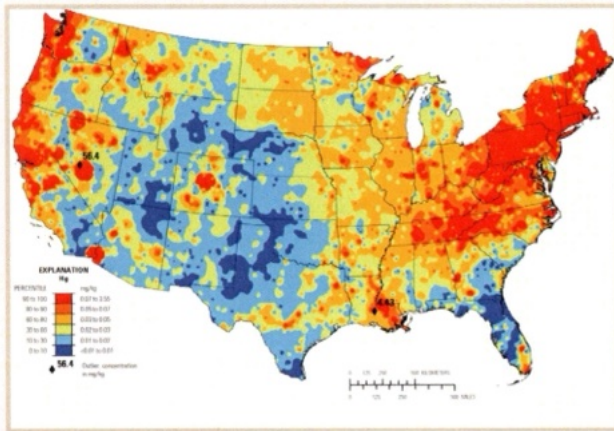
Mercury in Our Environment

Mercury Is Naturally Occurring

Mercury occurs widely in nature as a low-level component of rocks, soils, and minerals. Cinnabar is the main source of mercury for commercial uses.¹ Mercury is used in thermometers, fluorescent lamps, electrical switches, and telescopes. Medical uses include dental amalgams, contact lens solutions, cosmetics, and eye drops.^{1,2} Most people are exposed daily to trace amounts of mercury in soils, food, water, and air without adverse effects.



Mercury in Soil



Mercury is one of the rarest elements in Earth's crust, occurring at an average concentration of about 0.05 parts per million world-wide. This map, adapted from a U.S. Geological Survey (USGS) report,³ shows relative amounts of naturally occurring mercury in surface soils across the United States.

The USGS data shows that national average mercury concentration in surface soils in the U.S. is approximately 0.035 mg/kg in surface soils⁴ but can range much higher in some areas of the country.

Mercury in Food

Eating seafood is the most common way people are exposed to mercury, but grains, leafy vegetables, and processed foods also contain traces of mercury.^{5,6}



Longer-lived fish such as tuna and swordfish tend to have higher levels of mercury. The Food & Drug Administration allows up to 1 ppm mercury in fish sold for human consumption.

1 www.cdc.gov/TSP/substances/ToxSubstance.aspx?toxid=24

2 <https://pubs.usgs.gov/sir/2013/5137/>

3 USGS Scientific Investigations Report 2017-5118: Geochemical and Mineralogical Maps, with Interpretation, for Soils of the Conterminous United States, https://pubs.usgs.gov/sir/2017/5118/sir20175118_element.php?el=80

4 https://pubs.usgs.gov/pp/1270/pdf/PP1270_508.pdf

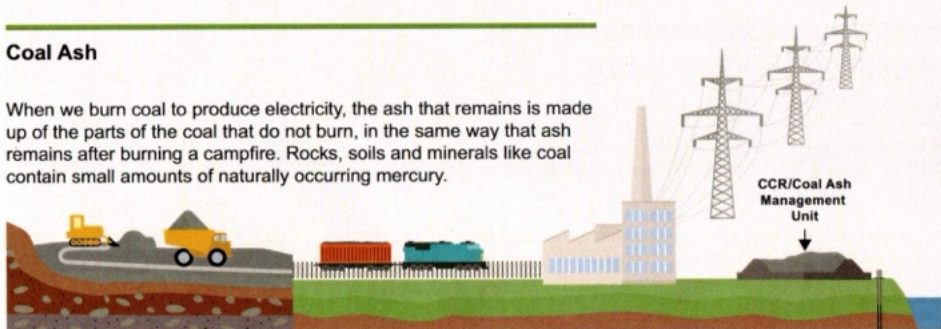
5 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5775204/>

6 www.fda.gov/food/environmental-contaminants-food/mercury-food-and-dietary-supplements

Coal Ash and Mercury

Coal Ash

When we burn coal to produce electricity, the ash that remains is made up of the parts of the coal that do not burn, in the same way that ash remains after burning a campfire. Rocks, soils and minerals like coal contain small amounts of naturally occurring mercury.

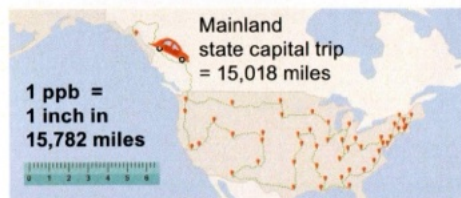


Groundwater Monitoring

The EPA requires electric utilities to measure levels of mercury in groundwater from wells next to coal combustion residuals (CCR) management units.

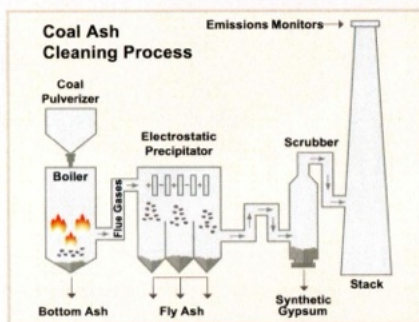
The groundwater sample results are compared to the EPA drinking water standard of 2 µg/L (parts per billion). For comparison, a 5-oz can of tuna contains about 3.5 times as much mercury as is consumed in drinking 2 liters of drinking water with mercury at the EPA drinking water standard.⁶

One part per billion, or ppb, is like traveling in your car just 1 inch versus traveling more than 15,018 miles in your car to every state capital in the continental U.S.



Coal Ash and People

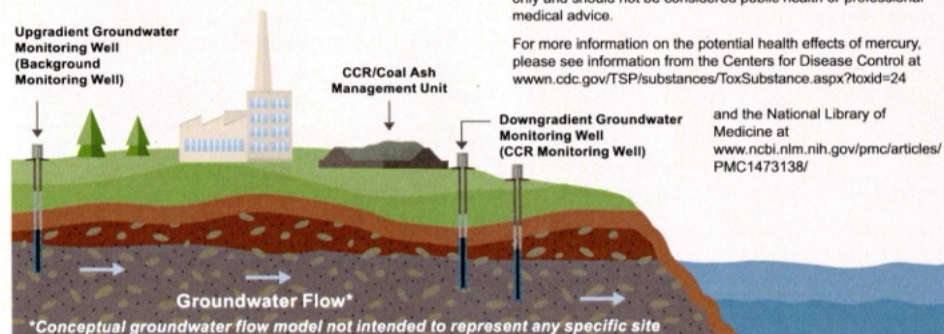
Coal ash is maintained and managed on access-controlled industrial sites. The chance of anyone from the community coming into contact with the coal ash is remote; thus the chance of receiving a significant exposure to mercury from coal ash is also remote. Modern air pollution control technologies capture coal ash particulates and reduce the potential human exposure to background levels that meet applicable regulatory requirements.



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For more information on the potential health effects of mercury, please see information from the Centers for Disease Control at www.cdc.gov/TSP/substances/ToxSubstance.aspx?toxid=24

and the National Library of Medicine at www.ncbi.nlm.nih.gov/pmc/articles/PMC1473138/

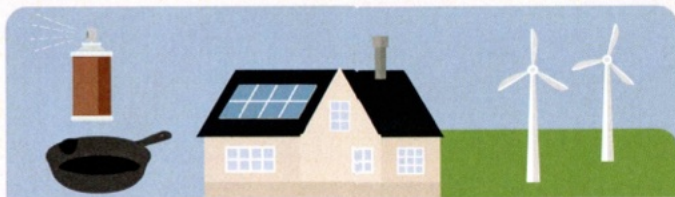


Molybdenum in Our Environment

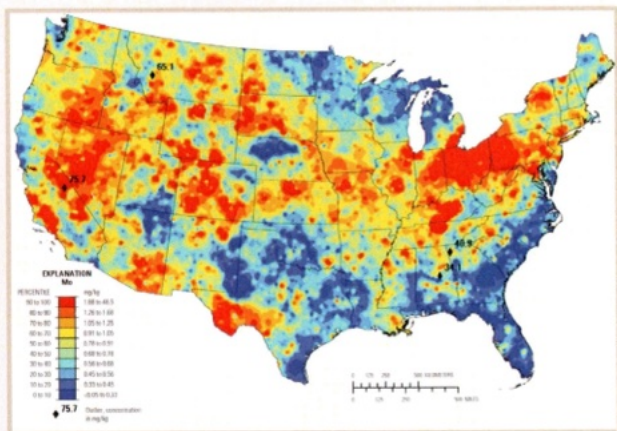
Molybdenum Is Naturally Occurring

Molybdenum is a naturally occurring element in rocks, soils and minerals such as coal. We are exposed to low levels of molybdenum every day, mostly in food. In fact, it is an essential nutrient, and a small amount of it is needed by the body to maintain proper metabolism.¹

Molybdenum is an important component of cast iron and steel and is used in lubricants and paints. It is becoming more and more important in green technologies such as manufacturing solar panels and wind turbine blades.²



Molybdenum in Soil



This map, adapted from a U.S. Geological Survey (USGS) report,³ shows relative amounts of naturally occurring molybdenum in surface soils across the United States. The USGS data shows that national average molybdenum concentration in surface soils in the U.S. is approximately 1 mg/kg⁴ but can range much higher in some areas of the country.

Molybdenum and Health

Molybdenum is an essential nutrient and is often included in nutritional supplements. We get the molybdenum required for human nutrition from foods such as beans, cereal grains and leafy vegetables. Milk and milk products are also an important source, with concentrations in milk around 35 µg/L (or parts per billion).⁵



1 ATSDR, www.atsdr.cdc.gov/toxfaqs/tfacts212.pdf

2 www.atsdr.cdc.gov/ToxProfiles/tp212.pdf, page 89.

3 USGS, 2014, Geochemical and mineralogical maps for soils of the conterminous United States: U.S. Geological Survey Open-File Report 2014-1082, page 386, <http://dx.doi.org/10.3133/ofr20141082>

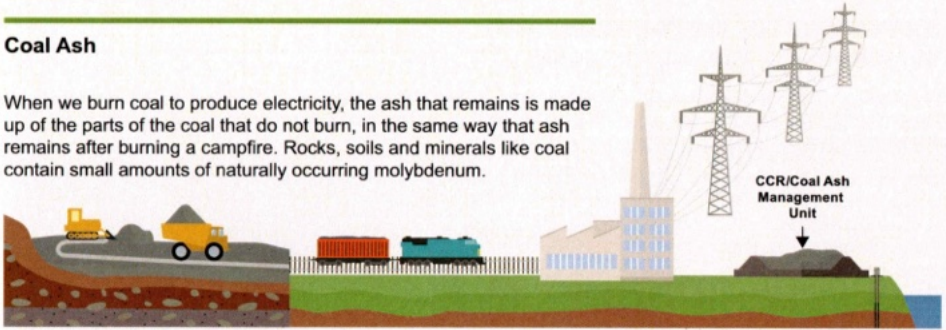
4 USGS, 2013, Geochemical and mineralogical data for soils of the conterminous United States: U.S. Geological Survey Data Series 801, Table 2, <http://pubs.usgs.gov/ds/801/>

5 www.atsdr.cdc.gov/ToxProfiles/tp212.pdf, pages 2 and 106.

Coal Ash and Molybdenum

Coal Ash

When we burn coal to produce electricity, the ash that remains is made up of the parts of the coal that do not burn, in the same way that ash remains after burning a campfire. Rocks, soils and minerals like coal contain small amounts of naturally occurring molybdenum.

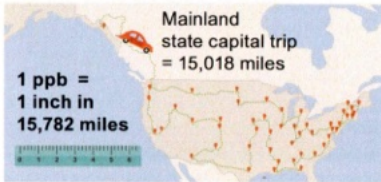


Groundwater Monitoring

The EPA requires electric utilities to measure levels of molybdenum in groundwater from wells next to coal combustion residuals (CCR) management units.

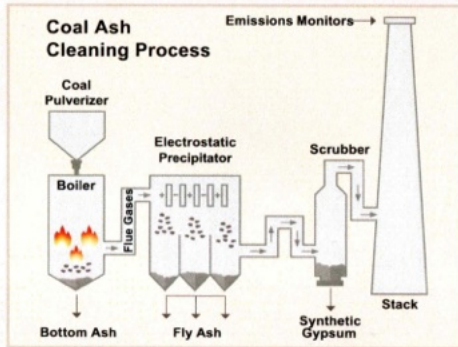
The EPA drinking water screening level for molybdenum is 100 µg/L (parts per billion). For comparison, one serving of black-eyed peas contains more molybdenum than a whole day's consumption of drinking water with molybdenum at EPA's 100 µg/L screening level.⁶

One part per billion, or ppb, is like traveling in your car just 1 inch versus traveling more than 15,018 miles in your car to every state capital in the continental U.S.



Coal Ash and People

Coal ash is maintained and managed on access-controlled industrial sites. The chance of anyone from the community coming into contact with the coal ash is remote, and thus, the chance of receiving a significant exposure to molybdenum from coal ash is also remote. Modern air pollution control technologies capture coal ash particulates and reduce the potential human exposure to background levels that meet applicable regulatory requirements.

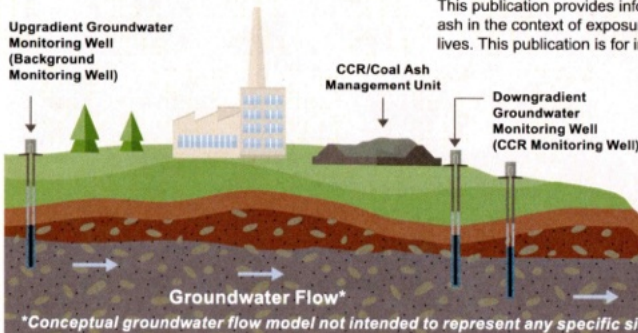


⁶ <https://ods.od.nih.gov/factsheets/Molybdenum-HealthProfessional/>

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be considered public health or professional medical advice.

For more information on the potential health effects of molybdenum, please see information from the Centers for Disease Control at www.cdc.gov/TSP/substances/ToxSubstance.aspx?toxid=289



Nickel in Our Environment

Nickel Is Naturally Occurring

Nickel is a very abundant naturally occurring element in rocks, soils and minerals such as coal. We are exposed to low levels of nickel every day, through our contact with soils, the food we eat, water we drink and the air we breathe.

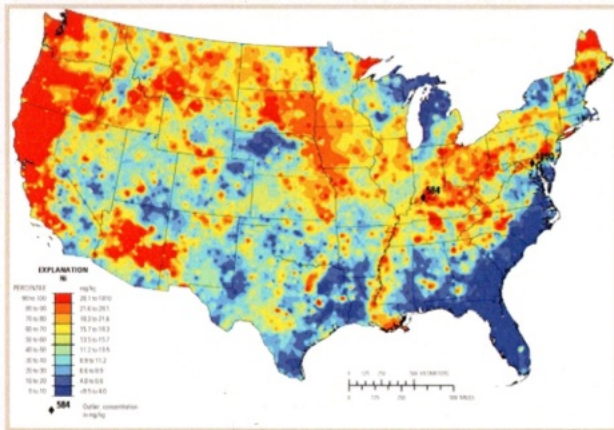
Most nickel is used to make stainless steel. Nickel is also used in coins and jewelry and imparts a green color to ceramics. Nickel obviously is a main component of nickel-cadmium batteries.¹



Fun fact: The U.S. 5-cent coin is composed of a copper-nickel alloy containing 25% nickel and 75% copper, whereas only the faces of the 10-cent, quarter, half-dollar, and 1-dollar coins contain a copper-nickel alloy.²



Nickel in Soil



This map, adapted from a U.S. Geological Survey (USGS) report,³ shows relative amounts of naturally occurring nickel in surface soils across the United States. The USGS data shows that national average nickel concentration in surface soils in the U.S. is approximately 18 mg/kg⁴ but can range much higher in some areas of the country.

Nickel in Food

Nickel in soils and water is taken up by plants, crops, and livestock, and gets incorporated into our diets. Foods that contain nickel are the major source of nickel exposure for the general population. We all eat about 170 micrograms (μg) of nickel in our food every day. Foods naturally high in nickel include chocolates, soybeans, nuts, and oatmeal.²



1 <https://www.cdc.gov/TSP/ToxFAQs/ToxFAQsDetails.aspx?faqid=244&toxid=44>

2 www.atsdr.cdc.gov/ToxProfiles/tp15-c1-b.pdf

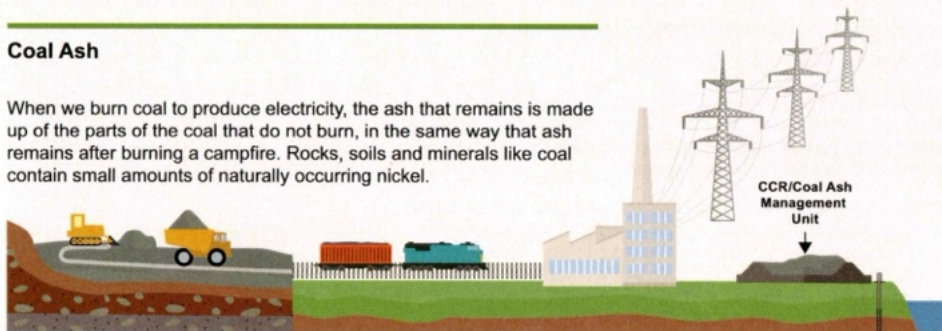
3 USGS, 2014, Geochemical and mineralogical maps for soils of the conterminous United States: U.S. Geological Survey Open-File Report 2014-1082, page 386, <http://dx.doi.org/10.3133/ofr20141082>

4 USGS, 2013, Geochemical and mineralogical data for soils of the conterminous United States: U.S. Geological Survey Data Series 801, Table 2, <http://pubs.usgs.gov/ds/801/>

Coal Ash and Nickel

Coal Ash

When we burn coal to produce electricity, the ash that remains is made up of the parts of the coal that do not burn, in the same way that ash remains after burning a campfire. Rocks, soils, and minerals like coal contain small amounts of naturally occurring nickel.

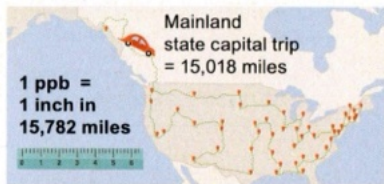


Groundwater Monitoring

The EPA does not require electric utilities to measure levels of nickel in groundwater, however, some states do.

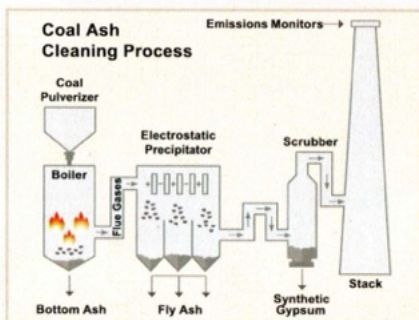
The EPA drinking water screening level for nickel is 390 µg/L (parts per billion). For comparison, 1 cup of nuts contains about 130 µg of nickel.⁵

One part per billion, or ppb, is like traveling in your car just 1 inch versus traveling more than 15,018 miles in your car to every state capital in the continental U.S.



Coal Ash and People

Coal ash is maintained and managed on access-controlled industrial sites. The chance of anyone from the community coming into contact with the coal ash is remote, and thus, the chance of receiving a significant exposure to nickel from coal ash is also remote. Modern air pollution control technologies capture coal ash particulates and reduce the potential human exposure to background levels that meet applicable regulatory requirements.



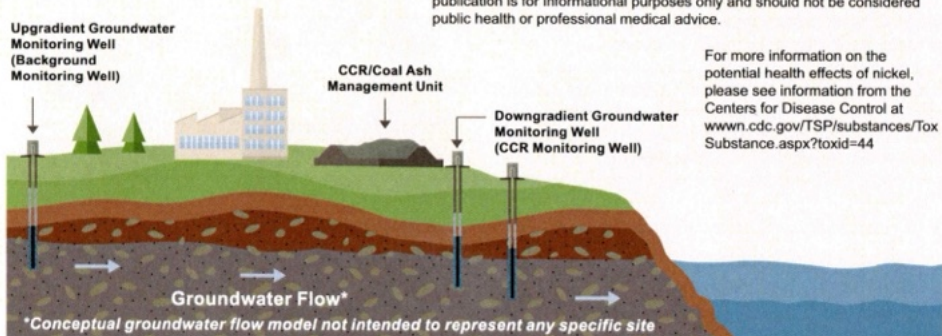
⁵ www.atsdr.cdc.gov/ToxProfiles/tp15-c1-b.pdf

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Upgradient Groundwater Monitoring Well (Background Monitoring Well)

CCR/Coal Ash Management Unit

Downgradient Groundwater Monitoring Well (CCR Monitoring Well)



*Conceptual groundwater flow model not intended to represent any specific site

For more information on the potential health effects of nickel, please see information from the Centers for Disease Control at www.cdc.gov/TSP/substances/ToxSubstance.aspx?toxid=44

Selenium in Our Environment

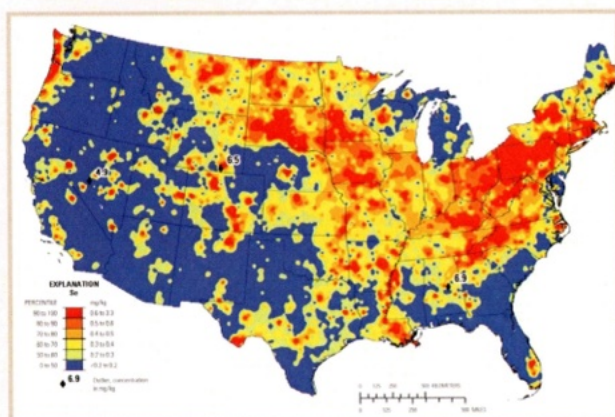
Selenium Is Naturally Occurring

Selenium is a naturally occurring element that is distributed widely in nature in rocks, soils and minerals such as coal.¹ Everyone is exposed to low levels of selenium daily through the food we eat, the beverages and water we drink, and the air we breathe.

Selenium is used in a variety of household and consumer products, such as paints, blue-tinted glass and personal care products. In fact, selenium is the active agent in several anti-dandruff shampoos, and is an antioxidant present in many dietary supplements.



Selenium in Soil



This map, adapted from a U.S. Geological Survey (USGS) report,² shows relative amounts of naturally occurring selenium in surface soils across the United States. The USGS data shows that national average selenium concentration in surface soils in the U.S. is approximately 0.3 mg/kg³ but can range much higher in some areas of the country.

Selenium and Health

Selenium plays a critical role in healthy metabolism and thyroid function, thus is an essential nutrient for humans and other organisms. Studies show most selenium compounds are not carcinogens. In fact, studies suggest that lower-than-normal selenium levels in the diet may *increase* the risk of cancer and the presence of selenium may *prevent* some cancers.¹

As an essential nutrient, a proper daily dose of selenium is required to maintain good health. Most people get enough selenium in their normal diet, but multiple vitamins include small amounts of selenium. Selenium-rich foods include Brazil nuts, salmon, tuna, shellfish, oats, eggs, and many nuts and grains.

The Recommended Dietary Allowance of selenium is 55 micrograms per day (µg/day) for men and women, and the tolerable upper daily limit for adults (i.e., a level that is still safe) is 400 µg/day.⁴

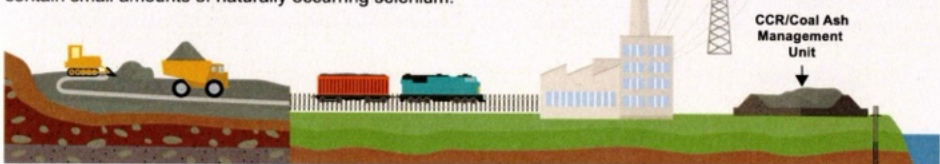


- 1 www.atsdr.cdc.gov/toxfaqs/tfacts92.pdf
- 2 USGS, 2014, Geochemical and mineralogical maps for soils of the conterminous United States: U.S. Geological Survey Open-File Report 2014-1082, page 386, <http://dx.doi.org/10.3133/ofr20141082>.
- 3 USGS, 2013, Geochemical and mineralogical data for soils of the conterminous United States: U.S. Geological Survey Data Series 801, Table 2, <http://pubs.usgs.gov/ds/801/>
- 4 NIH. 2019. Selenium Fact Sheet for Consumers. <https://ods.od.nih.gov/pdf/factsheets/Selenium-Consumer.pdf>

Coal Ash and Selenium

Coal Ash

When we burn coal to produce electricity, the ash that remains is made up of the parts of the coal that do not burn, in the same way that ash remains after burning a campfire. Rocks, soils and minerals like coal contain small amounts of naturally occurring selenium.

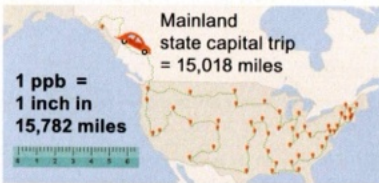


Groundwater Monitoring

The EPA requires electric utilities to measure levels of selenium in groundwater from wells next to coal combustion residuals (CCR) management units.

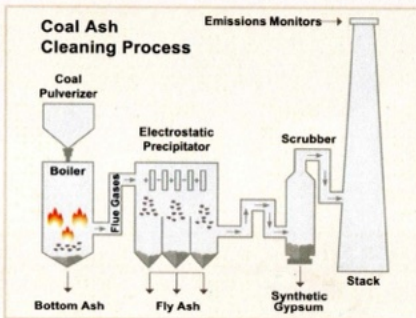
The EPA drinking water screening level for selenium is 50 µg/L (parts per billion). To put this into context, one serving of Brazil nuts (1 oz, or 4-5 nuts) has 4-times as much selenium⁵ than is consumed in drinking 2 liters of drinking water with selenium at the EPA drinking water standard.

One part per billion, or ppb, is like traveling in your car just 1 inch versus traveling more than 15,018 miles in your car to every state capital in the continental U.S.



Coal Ash and People

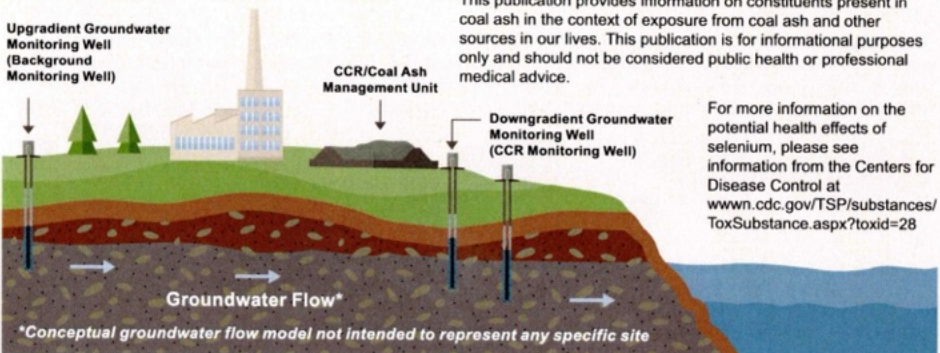
Coal ash is maintained and managed on access-controlled industrial sites. The chance of anyone from the community coming into contact with the coal ash is remote, and thus, the chance of receiving a significant exposure to selenium from coal ash is also remote. Modern air pollution control technologies capture coal ash particulates and reduce the potential human exposure to background levels that meet applicable regulatory requirements.



5 www.atsdr.cdc.gov/ToxProfiles/tp92.pdf, page 254.

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For more information on the potential health effects of selenium, please see information from the Centers for Disease Control at www.cdc.gov/TSP/substances/ToxSubstance.aspx?toxid=28



Thallium in Our Environment

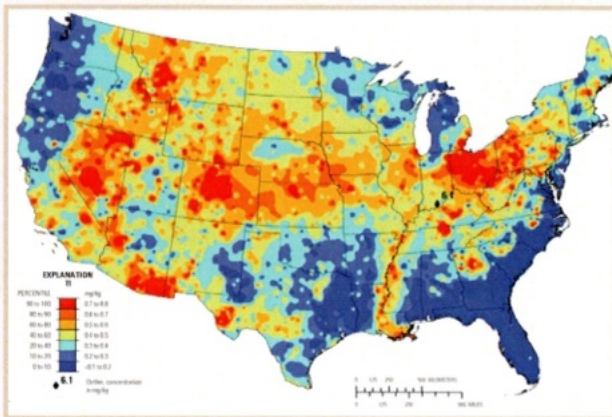
Thallium Is Naturally Occurring

Thallium is a metal that occurs in nature as a trace-level component of rocks, soils, and minerals. It is used in electronic devices, fiber optics, switches, camera lenses, and other glass lenses.^{1,2}

Thallium is present at about 0.7 parts per million in the Earth's crust. It mainly is associated with potassium minerals in clays, soils, and granites, but is not easily recoverable in those forms.^{1,2}



Thallium in Soil



This map, adapted from a U.S. Geological Survey (USGS) report³, shows relative amounts of naturally occurring thallium in surface soils across the United States. The USGS data shows that national average thallium concentration in surface soils in the U.S. is <0.1 mg/kg³ but can range much higher in some areas of the country.

Thallium in Food

People are exposed to thallium in air, water, and food, but the levels of thallium in air and water are very low.¹ The greatest potential exposure is through foods, mostly home-grown fruits and green vegetables.¹ The estimated adult daily intake is about 5 µg thallium from food.¹

Cigarette smokers typically have twice as much thallium in their bodies as nonsmokers.¹



1 www.atsdr.cdc.gov/ToxProfiles/tp54.pdf

2 www.usgs.gov/centers/national-minerals-information-center/thallium-statistics-and-information

3 https://pubs.usgs.gov/sir/2017/5118/sir20175118_element.php?el=81

Coal Ash and Thallium

Coal Ash

When we burn coal to produce electricity, the ash that remains is made up of the parts of the coal that do not burn, in the same way that ash remains after burning a campfire. Rocks, soils and minerals like coal contain small amounts of naturally occurring thallium.



Groundwater Monitoring

The EPA requires electric utilities to measure levels of thallium in groundwater from wells next to coal combustion residuals (CCR) management units.

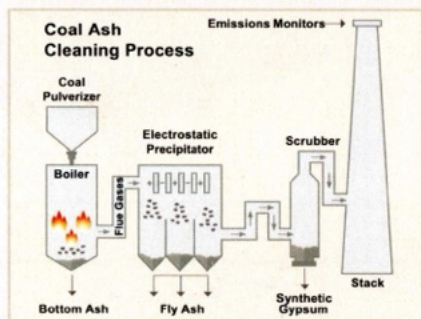
The groundwater sample results are compared to the EPA drinking water standard of 2 µg/L (parts per billion).

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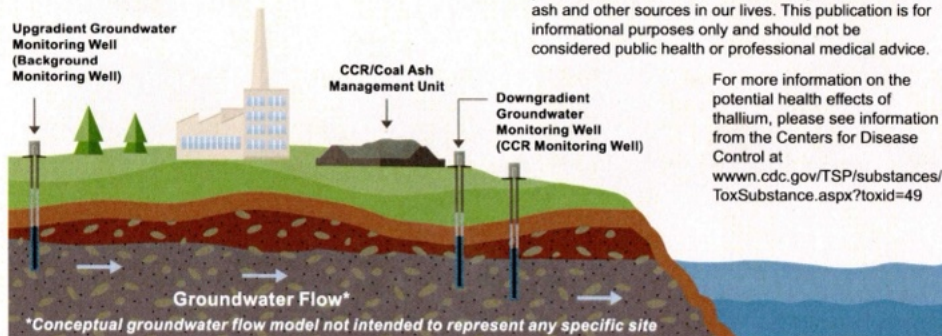


Coal Ash and People

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For more information on the potential health effects of thallium, please see information from the Centers for Disease Control at www.cdc.gov/TSP/substances/ToxSubstance.aspx?toxid=49