

# A Summary of ATSDR's Evaluation of Y-12 Uranium Releases—Oak Ridge Reservation

## MAJOR Y-12 URANIUM PROCESSES

### 1943-1947

Feed Preparation for Uranium Enrichment Operations

### 1944-1947

Electromagnetic Uranium Enrichment

### 1944-1951

Uranium Recovery and Recycle Operations

### 1944-1972

Disposal in Boneyard/Burnyard

### 1947-1951

Uranium Salvage Operations

### 1949-present

Uranium Preparation and Recycle for Weapon Component Operations

### 1949-present

Uranium Forming and Machining for Weapon Component Operations

### 1951-1982

Waste Disposal in S-3 Ponds

### 1952-present

Weapon Component Assembly Operations

### 1954-1992

Disposal in Bear Creek Burial Ground

### 1963-1988

Waste Disposal in New Hope Pond

### 1992-present

Y-12 National Security Complex



## About the Y-12 Plant

In 1942, the federal government established the Oak Ridge Reservation as part of the Manhattan Project to research, develop, and produce special nuclear material for nuclear weapons. Four large complexes were built. The Y-12 plant, the K-25 site, and the S-50 site were created to enrich uranium, and the X-10 site was created to produce and separate plutonium.

The 825-acre Y-12 plant, now called the Y-12 National Security Complex, is located in the eastern end of Bear Creek Valley about two miles south of downtown Oak Ridge. The Scarboro community, a residential area within the city of Oak Ridge, is about a half mile from the Y-12 plant. The plant is separated from the Scarboro community and the other residential areas of Oak Ridge by Pine Ridge, a ridge that rises to about 300 feet above the valley floor.

From 1944 to 1947, the Y-12 plant was used to enrich uranium. In 1952, the plant was converted to enrich lithium-6 using a column-exchange process and to fabricate components for thermonuclear weapons using high-precision machining and other specialized processes. In 1992, the mission of the Y-12 plant was curtailed. Currently, the plant is used to remanufacture nuclear weapons components and dismantle and store strategic nuclear materials. The National Nuclear Security Administration uses the Y-12 National Security Complex as the primary storage site for highly enriched uranium. Operational levels have increased since 1992, but total operations have not approached the levels that occurred before the 1990s.

### ENVIRONMENTAL HEALTH TERMS

**Health effect**—A change in body function or cell structure that might lead to disease or health problems.

**Exposure**—Contact with a substance through swallowing, breathing, or touching the skin or eyes.

**Radiation dose**—The amount of energy from radiation that is actually absorbed by the body.

**Chemical dose**—A measurement of exposure—the amount of a substance to which a person is exposed over some time period.

**No apparent public health hazard**—A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but is not expected to cause any harmful health effects.

### Why is ATSDR at the Oak Ridge Reservation?

The Agency for Toxic Substances and Disease Registry (ATSDR) is the principal federal public health agency charged with evaluating the human **health effects** of **exposure** to hazardous substances in the environment. Congress created ATSDR to implement the health-related

sections of the 1980 Superfund law and other laws that protect the public from hazardous waste and environmental spills of hazardous substances. The Oak Ridge Reservation is on the U.S. Environmental Protection Agency's National Priorities List for Uncontrolled Hazardous Waste Sites.

People living near the Oak Ridge Reservation want to know if their health could be affected by uranium releases from the Y-12 plant. ATSDR conducted a public health assessment to evaluate whether the releases could be harmful to people who live in communities near the reservation. ATSDR is working with the Oak Ridge Reservation Health Effects Subcommittee (ORRHES) to ensure that the public health questions of people living in the Oak Ridge Reservation area are answered.

The Oak Ridge Reservation Health Effects Subcommittee was formed in 1999 under the guidelines of the Federal Advisory Committee Act to serve as an advisory group to ATSDR and the Centers for Disease Control and Prevention (CDC) on matters related to public health activities and research at the Oak Ridge Reservation. Members of the Subcommittee represent diverse interests, expertise, backgrounds, and communities. The Subcommittee provides an opportunity for all people to comment on issues discussed and helps prioritize issues evaluated by ATSDR.

### What is ATSDR doing at the Oak Ridge Reservation?

ATSDR is using the public health assessment process to evaluate previous studies and environmental data to determine whether releases of hazardous substances from the Oak Ridge Reservation could have affected the health of people in communities near the reservation. The public health assessment is the primary public health process ATSDR uses to

- ❖ **Identify** populations off the site who could have been exposed to hazardous substances
- ❖ **Determine** the potential health effects of exposure
- ❖ **Address** the health concerns of people in the community
- ❖ **Recommend** any needed follow-up public health actions to address exposure

### What conclusion did ATSDR reach about health effects related to Y-12 uranium releases?

ATSDR's extensive public health assessment concludes that residents living in the city of Oak Ridge were exposed to uranium released from the Y-12 plant. Although people in the area were exposed to uranium, these exposures resulted in **radiation doses** and **chemical doses** below levels that would be expected to result in harmful health effects. Residents in Oak Ridge, including those in the Scarboro community, were not exposed to uranium releases from the Y-12 plant at levels associated with harmful human health effects. ATSDR has therefore categorized the Y-12 uranium releases as being **no apparent public health hazard**.

#### What is ATSDR's mission?

ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances.

**Uranium released from the Y-12 plant is not a public health hazard for people living near the Oak Ridge Reservation.**

Figure 1. Key Issues and Concerns Evaluated by ATSDR



### ENVIRONMENTAL HEALTH TERMS

**Concentration**—The amount of a substance present in a certain amount of soil, water, air, or food.

**Exposure pathway**—The route a substance takes to get to people.

*WHERE* the substance comes from

*HOW* the substance moves in the environment

*WHERE* people can come into contact with the substance

*HOW* the substance can get into a person's body

**Committed effective dose equivalent**—The sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to the organs or tissues. The committed effective dose equivalent is used in radiation safety because it implicitly includes the relative carcinogenic sensitivity of the various tissues.

**Comparison value**—Calculated amount of a substance present in air, water, food, or soil that is unlikely to cause harmful health effects in exposed people.

**Radiation**—Energy given off by some atoms in the form of particles or waves.

### Evaluation of Past Uranium Releases (1944–1995)

To evaluate potential harmful effects from exposure to uranium in the past, ATSDR used the estimates of uranium releases and the modeling results from the screening evaluation conducted by the Tennessee Department of Health (TDOH) in their Oak Ridge Reconstruction Report, *Uranium Releases from the Oak Ridge Reservation*.

*ATSDR concluded that the levels of uranium to which people living near the Y-12 plant were exposed in the past pose no apparent health hazard from either radiation or chemical exposure.*

TDOH selected the Scarboro community as the reference community because air modeling results showed uranium **concentrations** in Scarboro were higher than the concentrations in other areas of Oak Ridge. Because Scarboro residents would have been exposed to higher levels of uranium than residents in other areas near Oak Ridge, TDOH concluded that they were the most appropriate population for screening both maximally and typically exposed individuals. ATSDR agrees and; therefore, used the Scarboro location as the reference community to estimate concentrations of uranium in the air, surface water, and soil in an off-site area where people lived in the past when uranium releases from the Y-12 plant were higher.

ATSDR evaluated the exposure that a person in the area could have received from the following **exposure pathways**: breathing dust or particles containing uranium, playing in the East Fork Poplar Creek (EFPC) floodplain soil and water, contacting the soil and water in the Scarboro community area, eating vegetables grown in the area surrounding the Y-12 plant, eating fish from EFPC, and eating beef or drinking milk from cows raised near the Y-12 area. (Figure 1 shows an illustration of the area and a list of the concerns evaluated.)

#### *Did past Y-12 plant uranium releases cause harmful radiation health effects in people living near the Oak Ridge Reservation?*

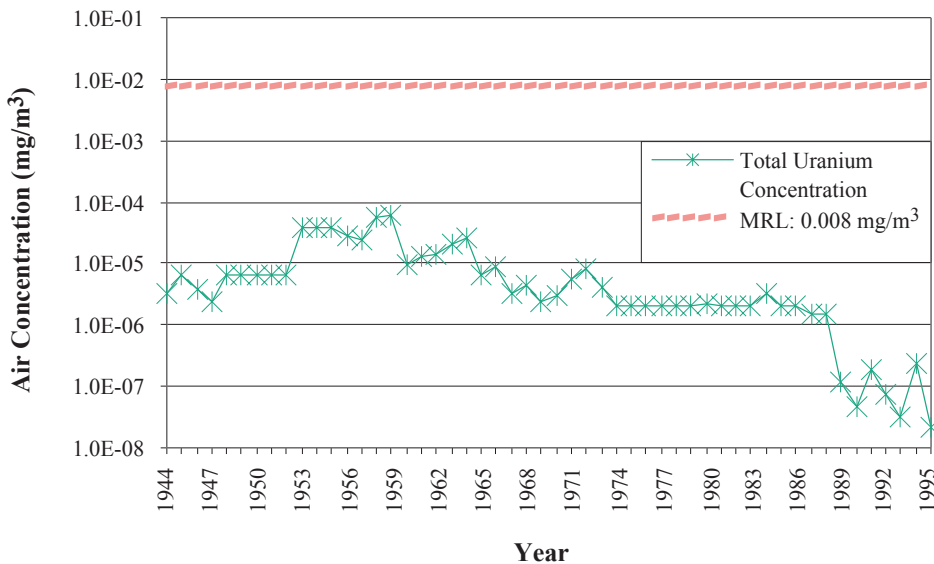
Combining the maximum exposures for the key issues and concerns evaluated (see Figure 1), ATSDR estimated that persons in the area may have received a **committed effective dose equivalent** (total radiation dose) of 155 millirem (mrem) over 70 years. This total radiation dose is 32 times less than ATSDR's radiogenic cancer **comparison value** of 5,000 mrem over 70 years, which is a level that was determined to be protective of human health. Radiation doses below this level are not expected to result in adverse health effects. Therefore, ATSDR does not expect harmful **radiation** health effects to have occurred from off-site radiation exposure to uranium in the past because the total dose received was lower than the cancer comparison value. A comparison of radiation doses is shown in Figure 4.

#### *Did past Y-12 plant uranium releases cause harmful chemical health effects in people living near the Oak Ridge Reservation?*

TDOH's dose reconstruction report for uranium releases estimated the average uranium air concentration in Scarboro for each year from 1944 to 1995. (Figure 2 presents a graph of the air concentration estimates.) For each year, the estimated uranium air concentrations were less than 1% of ATSDR's **minimal risk level (MRL)** for **chronic exposure** to insoluble forms of uranium in air. Concentrations below the MRL are not a health hazard and do not require further evaluation. Therefore, ATSDR concludes that residents of Oak Ridge were not exposed to uranium in the air at levels that would cause harmful chemical health effects.

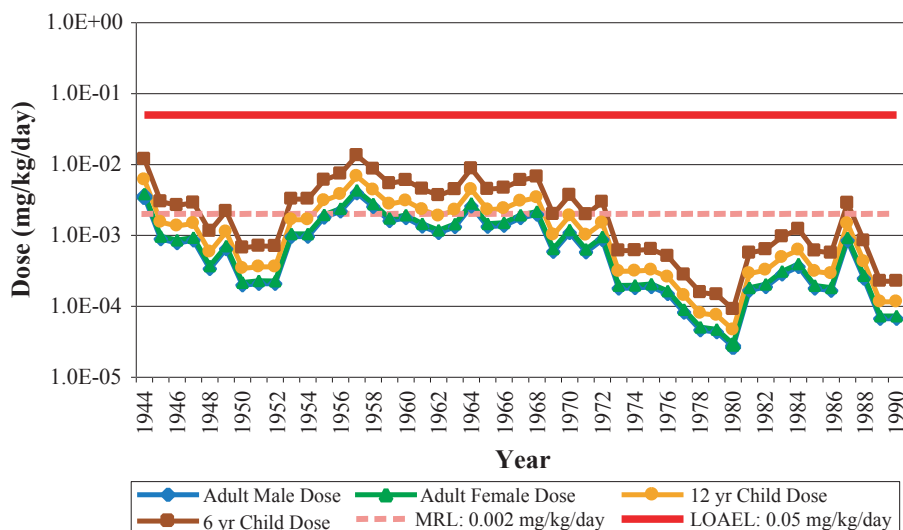
## Y-12 Uranium Releases

**Figure 2. Estimated Average Annual Air Concentrations of Total Uranium in Scarboro—Past Exposure**



ATSDR also estimated average uranium doses from the EFPC floodplain soil and surface water exposure pathways for each year from 1944 to 1990. For several years, uranium doses exceeded ATSDR's MRL for uranium chemical toxicity. Therefore, ATSDR conducted additional evaluation of the toxicologic literature for doses exceeding the screening value. ATSDR's investigation found that all the estimated uranium doses are well below the lowest uranium dose at which the most sensitive health effect (kidney toxicity) has been observed. Therefore, past exposure to uranium from all surface water and soil exposure pathways is not a health hazard. See Figure 3 for a graph of the dose estimates compared to the MRL and **lowest-observed-adverse-effects level (LOAEL)**.

**Figure 3. Estimated Average Annual Doses of Uranium via the Soil and Surface Water Pathways—Past Exposure**



Several levels of conservatism were built into the evaluation of past exposures to uranium. For example, the majority of the total uranium dose in the past is attributed to frequently eating EFPC fish and homegrown vegetables. For people who did not regularly eat fish from EFPC or regularly eat vegetables grown near the Y-12 plant, the radiation and chemical doses would likely have been substantially lower.

## ENVIRONMENTAL HEALTH TERMS

**Minimal risk level (MRL)**—An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse) noncancerous effects.

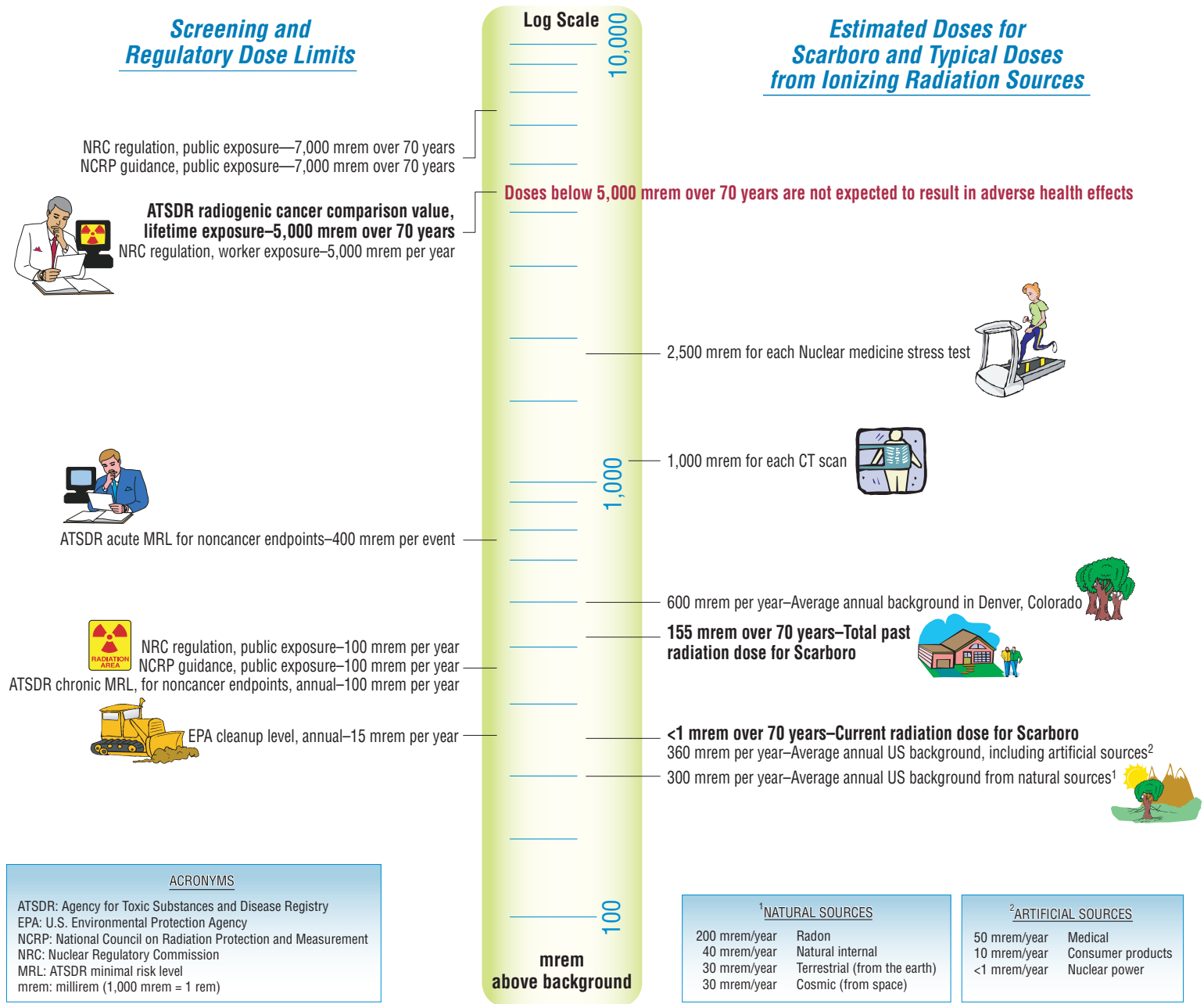
An MRL is a screening value, used to determine whether further evaluation is needed. Values at or below the MRL are considered safe and do not require further evaluation.

Values above the MRL indicate only that additional evaluation is needed to find out whether exposure could cause health effects. Values above the MRL do not necessarily mean that harmful health effects will occur.

**Chronic exposure**—Contact with a substance that occurs over a long period of time (longer than one year).

**Lowest-observed-adverse-effect level (LOAEL)**—The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

**Figure 4. Comparison of Radiation Doses**



# Y-12 Uranium Releases

## Evaluation of Current Uranium Releases (1995–2002)

To determine whether residents living near the Y-12 plant are currently being exposed to harmful levels of uranium, ATSDR evaluated recent

- ❖ Soil and surface water data collected in Scarboro by Florida Agricultural and Mechanical University (FAMU) and the U.S. Environmental Protection Agency (EPA)
- ❖ Air monitoring data collected by the U.S. Department of Energy (DOE)
- ❖ Surface water samples collected from EFPC by DOE
- ❖ DOE data on garden vegetables grown in the Y-12 plant area

**ATSDR concludes that the presence of uranium in air, soil, vegetables, and surface water poses no apparent health hazard to people living near the Y-12 plant.**

### *Are current Y-12 plant uranium releases causing harmful radiation health effects in people living near the Oak Ridge Reservation?*

To evaluate the potential for harmful effects from radiation exposure to occur from uranium currently being released from the Y-12 plant, ATSDR calculated a committed effective dose equivalent of 0.216 mrem over 70 years from exposure to uranium in the representative community (Scarboro) as well as other areas. (See Figure 1 for the key issues and concerns ATSDR evaluated.) This radiation dose of 0.216 mrem is 23,000 times less than the ATSDR radiogenic cancer comparison value of 5,000 mrem over 70 years. Therefore, ATSDR concludes that radiation doses received from current uranium exposures to residents living near the Y-12 plant will not result in harmful health effects. See Figure 4 for a comparison of radiation doses.

### *Are current Y-12 plant uranium releases causing harmful chemical health effects in people living near the Oak Ridge Reservation?*

To evaluate the potential for harmful effects from chemical exposure to uranium, ATSDR evaluated exposures through breathing air and eating soil, homegrown vegetables, and surface water in the representative community, Scarboro.

- ❖ The average current uranium air concentrations ( $5.4 \times 10^{-11}$  milligrams per cubic meter ( $\text{mg}/\text{m}^3$ ) in Scarboro and  $1.4 \times 10^{-10}$   $\text{mg}/\text{m}^3$  in the city of Oak Ridge) are over a million times less than ATSDR’s chronic MRL of  $8 \times 10^{-3}$   $\text{mg}/\text{m}^3$  for **inhalation** of insoluble uranium. (See Figure 5.)

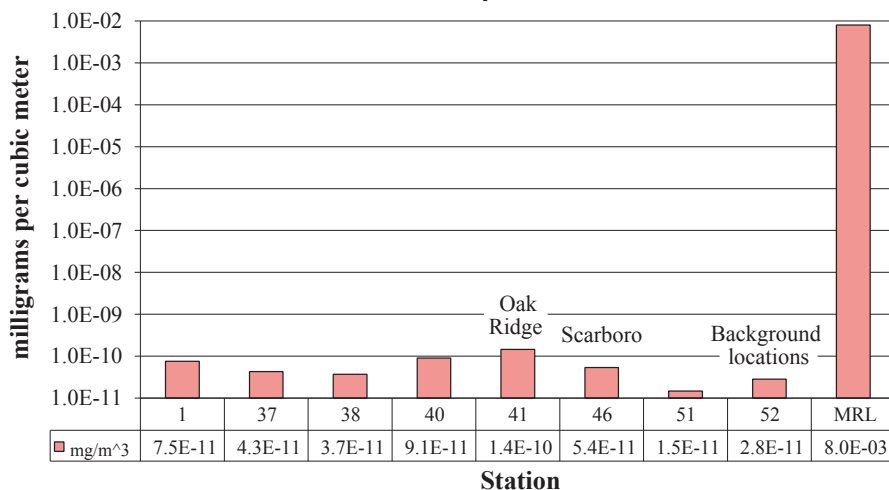
## ENVIRONMENTAL HEALTH TERMS

**Inhalation**—The act of breathing—inhalation exposure occurs when people breathe air containing a hazardous substance into the lung.

The same value can be presented in different ways:

- 0.001
- 1.0E-03
- $1.0 \times 10^{-3}$
- 1/1,000
- one in a thousand

**Figure 5. Average Uranium Air Concentrations Compared to the MRL—Current Exposure**



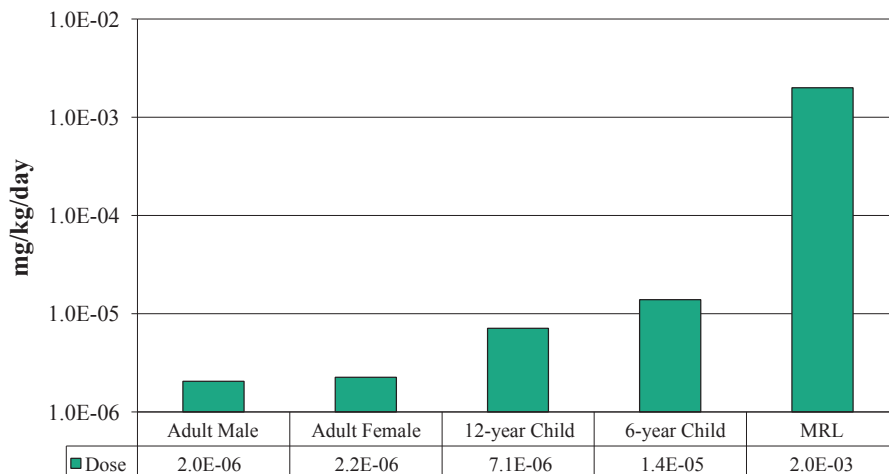
## Y-12 Uranium Releases

### ENVIRONMENTAL HEALTH TERMS

**Ingestion**—The act of swallowing something through eating or drinking or by mouthing objects.

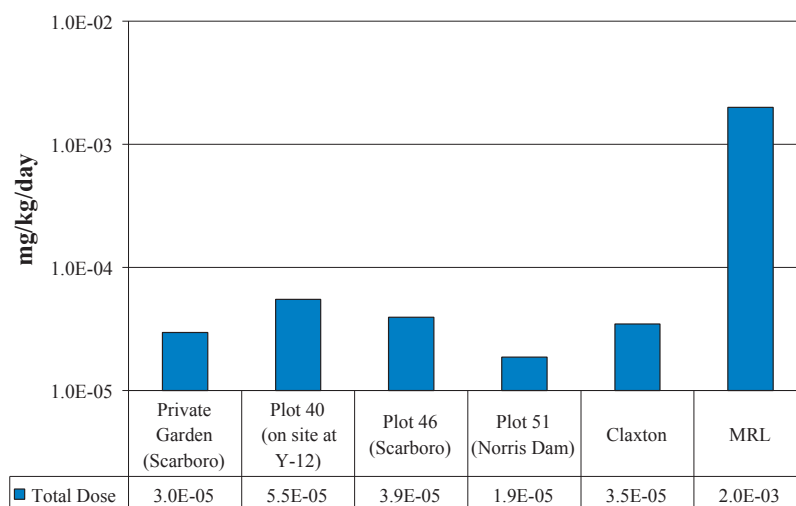
- ❖ ATSDR calculated uranium doses from incidental **ingestion** of Scarboro soil ranging from  $2.0 \times 10^{-6}$  milligrams per kilogram per day (mg/kg/day) for an adult male to  $1.4 \times 10^{-5}$  mg/kg/day for a 6-year old child. These doses are at least 140 times less than ATSDR's MRL of  $2 \times 10^{-3}$  mg/kg/day for chronic exposure to uranium through ingestion. (See Figure 6.)

**Figure 6. Uranium Doses Following Ingestion of Soil—Current Exposure**



- ❖ ATSDR calculated uranium doses of  $3.0 \times 10^{-5}$  and  $3.9 \times 10^{-5}$  mg/kg/day from eating vegetables grown in Scarboro. These doses are at least 50 times less than ATSDR's MRL of  $2 \times 10^{-3}$  mg/kg/day for chronic exposure to uranium through ingestion. (See Figure 7.)

**Figure 7. Uranium Doses Following Ingestion of Vegetables—Current Exposure**



- ❖ The mean uranium concentrations (0.197 micrograms per liter ( $\mu\text{g/L}$ ) in surface water from ditches in Scarboro are 100 times less than ATSDR's comparison value of  $20 \mu\text{g/L}$  for highly soluble uranium salts.

Therefore, ATSDR concludes that the levels of uranium to which people living near the Y-12 plant are currently being exposed are below levels that would cause harmful chemical effects.

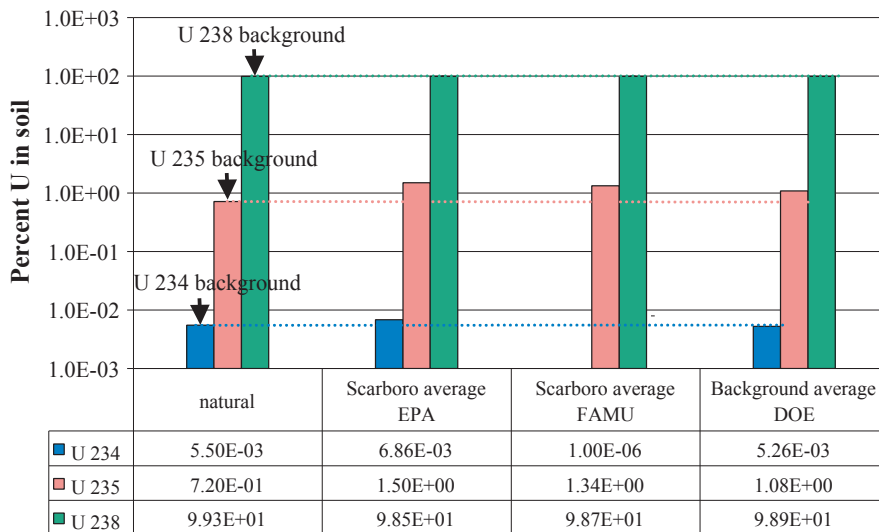


## Y-12 Uranium Releases

### *Does soil in Scarboro contain elevated levels of uranium or enriched uranium produced during various activities at the Y-12 plant?*

To evaluate the soil data collected in Scarboro, ATSDR compared the composition of uranium isotopes in Scarboro soil to natural background values as well as to soil samples collected in uncontaminated areas on and off the Oak Ridge Reservation. (See Figure 8.) Overall, this evaluation indicates that the concentrations of uranium detected in Scarboro are indistinguishable from the background concentrations of uranium in uncontaminated areas around the reservation. Furthermore, the percentages of uranium in the Scarboro community are essentially the same as the percentages occurring naturally.

**Figure 8. Comparison of the Average Uranium Isotopic Concentrations**



### *Are the residents in Oak Ridge areas other than Scarboro being exposed to harmful levels of uranium?*


Residents of Oak Ridge in areas other than Scarboro are not being exposed to harmful levels of uranium. TDOH's modeling of uranium releases from the Y-12 plant indicated that the Scarboro community was most likely to have received the highest exposure to uranium released from the Y-12 plant. All of the exposure pathways evaluated by ATSDR in Scarboro, for both radiation and chemical health effects, indicated that the uranium doses received were too low to pose a health hazard. Therefore, if the Scarboro community (the population likely to have received the highest uranium exposures from the Y-12 plant)—was not exposed in the past to harmful levels of uranium from the Y-12 plant and is not currently exposed to harmful levels of uranium from the Y-12 plant—then other Oak Ridge residents and persons living near the Y-12 plant are also not being exposed to harmful levels of uranium.

## ENVIRONMENTAL HEALTH TERMS

**Isotopes**—Nuclides having the same number of protons, but differing in the number of neutrons.

**Natural background**—Typical amounts of substances that occur naturally in the environment.

**Table 1. Summary of ATSDR's Evaluation of Exposure of Off-Site Populations to Past and Current Releases of Uranium From the Y-12 Plant**

Exposure	Effects	Media	Route	Estimated Dose	ATSDR Screening Comparison Value	Is the dose above or below the screening value (magnitude)?	ATSDR Conclusion Category
Past 1944–1995	Radiation	<ul style="list-style-type: none"> <li>• Air</li> <li>• Soil</li> <li>• Surface water</li> </ul>	Ingestion & Inhalation 	155 mrem over 70 years	5,000 mrem over 70 years	Below (32 times less than the screening value)	No apparent public health hazard
	Chemical	• Air	Inhalation 	$2.1 \times 10^{-8}$ to $6.0 \times 10^{-5}$ mg/m <sup>3</sup>	$8 \times 10^{-3}$ mg/m <sup>3</sup>	Below (130 times less than the screening value)	
		<ul style="list-style-type: none"> <li>• Soil</li> <li>• Surface water</li> </ul>	Ingestion 	$2.7 \times 10^{-5}$ to $1.3 \times 10^{-2}$ mg/kg/day	$2 \times 10^{-3}$ mg/kg/day	Above the screening value. However, all doses are less than the dose ( $5 \times 10^{-2}$ mg/kg/day) at which the most sensitive health effect (kidney toxicity) has been observed in the most sensitive mammalian species.	
Current 1995–2002	Radiation	<ul style="list-style-type: none"> <li>• Soil</li> <li>• Vegetables</li> <li>• Air</li> </ul>	Ingestion & Inhalation 	0.216 mrem over 70 years	5,000 mrem over 70 years	Below (23,000 times less than the screening value)	No apparent public health hazard
	Chemical	• Air	Inhalation 	$5.4 \times 10^{-11}$ and $1.4 \times 10^{-10}$ mg/m <sup>3</sup>	$8 \times 10^{-3}$ mg/m <sup>3</sup>	Below (more than a million times less than the screening value)	
		• Soil	Ingestion 	$2.0 \times 10^{-6}$ to $1.4 \times 10^{-5}$ mg/kg/day	$2 \times 10^{-3}$ mg/kg/day	Below (at least 140 times less than the screening value)	
		• Vegetables	Ingestion 	$3.0 \times 10^{-5}$ and $3.9 \times 10^{-5}$ mg/kg/day	$2 \times 10^{-3}$ mg/kg/day	Below (at least 50 times less than the screening value)	
		• Surface water	Ingestion 	0.197 µg/L	20 µg/L	Below (100 times less than the screening value)	

## Y-12 Uranium Releases

### About Uranium

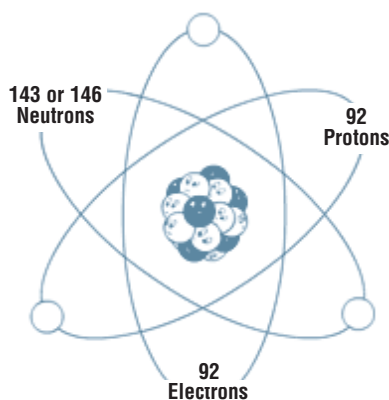
Uranium is a naturally occurring element. It is found in very small amounts in nature in the form of minerals. Rocks, soil, surface and underground water, air, plants, and animals all contain varying amounts of uranium. Its naturally occurring isotopes are uranium 234, uranium 235, and uranium 238. All three isotopes behave the same chemically, so any combination of the three would have the same chemical effect on the body. However, the three isotopes have different radioactive properties.

The industrial process called enrichment is used to increase the amount of uranium 234 and uranium 235 and decrease the amount of uranium 238 in natural uranium. The product of this process is called enriched uranium, and the leftover uranium 238 is called depleted uranium. Enriched uranium is more radioactive than natural uranium, and natural uranium is more radioactive than depleted uranium.

Uranium is a chemical substance that is also weakly radioactive, and most of the radiation it gives off cannot travel far. If the uranium is outside your body (in soil, for example), most of its radiation cannot penetrate your skin and enter your body. To be exposed to radiation from uranium, you have to eat, drink, or breathe it, or get it on your skin. If a person is exposed to uranium, many factors determine whether the person will be harmed. The factors include dose (how much), duration (how long), distance (how close), shielding (what is between the person and the uranium), and route of exposure (how a person comes into contact with the uranium). The organ that is most sensitive to chemical effects from uranium exposure is the kidney. In animals, kidney damage is the principal toxic effect of exposure to uranium. The same effects can occur in humans if the dose is high enough.

There is also a chance of getting **cancer** from any radioactive material like uranium. However, no human cancer of any type has ever been seen as a result of exposure to natural or depleted uranium. Because enriched uranium is more radioactive than natural uranium, the chance of getting cancer is greater if a person is exposed to enriched uranium. Eating food or drinking water that has normal amounts of uranium will most likely not cause cancer or other health problems in most people.

Studies of **developmental effects** in the children of uranium miners and millers have not reported any chemical or radiological effects on human development. Studies of animals report that very high doses of uranium in drinking water—doses far above any plausible human exposure—can affect the development of the fetus in laboratory animals. There is no evidence to suggest that uranium can cause these problems in pregnant women who take in normal amounts of uranium from food and water or breathe air around a hazardous waste site that contains uranium.



### ENVIRONMENTAL HEALTH TERMS

**Cancer**—Any one of a group of diseases that occurs when cells in the body become abnormal and grow or multiply out of control.

**Developmental effects**—Effects (usually adverse effects) on the growing or aging process. Developmental effects are usually most pronounced in the fetus or newborn but can impact a person at any age. Developmental effects may include effects on both the physical body and mental abilities.

*ATSDR has evaluated estimates of the uranium doses to which people living near the Y-12 plant received in the past and has evaluated the uranium doses to which people are currently receiving. After thorough evaluation of the health effects associated with those doses, ATSDR does not expect kidney problems, cancer, developmental effects, or any other harmful health effects to result from exposure to uranium released from the Y-12 plant.*

*Atom illustration provided by SA Chamber of Mines and Energy*

## Y-12 Uranium Releases

### What other issues is ATSDR evaluating at the Oak Ridge Reservation?

In addition to the public health assessment on uranium releases from the Y-12 plant, ATSDR scientists are conducting public health assessments on the following issues related to the Oak Ridge Reservation:

- ❖ Mercury
- ❖ Iodine 131
- ❖ Radionuclides from White Oak Creek
- ❖ Polychlorinated biphenyls
- ❖ Uranium and fluoride releases from the K-25 site
- ❖ TSCA incinerator
- ❖ Off-site groundwater
- ❖ Screening for current chemical exposures

**Please note:** ATSDR and ORRHES *do not* address public health issues related to workplace exposure or risk. Information specific to workers can be found on the Internet at <http://cedr.lbl.gov>. This site provides information about epidemiologic studies of U.S. Department of Energy workers, including studies of Oak Ridge Reservation workers at the Y-12, X-10, and K-25 sites.

### Where can I get more information?

You can get more detailed information from the ATSDR Y-12 Uranium Releases Public Health Assessment, which is available on the ORRHES Web site at <http://www.atsdr.cdc.gov/HAC/oakridge/index.html> and on ATSDR's Web site at <http://www.atsdr.cdc.gov/>. You may also contact ATSDR headquarters toll free at 1-888-42ATSDR (1-888-422-8737) or contact Jack Hanley or William Taylor.

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