APPENDICES

APPENDIX A

ATSDR Glossary of Environmental Health Terms

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The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. 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. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health.

This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

Absorption
The process of taking in. For a person or animal, *absorption* is the process through which a substance gets into the body through the eyes, skin, stomach, intestines, or lungs.

Activity
The number of radioactive nuclear transformations occurring in a material per unit time. The term for *activity* per unit mass is specific activity.

Acute
Occurring over a short time [compare with **chronic**].

Acute exposure
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with **intermediate-duration exposure** and **chronic exposure**].

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

Ambient
Surrounding (for example, *ambient* air).

Analytic epidemiologic study
A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

Background level
An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Background radiation
The amount of radiation to which a member of the general population is exposed from natural sources, such as terrestrial radiation from naturally occurring **radionuclides** in the soil, cosmic radiation originating from outer space, and naturally occurring radionuclides deposited in the human body.

Biota
Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Body burden
The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they leave the body very slowly.

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

Cancer risk
A theoretical risk of for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen
A substance that causes cancer.

Case-control study
A study that compares exposures of people who have a disease or condition (cases) with people who do not have the disease or condition (controls). Exposures that are more common among the cases may be considered as possible risk factors for the disease.

Central nervous system
The part of the nervous system that consists of the brain and the spinal cord.

CERCLA
[See **Comprehensive Environmental Response, Compensation, and Liability Act of 1980.**]

Chronic
Occurring over a long time (more than 1 year) [compare with **acute**].

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with **acute exposure** and **intermediate-duration exposure**].

Committed Effective Dose Equivalent (CEDE)
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. The unit of dose for the CEDE is the rem (or, in SI units, the sievert—1 sievert equals 100 rem.)

Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway
[See **exposure pathway.**]

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as **Superfund,** is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by *CERCLA*, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances.

Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other medium.

Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Curie (Ci)
A unit of radioactivity. One *curie* equals that quantity of radioactive material in which there are 3.7×10^{10} nuclear transformations per second. The activity of 1 gram of radium is approximately 1 Ci; the activity of 1.46 million grams of natural uranium is approximately 1 Ci.

Decay product/daughter product/progeny
A new nuclide formed as a result of radioactive decay: from the radioactive transformation of a radionuclide, either directly or as the result of successive transformations in a radioactive series. A *decay product* can be either radioactive or stable.

Depleted uranium (DU)
Uranium having a percentage of U 235 smaller than the 0.7% found in natural uranium. It is obtained as a byproduct of U 235 enrichment.

Dermal
Referring to the skin. For example, *dermal* absorption means passing through the skin.

Dermal contact
Contact with (touching) the skin [see **route of exposure**].

Descriptive epidemiology
The study of the amount and distribution of a disease in a specified population by person, place, and time.

Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Disease registry
A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

DOE
The United States Department of Energy.

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. *Dose* is a measurement of exposure. *Dose* is often expressed as milligrams (a measure of quantity) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the *dose*, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually gets into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals)
The radiation *dose* is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Dose-response relationship
The relationship between the amount of exposure [**dose**] to a substance and the resulting changes in body function or health (response).

EMEG
Environmental Media Evaluation Guide, a media-specific comparison value that is used to select contaminants of concern. Levels below the EMEG are not expected to cause adverse noncarcinogenic health effects.

Enriched uranium
Uranium in which the abundance of the U 235 isotope is increased above normal.

Environmental media
Soil, water, air, **biota** (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism
Environmental media include water, air, soil, and **biota** (plants and animals). *Transport mechanisms* move contaminants from the source to points where human exposure can occur. The *environmental media and transport mechanism* is the second part of an **exposure pathway.**

EPA
The United States Environmental Protection Agency.

Epidemiologic surveillance
The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

Epidemiology
The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

Equilibrium, radioactive
In a radioactive series, the state that prevails when the ratios between the activities of two or more successive members of the series remain constant.

Exposure
Contact with a substance by swallowing, breathing, or touching the skin or eyes. *Exposure* can be short-term [see **acute exposure**], of intermediate duration [see **intermediate-duration exposure**], or long-term [see **chronic exposure**].

Exposure assessment
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure-dose reconstruction
A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

Exposure investigation
The collection and analysis of site-specific information and biological tests (when appropriate) to determine whether people have been exposed to hazardous substances.

Exposure pathway
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An *exposure pathway* has five parts: a **source of contamination** (such as an abandoned business); an **environmental media and transport mechanism** (such as movement through **groundwater**); a **point of exposure** (such as a private well); a **route of exposure** (eating, drinking, breathing, or touching), and a **receptor population** (people potentially or actually exposed). When all five parts are present, the *exposure pathway* is termed a **completed exposure pathway.**

Exposure registry
A system of ongoing follow up of people who have had documented environmental exposures.

Feasibility study
A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.

Grand rounds
Training sessions for physicians and other health care providers about health topics.

Groundwater
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with **surface water**].

Half-life ($t_{1/2}$)
The time it takes for half the original amount of a substance to disappear. In the environment, the *half-life* is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other chemical processes. In the human body, the *half-life* is the time it takes for half the original amount of the substance to disappear either by being changed to another substance or by leaving the body. In the case of radioactive material, the *half-life* is the amount of time necessary for one half the initial number of radioactive atoms to change or transform into other atoms (normally not radioactive). After two *half-lives*, 25% of the original number of radioactive atoms remain.

Hazard
A source of potential harm from past, current, or future exposures.

Hazardous waste
Potentially harmful substances that have been released or discarded into the environment.

Health consultation
A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. *Health consultations* are focused on a specific exposure issue. They are therefore more limited than public health assessments, which review the exposure potential of each pathway and chemical [compare with **public health assessment**].

Health education
Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation
The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to estimate the possible association between the occurrence and exposure to hazardous substances.

Health statistics review
The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific population, geographic area, and time period. A *health statistics review* is a descriptive epidemiologic study.

Indeterminate public health hazard
The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence
The number of new cases of disease in a defined population over a specific time period [contrast with **prevalence**].

Ingestion
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see **route of exposure**].

Inhalation
The act of breathing. A hazardous substance can enter the body this way [see **route of exposure**].

Intermediate-duration exposure
Contact with a substance that occurs for more than 14 days and less than a year [compare with **acute exposure** and **chronic exposure**].

Ionizing radiation
Any radiation capable of knocking electrons out of atoms and producing ions. Examples: alpha, beta, gamma and x rays, and neutrons.

Isotopes
Nuclides having the same number of protons in their nuclei, and hence the same atomic number, but differing in the number of neutrons, and therefore in the mass number. Identical chemical properties exist in *isotopes* of a particular element. The term should not be used as a synonym for "nuclide," because "isotopes" refers specifically to different nuclei of the same element.

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.

Metabolism
The conversion or breakdown of a substance from one form to another by a living organism.

mg/kg
Milligrams per kilogram.

mg/m^3
Milligrams per cubic meter: a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Migration
Moving from one location to another.

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. *MRLs* are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). *MRLs* should not be used as predictors of harmful (adverse) health effects [see **reference dose**].

Mortality
Death. Usually the cause (a specific disease, condition, or injury) is stated.

Mutagen
A substance that causes **mutations** (genetic damage).

Mutation
A change (damage) to the DNA, genes, or chromosomes of living organisms.

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The *NPL* is updated on a regular basis.

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.

No-observed-adverse-effect level (NOAEL)
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL
[See **National Priorities List for Uncontrolled Hazardous Waste Sites.**]

Parent
A radionuclide which, upon disintegration, yields a new nuclide, either directly or as a later member of a radioactive series.

Plume
A volume of a substance that moves from its source to places farther away from the source. *Plumes* can be described by the volume of air or water they occupy and the direction in which they move. For example, a *plume* can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure
The place where someone can come into contact with a substance present in the environment [see **exposure pathway**].

Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

ppb
Parts per billion.

ppm
Parts per million.

Prevalence
The number of existing disease cases in a defined population during a specific time period [contrast with **incidence**].

Prevention
Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public comment period
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public health action plan
A list of steps to protect public health.

Public health advisory
A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed by coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with **health consultation**].

Public health hazard
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or **radionuclides** that could result in harmful health effects.

Public health hazard categories
Statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five *public health hazard categories* are **no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard,** and **urgent public health hazard.**

Public health statement
The first chapter of an ATSDR **toxicological profile.** The *public health statement* is a summary written in words that are easy to understand. It explains how people might be exposed to a specific substance and describes the known health effects of that substance.

Public meeting
A public forum with community members for communication about a site.

Quality factor (radiation weighting factor)
The linear-energy-transfer-dependent factor by which absorbed doses are multiplied to obtain (for radiation protection purposes) a quantity that expresses - on a common scale for all ionizing radiation - the approximate biological effectiveness of the absorbed dose.

Rad
The unit of absorbed dose equal to 100 ergs per gram, or 0.01 joules per kilogram (0.01 gray) in any medium [see **dose**].

Radiation
The emission and propagation of energy through space or through a material medium in the form of waves (e.g., the emission and propagation of electromagnetic waves, or of sound and elastic waves). The term "radiation" (or "radiant energy"), when unqualified, usually refers to electromagnetic *radiation.* Such *radiation* commonly is classified according to frequency, as microwaves, infrared, visible (light), ultraviolet, and x and gamma rays and, by extension, corpuscular emission, such as alpha and beta *radiation*, neutrons, or rays of mixed or unknown type, such as cosmic *radiation.*

Radioactive material
Material containing radioactive atoms.

Radioactivity
Spontaneous nuclear transformations that result in the formation of new elements. These transformations are accomplished by emission of alpha or beta particles from the nucleus or by the capture of an orbital electron. Each of these reactions may or may not be accompanied by a gamma photon.

Radioisotope
An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.

Radionuclide
Any radioactive isotope (form) of any element.

RBC
Risk-based Concentration, a contaminant concentration that is not expected to cause adverse health effects over long-term exposure.

RCRA
[See **Resource Conservation and Recovery Act (1976, 1984).**]

Receptor population
People who could come into contact with hazardous substances [see **exposure pathway**].

Reference dose (RfD)
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Rem
A unit of dose equivalent that is used in the regulatory, administrative, and engineering design aspects of radiation safety practice. The dose equivalent in *rem* is numerically equal to the absorbed dose in rad multiplied by the quality factor (1 *rem* is equal to 0.01 sievert).

Remedial investigation
The CERCLA process of determining the type and extent of hazardous material contamination at a site.

Resource Conservation and Recovery Act (1976, 1984) (RCRA)
This act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

RfD
[See **reference dose.**]

Risk
The probability that something will cause injury or harm.

Route of exposure
The way people come into contact with a hazardous substance. Three *routes of exposure* are breathing [**inhalation**], eating or drinking [**ingestion**], and contact with the skin [**dermal contact**].

Safety factor
[See **uncertainty factor**.]

Sample
A portion or piece of a whole; a selected subset of a population or subset of whatever is being studied. For example, in a study of people the *sample* is a number of people chosen from a larger population [see **population**]. An environmental *sample* (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Sievert (Sv)
The SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sieverts is equal to the absorbed dose, in gray, multiplied by the quality factor (1 sievert equals 100 rem).

Solvent
A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A *source of contamination* is the first part of an **exposure pathway.**

Special populations
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered *special populations.*

Specific activity
Radioactivity per unit mass of material containing a radionuclide, expressed, for example, as Ci/gram or Bq/gram.

Stakeholder
A person, group, or community who has an interest in activities at a hazardous waste site.

Statistics
A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance
A chemical.

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with **groundwater**].

Surveillance
[see **epidemiologic surveillance**]

Survey
A systematic collection of information or data. A *survey* can be conducted to collect information from a group of people or from the environment. *Surveys* of a group of people can be conducted by telephone, by mail, or in person. Some *surveys* are done by interviewing a group of people.

Toxicological profile
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A *toxicological profile* also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology
The study of the harmful effects of substances on humans or animals.

Uncertainty factor
A mathematical adjustment for reasons of safety when knowledge is incomplete—for example, a factor used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). *Uncertainty factors* are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use *uncertainty factors* when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a **safety factor**].

Units, radiological

Units	*Equivalents*
Becquerel* (Bq)	1 disintegration per second = 2.7×10^{-11} Ci
Curie (Ci)	3.7×10^{10} disintegrations per second = 3.7×10^{10} Bq
Gray* (Gy)	1 J/kg = 100 rad
Rad (rad)	100 erg/g = 0.01 Gy
Rem (rem)	0.01 sievert
Sievert* (Sv)	100 rem

*International Units, designated (SI)

Urgent public health hazard
A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

Other Glossaries and Dictionaries

Environmental Protection Agency http://www.epa.gov/OCEPAterms/
National Center for Environmental Health (CDC) http://www.cdc.gov/nceh/dls/report/glossary.htm
National Library of Medicine http://www.nlm.nih.gov/medlineplus/mplusdictionary.html

APPENDIX B

Summary of Other Public Health Activities

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Summary of ATSDR Activities

Exposure Investigations, Health Consultations, and Other Scientific Evaluations. ATSDR health scientists have addressed current public health issues and community health concerns related to two areas affected by Oak Ridge Reservation (ORR) operations—the East Fork Poplar Creek (EFPC) area and the Watts Bar Reservoir area.

Following are summaries of other ATSDR public health activities involving EFPC:

- *Health Consultation on Proposed Mercury Cleanup Levels, January 1996*. In response to a request from community members and the city of Oak Ridge, ATSDR evaluated the public health impact of the U.S. Department of Energy's (DOE's) cleanup levels of 180 milligrams per kilogram (mg/kg) and 400 mg/kg of mercury in the EFPC floodplain soil. ATSDR concluded that the cleanup levels of 180 mg/kg and 400 mg/kg of mercury in the soil of the EFPC floodplain would be protective of public health and pose no health threat to adults or children.

- *ATSDR Science Panel Meeting on the Bioavailability of Mercury in Soil, August 1995*. The purpose of the science panel was to identify methods and strategies that would enable health assessors to develop data-supported, site-specific estimates of the bioavailability of inorganic mercury and other metals (arsenic and lead) from soils. The panel consisted of private consultants and academicians internationally known for their metal bioavailability research along with experts from ATSDR, the Centers for Disease Control and Prevention (CDC), the U.S. Environmental Protection Agency (EPA), and the National Institute for Environmental Health Science. ATSDR used information obtained from the panel meeting to evaluate the EFPC cleanup level. ATSDR also used the findings to characterize and evaluate soil containing mercury at other waste sites. Three technical papers and an ATSDR overview paper on the findings of the panel meeting were published in the International Journal of Risk Analysis in 1997 (Volume 17:5).

Following are summaries of other ATSDR public health activities involving Watts Bar Reservoir:

- *Community and Physician Education, September 1996*. To follow up on the recommendations in the ATSDR Lower Watts Bar Reservoir Health Consultation, ATSDR developed community and physician education programs on polychlorinated biphenyls (PCBs) in the Watts Bar Reservoir. Daniel Hryhorczuk, MD, MPH, ABMT, of the Great Lakes Center, University of Illinois at Chicago, made presentations on the health risk associated with PCBs in fish at a community health education meeting in Spring City, TN on September 11, 1996. In addition, a physician and health professional education meeting for health care providers in the vicinity of the Lower Watts Bar Reservoir was held at the Methodist Medical Center in Oak Ridge on September 12,

1996. ATSDR, in collaboration with local citizens, organizations, and state officials, developed an instructive brochure on the Tennessee Department of Environment and Conservation's (TDEC's) fish consumption advisories for the Watts Bar Reservoir.

➢ *Watts Bar Reservoir Exposure Investigation*. In following up on the findings of previous studies and investigations of the Watts Bar Reservoir, including Feasibility of Epidemiologic Studies by the Tennessee Department of Health (TDOH), ATSDR conducted the exposure investigation with cooperation from the TDOH and the Roane County Health Department. The 1996 exposure investigation was conducted to measure actual PCB and mercury levels in people consuming moderate to large amounts of fish and turtles from the Watts Bar Reservoir, and to determine whether these people are being exposed to high levels of PCBs and mercury. ATSDR published the following three major findings:

- The exposure investigation participants' serum PCB levels and blood mercury levels are very similar to levels found in the general population.
- Only 5 of the 116 people tested (4%) had PCB levels that were higher than 20 micrograms per liter (µg/L) or parts per billion (ppb), which is considered to be an elevated level of total PCBs. Of the five participants who exceeded 20 µg/L, four had levels of 20–30 µg/L. Only one participant had a serum PCB level of 103.8 µg/L, which is higher than the general population distribution.
- Only one participant in the exposure investigation had a total blood mercury level higher than 10 µg/L, which is considered to be elevated. The remaining participants had mercury blood levels that ranged up to 10 µg/L, as might be expected to be found in the general population.

Clinical Laboratory Analysis. In June 1992, an Oak Ridge physician reported to the TDOH and the Oak Ridge Health Agreement Steering Panel (ORHASP) that approximately 60 of his patients may have been exposed, either occupationally or from the environment, to several heavy metals. The physician felt that these exposures had resulted in a number of adverse health outcomes (for example, increased incidence of cancer, chronic fatigue syndrome, neurological diseases, autoimmune disease, and bone marrow damage). In 1992 and 1993, ATSDR and CDC's National Center for Environmental Health (NCEH) facilitated clinical laboratory support by the NCEH Environmental Health Laboratory for patients referred by an Oak Ridge physician to the Howard Frumkin, M.D., Dr.PH., Emory University School of Public Health.

Because of patient-to-physician and physician-to-physician confidentiality, results of the clinical analysis have not been released to public health agencies. However, Dr. Frumkin recommended (in an April 26, 1995 letter to the Commissioner of TDOH) that one should "not evaluate the patients seen at Emory as if they were a cohort for whom group statistics would be meaningful. This was a self-selected group of patients, most with difficult to answer medical questions (hence their trips to Emory), and cannot in any way be taken to typify the population at Oak Ridge. For that reason, I have consistently urged Dr. Reid, each of the patients, and officials of the CDC and the Tennessee Health Department, not to attempt group analyses of these patients."

Review of Clinical Information on Persons Living In or Near Oak Ridge. In addition to the above Clinical Laboratory Analysis, an ATSDR physician reviewed the clinical data and medical histories provide by the Oak Ridge physician on 45 of his patients. The purpose of this review was to evaluate clinical information on persons tested for heavy metals and to determine whether exposure to metals was related to these patients' illnesses. ATSDR concluded that this case series did not provide sufficient evidence to associate low levels of metals with these diseases. The TDOH came to the same conclusion. ATSDR sent a copy of its review to the Oak Ridge physician in September 1992.

Health education. Another essential part of the public health assessment process is designing and implementing activities that promote health and provide information about hazardous substances in the environment.

- *Health Professional Education on Cyanide.* A physician education program was conducted in 1996, to provide information regarding the health impacts of possible cyanide intoxication. The program was intended to assist community health care providers in responding to health concerns expressed by employees working at the East Tennessee Technology Park (formerly the K-25 facility). ATSDR provided the local physicians with copies of the ATSDR Case Studies in Environmental Medicine publication "Cyanide Toxicity," the National Institute for Occupational Safety and Health (NIOSH) final health hazard evaluation, and the ATSDR public health statement for cyanide. Further, ATSDR instituted a system through which local physicians could make patient referrals to the Association of Occupational and Environmental Clinics (AOEC). Finally, ATSDR conducted an environmental health education session for physicians at the Methodist Medical Center in Oak Ridge, Tennessee. The medical staff grand rounds provided the venue for conducting this session. The workshop focused on providing local physicians and other health care providers with information to help them diagnose chronic and acute cyanide intoxication and to answer patients' questions.

- *Workshops on Epidemiology.* At the request of members of the Oak Ridge Reservation Health Effects Subcommittee (ORRHES), ATSDR held two workshops on epidemiology for the subcommittee. The first epidemiology workshop was presented at the June 2001 ORRHES meeting. Ms. Sherri Berger and Dr. Lucy Peipins of ATSDR's Division of Health Studies provided an overview of the science of epidemiology. The second epidemiology workshop was presented at the December 2001 ORRHES meeting and was designed to help subcommittee members develop the skills needed to review and evaluate scientific reports. In addition, at the August 28, 2001, meeting of the Public Health Assessment Work Group (PHAWG), Dr. Peipins guided the work group and community members through a systematic scientific approach as they critiqued a report by J. Mangano, "Cancer Mortality Near Oak Ridge, Tennessee" (Int. J. of Health Services, V. 24 #3, 1994, p. 521). Based on the PHAWG critique, the ORRHES made the following conclusions and recommendation to ATSDR.

    1. The Mangano paper is not an adequate, science-based explanation of any alleged anomalies in cancer mortality rates of the off-site public.

2. The Mangano paper fails to establish that radiation exposure from the ORR are the cause of any such alleged anomalies of cancer mortality rates in the general public.

3. The ORRHES recommends to the ATSDR that the Mangano paper be excluded from consideration in the ORR public health assessment process.

- *Health Education Needs Assessment.* Throughout the public health assessment process, ATSDR staff members have gathered concerns from people in the communities around the ORR. Through a cooperative agreement with ATSDR, AOEC began a community health education needs assessment in 2000 to aid in developing a community health education action plan. George Washington University and MCP Hahnemann University are conducting the assessment for the AOEC. The needs assessment will help in planning, implementing, and evaluating the health education program for the site. It will also help health educators identify key people, cultural norms, attitudes, beliefs, behaviors, and practices in the community, which is information that will aid in developing effective health education activities. Information on the needs assessment was presented at several ORRHES meetings.

Coordination with other parties. Since 1992 and continuing to the present, ATSDR has consulted regularly with representatives of other parties involved with the ORR. Specifically, ATSDR has coordinated efforts with TDOH, TDEC, NCEH, NIOSH, and DOE. This effort led to the establishment of the Public Health Working Group in 1999, which led to the establishment of ORRHES. In addition, ATSDR provided some assistance to TDOH in its study of past public health issues. ATSDR has also obtained and interpreted studies prepared by academic institutions, consulting firms, community groups, and other parties.

Establishment of the ORR Public Health Working Group and the ORRHES. In 1998, in collaboration with the DOE Office of Health Studies, ATSDR and CDC embarked on a process of developing credible, coherent, and coordinated agendas of public health activities and health studies for each DOE site. In February 1999, ATSDR was given the responsibility to lead the interagency group’s efforts to improve communication at ORR. In cooperation with other agencies, ATSDR established the ORR Public Health Working Group to gather input from local organizations and individuals regarding the creation of a public health forum. After careful consideration of the input gathered from community members, ATSDR and CDC determined that the most appropriate way to meet the needs of the community would be to establish the ORRHES.

Site visits. To better understand site-specific exposure conditions, ATSDR scientists have conducted site visits to the ORR and visited surrounding areas numerous times since 1992. The site visits included guided tours of the ORR operation areas, as well as tours of the local communities to identify how community members might come into contact with environmental contamination.

Summary of U.S. Department of Health and Human Services Activities

U.S. Department of Health and Human Services' Evaluation of Data in The Tennessean Article. In a November 2,1998 letter, the Honorable William H. Frist, M.D., United States Senator requested Donna E. Shalala, Secretary of the Department of Health and Human Services (DHHS), have the CDC, ATSDR, and the National Institutes of Health (NIH) evaluate the data on which the *The Tennessean* article describes reports of a pattern of illnesses among residents living near nuclear plants, including the DOE ORR.

In particular, Senator Frist requested the following:

- Assess the quality and usefulness of the data on which the report is based.
- Examine the data for any patterns of illness and assess whether there is sufficient data to establish a relationship to the nuclear plants.
- Summarize the current DHHS studies that are currently underway at the 11 sites.
- Estimate how the key questions raised by the newspaper articles could be addressed in a potential study.
- Describe any existing programs at the three agencies that may help address the medical needs of people living near nuclear plants.

In a February 22, 1999, Donna E. Shalala, Secretary of DHHS, responded to Senator Frist's request. The DHHS evaluated the *The Tennessean* article and responded to the Senator Frist's five specific issues. DHHS concluded the following:

1. The data in *The Tennessean* article were not compiled from an epidemiologic study and thus have many limitations. It is impossible to calculate rates for the reported illnesses or to determine whether rates of the illnesses were abnormal. It is also difficult to relate excess illnesses to specific nuclear plants because primary exposures differ among the plants.

2. Epidemiologically, it is neither acceptable to tabulate data collected in an unstandardized manner, nor to assess illnesses and symptom based on limited diagnostic information. Thus, it is not possible to determine if data in this report represent a new or unusual occurrence of symptoms in this population.

3. DHHS has a significant number of ongoing studies that seek to analyze environmental exposure at each of the 11 sites rather than focusing on general medical evaluations of the populations near the sites. However, clinical data from the Fernald Medical Monitoring Program and the Scarboro, Tennessee survey focus on respiratory illnesses in children and, although quite limited, are most relevant to the issues raised by the report.

4. Sound data using standardized information is essential in order to establish increased prevalence of a disease and linkage to the nuclear plants.

   First, the occurrence of a single, definable illness would have to be assessed.

   Second, studies including structured population surveys would need to be developed for general health and illness data in well-defined population groups near the nuclear sites. The finding would then be compared to results form other well-defined populations living elsewhere.

   Third, any attempt to determine a causal relationship between disease or illness rates in these populations and exposures to hazards would be difficult since historic exposures are difficult to identify and measure.

5. CDC, ATSDR, and NIH are working with DOE to plan appropriate public health follow-up activities to address the concerns of communities and workers regarding the nuclear weapons complexes. Embarking on such a comprehensive program will require considerable resource, planning, and evaluation. Please note that CDC, ATSDR, and NIH do not provide direct primary medical services to communities. However, where possible, CDC, ATSDR, and NIH will continue to support community leaders and existing medical care systems to address public health concerns of communities that are near nuclear plants.

Summary of TDOH Activities

Pilot Survey. In the fall of 1983, TDOH developed an interim soil mercury level for use in environmental management decisions. CDC reviewed the methodology for the interim mercury level in soil and recommended that a pilot survey be conducted to determine whether populations with the highest risk for mercury exposure had elevated body burdens of mercury. In June and July 1984, a pilot survey was conducted to document human body levels of inorganic mercury for residents of Oak Ridge with the highest potential for mercury exposure from contaminated soil and fish. The survey also examined whether exposure to mercury-contaminated soil and fish constituted an immediate health risk to the Oak Ridge population. The results of the pilot survey, released in October 1985, suggested that residents and workers in Oak Ridge, Tennessee, are not likely to be at increased risk for having significantly high mercury levels. Mercury concentrations in hair and urine samples were below levels associated with known health effects.

Health Statistics Review. In June 1992, an Oak Ridge physician reported to TDOH and ORHASP that he believed approximately 60 of his patients had experienced occupational and environmental exposures to several heavy metals. The physician felt that these exposures had resulted in increased cancer, immunosuppression, chronic fatigue syndrome, neurologic diseases, autoimmune disease, bone marrow damage, and hypercoagulable state including early myocardial infarctions and stroke. In 1992, the TDOH conducted a health statistics review to compare cancer incidence rates for the period of 1988 to 1990 for counties surrounding the ORR to rates from the rest of the state. Findings of the review are in a TDOH memorandum dated October 19, 1992, from Mary Layne Van Cleave to Dr. Mary Yarbrough. The memorandum details an Oak Ridge physician's concerns about the health status in the Oak Ridge area. Also available from the TDOH are the minutes and handouts from a presentation given by Ms. Van Cleave at the ORHASP meeting on December 14, 1994.

Health Statistics Review. In 1994 local residents reported that there were many community members with amyotrophic lateral sclerosis (ALS) and multiple sclerosis (MS). The TDOH in consultation with Peru Thapa, MD, MPH, from the Vanderbilt University School of Medicine conducted a health statistics review of mortality rates for amyotrophic lateral sclerosis (ALS), multiple sclerosis (MS), and other selected health outcomes.

TDOH found that because ALS and MS are not reportable diseases, it is impossible to calculate reliable incidence rates. Mortality rates for the period of 1980 to 1992 were reviewed for the 10 counties surrounding the ORR and compared with mortality rates for the state of Tennessee. The following results were reported by the TDOH at the ORHASP public meeting on August 18, 1994.

- There were no significant differences in ALS mortality in any of the counties in comparison to the rest of the state.

- For Anderson County, the rate of age-adjusted deaths from chronic obstructive pulmonary disease (COPD) was significantly higher than rates in the rest of the state, but rates for total deaths, deaths from stroke, deaths from congenital anomalies, and deaths from heart disease were significantly lower for the period from 1979 to 1988. There were no significant differences in the rates of deaths due to cancer, for all sites, in comparison to rates in the rest of state. Rates of deaths from uterine and ovarian cancer were significantly higher than the rates in the rest of the state. The rate of deaths from liver cancer was significantly lower in comparison to the rest of the state.

- For Roane County, the rates of total deaths and deaths from heart disease were significantly lower than the rates in the rest of the state for the period from 1979 to 1988. Although the total cancer death rate was significantly lower than the rate in the rest of the state, the rate of deaths from lung cancer was significantly higher than the rate in the rest of the state. Rates of deaths from colon cancer, female breast cancer, and prostate cancer were also significantly lower than the rates in the rest of the state.

- For Knox County, the rates for total deaths and deaths from heart disease were significantly lower than the rates in the rest of the state. There was no significant difference in the total cancer death rate in comparison to the rest of the state.

- There were no significant exceedances for any cause of mortality studied in Knox, Loudon, Rhea, and Union counties in comparison to the rest of the state.

- Rates of total deaths were significantly higher in Campbell, Claiborne, and Morgan counties in comparison to the rest of the state.

- Cancer mortality was significantly higher in Campbell County in comparison to the rest of the state. The excess in number of deaths from cancer appeared to be attributed to the earlier part of the time period (1980 to 1985); the rate of deaths from cancer was not higher in Campbell County in comparison to the rest of the state for the time periods from 1986 to 1988 and 1989 to 1992.

- Cancer mortality was significantly higher in Meigs County in comparison to the rest of the state from 1980 to 1982. This excess in cancer deaths did not persist from 1983 to 1992.

Knowledge, Attitude, and Beliefs Study. A study, coordinated by TDOH, was conducted in an eight-county area surrounding Oak Ridge, Tennessee. The purpose of the study was to (1) investigate public perceptions and attitudes about environmental contamination and public health problems related to the ORR, (2) ascertain the public's level of awareness and assessment of the ORHASP, and (3) make recommendations for improving public outreach programs. The report was released in August 1994. Following is a summary of the findings.

- A majority of the respondents regard their local environmental quality as better than the national environmental quality. Most rate the quality of the air and their drinking water as good or excellent. Almost half rate the local groundwater as good or excellent.

- A majority of the respondents think that activities at the ORR created some health problems for people living nearby and most think that activities at ORR created health problems for people who work at the site. Most feel that researchers should examine the actual occurrence of disease among Oak Ridge residents. Twenty-fine percent know of a specific local environmental condition that they believe has adversely affected public health, but many of these appear to be unrelated to ORR. Less than 0.1% have personally experienced a health problem that they attribute to the ORR.

- About 25% have heard of the Oak Ridge Health Study and newspapers are the primary source of information about the study. Roughly 33% rate the performance of the study as good or excellent and 40% think the study will improve public health. Also, 25% feel that communication about the study has been good or excellent.

Health Assessment. A health assessment of the East Tennessee region was conducted by TDOH's East Tennessee Region to evaluate the health status of the population, assess the availability and utilization of health services, and develop priorities in planning to use resources. In December 1991, the East Tennessee Region released the first edition of *A Health Assessment of the East Tennessee Region*, which included data generally from 1986 to 1990. The second edition, released in 1996, included data generally from 1990 through 1995. A copy of the document is available from the TDOH East Tennessee Region.

Presentation. Dr. Joseph Lyon of the University of Utah gave a presentation to inform the ORHASP and the public of the multiple studies related to the fallout from the Nevada Test Site, including the study of leukemia and thyroid disease. The presentation was sponsored by TDOH and held on February 16, 1995, at the ORHASP public meeting.

Summary of Joint Center for Political and Economic Studies Activities

Scarboro Community Assessment Report. In 1999, the Joint Center for Political and Economic Studies conducted a survey of the Scarboro community to identify environmental and health concerns of the residents. The surveyors attempted to elicit responses from the whole community and achieved an 82% response rate. Additionally, with support from DOE Oak Ridge Operations, the Joint Center has been working with the community since 1998 to help residents articulate their environmental, health, economic, and social needs. Because Scarboro is a small community, the community assessment provided new information about the community that is not available through sources such as the U.S. Census Bureau. It also identified Scarboro’s strengths and weaknesses and illustrated the relative unimportance of environmental health issues to other community concerns–environmental and health issues are not a priority for most Scarboro residents; rather the community is more concerned about crime and security, children, and economic development. The Joint Center recommended more active community involvement in city and community planning (Friday and Turner 2001).

APPENDIX C

Toxicologic Implications of Uranium Exposure

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Toxicologic Implications of Uranium Exposure

ATSDR's toxicological profiles identify and review the key peer-reviewed literature that describes particular hazardous substances' toxicologic properties. They also present other pertinent literature, but describe it in less detail than the key studies. Toxicological profiles are not intended to be exhaustive documents, but they do reference more comprehensive sources of specialty information.

In 1999, ATSDR published an updated toxicological profile for uranium (ATSDR 1999a). This document, like all such profiles, succinctly characterizes the toxicologic and adverse health effects information for the hazardous substance it describes. The discussion below is drawn from the updated profile for uranium, except where otherwise noted.

What Is Uranium?

Uranium, a natural and commonly occurring radioactive element, is found in very small amounts in nature in the form of minerals. Rocks, soil, surface and underground water, air, and plants and animals all contain varying amounts of uranium. Typical concentrations in most materials are a few parts per million (ppm). This corresponds to around 4 tons of uranium in 1 square mile of soil 1 foot deep, or about half a teaspoon of uranium in a typical 8-cubic-yard dump truck load of soil (ATSDR 1999a).

Natural uranium is a mixture of three types (or isotopes) of uranium, written as U 234, U 235, and U 238. By weight, natural uranium is about 0.005% U 234, 0.72% U 235, and 99.27% U 238. For uranium that has been in contact with water, the natural weight and radioactivity percentages can vary slightly from these percentages. All three isotopes behave the same chemically, so any combination of the three would have the same chemical effect on your body. But they are different radioactive materials with different radioactive properties. About 48.9% of the radioactivity is associated with U 234, 2.2% is associated with U 235, and 48.9% is associated with U 238 (ATSDR 1999a).

Uranium Use at ORR

One of the industrial processes at the Y-12 plant artificially increased (enriched) the amount of U 235 over and above the enrichment from the K-25 plant. This enrichment process is used to increase the amount of U 235 and decrease the amount of U 238 in uranium. Enriched uranium used for nuclear power plants is typically 3% U 235. Uranium enrichment for nuclear weapons and nuclear propulsion can produce uranium that contains as much as, if not more than, 97% U 235. The uranium left over after enrichment is called depleted uranium. Uranium enriched as at Y-12 is more radioactive than natural uranium, and natural uranium is more radioactive than depleted uranium.

Various types and amounts of uranium compound were used and produced at the Y-12 facility and potentially released to the environment. The chemical forms of uranium used at Y-12 included uranium tetrachloride, uranium oxides in the form of UO_2, UO_3, and U_3O_8, and uranium hexafluoride (ChemRisk 1999). Of these forms, U_3O_8 is most commonly found in nature and chemically is the most stable. Uranium dioxide (UO_2) is the form most used in nuclear reactors; over time, it converts to U_3O_8. The following table gives the water solubility and kidney toxicity of the common uranium compounds used at the Y-12 facility.

Table C-1. Relative Water Solubility and Kidney Toxicity of the Uranium Compounds Used at Y-12

Relative Water Solubility	Relative Toxicity to Kidney	Uranium Compound
Most water soluble	Most toxic	Uranium hexafluoride Uranium tetrachloride
Low water solubility	Low to moderate toxicity	Uranium trioxide
Insoluble	Least toxic	Uranium dioxide Triuranium octaoxide

How Can Uranium Enter and Leave My Body?

Plants and animals can take up uranium. Uranium in soil can be taken into plants without entering into the plants' bodies. Root vegetables (like potatoes and radishes) that are grown in soils with high concentrations of uranium may contain more uranium than other vegetables grown in the same conditions. Uranium can also get into livestock through food, water, and soil. Therefore, uranium is taken into our bodies in the food we eat, the water we drink, and the air we breathe. But it does not stay in the body long—it is eliminated quickly in urine and feces.

What we take in from industrial activities is in addition to what we take in from natural sources. When you breathe uranium dust, some is exhaled and some stays in your lungs. The size of the uranium dust particles and how easily they dissolve determines where in the body the uranium goes and how it leaves your body. Uranium dust can consist of small, fine particles and coarse, big particles. The big particles are caught in the nose, the sinuses, and the upper part of your lungs; from there, they are blown out or pushed to the throat and swallowed. The small particles are inhaled down to the lower part of your lungs. If they do not dissolve easily, they stay there for years. (Most of uranium's radiation dose to the lungs comes from these small particles.) Given these solubilities, the International Commission on Radiological Protection has grouped uranium compounds into three classes, as shown in the following table (ICRP 1993, 1995).

Table C-2. Types of Uranium Compound According to Their Solubilities

	Type F	Type M	Type S
Initial Dissolution Rate (per day)	100	10	0.1
Representative Uranium Compounds	Hexafluoride, tetrafluoride; pure trioxide form (UO_3)	Tetrafluoride, trioxide, octoxide (U_3O_8) (dependent on process)	Octoxide, dioxide (UO_2)

Uranium particles can also gradually dissolve and go into your blood. If the particles dissolve easily, they go into your blood more quickly. When you eat foods and drink liquids containing uranium, most of it leaves within a few days in your feces and never enters your blood. A small portion does get into your blood, which carries it throughout your body. Some of the uranium in your blood leaves your body through your urine within a few days, but the rest stays in your bones, kidneys, or other soft tissues. A small amount of the uranium that goes to your bones can stay there for years. Most people have very small amounts of uranium, about 1/5,000th of the weight of an aspirin tablet, in their bodies, mainly in their bones.

Once in the blood, uranium is distributed to the organs of the body. Uranium in body fluids generally exists as the uranyl ion (UO2)2+ complexed with anions such as citrate and bicarbonate. Approximately 67% of uranium in the blood is filtered in the kidneys and leaves the body in urine within 24 hours; the remainder distributes to tissues. Uranium preferentially distributes to bone, liver, and kidney. Half-times for retention of uranium are estimated to be 11 days in bone and 2–6 days in the kidney… [However,] the less soluble uranium particles may remain in the lungs and in the regional lymph nodes for weeks (uranium trioxide, uranium tetrafluoride, uranium tetrachloride) to years (uranium dioxide, triuranium octaoxide). The human body burden of uranium is approximately 90 µg; it is estimated that 66% of this total is in the skeleton, 16% in the liver, 8% in the kidneys, and 10% in other tissues. The large majority of [ingested] uranium (>95%) that enters the body is not absorbed and is eliminated from the body via the feces. Excretion of absorbed uranium is mainly via the kidney.”

How Can Uranium Affect My Health?

Although uranium is weakly radioactive, most of the radiation it gives off cannot travel far from its source. 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 (ATSDR 1999a).

Scientists have never detected harmful radiation effects from low levels of natural uranium, although some may be possible. However, scientists have seen chemical effects. A few people have developed signs of kidney disease after taking in large amounts of uranium (e.g., one man ingested 131 milligrams per kilogram of uranyl acetate in a suicide attempt; see Pavlakis et al. 1996 as cited in ATSDR 1999a). Animals have also developed kidney disease after they have been treated with large amounts of uranium. It is possible that intake of a large amount of uranium will damage your kidneys.

Animal studies in a number of species and using a variety of compounds confirm that uranium is a nephrotoxin. The kidneys have been identified as the most sensitive target of uranium toxicosis, consistent with the metallotoxic action of a heavy metal. All of the MRLs derived for uranium are based on renal effects, the most sensitive toxic end point.

Although no studies were located that specifically tested immunological effects in humans following inhalation exposure to uranium, all epidemiologic studies of workers in uranium mines and fuel fabrication plants showed no increased incidence of death due to diseases of the immune system (Brown and Bloom 1987; Checkoway et al. 1988; Keane and Polednak 1983; Polednak and Frome 1981). Human studies that assessed damage to cellular immune components following inhalation exposure to uranium found no clear evidence of an immunotoxic potential for uranium. No association was found between the uranium exposure and the development of abnormal leukocytes in workers employed for 12–18 years at a nuclear fuels production facility (Cragle et al. 1988)… There is some evidence from animal studies that exposure to $\geq$90% enriched uranium may affect the immune system. Adverse effects reported from such exposures include damage to the interstitium of the lungs (fibrosis) and cardiovascular abnormalities (friable vessels). However, access to U 235 enriched or other high specific-activity uranium is strictly regulated by the NRC and the U.S. Department of Energy (DOE). Therefore, the potential for human exposure to this level of radioactivity is limited to rare accidental releases in the workplace. No information was located regarding the effects of uranium on the immune system in humans following oral exposure for any duration. In laboratory animals, oral exposure of rats, mice, and rabbits to uranium had no significant effect on immune system function

There is also a chance of getting cancer from any radioactive material like uranium. Again, natural and depleted uranium are only weakly radioactive, and their radiation is not likely to cause cancer. No human cancer of any type has ever been seen as a result of exposure to natural or depleted uranium (ATSDR 1999a). Although several studies of uranium miners found that they were more likely to die from lung cancer, it is difficult to say whether uranium exposure caused these cancers: while they were being exposed to the uranium, the miners were also being exposed to known cancer-causing agents (tobacco smoke, radon and decay products, silica, and diesel engine exhaust). The studies attributed the cancers to exposure to these agents and not to uranium exposure.

The National Academy of Sciences' Committee on the Biological Effects of Ionizing Radiation (BEIR IV) reported that eating food or drinking water that has normal amounts of uranium will most likely not cause cancer or other health problems in most people (National Research Council 1988). The Committee used data from animal studies to estimate that a small number of people who steadily eat food or drink water containing larger-than-normal quantities of uranium could get a kind of bone cancer called a sarcoma. The Committee reported calculations showing that if a million people steadily ate food or drink water containing about 1 picocurie of uranium every day of their lives, one or two of them would have developed bone sarcomas after 70 years, based on the radiation dose alone. However, we do not know this for certain because people normally ingest only slightly more than this amount each day, and people who have been exposed to larger amounts have not been found to get cancer. We do not know if exposure to uranium causes reproductive effects in people. Very high doses of uranium have caused reproductive problems (reduced sperm counts) in some experiments with laboratory animals. Most studies show no effects (ATSDR 1999a).

How Can Uranium Affect Children?

Children are also exposed to small amounts of uranium in air, food, and drinking water. However, no cases have been reported in which exposure to uranium was known to have caused health effects in children. Children exposed to very high amounts of uranium might have damage to their kidneys like that seen in adults. We do not know whether children differ from adults in their susceptibility to health effects from uranium exposure. It is not known if exposure to uranium has effects on the development of the human fetus. Very high doses of uranium in drinking water can affect the development of the fetus in laboratory animals. One study reported birth defects and another reported an increase in fetal deaths. However, we do not believe that uranium can cause these problems in pregnant women who take in normal amounts of uranium from food and water, or who breathe the air around a hazardous waste site that contains uranium (ATSDR 1999a).

Is There a Medical Test to Determine Whether I Have Been Exposed to Uranium?

There are medical tests that can determine whether you have been exposed by measuring the amount of uranium in your urine, blood, and hair. Urine analysis is the standard test. If your body takes in a larger-than-normal amount of uranium over a short period, the amount of uranium in your urine may be increased for a short time. Because most uranium leaves the body within a few days, normally the amount in the urine only shows whether you have been exposed to a larger-than-normal amount within the last week or so. If the intake is large or if higher-than-normal levels are taken in over a long period, the urine levels may be high for a longer period of time. Many factors can affect the detection of uranium after exposure. These factors include the type of uranium you were exposed to, the amount you took into your body, and the sensitivity of the detection method. Also, the amount in your urine does not always accurately show how much uranium you have been exposed to. If you think you have been exposed to elevated levels of uranium and want to have your urine tested, you should do so promptly while the levels may still be high. In addition to uranium, the urine could be tested for evidence of kidney damage, through tests for protein, glucose, and nonprotein nitrogen, which are some of the chemicals that can appear in your urine because of kidney damage. Though such tests could determine whether you have kidney damage, they would not tell you if uranium in your body caused that damage: several common diseases, such as diabetes, also damage the kidneys (ATSDR 1999a).

What Recommendations Has the Federal Government Made to Protect Human Health?

Federal agencies have set limits for uranium in the environment and workplace. In 1991, the U.S. Environmental Protection Agency established a maximum contaminant level for uranium in drinking water of 20 micrograms per liter (µg/L). In December 2003, the maximum contaminant level for uranium will increase to 30 µg/L. The National Institute of Occupational Safety and Health and the Occupational Safety and Health Organization have established a recommended exposure limit and a permissible exposure limit of 0.05 milligrams per cubic meter for water-soluble uranium dust in the workplace. The Nuclear Regulatory Commission has set uranium release limits of 0.06 picocuries per cubic meter in air and 300 picocuries per liter in water (or approximately 438 µg/L).

APPENDIX D

ATSDR's Derivation of the Radiogenic Cancer Comparison Value

APPENDIX D
ATSDR's Derivation of the Radiogenic Cancer Comparison Value

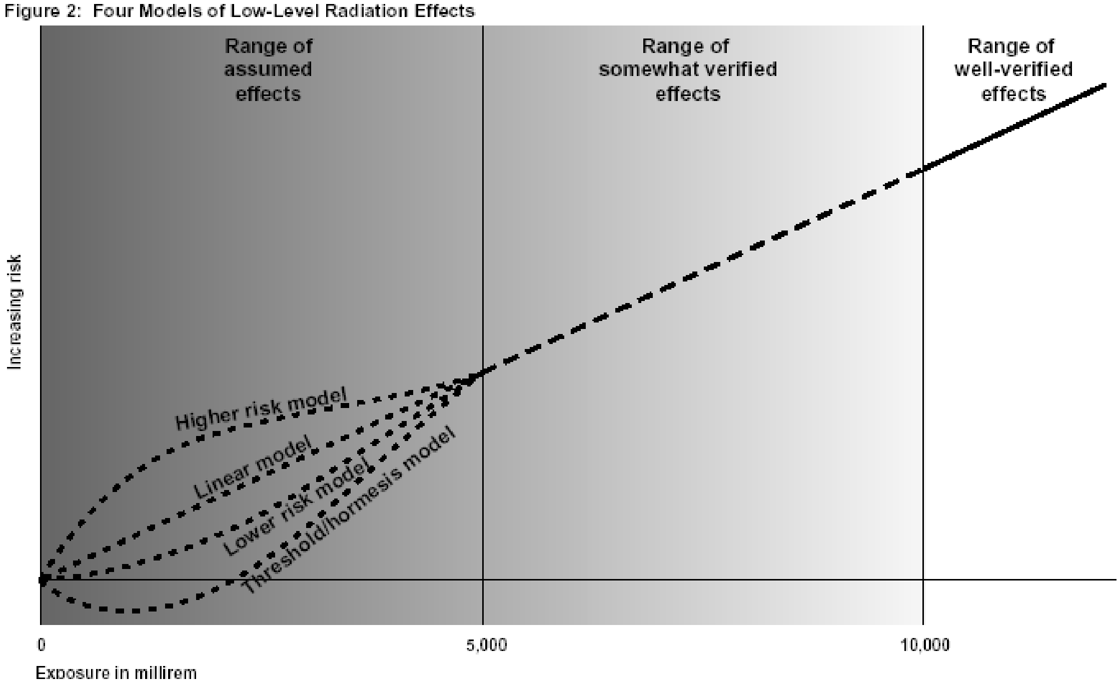
For the evaluation of radiation doses at Oak Ridge, ATSDR used the concept of committed effective dose equivalent (CEDE). The CEDE is a calculated dose arising from the one-time intake of radiological uranium, with the assumption that the entire dose (a 70-year dose, in this case)[19] is received in the first year following the intake. The value used by ATSDR for the radiogenic cancer comparison value is 5,000 millirem (mrem) over 70 years. ATSDR derived this value after reviewing the peer-reviewed literature and other documents developed to review the health effects of ionizing radiation.

In 1994, the General Accounting Office (GAO) released a report reviewing the U.S. radiation standards and radiation protection issues (GAO 1994). The GAO further refined their results in 2000 (GAO 2000). According to the later report, "conclusive evidence of radiation effects is lacking below a total of about 5,000 to 10,000 mrem, according to the scientific literature," which was also the consensus of experts they interviewed (GAO 2000).[20] The GAO then developed the following figure from their analysis. The figure shows the representative knowledge base of radiation effects in relation to radiation dose. Besides the four possible dose response curves indicated on the figure, it also shows that at a dose of 10,000 mrem (which is equal to 10 rems or 0.1 sieverts; "rems" is abbreviated as "rem" and "sieverts" is abbreviated as "Sv") or more, the data are conclusive with respect to health effects from radiation exposure. Between 10 rem and 5 rem, the data are not clear as to the health effects. Below 5 rem the effects are not observed, only assumed to occur. Therefore, the risk associated with a dose that approaches background, 0.36 rem/year (360 mrem or 3.6 millisieverts [mSv]) is essentially impossible to measure. However, studies suggest that when one considers radon, evidence suggests that elevated levels of indoor radon have been associated with elevated rates of lung cancer.

[19] In this case, the entire dose is the dose a person would receive over 70 years of exposure. ATSDR chose a 70-year period of exposure under the assumption that a member of the public would be exposed over an entire lifetime.

[20] Expert organizations estimate risks associated with radiation doses at these levels using complex models of existing data. Here, for example, is an estimate from a 1990 study by a National Academy of Sciences committee called BEIR V: at the 90% statistical confidence interval, out of 100,000 adults exposed to 100 mrem a year of radiation over a lifetime, anywhere from 410 to 980 men and 500 to 930 women might die of cancer caused by the exposure. This confidence interval assumes the validity of the linear model and reflects the uncertainty of inputs to the model.

Figure 2: Four Models of Low-Level Radiation Effects



The National Council on Radiation Protection and Measurement (NCRP), in their Report 136 on linear non-threshold issues, reevaluated the existing data on the dose-response of ionizing radiation and the health effects associated with exposures to ionizing radiation (NCRP 2001). Their evaluation focused on “the mutagenic, clastogenic (chromosome-damaging), and carcinogenic effects of radiation.” As in other reviews, the NCRP found no conclusive evidence to reject the linear no-threshold model for radiation dose response. One result of these reviews, however, is that the NCRP stated that for cell systems receiving “low-LET [Linear Energy Transfer] radiations the lowest dose at which a statistically significant increase of transformation over background has been demonstrated is 10 mGy.” (10 mGy, or milligrays, are equivalent to a radiation dose of 1 rad.) Animal studies, meanwhile, show variation in the dose-response curves. Accordingly, page 210 of the NCRP report states that “the available information does not suffice to define the dose-response curve unambiguously for any neoplasm in the dose range below 0.5 Sv.” Note that the NCRP also stated that other data on induction of neoplasms and life shortening in mice were not inconsistent with a linear response. Thus, there is uncertainty in the response to the types of radiation (photons, neutrons, alpha-emitters, and similar types), the endpoint under investigation, and the animal system being studied.

According to the NCRP, similar dose responses occur in humans, as evidenced by many studies. However, many of these studies were atomic bomb survivor studies—the doses and dose rates involved were very different from the doses and rates typically observed at hazardous waste sites. The NCRP states that in the bomb survivors, induction of leukemia appears to be linear-quadratic; however, the studies on which that statement is based began at least 5 years after the bombing, so they may have missed some of the early deaths from leukemia. Overall, the induction of solid cancers has a linear nonthreshold (LNT) component as low as 50 mSv (5,000 mrem). Other radiation studies show a possible increase in fetal cancer following an exposure of

10 mGy and increased thyroid cancer following irradiation during childhood following a dose of 100 mSv (10,000 mrem).

The adverse health effects from acute exposures to radiation have been well defined through studies of atomic bomb survivors, medical accidents and treatments, and industrial accidents. But this document is concerned with health effects associated with low-dose chronic exposures to ionizing radiation. These health effects are more difficult to define, characterize, and discuss. ATSDR's experience at sites contaminated with radioactive materials shows that chronic exposures are incremental in comparison to background. In the United States, background consists of naturally occurring radon (54%), terrestrial and cosmic radiation (8% each), and radiation from natural internal sources (11%). The remainder (19%) is associated with medical exposures and consumer products (ATSDR 1999b). The typical average background radiation in the United States is 3.6 mSv (360 mrem) per year. Excluding medical and consumer products, the average background is about 300 mrem (3 mSv).

Exposures Associated with Background Radiation

ATSDR could not identify any peer-reviewed studies that show that background-level radiation caused any noncancerous health effects. In fact, there are portions of the globe where the background is higher than in the typical area in the United States. According to the United Nations, the world's background radiation can vary from below 1 mSv (100 mrem) to above 6.4 mSv (640 mrem), or higher, per year. For example, in an area in China where elevated levels of natural background radiation are found, studies have shown a significant increase in chromosomal aberrations; however, no increases in adverse health effects have been observed in the 20 or more years this area has been studied. Other areas in the world where there are high background radiation levels are India, Brazil, and Iran. An area in Iran called Ramsar has verified doses as high as 130 mSv per year (13,000 mrem).[21]

With respect to cancerous health effects, radon health studies are beginning to emerge that indicate a correlation of lung cancer with elevated radon. Of note is the Iowa radon lung cancer study published in 2000 in the Journal of Epidemiology, volume 151, pages 1091-1102.

Incremental Exposures Above Background Radiation

Many studies have attempted to show a cause and effect from low-level chronic radiation exposure. In these studies, low dose can be defined as doses in excess of 10 mSv (1,000 mrem). Many epidemiological studies have included exposed individuals who were classified as receiving doses less than 1,000 mrem. The rates of disease in this category of individuals are indistinguishable from control groups. For many of these low-dose epidemiological studies, researchers used the standardized mortality ratio (SMR). The Society for Risk Analysis defines the SMR as "the ratio of observed deaths in a population to the expected number of deaths as derived from rates in a standard population with adjustment of age and possibly other factors such as sex or race."

[21] ATSDR used several data sources in developing this section: Internet searches, the *Health Physics* journal, and United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) reports.

An English study of over 95,000 radiation workers whose collective dose from external radiation was about 3,200 man Sv (3,200/95,000 = 34 mSv or 3,400 mrem[22]) only took into account external radiation exposure and dose. The results showed that the SMR for all cancers was less than 1 (Kendall et al. 1992).

A later study by Cardis and coworkers included 95,000 nuclear industry workers in the United States, Canada, and the United Kingdom. The study participants were monitored for external radiation exposure (mostly gamma) and were employed for at least 6 months. In all, there were 15,825 deaths, of which 3,976 were from cancer. The authors found no evidence of a dose response and mortality association from all causes or from all cancers. Of the cancer types, leukemia (except for chronic lymphocytic leukemia and multiple myeloma) showed a significant association with cumulative external radiation dose (Cardis et al. 1995).

In a cohort study to determine if radiation workers' children were at risk of developing leukemia or other cancers before they reached 25 years of age, Roman and coworkers included 39,557 children of male workers and 8,883 children of female workers. The study suggested that the incidence of cancer and leukemia among children of nuclear industry employees is similar to that in the general population. The SMR for all cancers and leukemias for each sex of the worker was less than 1 (Roman et al. 1999).

In conclusion, ATSDR believes that doses below the radiogenic cancer comparison value of 5,000 mrem over 70 years are not expected to result in adverse health effects at Oak Ridge.

[22] Since the collective dose is the dose to the entire study population, dividing the collective dose by the number of individuals in the study gives an estimate of the average dose to an individual in the study.

APPENDIX E

Measured vs. Estimated
Average Annual Uranium Air Radioactivity Concentrations
at ORR Air Monitoring Station 46 in Scarboro

Appendix E
Measured vs. Estimated
Average Annual Uranium Air Radioactivity Concentrations
at ORR Air Monitoring Station 46 in Scarboro

Task 6 of the Oak Ridge Health Studies Phase II (ChemRisk 1999) included an extensive assessment of uranium air emissions from the Y-12 facility and an attempt to estimate historic uranium air radioactivity concentrations in Scarboro from 1944 to 1995 based on the annual airborne uranium release estimates for Y-12 from 1944 to 1995. This section of the public health assessment compares the estimated uranium air radioactivity concentrations (1985 to 1995) in Scarboro to the uranium air radioactivity concentrations measured in Scarboro between 1986 and 1995.

The DOE perimeter air monitoring station 46 in Scarboro has been in operation since 1986. The Task 6 report evaluated the environmental monitoring procedures and methods used for that sampling. The Task 6 report concluded that the "procedures and methods that have been used to collect and analyze air samples for uranium concentrations at the Scarboro location were deemed by the project team to be of adequate quality for use in the Scarboro χ/Q [chi/Q] evaluation presented below. The methods employed by ORNL are consistent with industry standards and are capable of producing reliable estimates of uranium concentrations in Scarboro."

Given the Task 6 conclusion about air sampling at station 46, ATSDR assumes that the measured uranium air concentrations at Scarboro, beginning in 1986, are a reliable basis for calculating uranium air exposures and doses to the Scarboro community. Uranium air concentrations at Scarboro from 1944 to 1985 are unknown and must be estimated. If the 1986 to 1995 annual airborne release estimates for Y-12 and the 1986 to 1995 measured air concentrations in Scarboro are correlated, the correlation will provide a quantitative basis for estimating historic annual average air radioactivity concentrations (1944 to 1995) at Scarboro from the annual airborne uranium release estimated for Y-12 between 1944 and 1995.

The Task 6 study used the correlation between the measured Scarboro air concentrations (1986 to 1995) and the estimated Y-12 airborne uranium emissions (1986 to 1995) to create a multiplying factor (termed "an empirical χ/Q"). This χ/Q is simply the ratio of an observed (measured) annual average uranium air concentration in Scarboro to the estimated airborne uranium releases from Y-12 for the same year.[23] As there were 10 years (1986 to 1995) of observed annual average air concentrations in Scarboro and Y-12 airborne emission rates at the time of the Task 6 report, the χ/Q multiplier corresponding to the 95th upper confidence limit of the mean was used.

Figure E-1 shows the annual average U 234/235 air concentrations calculated using the Task 6 χ/Q multiplier relative to the measured Scarboro air concentrations for 1986 to 1995. The figure shows that the χ/Q estimation of Scarboro air concentrations overestimates the measured air

[23] χ represents the average annual Scarboro uranium concentration; Q represents the annual Y-12 uranium emissions. Multiplying the historic Y-12 emissions (Q) by the χ/Q term results in an estimate of the historic Scarboro air concentration, or χ.

concentrations by up to a factor of 5. Consequently, airborne uranium doses to Scarboro residents calculated from χ/Q concentration estimates were probably also overestimated by a factor of up to 5.

Figure E-1 also shows Scarboro air concentrations estimated using linear regression of Y-12 airborne emissions and measured air concentrations. This is a different method of estimating Scarboro air concentrations from Y-12 emissions data. As the air concentrations estimated using linear regression directly overlie the measured air concentrations in Figure E-1, this method appears to be a better estimator of historic Scarboro air concentrations than the χ/Q method.

The linear regression relationship is illustrated in Figure E-2. This method plots the measured air radioactivity concentrations (in femtocuries per cubic meter, or fCi/m^3; 1 femtocurie equals 1×10^{-15} curies) with the Y-12 uranium airborne emissions and draws a best fit straight line through the plotted points. The linear regression is the equation of the best fit line. The correlation coefficient (shown as R^2 in Figure E-2) is a measure of the strength of association between the air concentrations and emissions. The perfect correlation between factors would be 1. The coefficient of 0.9657 between Scarboro air concentrations and Y-12 U 234/235 emissions indicates that the linear regression is a very reliable estimator of historic Scarboro air radioactivity concentrations.

The regression equation (Figure E-2) for estimating historic Scarboro air radioactivity concentrations from Y-12 emissions is:

$$y = 1.7059x + 0.0784$$

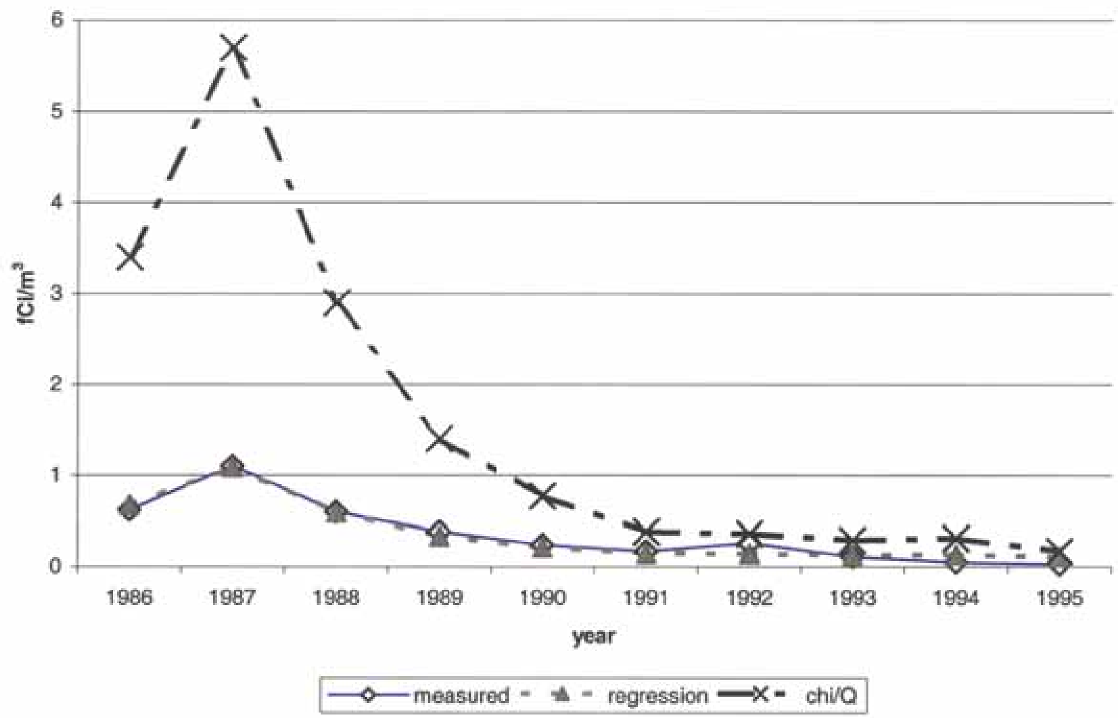
where: y = the estimated Scarboro air radioactivity concentration in fCi/m^3
x = the Y-12 uranium emission rate in curies

The equation above is based on correlation of U 234/235 release rates (Y-12 emissions) and measured U 234/235 air concentrations.

Figure E-3 shows the relationship between U 238 airborne emissions and measured air concentrations. Although this relationship also shows a positive correlation, it is a much weaker association: the correlation coefficient (R^2) is only 0.6377 and there is much greater scatter of the plotted points relative to the best fit regression line. Consequently, the regression equation based on U 238 emissions and measured Scarboro air concentrations is not considered a reliable estimator of historic air concentrations.

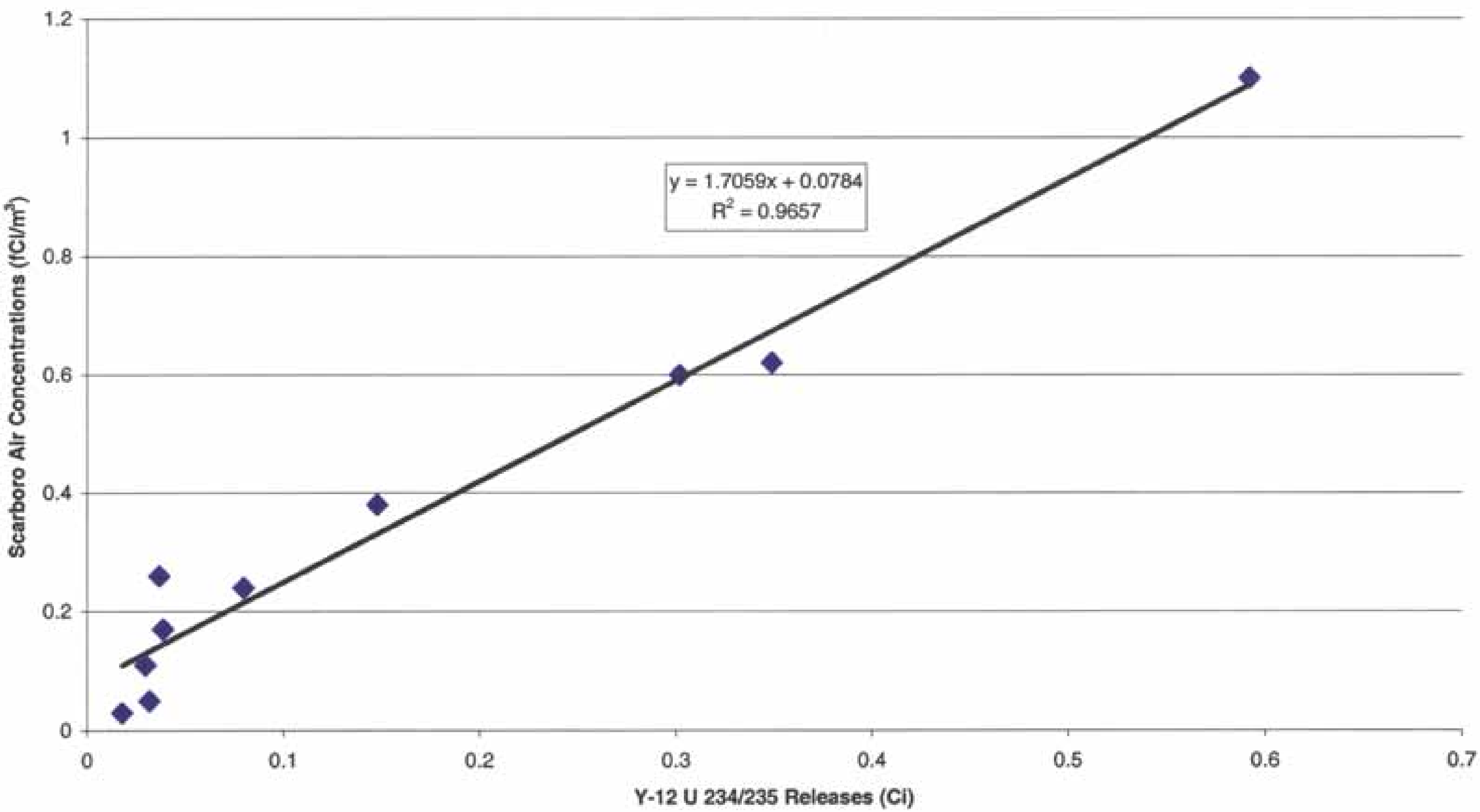
Figure E-4 shows measured and estimated U 238 air concentrations in Scarboro based on the χ/Q and linear regression methods. In this case, the U 238 concentrations are estimated using the U 234/235 regression equation (Figure E-2). The χ/Q estimates show little correspondence with the measured concentrations and either greatly overestimate or underestimate the measured U 238 concentrations. The concentrations estimated using the linear regression method correspond much more closely to the measured U 238 concentrations and never underestimate the measured values. Consequently, airborne U 238 doses to Scarboro residents based on the historic χ/Q concentrations will most likely overestimate, and in some cases underestimate, actual doses.

Figure E-1. Measured vs. Estimated U 234/235 Air Concentrations for Scarboro



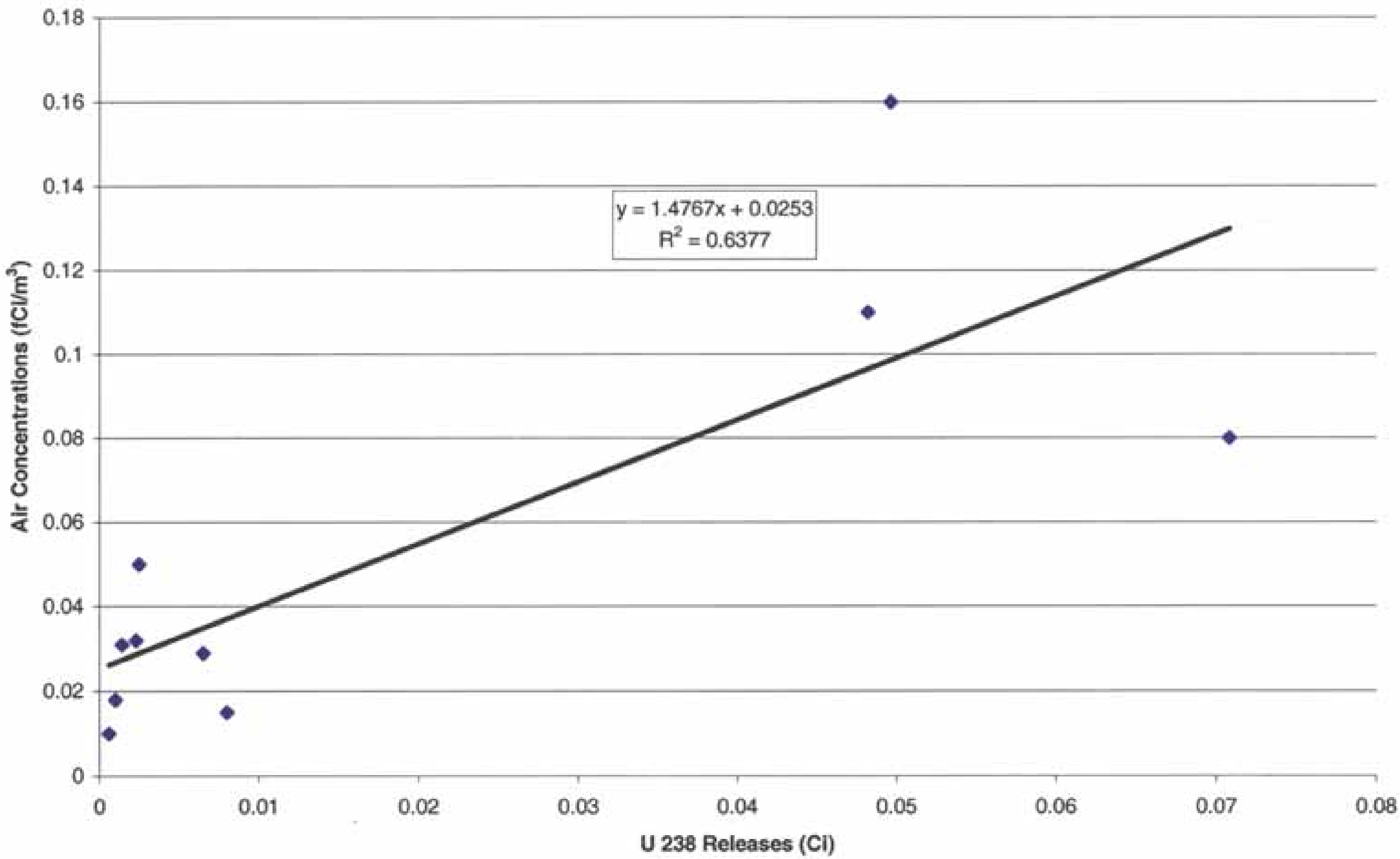
Concentrations estimated using the Task 6 χ/Q method overestimate measured concentrations in Scarboro by a factor of up to 5. Air concentrations estimated using linear regression of measured U 234/235 air concentrations in Scarboro and Y-12 airborne U 234/235 emissions have a much closer agreement with measured air concentrations.

Figure E-2. Airborne U 234/235 Releases Estimates for Y-12 vs. Measured Uranium Air Concentrations in Scarboro



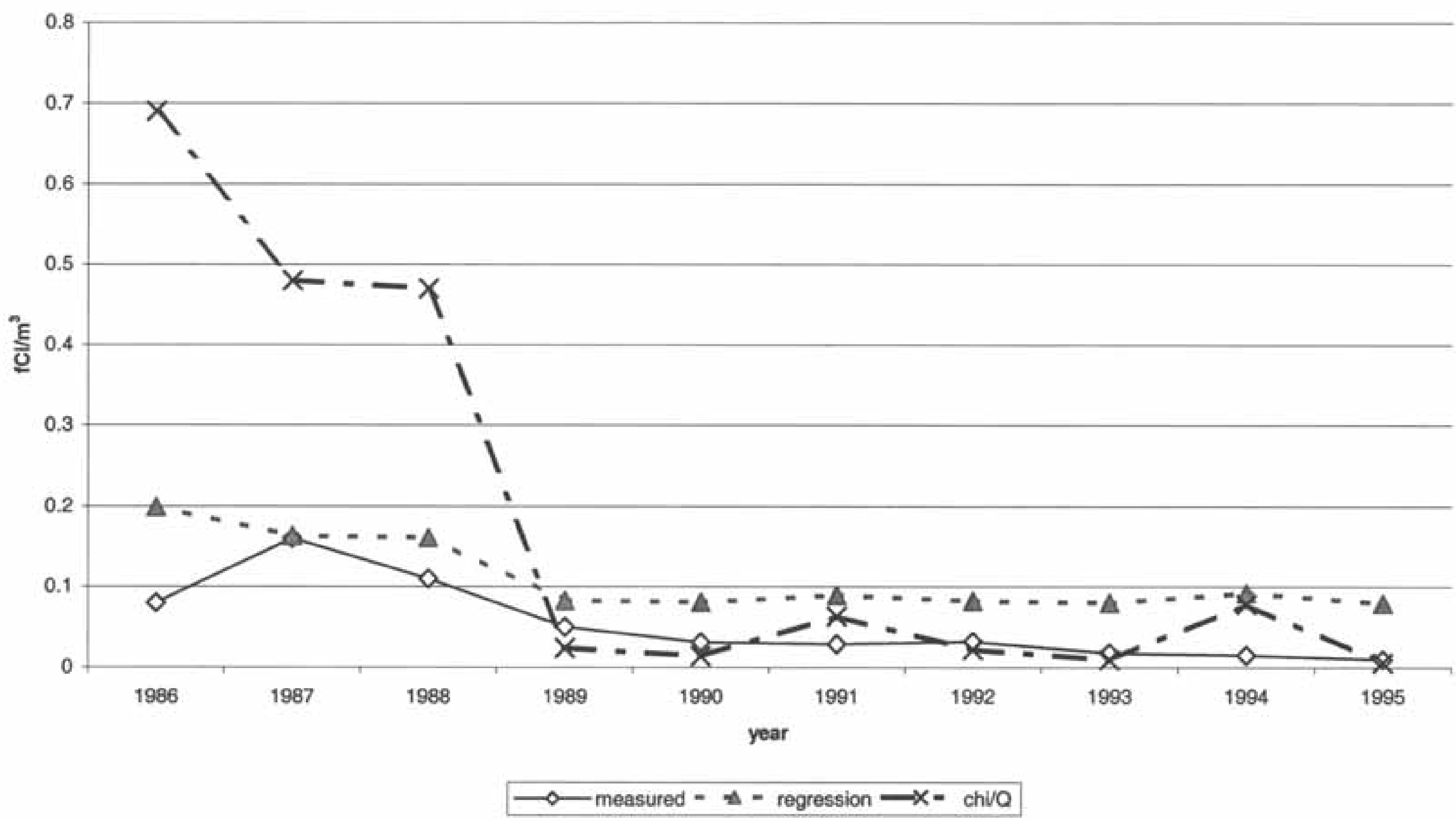
Linear regression between measured Scarboro U 234/235 air concentrations (annual average in fCi/m^3) and Y-12 U 234/235 airborne emissions (in curies) for the years 1986 to 1995. The correlation coefficient (R^2) of 0.9657 indicates a strong positive relationship and the regression equation ($y = 1.7059x + 0.0784$) is a reliable estimator of historic Scarboro air concentrations.

Figure E-3. Airborne U 238 Releases Estimates for Y-12 vs. Measured Uranium Air Concentrations in Scarboro



Linear regression between measured Scarboro U 238 air concentrations (annual average in fCi/m^3) and Y-12 airborne U 238 releases (in curies) for the years 1986 to 1995. The correlation coefficient (R^2) of 0.6377 indicates a weak positive relationship and that the regression equation ($y = 1.4767x + 0.0253$) is a poor estimator of historic Scarboro air concentrations.

Figure E-4. Measured vs. Estimated U 238 Air Concentrations for Scarboro



Concentrations estimated using the Task 6 χ/Q method overestimate or underestimate measured concentrations in Scarboro. Air concentrations estimated using linear regression of measured U 234/235 air concentrations in Scarboro and Y-12 airborne emissions of U 234/235 have a much closer agreement with measured air concentrations in Scarboro.

APPENDIX F

A Conservative Approach in Radiation Dose Assessment

APPENDIX F
A Conservative Approach in Radiation Dose Assessment

Issues Associated with Being Protective or Overestimating Radiation Doses

Research has shown that there is little evidence of harm associated with exposure to ionizing radiation at or below the limits recommended by the International Commission on Radiological Protection (ICRP).

Most of the observed data showing adverse health effects related to radiation exposure come from high-dose, high-dose-rate exposures. Therefore, the ICRP's initial goal in setting dose limits was to prevent the directly observable, nonmalignant, and not necessarily cancerous effects of such exposures. As the science of radiation protection advanced, the ICRP modified its dose limits to reduce the incidence of cancer and the detrimental hereditary effects resulting from exposure to radiation (ICRP 1991).

Estimation of Radiation Dose

Radiation dose is a function of the energy from radiation, the amount of radiation absorbed, and the mass of the material absorbing the radiation. The energy of radiation is well known, being derived from the first principles of physics. The amount of radiation absorbed is based either on estimated measurements of energy transfer or, in the case of human exposures, on models called phantoms that are used to estimate the shapes, sizes, and masses of organs. Using mathematical models called transport models, one estimates the amount of radiation absorbed by these phantoms. These data are then applied to realistic human data. The ICRP has reviewed and prepared publications discussing tissue masses, ethnicity issues, composition, age, and sex from medically derived information. The masses of human organs used, therefore, are best estimates. Because of these variabilities, the ICRP established a standardized human, the "reference man" (ICRP 1975).

ICRP Dose Coefficients

In its earlier publications, the ICRP only concerned itself with radiation exposure to workers. Following the events associated with the nuclear reactor accident at Chernobyl, the ICRP expanded its role to include members of the public. To characterize exposure to members of the public, ICRP Publication 56 stated that one must have a good understanding of age dependency, biokinetics, anatomical, and physiological data (ICRP 1989).

The ICRP has developed factors called dose coefficients (DCF) used to convert intakes of radioactive material to dose. These factors can be used for the purposes of dose assessment and are a combination of factors, some of which may contain some degree of uncertainty. To compensate for this uncertainty, the ICRP adds, when necessary, conservative assumptions to the DCF values. Thus, they may overestimate radiation doses for some radioactive materials where there is not a clear understanding of the metabolic fate of the radioactive material. For other parameters comprising the DCF, the physical interactions associated with the radiation emissions are well known. For the more common radionuclides used in industry or research, such as calcium, iron, strontium, iodine, barium, lead, radium, thorium, uranium, neptunium, plutonium, americium, and curium, biological models (physiologically based) have been developed and validated. These models identify specific intake, storage, and excretion pathways. Furthermore, researchers using these models have been able to identify biological feedback mechanisms whereby materials from organs to blood and the extracellular fluids, and certain physiological processes influence the distribution and translocation of the elements in the body. In the past, many of these models were based on overly conservative assumptions or incomplete data.

More recently, to reduce the uncertainties, the ICRP has introduced a more up-to-date series of dosimetric, biokinetic, and physiological reports[24] that discusses these parameters and uncertainties in more detail. These reports have resolved and reduced the uncertainties associated with many of the physical and chemical processes that may affect the distribution and thus, the radiological dose, in the human body. For example, a new respiratory tract model more closely represents the actual design of the human system more so than the previous 4-compartment model used prior to 1994. Similarly, the ICRP has redefined its description of the gastrointestinal system, performed age-adjusted and organ-adjusted calculations. They continue to work on other biological systems. The ICRP is continuing their effects to achieve a more accurate representation of the human body in response to the intake of radioactive materials resulting from both occupational and environmental exposures.

As radioactive materials decay and emit particles and, in some cases, photons, the energy emitted can interact with matter. This interaction has been assigned a weighting factor (called the radiation weighting factor, W_R). The ICRP selected the W_R to be representative of values that are broadly compatible with the dosimetric quantity of Linear Energy Transfer (LET). The LET estimates the number of ionizations produced by radioactive emissions along their paths as they traverse matter. Because different types of matter have different densities, the number of ionizations produced along the path taken by the particles vary so the LET will vary as a function of the distance traveled in matter. Although, LET is based on the energy deposited per distance traveled in a small volume of matter, the ICRP selected one specific value (1) for beta particles and gamma radiation, and another value (20) for alpha particles based on the energy distribution curves (ICRP 1990).

- [24] ICRP (1989) Age-Dependent Doses to Members of the Public from Intake of Radionuclides, Part 1, ICRP Publication 56.
- ICRP (1991) 1990 Recommendations of the International Commission on Radiological Protection, ICRP Publication 60.
- ICRP (1992) The Biological Basis for Dose Limitation in the Skin, ICRP Publication 59.
- ICRP (1993) Age-Dependent Doses to Members of the Public from Intake of Radionuclides, Part 2, ICRP Publication 67.
- ICRP (1994a) Human Respiratory Tract Model for Radiological Protection, ICRP Publication 66.
- ICRP (1994b) Dose Coefficients for Intakes of Radionuclides by Workers, ICRP Publication 68.
- ICRP (1995a)Age-Dependent Doses to Members of the Public from Intake of Radionuclides, Part 3, ICRP Publication 69.
- ICRP (1995b) Age-Dependent Doses to Members of the Public from Intake of Radionuclides, Part 4, ICRP Publication 71.
- ICRP (1995c) Basic Anatomical and Physiological Data for Use in Radiological Protection: The Skeleton, ICRP Publication 70.
- ICRP (1996) Age-Dependent Doses to Members of the Public from Intake of Radionuclides, Part 5. Compilation of Ingestion and Inhalation Dose Coefficients, ICRP Publication 72.

For radiation effects on tissues, the ICRP also established a tissue weighting factor (W_T), which is based on the organ and tissue contribution to overall health and incidence of cancers, and is also based on the "reference man" concept and rates of disease in the population. The weighting factors range from 1% for bone surfaces and skin to 20% for the gonads. Except in the case of radiation effects to the breast, the sexes differ little in response to ionizing radiation. The factors in many respects, are probabilities or risks, based on latency periods, of fatal cancers and non-fatal or hereditary effects in the whole population and in workers. This is a concept of detriment that the ICRP defines as a "measure of the total harm that would eventually be experienced by an exposed group and its descendants as a result of the group's exposure to a radiation source" (ICRP 1990). Accordingly, the ICRP established coefficients for detriment following exposure to ionizing radiation as shown in Table C-1. The authors of the Task 6 report used the total detriment value of 0.00073 per rem as their coefficient to convert dose to risk.

Table F-1. ICRP Detriment Coefficients

	Fatal Cancers	Non-Fatal	Hereditary Effects	Total
Adult Workers	0.0004 per rem	0.00008 per rem	0.00008 per rem	0.00056 per rem
Population	0.0005 per rem	0.0001 per rem	0.00013 per rem	0.00073 per rem

Source: ICRP 1990

Biokinetic Models

After radioactive materials are ingested or inhaled, they are absorbed and distributed throughout the body. The degree of absorption depends on the chemical form of the material; the ICRP has grouped the compounds into general categories based on solubilities in water or body fluids. Furthermore, the ICRP divided the human body into compartments into or out of which the materials are transported, or where they are stored for extended time periods. The models explaining radioactive materials' movement relative to compartments are based on autopsy studies, human volunteers, and animal studies, with adjustments for the "reference man" incorporated. After reviewing these studies, the ICRP selected coefficients for rates of absorption, transit times, and storage times in the organs of interest. In many cases, the variables selected are an overestimation of the true but uncertain biological function (ICRP 1989).

The ICRP bases many of their biokinetic models on 1 of 4 types of data: (1) direct human data with the element in question; (2) direct human data with similarly acting elements; (3) non-human studies with the element in question and; (4) non-human studies with similarly acting elements. Previously, errors in the biokinetic models were associated with older studies. As an example, Table 1 of Leggett (2001) indicates initial conclusions of gastrointestinal uptake of uranium at environmental uptake were set at 20%; however, the actual value is closer to 2% or less. Even in cases where animals thought to be similar in biophysical nature to humans can lead to a misevaluation of the data. For example, Leggett (2001) states that pigs are thought to be good surrogates for humans because of similarities in metabolism and nutrient needs; however, the pig does not have some of the biochemical processes of humans, such as some reactions requiring sulfur compounds. Other examples of animal-human irregularities are presented in Leggett's Tables 7 and 8.

In a review of the uncertainties of absorption fractions, Harrison, et al. (2001) reviewed 12 elements including strontium, iodine, cesium, radium, uranium, and plutonium. Their evaluations showed that these uncertainties ranged from of low of 1.1 for hydrogen and iodine to a high of 20 for zirconium. The average uncertainty for adults, 10 year old child, and a 3 month old infant was about 2.5. These researchers stated in their conclusions that the ranges of uncertainties, in general, were wider for infants and children than for adults based on more limited data for the younger individuals.

Summary

Typical dose assessments use dose coefficients to estimate the radiation dose to a given population. Many of these assessments do not use site-specific information, such as demographics or inhalation and ingestion rates. ATSDR, in its evaluation of the radiation doses associated with the Oak Ridge Reservation, has used site-specific parameters and variables more related to the southern lifestyle than to the human population.

The establishment of a series of dose coefficients or dose conversion factors may involve uncertainty in the parameters leading to the calculation of the coefficient; however, these are isotope dependent. Because of human variability, a standardized human commonly called a “reference man” is used to estimate the radiation dose. Where little information on the physiological processing of the element in question exists, the ICRP is limited to the available data and the inherent uncertainties. In cases where the information associated with the element under consideration, such as uranium, is extensive and well studied, there is little uncertainty in the dose coefficients.

APPENDIX G

Summary of Technical Review Comments

on the

Oak Ridge Health Studies
Reports of the Oak Ridge Dose Reconstruction, Vol. 5 —Task 6 Report

Uranium Releases from the Oak Ridge Reservation—a Review of the Quality of Historical Effluent Monitoring Data and a Screening Evaluation of Potential Off-Site Exposures

Appendix G
Summary of Technical Review Comments

FOREWORD

As provided for by the 1991 Tennessee Oversight Agreement between the state of Tennessee and the U.S. Department of Energy (DOE), the Tennessee Department of Health conducted the Oak Ridge Health Studies. The Oak Ridge Health Studies are independent state evaluations of hazardous substances released from the DOE Oak Ridge Reservation (ORR) since its creation. The purpose of the studies is to evaluate whether off-site populations experienced exposures to chemical and radiological substances released from ORR and to assess the risk posed by off-site exposures. The Commissioner of TDH appointed a 12-member panel (the Oak Ridge Health Agreement Steering Panel or ORHASP) to direct and oversee the Oak Ridge Health Studies and facilitate interaction and cooperation with the community. McLaren/Hart-ChemRisk was hired to conduct Phase I of Oak Ridge Health Studies, the feasibility study, which it did during 1992 and 1993. Based on the feasibility study, ORHASP and TDH recommended that dose reconstruction be conducted for radioactive iodine releases from X-10, mercury releases from Y-12, releases of polychlorinated biphenyls (PCBs), radionuclides released from X-10 to the Clinch River via White Oak Creek, screening evaluations of Y-12 and K-25 uranium releases, and a screening-level evaluation of additional materials of potential concern. Phase II of the Oak Ridge Health Studies, the Oak Ridge Dose Reconstruction Project (as the TDOH and ORHASP work became known), began in late 1994 and was completed in July 1999. The primary contractors performing the work were McLaren/Hart-ChemRisk, SENES Oak Ridge, and Shonka Research Associates.

The Agency for Toxic Substances and Disease Registry (ATSDR) is having each of the Phase II Oak Ridge Health Studies documents reviewed by a group of technical experts to evaluate the quality and completeness of the studies and to determine if the studies provide a foundation for follow-up public health actions or studies. ATSDR will use the information from the Oak Ridge Health Studies, as well as data from the technical reviews and other studies, to develop public health assessments for the ORR. The public health assessments will assess the overall public health impact on off-site populations and determine which follow-up public health actions or studies are indicated.

PURPOSE OF TECHNICAL REVIEW

Introduction

Using the findings of the September 1993 Oak Ridge Health Studies Phase I Report—Dose Reconstruction Feasibility Study, the Tennessee Department of Health developed six dose reconstruction reports in July 1999. The subject of this technical review is the Report of the Oak Ridge Dose Reconstruction, Vol. 5: The Report of Project Task 6 entitled *Uranium Releases from the Oak Ridge Reservation—a Review of the Quality of Historical Effluent Monitoring Data and a Screening Evaluation of Potential Off-Site Exposures*; hereafter referred to as “the report” or “the uranium report.” Some reviewers also refer to the report as the “Task 6 document.” The report focuses entirely on uranium dose reconstruction and risk assessment. The main text of the report contains the overall approach, an extensive source term analysis, and an estimation of uranium concentrations in the environment. It concludes by considering the health implications (expressed as screening indices) of these concentrations. The appendices to the report contain supporting data and documents, including detailed discussions, calculations, and analyses concerning uranium present in the areas surrounding Oak Ridge Reservation (ORR).

The December 1999 report of the Oak Ridge Health Agreement Steering Panel (ORHASP), entitled *Releases of Contaminants from Oak Ridge Facilities and Risks to Public Health,* hereafter referred to as the “steering panel document,” was also reviewed. ORHASP prepared the steering panel document to compile, in a condensed format accessible to the general public, the results of the uranium report with those of a series of analogous reports that reconstruct the release of other contaminants from the ORR: iodine 131, mercury, PCBs, and other radionuclides.

Finally, reviewers considered two recently released documents dealing with uranium contamination near ORR. The conclusions of these documents were not available until after the uranium document was finalized. The first document, *Scarboro Community Environmental Study,* is a collection of sampling data obtained by scientists from the Florida Agricultural and Mechanical University (FAMU) during a site visit to the Scarboro Community (a small community within the City of Oak Ridge). It will be referred to hereafter as the “FAMU study.” The second document, *Scarboro Community Sampling Results: Implications for Task 6 Environmental Projections and Assumptions,* is a report developed by Auxier & Associates that analyzes the results of FAMU’s study. It will be referred to hereafter as the “Auxier report.” Reviewers were asked to comment on what effect the FAMU study and the Auxier report may have on the conclusions of the uranium document.

Review Process

The purpose of this technical review was to determine if the Task 6 uranium screening evaluation report provides a foundation on which the Agency for Toxic Substances and Disease Registry (ATSDR) can base follow-up public health actions or studies, and particularly, to support its congressionally mandated public health assessment of the Oak Ridge Reservation (ORR).

ATSDR contracted with Eastern Research Group, Inc. (ERG) of Lexington, Massachusetts, to select four expert reviewers to technically review the uranium screening evaluation report: Melvin Carter, Nolan Hertel, Ronald Kathren, and Fritz Seiler. The reviewers were asked to comment on the study design, methods, and completeness of the uranium report, as well as the conclusions of the authors of the report. The four reviewers read the entire dose reconstruction document on uranium releases, including appendices and the appropriate sections of the steering panel document (“Summary,” “Screening Analysis for Uranium and Other Contaminants” [pp. 51–55], “Technical Issues,” “Procedural Issues,” and “Recommendations and Discussions”). The reviewers also read and considered both the FAMU study and the Auxier report in preparation for commenting on the uranium report. ERG received the reviewer comments and compiled this summary document for ATSDR in June 2001.

ATSDR recognizes the great amount of oversight, technical peer review, and overall work that went into the Oak Ridge dose reconstruction project. However, ATSDR wanted an additional round of expert review of the Task 6 uranium screening evaluation to consider for its public health assessment for two reasons. First, ATSDR will not attempt to reproduce (*ab initio*) the work or results of the uranium screening evaluation for its public health assessment. Such an attempt cannot be justified without substantial new information about past releases of uranium, or historic environmental sampling data or meteorological data, which ATSDR does not presently have. Secondly, uranium screening evaluation is a technical investigation fraught with uncertainty. ATSDR believes that an independent expert review of the methods and assumptions in the Task 6 uranium screening evaluation offers the best insight into the validity and usefulness of the results for making public health decisions.

ATSDR cautions the reader that some of the technical reviewers’ comments are critical of the Task 6 uranium screening evaluation report. This does not mean that the uranium screening evaluation report is flawed or should not be used. The reviewers were not provided a forum for group discussion nor formal access to the uranium Task 6 study authors to ask questions. Not all reviewers answered every question posed to them. Sometimes they acknowledged they were commenting outside their field of expertise and sometimes they acknowledged that they did not wish to comment outside their field of expertise. The reviewers brought their varied experience to the task, and not all reviewer comments are equally valid. Occasionally two opinions are conflicted. In such an instance (and other information being equal) ATSDR will tend to prefer comments from the reviewer who had the greater expertise in the subject area. Finally, it is noted that the technical reviewer comments do not provide a clear sense of which exposure pathways are most important for public health. Nor do they clearly provide the reader a means by which to prioritize pathway exposures. ATSDR intends to evaluate each of the reviewer comments for its applicability and usefulness on its own merit and it encourages the reader to do the same.

Appendices A through D of the full report contain reviewer comments in their entirety, listed alphabetically by author. The appendices are not included in this public health assessment, however, copies of the full report can be obtained by calling ATSDR at 1-888-42-ATSDR or writing to:

ATSDR
Division of Health Assessment and Consultation
Attn: Chief, Program Evaluation, Records, and Information Services Branch, E-60
1600 Clifton Road, N.E., Atlanta, Georgia 30333

Charge to Reviewers

ATSDR charged the technical reviewers to comment on whether the study results were scientifically valid and applicable to public health decision-making and to provide recommendations necessary to strengthen the report's study analyses. Reviewers considered and commented on the report's study design and scientific approaches; its methods of data acquisition, analyses, and statistical reliability; and the scientific interpretations made by the study authors. Reviewers evaluated whether the conclusions and recommendations of the uranium report were substantiated and developed on the sole basis of the information in the documents. ATSDR specifically asked reviewers to critique:

- Study design and scientific approaches
- Methods of data acquisition, analyses, and statistical reliability
- Completeness of data and analyses
- Model validation
- Conformance with current scientific consensuses; internal consistency of methodologies
- Dose validation
- Data gaps
- Bias
- Clarity and thoroughness (e.g., is there enough information to draw conclusions and make public health decisions?)

ATSDR asked reviewers to comment on any and all technical aspects of the dose reconstruction study and how the report might be improved. Each reviewer assessed the dose reconstruction by responding to the study outline below.

1. Source Term and Environmental Concentration Estimates

a. Comment on the quality, completeness, and reasonableness of the estimates of the source terms (releases to air and water) and environmental concentrations (air, water, and soil).

b. In the absence of soil data from the Y-12 reference location (Scarboro community), the authors used uranium concentrations in sediments from the East Fork Poplar Creek floodplain to evaluate the soil exposure pathways. However, in 1998, the Environmental Sciences Institute at FAMU and its contractual partners conducted the Scarboro Community Environmental Study, in which soil, sediment, and surface water samples from the Scarboro community were analyzed for uranium.

Please review the radiological analyses in the *Scarboro Community Environmental Study* by FAMU and the *Scarboro Community Sampling Results: Implications for Task 6 Environmental Projections and Assumptions* by Auxier & Associates, Inc. Comment on whether the 1998 uranium concentrations from Scarboro soil could be used to estimate committed effective dose equivalents, annual average intake, and kidney burdens for the period 1944–1990 in Scarboro. Reviewers may benefit from an on-line bibliography on Cs 137 soil studies available at http://hydrolab.arsusda.gov/cesium137bib.htm.

2. Uncertainty and Sensitivity Analysis

a. Comment on the quality and completeness of the statistical approaches, uncertainty analysis, and sensitivity analysis.

b. Comment on the appropriateness and reasonableness of parameters, assumptions, distribution functions, and qualifiers used to estimate the Level II screening indices, committed effective dose equivalents, annual average intakes, uranium kidney burdens, and hazard index. Do the authors provide sufficient details and justification for independent evaluation and verification?

c. Do the distribution functions appropriately describe the variability of the parameters?

d. Comment on the quality of available data and identify where important data are unreliable, incomplete, or absent.

e. Comment on the degree of reliability and statistical uncertainty in the estimates of committed effective dose equivalents, annual average intakes, uranium kidney burdens, and hazard index.

f. Comment on the limitations of interpreting these estimates.

3. Health Effects/Public Health

a. Comment on quality and completeness of the screening indices, committed effective dose equivalents, annual average intakes, uranium kidney burdens, and the hazard index.

b. Are the screening indices, committed effective dose equivalents, annual average intakes, uranium kidney burdens, and the hazard index appropriately determined?

c. Are the appropriate decision guide (1×10^{-4} cancer risk), the oral reference dose (RfD), and toxicity threshold criteria for uranium kidney burdens used to estimate the potential health impact from uranium exposures?

d. Given the uncertainties, are the committed effective dose equivalents, annual average intakes, and uranium kidney burdens at sufficient levels to be a significant human health problem? If so, explain. Which reference populations might be at significant risk? What are the potential or likely health consequences?

e. Are adverse health effects likely to be statistically detectable?

f. Is the hazard index an appropriate indicator of possible health effects?

g. Are the screening decision tree and criterion appropriate to determine the need for further study?

h. Given the uncertainties, is there a need for a more detailed study with full uncertainty analysis to estimate the potential health impact from uranium exposures? Explain.

i. Is there sufficient information to identify and carefully define by one or more distinguished characteristics a population at significant increased risk? Such distinguishing characteristics might be for example age, sex, ethnicity, geographic area, time period, dietary habits, or lifestyle characteristics.

j. Is the dosimetric and exposed population information appropriate for epidemiologic planning and decisions?

SUMMARY OF REVIEWER COMMENTS

I. Executive Summary

Three of the four reviewers commented on the overall quality of the uranium report. These three reviewers agreed that the report met basic methodological standards and that, while it was not a complete analysis of possible uranium exposure near ORR, it was "a good first pass." Reviewers praised the report in terms such as these: "technically sound and applicable to decision-making," "supported by and developed on the basis of information in the reports," and "no major or significant problems with respect to the study design or the scientific approaches used." One reviewer affirmed that most of the work described in the study conformed with "established and generally accepted techniques." One reviewer applauded the efforts of the Oak Ridge Health Assessment Steering Panel (ORHASP) in developing the report, calling it logically constructed and "state-of-the-art." Overall, the reviewers agreed that the screening assessment is adequate for public health decision-making. However, they felt that additional modifications are required for an adequate past dose reconstruction to be completed.

Two of the four reviewers commented that the report is somewhat lacking in uncertainty or sensitivity analysis. One reviewer indicated that the study did conduct some uncertainty analyses, but they were limited in scope and non-quantitative. The consequence of this lack is that the report does not characterize the error ranges of its quantitative estimates as fully as reviewers would have liked. Two reviewers pointed out that the estimates made in the report tend to be on the conservative side—one expects, therefore, that (when in error) the report would tend to *overestimate* the extent to which exposure to uranium is a problem in the Oak Ridge area. Further refinements to the study are likely to reveal that uranium exposures are actually *lower* than those currently estimated.

Two reviewers noted that the large difference between the new source term estimates and the earlier estimates provided by DOE raise concerns about the underlying reliability of either estimate. One reviewer was surprised that the study authors, after having determined that actual release levels for 1987 and 1988 were 30% greater than those DOE had reported, were willing to accept DOE's release estimates for the years between 1989 and 1995 at face value. The reviewers indicated that their concerns about the source terms estimates would probably be resolved if a full uncertainty analysis were performed for the relevant calculations.

One reviewer was somewhat skeptical of the reported mass distribution for emitted airborne uranium particles. The reviewer suspected that the actual mass distribution of emissions contained a higher percentage of higher-mass particles than that which was recorded by the monitoring equipment. This issue is important to evaluating the public health consequences of the uranium release because higher-mass particles are less likely to be absorbed in the lung than lower-mass particles are.

One of the reviewers noted that the study makes no effort to differentiate between anthropogenic and background concentrations of airborne uranium, while conceding that background levels would probably prove to be insignificant. Another reviewer, however, encouraged further work to quantify the contribution of radioisotopes originating from coal-burning power plants in the area.

Two reviewers considered the basic appropriateness of the report's use of χ/Q calculations to correlate historical uranium releases from the Y-12 facility and historical air concentrations in the Scarboro area. Both reviewers agreed that, at a basic level, this kind of calculation was appropriate for estimating past airborne uranium concentrations in Scarboro. One of these reviewers cautioned, however, that the usefulness of the χ/Q calculations depends on the assumption that there has been no significant change in the sizes of emitted uranium particles between the times when χ/Q data were collected and the times when the χ/Q ratio is being used to estimate airborne uranium concentrations.

Two reviewers disagreed about whether or not the tracer dispersion study suggested in Recommendation #4 of the Steering Panel Report was warranted. One reviewer suggested that this experiment *was* warranted, citing the sparse distribution of air monitoring stations in the Oak Ridge area (which leave many gaps in coverage) and the continuing uncertainty about how effectively Pine Ridge acts as a barrier between the air around ORR and the air around Scarboro. The other reviewer thought that tracer release studies seemed somewhat excessive and suggested that, as an alternative, the existing χ/Q calculations be re-worked, making use of additional historical weather data, where available.

The reviewers, as a whole, found the treatment of waterborne uranium transport somewhat cursory, and had a range of unanswered questions and concerns in regard to it.

Two reviewers felt that the uranium report's use of sediment samples as a surrogate for uranium soil sampling data was unacceptable. A third reviewer stated that the analogy between soil and sediment data *might* be acceptable but nevertheless praised the actual soil data collected by FAMU as clearly preferable to this analogy. Other reviewers called for further soil sampling in the Oak Ridge area, particularly subsurface soil core sampling.

All four reviewers expressed confidence in the soil sampling data collected by researchers from FAMU. One reviewer considered them clearly superior to the uranium report's sediment data for use in public health decision-making. Three reviewers called for additional uranium monitoring in strategic locations where one might expect past releases of uranium to have accumulated: in sediments behind dams, on flood plains, and around lakes and swamps. Two reviewers also called for soil core samples at depths of up to 1 meter, noting that one would not expect to find significant uranium accumulation near the soil surface (where FAMU collected its samples).

One reviewer concluded that the reference locations selected seemed appropriate but another questioned the report's degree of emphasis on the town of Scarboro as an area of primary public health concern. The reviewer indicated that Scarboro seems to have been chosen as a primary public health concern for the Y-12 uranium releases simply because it is the closest community to the facility. This conclusion, the reviewer stated, is premature and might be modified by further analysis of population distribution, wind patterns, and surface water features in the Oak Ridge area. The reviewer noted that, even if it were determined that uranium exposure was higher in Scarboro than in any other community, overall risk to the public health might still be greater in another town with lower exposure levels but a larger population.

Three reviewers agreed that epidemiological investigation of the Scarboro community was unlikely to produce a statistically significant finding, given the limited screening results of the "likely magnitude of the risk." One reviewer cautioned, however, that the uranium report did not contain enough information about Scarboro to answer questions about the value of further epidemiological study or the possible existence of vulnerable subpopulations.

One reviewer noted that the report, despite its lack of uncertainty analysis, does support the conclusion that ORR uranium exposure has had no *detectable* health effect on persons living in Scarboro. This is not the same as saying that there has been no health effect—the same reviewer said there was a reasonable likelihood that a few cases of cancer in Scarboro were caused by uranium exposure. Even if this were the case, however, there would probably be no statistically valid way to distinguish those cases caused by ORR emissions from those which were not.

II. Review of Documents' Overall Quality

Uranium Report

Three of the four reviewers commented on the overall quality of the uranium report. These three reviewers agreed that the report met basic methodological standards and that, while it was not a complete analysis of possible uranium exposure near ORR, it was "a good first pass." Reviewers praised the report in terms such as these: "technically sound and applicable to decision-making," "supported by and developed on the basis of information in the reports," "no major or significant problems with respect to the study design or the scientific approaches used." One reviewer affirmed that most of the work described in the study conformed with "established and generally accepted techniques." One reviewer applauded the efforts of the Oak Ridge Health Assessment Steering Panel (ORHASP) in developing the report, calling it logically constructed and "state-of-the-art."

Two of the four reviewers commented that the report is somewhat lacking in uncertainty or sensitivity analysis. One reviewer indicated that the study did conduct some uncertainty analyses, but they were limited in scope and non-quantitative. The consequence of this lack is that the report does not characterize the error ranges of its quantitative estimates as fully as reviewers would have liked. Two reviewers pointed out that the estimates made in the report tend to be on the conservative side—one expects, therefore, that, (when in error) the report would tend to *overestimate* the extent to which exposure to uranium is a problem in the Oak Ridge area. Further refinements to the study are likely to reveal that uranium exposures are actually *lower* than those currently estimated.

Other general limitations of the report, as asserted by the reviewers, are that:

- The evaluation of uranium concentrations in soil was not covered in depth; one reviewer noted that it almost seemed incidental to the rest of the report.

- The report lacked background information on how operations data from ORR were obtained, evaluated, and interpreted.

- The report's data were limited to effluent monitoring and included no environmental monitoring data.

- The report fails to adequately differentiate natural and anthropogenic uranium levels in the Oak Ridge area. One reviewer emphasized the importance of this distinction, stating that natural background concentrations must not be mixed in with anthropogenic concentrations for the purposes of risk assessment.

- The report is overly weighted toward gauging the radiological effects of uranium exposure. It should have placed more focus on the chemical toxicity of uranium.

FAMU Study

All four reviewers expressed confidence in the soil sampling data collected by researchers from Florida Agricultural and Mechanical University. One reviewer considered them clearly superior to the uranium report's sediment data for use in public health decision-making. Another stated that the new measurements have "changed the picture completely." Although they applauded FAMU's research efforts, the reviewers were cautious about using the FAMU data to estimate past exposure without additional research into the environmental distribution of uranium in the Oak Ridge area. Three reviewers called for additional uranium monitoring in strategic locations where one might expect past releases of uranium to have accumulated: in sediments behind dams, on flood plains, and around lakes and swamps. Two reviewers also called for soil core samples at depths of up to 1 meter, noting that one would not expect to find significant uranium accumulation near the soil surface (where FAMU collected its samples).

Auxier Report

Three reviewers commented on the Auxier report, describing its analysis and overall conclusions as compelling. Two reviewers stated that it presented convincing evidence that the FAMU soil sampling data are superior to the sediment samples used as surrogates for soil data in the uranium report. One reviewer indicated that the Auxier report convinced him that uranium soil concentrations are 10 to 100 times lower than the values listed in the ORHASP uranium report. Another reviewer praised the Auxier report's study of U 235/U 238 activity ratios in soil samples, which indicated to him that at least *some* anthropogenic uranium is present in Scarboro's soil (probably originating from the Y-12 facility). The reviewer described the Auxier report as "valuable work" that will "add the kind of information which will be needed for a risk assessment."

Steering Panel Report

Two reviewers commented briefly on the overall quality of the steering panel report. One reviewer praised its clarity and thoroughness and stated that it "reached reasonable conclusions and made sound and useful recommendations." The other reviewer noted that, in general, it seemed overly pessimistic in its summary of the uranium report's results.

III. Review of Source Term Estimates

Two reviewers approved of the basic methods used to estimate uranium releases from ORR, calling them reasonable. A broad concern surrounding the estimates, however, was a lack of statistical information about the uncertainties associated with the monitoring data (or lack of such data). One reviewer emphasized that he did not fault the research team for not finding more data, as he recognized that they were constrained by the limits of their archival records. His concern was rather that the team had not adequately expressed the limits of their knowledge in statistical terms.

In particular, reviewers sought more information about the assumptions and justifications used in the source term estimates than was available to them in the text of the uranium report. One reviewer stated that he was unable to evaluate the appropriateness and reasonableness of the source term estimates (and hence of derivative dose estimates) because of this lack of information.

Two reviewers expressed disappointment that no quantitative information is available on over a third of the reported releases of uranium from the K-25 facility. One of these reviewers was puzzled that the study authors chose to treat these data gaps as periods of zero release rather than develop a probability distribution function (PDF) to address their uncertainty. The second reviewer was troubled by this understatement of K-25 releases, given that the report did not attempt to estimate the extent of that understatement. A third reviewer cautioned, however, that it is in fact proper to assign zero values to periods with data gaps if there is truly no information upon which a PDF could be developed.

Two reviewers noted that the large difference between the new source term estimates and the earlier estimates provided by DOE raises concerns about the underlying reliability of interpreting ORR operations and monitoring data. For example, one reviewer wanted additional assurance that uranium releases have not been "double counted" (i.e., counted once in the release reports and again in the monitoring data).

One reviewer was surprised that the study authors, after having determined that actual release levels for 1987 and 1988 were 30% greater than those DOE had reported, were willing to accept DOE's release estimates for the years between 1989 and 1995 at face value.

One reviewer was somewhat skeptical of the reported mass distribution for emitted airborne uranium particles. After considering the configuration of the monitoring equipment used in ORR's stacks, the reviewer suspected that monitoring results may have been erroneously skewed in favor of recording smaller particles. The reviewer suspected that the actual mass distribution of emissions contained a higher percentage of higher-mass particles than that which was recorded by the monitoring equipment. This issue is important to evaluating the public health consequences of the uranium release because higher-mass particles are less likely to be absorbed in the lung than lower-mass particles are.

One reviewer was of the opinion that release estimates of depleted and natural uranium (as opposed to enriched uranium) were particularly uncertain. This uncertainty, the reviewer believed, could affect the *chemical* (as opposed to radiological) health consequences of Oak Ridge residents' uranium exposure.

One reviewer noted that there was very little data available about the release of uranium to surface water from the S-50 facility (in comparison to amount of information available on the Y-12 and K-25 releases). The reviewer qualified the significance of this lack of data, also noting that the overall magnitude of the S-50 release was low, so it would not have much effect on the overall uranium source term.

IV. Review of the Estimation and Measurement of Environmental Uranium Concentrations

Airborne Transport of Uranium

Two reviewers considered the basic appropriateness of the report's use of χ/Q calculations to correlate historical uranium releases from the Y-12 facility and historical air concentrations in the Scarboro area. Both reviewers agreed that, at a basic level, this kind of calculation was appropriate for estimating past airborne uranium concentrations in Scarboro. One of these reviewers cautioned, however, that the usefulness of the χ/Q calculations depends on the assumption that there has been no significant change in the sizes of emitted uranium particles between the times when χ/Q data were collected and the times when the χ/Q ratio is being used to estimate airborne uranium concentrations. The reviewer suggested that further studies ascertain the validity of this assumption.

Two reviewers disagreed about whether or not the tracer dispersion study suggested in Recommendation #4 of the Steering Panel Report was warranted. One reviewer suggested that this experiment *was* warranted, citing the sparse distribution of air monitoring stations in the Oak Ridge area (which leave many gaps of coverage) and the continuing uncertainty about how effectively Pine Ridge acts as a barrier between the air around ORR and the air around Scarboro. The other reviewer thought that tracer release studies seemed somewhat excessive and suggested that, as an alternative, the existing χ/Q calculations be re-worked along the following lines:

- *Use historical wind rose information, when available.* This reviewer noted that days of peak release from Y-12 do not always match days of peak uranium concentrations around Scarboro. The reviewers attributed this occasional lack of correlation to wind conditions that did not favor transport of particulate uranium from ORR to Scarboro. With this in mind, the reviewer suggested that future research efforts might attempt to evaluate Oak Ridge–area uranium concentrations as a function of both ORR release levels *and* specific wind conditions. The reviewer suggested that this might be a particularly worthwhile exercise for periods of known high releases, such as the five days in 1965 when uranium hexafluoride was released from K-25 as part of a fire test.

- *When historical wind rose information is not available, use 5-year average data.* The reviewer was somewhat puzzled by the report's use of meteorological conditions from 1987 to represent "average" weather. The reviewer suggested the report could be improved if 5-year meteorological averages were used instead.

- *Characterize uncertainty of uranium releases for years upon which χ/Q is based.* The reviewer pointed out that if ORR's uranium releases were underestimated in the years upon which χ/Q was based, the χ/Q value would itself be overestimated. Therefore, further information about the reliability of release estimates during those years will shed light on the reliability of χ/Q.

One of the reviewers noted that the study makes no effort to differentiate between anthropogenic and background concentrations of airborne uranium. That reviewer conceded that background levels would probably prove to be insignificant, but another reviewer encouraged further work to quantify the contribution of radioisotopes originating from coal-burning power plants in the area.

The one reviewer who considered the study's use of an ISCST3 dispersion model to estimate the transport of uranium from the K-25/S-50 and X-10 facilities confirmed that the study's methods were appropriate.

Waterborne Transport of Uranium

Three reviewers provided comments pertaining to the concentration of uranium in the East Fork Poplar Creek and Clinch River. Two of these reviewers noted that the results presented are derived from flow rates and concentrations at discharge points. One reviewer wondered if the report's analysis took into account the partitioning of uranium from water into sediment. Another reviewer noted that the absence of the raw data (i.e., the actual flow and concentration data at discharge points) upon which the results were based hampered his evaluation of those results. In particular, the reviewer noted that the reported uranium discharges to the East Fork Poplar Creek seemed "unreasonably high"; he required additional data and analysis before he would vouch for their accuracy.

The reviewers, as a group, found the treatment of waterborne uranium transport somewhat cursory. They had a range of unanswered questions and concerns in regard to it:

- Why did the report use a single annual volume for East Fork Poplar Creek instead of taking seasonable variation into account?

- Why was it assumed that waterborne uranium is at a natural level of enrichment?

- How likely is it that significant quantities of enriched uranium entered local water bodies via soil runoff?

- What is the background level of uranium in the Clinch River and East Fork Poplar Creek?

Concentration of Uranium in Soil and Sediment

Two reviewers agreed that the uranium report's use of sediment samples as a surrogate for uranium soil sampling data was unacceptable. A third reviewer stated that the analogy between soil and sediment data *might* be acceptable, but nevertheless praised the actual soil data collected by FAMU as clearly preferable to this analogy. Other reviewers called for further soil sampling in the Oak Ridge area, particularly subsurface soil core sampling. One reviewer argued that uranium levels in sediment should not be used as an indication of uranium levels in soil because uranium's provenance differs depending on its location:

- The level of uranium present in soil is a function of:
  - The natural prevalence of uranium ore (background uranium) in the region.
  - The deposition of airborne uranium particles onto the soil surface.

- The level of uranium present in sediment is a function of:
  - Groundwater leaching uranium out of soil and into rivers and lakes.
  - The deposition of airborne uranium particles onto the surface of the covering water body.
  - The partitioning of dissolved uranium from water to sediment.

Two reviewers found the FAMU data suggested that contamination of surface soil with uranium in the Oak Ridge area is less serious than previously thought. One reviewer said that the data show that uranium in the soil is close to natural levels of enrichment and concentration. Another said that the data show that the soil exposure pathway for uranium is less significant than previously thought. A third reviewer pointed out that he was not surprised that surface soil concentrations of uranium are near background levels—he expects that if elevated soil concentrations of uranium exist, they would exist further *below* the soil surface.

V. Reviewers' Conclusions and Recommendations for the Use of the Report in Public Health Decision-Making

Exposure and Dose Estimates

Two reviewers considered the methodology used in the uranium study to establish screening indices and compute effective doses. Both reviewers agreed the methodology used was appropriate and consistent with standard practice. Two other reviewers noted that the report was quite conservative in its use of correction factors.

One reviewer noted that although the lack of uncertainty analysis in the uranium report made it difficult to evaluate the reliability of the report's conclusions, he would guess that the report's exposure and dose estimates are accurate to within an order of magnitude. This reviewer also flagged a possible exposure pathway (the transfer of uranium from contaminated water to produce to human consumption) that was excluded from consideration in the report without explanation. Another reviewer held the opinion that the uranium dose estimates were accurate to a factor of 2 and were probably overestimates.

Two reviewers considered the appropriateness of the reference locations chosen to gauge the potential public health consequences of uranium releases from ORR. One reviewer concluded that the reference locations selected seemed appropriate, but the other questioned the report's degree of emphasis on the town of Scarboro as an area of primary public health concern. The reviewer indicated that Scarboro seems to have been chosen as a primary public health concern for the Y-12 uranium releases simply because it is the closest community to the facility. This conclusion, the reviewer stated, is premature and might be modified by further analysis of population distribution, wind patterns, and surface water features in the Oak Ridge area. The reviewer noted that, even if it were determined that uranium exposure was higher in Scarboro than in any other community, overall risk to the public health might still be greater in another town with lower exposure levels but a larger population.

One reviewer referred to the FAMU study's use of the RESRAD model. The reviewer noted that this model is appropriate only if residual soil contamination is the only source of uranium exposure, a situation that may be true at current emissions levels but was not necessarily the case in the past. The reviewer also sought more information about: (1) why the RESRAD model used default parameters instead of site-specific parameters and (2) why certain RESRAD exposure pathways, such as well water and livestock uptake, were eliminated from consideration.

Use of the Report by ATSDR for Public Health Purposes

The three reviewers who spoke to the issue of the uranium report's public health application agreed that the report is adequate for public health decision-making; however, it does not, at present, provide a reliable reconstruction of past uranium doses in the Oak Ridge area. The reviewers, however, affirmed the study's value as a suitable foundation for follow-up studies. One reviewer considered the report useful only as a first-order approximation of actual doses, but suggested that it could be used in cautious preliminary public health work—along with the caveat that it may have underestimated the degree of uncertainty inherent in its estimates.

Three reviewers agreed that epidemiological investigation of the Scarboro community was unlikely to produce a statistically significant finding, given the limited screening results of the "likely magnitude of the risk." One reviewer cautioned, however, that the uranium report did not contain enough information about Scarboro to answer questions about the value of further epidemiological study or the possible existence of vulnerable subpopulations.

One reviewer noted that the report, despite its lack of uncertainty analysis, does support the conclusion that ORR uranium exposure has had no *detectable* health effect on persons living in Scarboro. This is not the same as saying that there has been no health effect: the same reviewer said there was a reasonable likelihood that a few cases of cancer in Scarboro were caused by uranium exposure. Even if this were the case, however, there would probably be no statistically valid way to distinguish those cases caused by ORR emissions from those which were not.

Directions for Further Work

The reviewers had three principal recommendations for improving the quality of the uranium report in preparation for using it in public health decision-making:

- *Add/improve uncertainty and sensitivity analyses.* Three reviewers indicated that more work needs to be done to characterize the extent and significance of the lack of knowledge pertaining to past uranium exposures in the Oak Ridge area. As a guide, one reviewer suggested that future investigators develop probability distribution functions, develop reasonable estimates to fill in gaps in release data, and perform a sensitivity analysis to evaluate how uncertainty in the study's input data creates uncertainty in the study's output. One reviewer also recommended that uncertainty calculations be done separately for systematic and random errors.

- *Develop dynamic models to further characterize the fate of past uranium releases.* Two reviewers emphasized the need to measure uranium concentrations in *core* samples of soil from the Oak Ridge area. These measurements should be part of a broader research effort aimed at identifying how uranium has moved through the Oak Ridge environment after its release. For example, one reviewer asked future investigators to determine where and by what means past releases of uranium have accumulated. Another reviewer emphasized that most such analyses would have to make use of *dynamic* (as opposed to equilibrium) models. This is because ORR uranium releases prior to 1974 varied significantly from year to year and cannot be properly modeled with equilibrium models.

- *Continue searching for site-specific historical information.* One reviewer suggested that investigators collect additional site-specific information about the Oak Ridge area, such as information about the agricultural practices common there during the period in question. The reviewer also suggested that investigators continue to attempt to uncover additional archival information relating to uranium releases from ORR.

APPENDIX H

Responses to Public Comments

Appendix H. Responses to Public Comments on Y-12 Uranium Releases Public Health Assessment

The Agency for Toxic Substances and Disease Registry (ATSDR) received the following comments from the public and local organizations during the public comment period (April 22, 2003 to June 20, 2003) for the Y-12 Uranium Releases at the Oak Ridge Reservation (ORR) Public Health Assessment (PHA) (April 2003). For comments that questioned the validity of statements made in the PHA, ATSDR verified or corrected the statements. The list of comments does not include editorial comments, such as word spelling or sentence syntax.

	Public Comment	ATSDR's Response
General Comments		
1	The Agency for Toxic Substances and Disease Registry's (ATSDR) PHA supports the less detailed findings of previous studies, especially the Florida A&M University sampling and follow-on U.S. Environmental Protection Agency (EPA) Region 4 sampling in the Scarboro community both process that the **[organization]** has followed in detail.	In this PHA on Y-12 uranium releases, ATSDR evaluated and analyzed the information, data, and findings from previous studies and investigations to assess the public health implications of past and current off-site exposures to uranium. ATSDR concluded that there is no apparent public health hazard for people living near the Y-12 plant because the past and current off-site exposures are not at levels expected to cause either radiation or chemical health effects. The Y-12 uranium releases are not a public health hazard for people living near the Y-12 plant. The Scarboro Community Environmental Study (Florida Agricultural and Mechanical University [FAMU] 1998) was conducted to address community concerns about environmental monitoring in the Scarboro neighborhood. It addresses these concerns by validating the measurements taken at the perimeter air monitoring station #46 (located in the Scarboro community) and external gamma data collected during past aerial radiation surveys. The FAMU report presented the results of the soil, surface water, and sediment sampling in Scarboro and compared these concentrations with those measured in the Oak Ridge region. The study found that the concentrations of mercury and radionuclides in Scarboro are generally within the range found in the Oak Ridge region. As part of EPA's oversight responsibilities at the ORR, EPA Region IV re-sampled 20% of the 1998 FAMU sampling. Based on the concentrations detected in the soil, sediment, and surface water in Scarboro, the EPA report (EPA 2003) concluded that "there is not an elevation of chemical, metal, or radionuclides above a regulatory health level of concern…the Scarboro community is not currently being exposed to substances from the Y-12 facility in quantities that pose an unreasonable risk to health or the environment." To expand the information presented, ATSDR added summary briefs of the EPA and FAMU reports in Appendix I of the final PHA.
2	The **[organization]** provisionally accepts ATSDR's conclusions that there was and is no health risk to the Oak Ridge community due to uranium	It is ATSDR's policy to address comments collected during the public comment period. EPA's comments are included in this table along with ATSDR's responses.

	Public Comment	ATSDR's Response
	releases from Y-12. However, the detailed critique submitted by Lowell Ralston of the Office of Radiation and Indoor Air at EPA Headquarters seems to disagree with the ATSDR's conclusions on technical grounds. ATSDR must address this critique point-by-point in a manner that the public can comprehend, clearly explaining the points of disagreement and/or differences in approach so that no doubt remains regarding the conclusions of the PHA.	
3	When the Environmental Protection Agency disagreed with the ATSDR's findings, it seemed that lines were immediately drawn for damage control. I have talked with several community members who have all reached the conclusion that the ATSDR reports are controlled and predetermined, and public participation and input will be of little use, if the ATSDR's report is contested. Oak Ridge's nickname change to the "Secret City" seems to be no accident. My vote of credibility is with the EPA.	In a March 27, 2003 cover letter to ATSDR, EPA Region IV stated the following: "EPA concurs with the assessment's conclusion that the available data does not indicate the presence of uranium releases that constitute a past, current or future health threat for the Scarboro Community." Additionally, in a December 1, 2003 letter to ATSDR, EPA Region IV stated the following; "… EPA agrees with ATSDR that there are no apparent adverse health effects, as documented in the subject report…" " For the comments originating from EPA Region 4, we conclude that ATSDR has provided adequate response." Also, EPA's Office of Radiation and Indoor Air stated the following in their June 22, 2003 comments: "… we agree with ATSDR's conclusion that the current uranium exposures at Scarboro are probably within acceptable limits." ATSDR embraces the philosophy that community involvement is a key component of the public health assessment process. At the Department of Energy (DOE) ORR, ATSDR's community involvement activities promote collaboration between ATSDR scientists, community members, and other agencies. These activities also provide opportunities for community members to have a role in ATSDR's public health assessment process. ATSDR and the Centers for Disease Control and Prevention (CDC) established ORRHES in 1999 to provide a forum for communication and collaboration between citizens and the agencies that are evaluating public health issues and conducting public health activities at the ORR. The ORRHES consists of individuals who represent diverse interests, expertise, backgrounds, and communities, as well as liaison members from state and federal agencies. The ORRHES created the Public

	Public Comment	ATSDR's Response
		Health Assessment Work Group (PHAWG) to conduct in-depth exploration of issues, concerns, and the ATSDR PHAs. PHAWG meetings are held twice a month and are open to all who wish to attend and participate. Since ATSDR began developing (in the Fall of 2002) the PHA on the Y-12 uranium releases, ATSDR scientists have presented and discussed the PHA in detail at least 6 times with the PHAWG and twice with the ORRHES. In addition, the PHAWG developed technical and editorial comments on the initial release draft PHA for the ORRHES. In March 2002 the ORRHES reviewed, deliberated, and approved the comments on the initial release draft PHA. As noted in ATSDR's response to comment 102, the ORRHES comments (which also include comments from community members not on the ORRHES) were incorporated in the PHA and have been very helpful in improving the technical aspects and overall readability of the document. Figures 4 and 5 depict the process whereby the ORRHES, the PHAWG, and the public participate and provide input into the ATSDR public health assessment process. For example, ORRHES provided input in the discussion of the margin of safety in the uranium levels, degree of conservatism, the U 235 enrichment issue, ATSDR screening levels and process, the use of ATSDR's radiogenic cancer comparison value, and the development of the Y-12 Uranium Releases Brief. ATSDR also believes that collecting and addressing community health concerns is an essential part of ATSDR's overall mission and commitment to public health. ATSDR and the ORRHES developed the Community Health Concerns Comment Sheet for community members to provide written comments about specific health concerns or other issues. The comment sheets are available at the ATSDR Oak Ridge Field Office (197 South Tulane Avenue; Oak Ridge, TN; phone: 865-220-0295). To improve the documentation and organization of community health concerns at the ORR, ATSDR developed a Community Health Concerns Database specifically designed to compile and track community health concerns related to the site. Please see the Community Concerns section of the PHA (Section VI.) for ATSDR's responses to concerns related to issues associated with uranium releases from the Y-12 plant. Also, it is ATSDR's policy to address comments received during the public comment period.
Evaluation of Past Exposures		
4	Please note also, that the second level of screening performed in the Task 6 Report of the Oak Ridge Dose Reconstruction is not a rigorous analysis of retrospective exposure to real persons nor is it a conservative over-estimate of true exposure. Much more additional work is required prior to making a	As stated in the title, the Task 6 report was a "Screening Evaluation of Potential Off-Site Exposure" that routinely and appropriately used several layers of conservatism and protective assumptions and approaches (see list of conservative aspects of the screening evaluation on pages 48 and 92 of the PHA). In addition, the Task 6 report

	Public Comment	ATSDR's Response
	conclusion that past exposures are not of concern.	states on pages E-9 and 3-27 that "because of the scarcity of information regarding estimates of uranium concentrations in the environment over the period of interest, some conservatism was maintained in the uranium concentration estimates used in the Task 6 Level II screening to ensure that hazards to a significant portion of the potentially exposed population were not underestimated" (ChemRisk 1999). The internationally recognized expert technical reviewers hired by ATSDR to review the Task 6 report pointed out that "the estimates made in the report tend to be on the conservative side—one expects, therefore, that (when in error) the report would tend to *overestimate* the extent to which exposure to uranium is a problem in the Oak Ridge area. Further refinements to the study are likely to reveal that uranium exposures are actually *lower* than those currently estimated" (see page G-7 of the PHA). The expert technical reviewers also stated that the Task 6 uranium screening evaluation report was technically sound and applicable to public health decision-making (see page G-7 in the PHA). In addition, CDC's staff participated in the Oak Ridge Health Agreement Steering Panel (ORHASP) and agreed that the Task 6 report is appropriate for public health decision-making. Since the screening evaluation, which contained conservative aspects, resulted in an overestimation of total past uranium dose that is well below levels expected to cause adverse health effects, ATSDR does not believe the evaluation of Y-12 uranium releases requires a further nonconservative screening, a refined evaluation with uncertainty and sensitivity analyses, or additional sampling.
5	The fact that ATSDR committed to using the Oak Ridge Health Agreement Steering Panel Tasks as the main factual basis for conducting its public health assessment lays bare the inadequacy of its approach. The ORHASP Task 6 was found by the panel of experts who reviewed the original document as an inadequate factual basis for making public health findings and rightly concluded that more investigation is needed before drawing PH conclusions. ATSDR reviewers also concluded the information in Task 6 was insufficient to draw definite conclusions on the impact of uranium to local public health.	**ATSDR Technical Review Process** The Agency for Toxic Substances and Disease Registry (ATSDR) had each of the Phase II Oak Ridge Health Studies documents reviewed by a group of technical experts to evaluate the quality and completeness of the studies and to determine if the studies provide a foundation on which ATSDR can base follow-up public health actions or studies, and particularly, to support its congressionally mandated public health assessment of the ORR. ATSDR will use the information from the Oak Ridge Health Studies, as well as data from the technical reviews and other studies, to develop public health assessments for the ORR. ATSDR recognizes the great amount of oversight, technical peer review, and overall work that went into the Oak Ridge dose reconstruction project. However, ATSDR wanted an additional round of expert review of the Task 6 uranium screening evaluation to consider its value for the public health assessment. There are two

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		reasons for the additional round of review. First, ATSDR will not attempt to reproduce (*ab initio*) the work or results of the Task 6 uranium screening evaluation for its public health assessment. Such an attempt cannot be justified without substantial new information about past releases of uranium, or historic environmental sampling data or meteorological data, which ATSDR does not presently have. Secondly, Task 6 uranium screening evaluation is a technical investigation fraught with uncertainty. ATSDR believes that an independent expert review of the methods and assumptions in the Task 6 uranium screening evaluation offers the best insight into the validity and usefulness of the results for making public health decisions. ATSDR contracted with Eastern Research Group, Inc. (ERG) of Lexington, Massachusetts, to select four expert reviewers to technically review the uranium screening evaluation Task 6 report: Melvin Carter, Nolan Hertel, Ronald Kathren, and Fritz Seiler. The reviewers were asked to comment on the study design, methods, and completeness of the uranium report, as well as the conclusions of the authors of the report. **ATSDR Note to Reader of Technical Reviewers Comments** ATSDR cautions the reader that some of the technical reviewers' comments are critical of the Task 6 uranium screening evaluation report. This does not mean that the uranium screening evaluation report is flawed or should not be used. The reviewers were not provided with a forum for group discussion or with formal access to the uranium Task 6 study authors to ask questions. Not all reviewers answered every question posed to them. Sometimes they acknowledged they were commenting outside their field of expertise and sometimes they acknowledged that they did not wish to comment outside their field of expertise. The reviewers brought their varied experience to the task, and not all reviewer comments are equally valid. Occasionally two opinions are conflicted. In such an instance (and other information being equal) ATSDR will tend to prefer comments from the reviewer who had the greater expertise in the subject area. Finally, the technical reviewers knew and acknowledged the Task 6 report was a screening evaluation of the uranium releases and not a complete dose reconstruction. ATSDR intends to evaluate each of the reviewer comments for its applicability and usefulness on its own merit and it encourages the reader to do the same. **Technical Reviewers Comments** The internationally recognized expert reviewers concluded that the uranium screening evaluation in the Task 6 report was "technically sound and applicable to decision-making," that it was "supported by and developed on the basis of information in the

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		reports," that it "conformed with established and generally accepted techniques," and that it had "no major or significant problems with respect to the study design or the scientific approaches used." Overall, the reviewers agreed that the screening assessment is adequate for public health decision-making (see page G-7). The technical reviewers agreed that **IF** it is found necessary to evaluate beyond the screening stage, additional modifications would be required for a complete dose reconstruction. They noted that further refinements to the study are likely to reveal that uranium exposures are actually lower than those currently estimated (see page G-7). *Task 6 Teams Comment Regarding the Use of the Task 6 Screening Evaluation* Also, the Task 6 team noted that there are areas identified throughout the report that contribute to the overall uncertainty of the results of the screening evaluation. They state that "these areas should be examined **IF** the evaluation of Oak Ridge uranium releases is to proceed beyond the conservative screening stage, and on to nonconservative screening and possibly a stage of refined evaluations" (see pages 5-2 and 5-3). **ATSDR Conclusion** ATSDR concluded that since the Task 6 uranium screening evaluation routinely and appropriately used several layers of conservatism and protective assumptions and approaches that resulted in overestimated total past uranium doses that are well below (32 times less than) the ATSDR radiogenic comparison value and levels expected to cause adverse health effects, ATSDR categorizes the Y-12 plant as having no apparent public health hazard from uranium exposure and does not believe the evaluation of Y-12 uranium releases requires a further nonconservative screening, a refined evaluation with uncertainty and sensitivity analyses, or additional sampling.
6	**[Organization]** made it very clear from the beginning that use of the ORHASP tasks as a factual baseline was in and of itself highly inappropriate due to these aforementioned and other clear restrictions the results would have on the PHA.	The Task 6 report underwent the State of Tennessee's external peer review prior to release and ORHASP provided technical and community oversight throughout the project. In addition, ATSDR had the Oak Ridge Health Study reports technically reviewed by an expert panel of internationally recognized scientists. The purpose of the technical review was to determine if the uranium report provides a foundation on which ATSDR can base follow-up public health actions or studies. The ATSDR's expert technical reviewers concluded that the Task 6 report was "technically sound and applicable to decision-making," that it was "supported by and developed on the basis of information in the reports," and that it had "no major or significant problems with respect to the study design or the scientific approaches

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		used." Overall, the reviewers agreed that the screening assessment is adequate for public health decision-making (see page G-7). In addition, CDC's staff participated in ORHASP and agreed that the Task 6 report is appropriate for public health decision-making. Furthermore, one of the expert technical reviewers of the Task 6 report also participated in ATSDR's external peer review of the PHA on Y-12 Uranium Releases. In his peer review of the PHA, he stated that "the assessment is very well done, clearly characterized and summarized. I could find no errors of fact or logic, nor were assumptions inappropriate or unrealistic."
7	These restrictions include the lack of combined effects from other known releases of fallout such as NTS, Russian and Pacific weapons testing.	The air monitoring stations and soil sampling in Oak Ridge do not differentiate Y-12 uranium fallout from other sources. ATSDR's PHAs on the ORR focus on off-site exposure to contaminants released from the ORR and are not designed to evaluate exposure to radiation from other sources. As mentioned several times (e.g., pages 2 and 31), this PHA evaluates community health concerns and issues associated with the uranium releases from the Y-12 plant. The release and exposure to other contaminants of concern such as mercury, iodine 131, polychlorinated biphenyls (PCBs), uranium from the K-25 facility, and fluorides are not addressed in this document. These contaminants and other topics will be evaluated by ATSDR in separate PHAs.
8	The Task also did not consider direct inhalation as the most important exposure pathway of concern, which is evident from other detailed dose reconstructions on atmospheric releases of uranium, such as those performed by CDC at Fernald, OH.	Tables 7, 9, and 10 in the PHA identify the pathways considered by the Task 6 team. Not only was inhalation of airborne particulates considered, it was the largest contributor to total uranium exposure via the air pathway (30% for U 234/235 and 10% for U 238; see Table 7). During the evaluation, the Task 6 team also considered other human exposure pathways that were specific to the exposure potential of the communities living near ORR. For the water and soil pathways, fish consumption and vegetable consumption, respectively, were calculated to contribute larger percents of the total uranium dose (see Tables 9 and 10).
9	By repeated dismissal of such particulars in the face of comment submitted verbally and in writing from members of the community requesting such considerations ATSDR effectively has lost all credibility as a technically competent and independent investigator representing public health concerns.	ATSDR captured, reviewed, and considered the previous comments that were made during ORRHES and PHAWG meetings or provided in writing to ATSDR (see ATSDR's responses to comments 6, 7, and 8). As stated in ATSDR's response to comment 3, community involvement and responding to health concerns are key components of the public health assessment

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		process. There are several ways in which the public can become involved and provide input into the ATSDR public health assessment process. It is ATSDR's policy to address health concerns and comments collected during the public comment period. ATSDR had the Task 6 report technically reviewed and the PHA peer reviewed. The technical reviewers concluded that the Task 6 report was adequate for public health decision-making (see page G-7) and all three external peer reviewers agreed that ATSDR's conclusions are appropriate. In the words of one peer reviewer also familiar with the Task 6 report: "the assessment is very well done, clearly characterized and summarized. I could find no errors of fact of logic, nor were assumptions inappropriate or unrealistic." Furthermore, CDC's staff participated in ORHASP and agreed that the Task 6 report is appropriate for public health decision-making. Additionally, in a March 27, 2003 cover letter to ATSDR, EPA Region IV stated the following: "EPA concurs with the assessment's conclusion that the available data does not indicate the presence of uranium releases that constitute a past, current or future health threat for the Scarboro Community."
10	And how many of the studies used were based on information that was "incomplete, inconsistent, or in the shredder?	ATSDR's conclusions in the PHA are based primarily on data and information from the Task 6 report (ChemRisk 1999), the FAMU report (FAMU 1998), the EPA Region IV report (EPA 2003), and the Oak Ridge Environmental Information System (OREIS) database. The evaluation of past exposure is largely based on the evaluations in the Task 6 report. The references ("studies") used in the Task 6 report and all the other Oak Ridge Health Studies reports are available to the public. **Availability of References Used in Task 6 Uranium Screening Evaluation Report** During the Oak Ridge Health Studies, the State of Tennessee, through its contractor ChemRisk, contracted with the firm Shonka and Associates to conduct the most intensive search of documents ever performed for the ORR. Staff from ChemRisk and Shonka and Associates performed a systematic data and records search at all on-site document storage areas, national archives, libraries, individual offices, as well as at other areas where data of any form may have existed. The references used to generate all of the Oak Ridge Health Studies and Dose Reconstruction Reports are available to the public and researchers through five different mechanisms: 1) **Project-CD entitled, "The Oak Ridge Health Agreement Studies, Oak Ridge**

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		Dose Reconstruction." The project-CD contains the full abstracted bibliographic database of references collected, all project reports, and all of the interviews in their complete form. Every document ChemRisk collected was entered into the formal bibliographic database. This CD does not contain the full text of referenced documents. 2) **DOE Information Center** All references and final project reports generated during the study were sent to the Information Center. It should contain all the references identified on the Project-CD. It should be noted that some references may have been inadvertently removed as there is unrestricted access to the documents and staff were not expected to police document use. Also, this collection does not have the modeling and dose calculations that were done by ChemRisk to calculate dose and risk. 3) **On-Line DOE Comprehensive Epidemiologic Data Resource (CEDR)** The CEDR project has all references "utilized" in the dose reconstruction reports. Note that it does not have all references listed on the Project-CD, only those that were ***actually used*** and referenced in the dose reconstruction documents. CEDR is available on line (http://cedr.lbl.gov). 4) **CEDR on CD ROMs** The references contained in CEDR are also available on 18 CDs at ATSDR offices including the Oak Ridge Field Office. The references on the CDs link directly to the bibliographic database on the Project-CD. 5) **Tennessee State Library and Archive** The only complete set of project files, references, documents, reports, and calculations is at the Tennessee State Library and Archive in Nashville. It is the largest single collection ever accepted for permanent retention by the State. The library is now in the process of microfilming, indexing, and organizing the entire reference collection. When complete, the microfilmed records will be available to the public and the original documents will be catalogued and shelved in the library. The shelved documents will be made available through monitored access. This collection of documents represents the only fully complete document data set for this State Project. It is the only one that has the complete ChemRisk project file. See the February 2001 ORRHES meeting minutes for a presentation and paper on the document and data management process during the Tennessee Department of Health Oak Ridge Health Studies & Dose Reconstruction Project.

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		In addition, the Task 6 report underwent an external technical peer review, an independent expert technical review, and had ORHASP involvement throughout the project. The internationally recognized expert technical reviewers hired by ATSDR concluded that the Task 6 report was "technically sound and applicable to decision-making," "supported by and developed on the basis of information in the reports," and had "no major or significant problems with respect to the study design or the scientific approaches used." Overall, the reviewers agreed that the screening assessment is adequate for public health decision-making (see page G-7). In addition, CDC's staff participated in ORHASP and agreed that the Task 6 report is appropriate for public health decision-making. Additional data from OREIS, FAMU, and EPA Region IV were used to evaluate current exposures. OREIS is a centralized, standardized, quality-assured, and configuration-controlled environmental data management system that is publicly available (for additional details about the OREIS Web site, see http://www-oreis.bechteljacobs.org/oreis/help/oreishome.html). The validated sampling results presented in the FAMU report (FAMU 1998) were verified by EPA Region IV. The EPA report states on page vi: "EPA's study results are in agreement with similar, more extensive, studies done in 1998 by FAMU. EPA's study analyzed for hazardous substances and radionuclides associated with the operations of the nearby Y-12 Plant, several of which had not been included in sample analysis from other studies. EPA's work gives a completed representation of any contamination that might have been encountered. These results confirm that existing soil and water quality pose no risk to human health within the Scarboro community" (EPA 2003).
11	ATSDR's adjustment factor assumes an incorrect exposure duration of 52 years for the Task 6 report Level II assessment. According to Oak Ridge Dose Reconstruction Project Summary Report (ChemRisk 2000, p.70): "For radionuclides and carcinogenic chemicals, exposure durations of 50 years and 10 years were used in the Level I and Level II screening, respectively." Based on this, ATSDR's adjustment factor should be 0.14 (i.e., 10 y/70 y = 0.14) and, along with the Task 6 Level II total uranium dose of 114 mrem, should yield a corresponding recalculated total uranium dose of ~ 816 mrem (i.e., 114 mrem ÷ 0.14).	ATSDR used the correct exposure duration of 52 years to calculate the adjustment factor and doses. The Level II screening assessment described on page 70 in the Oak Ridge Dose Reconstruction Project Summary Report (ChemRisk 2000) pertains to the Task 7 screening of additional chemicals and radionuclides to identify materials as low, medium, or high priority for further study, not the Task 6 Level II uranium screening evaluation. The Task 6 Level II uranium screening evaluation is discussed on page 71 of the Oak Ridge Dose Reconstruction Project Summary Report (ChemRisk 2000). As stated on page 4-14 of the Task 6 report, "the doses are summed over 52 years of exposure" (ChemRisk 1999). In addition, ATSDR staff verified that the doses are summed over 52 years by

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		consulting the Task 6 manager and the Task 6 spreadsheets (personal communication, August 2003).
Scarboro		
12	In any event, the public health assessment for uranium rests upon the concentration of total uranium in the Scarboro environment and not on a departure of the isotopic ratio from its normal U235 value. Fortunately, the data which determines this is of sufficiently high quality to ascertain that Scarboro total uranium levels are within the expected background range for East Tennessee soils. In fact, the levels of uranium in Scarboro soils is so low that even a considerable increase in its U235 percentage would not change the conclusion that it is safe.	ATSDR agrees that the public health conclusions are based on the evaluation of exposure to total uranium in the environment through several pathways, not on the evaluation of uranium enrichment in the soil. The amount of uranium present in the community is below levels known to cause adverse health outcomes. ATSDR also agrees that a slight increase in the U 235 percentage would not change the conclusion that it is safe. However, if the percentage enrichment is about 10 to 15%, the uranium becomes a radiation hazard to the kidneys.
13	Considering the prior public demands for core samples, expand the footnote to indicate that finding background levels of total uranium in Scarboro soils indicates one of two cases: 1) little or no deposition of insoluble, immobile forms of uranium or 2) deposition of very soluble, mobile forms of uranium which have been eluted. Given the chemistry of uranium the latter case is very improbable on the clay soils of East Tennessee and surface soil sample are indicative of past exposures. (P67)	The predominant form of uranium released to the air was highly insoluble uranium oxide (ChemRisk 1999). As stated in the Current Soil Exposure Pathway discussion under the Current Radiation Effects section (Section III.B.2.a.), the overall results indicate that the concentrations of uranium detected in the Scarboro community are indistinguishable from the background concentrations of uranium in the area around Oak Ridge. Furthermore, the percentages of uranium in the Scarboro community are essentially identical to the amount of uranium found in nature (see Figures 24 and 25). In 2001, EPA Region IV collected uranium core samples from two locations in Scarboro. The report stated that "none of the analytical values for the uranium cores were elevated above the PRG [preliminary remediation goal] or background… There is no evidence that the substance is present at levels 12 inches below ground surface" (pages 7 and 17). From page 19 of their report, EPA Region IV "does not propose to conduct any further environmental sampling in the Scarboro community," and from page 26: "based on EPA's results, the Scarboro community is safe. Therefore, additional sampling to determine current exposure is not warranted" (EPA 2003). Page 29 in the PHA provides a short summary of the EPA sampling. To expand the information presented, ATSDR added a summary brief of the EPA report in Appendix I of the final PHA. In addition, the Auxier report compared the results of the FAMU Scarboro sampling results with the deposition estimates based on the August 1998 Task 6 results (Prichard 1998). The Auxier report concluded that the Task 6 air pathway analysis is supported by the 1998 FAMU Scarboro soil data (Prichard 1998). The report stated that the agreement between deposition inferred from soil samples and deposition predicted on the basis of Task 6 air concentrations projections is well within the uncertainties of the parameters used in the calculations (Prichard 1998). The

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		internationally recognized independent technical reviewers hired by ATSDR commented that the analysis and conclusions of the Auxier report are compelling.
14	The problem is the public perception that Scarboro has been contaminated by airborne enriched uranium. The real question is: Are there significant levels of U235 in Scarboro soils?	No. Based on the data supplied to ATSDR, the soils in Scarboro are indistinguishable from regional soils. The PHA addresses this question in the Current Soil Exposure Pathway discussion under the Current Radiation Effects section (Section III.B.2.a.). Even though the Oak Ridge area appears to contain more U 235 than typically found in nature, the overall results indicate that the concentrations of uranium detected in the Scarboro community are indistinguishable from the background concentrations of uranium in Oak Ridge area. Furthermore, the percentages of uranium in the Scarboro community are essentially identical to the amount of uranium found in nature (see Figures 24 and 25).
15	(pp. 3 & 5) On p.48, the statement is made that Scarboro was, "…likely to have received the highest uranium exposures from the Y-12 plant". But on p. 95, two current uranium concentrations are given, and the one for the city of Oak Ridge is almost 2.6 times the value for Scarboro. Therefore, is the statement on p. 48 still correct?	Yes, the statement on page 48 [ATSDR note: page 48 in the public comment version] is correct. As noted in the footnote of Figure 22, the average air concentration for Station 46 (Scarboro) is based on data from 1995 to present, whereas the average concentration for Station 41 (Oak Ridge) is based on data from 1986 to 1991. Since the Y-12 missions were curtailed in 1992, operations, and hence emissions, were higher from 1986 to 1991 than from 1995 to present (see Section IIB. Operational History). This is also the same reason why the total radiation doses from inhalation in Table 15 are higher in the city of Oak Ridge than in Scarboro. ATSDR compared the concentrations detected at Station 46 (Scarboro) to those detected at Station 41 (located in the city of Oak Ridge near the intersection of South Illinois Avenue and the Oak Ridge Turnpike) for the years in which both air monitors were in operation (1986 to 1991). The uranium air concentrations at Station 46 were, on average, 2.7 times higher than those at Station 41.
16	Both the comments by EPA Headquarters and by EPA Region 4 state that Scarboro may not have been the most affected community from releases from the Y-12 plant. The **[organization]** has requested repeatedly that other neighborhoods in Oak Ridge be sampled for potential contamination. Although a couple years ago DOE, Tennessee Department of Environmental and Conservation, and EPA had initiated discussions for a joint sampling program to cover the other neighborhoods in Oak Ridge, no such sampling has been performed to date. Terrain-based air-transport models reportedly find that the Woodland community may have received more emissions from Y-12 than Scarboro. In the PHA, pages 30-31, recommendations 3 and 4 by the Oak Ridge Health Agreement Steering Panel would have dispelled much of the controversy had they been	ATSDR believes the city of Oak Ridge is the only established community adjacent to ORR that could have been impacted by Y-12 uranium releases and that Scarboro is a representative community for the city of Oak Ridge. Therefore, the conclusions are valid for the people living near the Y-12 plant, including the city of Oak Ridge. As noted on page 43 of the PHA, the Task 6 team identified Scarboro as the reference location using the air dispersion modeling (USEPA 1995, as cited in ChemRisk 1999). The Task 6 team used the results of the flat terrain ISC dispersion model to identify the off-site housing area with the highest estimated uranium air concentrations. The Task 6 team understood the limitations of applying the flat terrain ISC dispersion model in the complex terrain surrounding the Y-12 facility and also understood that the flat terrain model overestimated the air concentrations in Scarboro and other

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	followed. Scarboro is not a representative and reference offsite-impact community, owing in part to the prevailing direction of the wind.	locations outside Bear Creek Valley (ChemRisk 1999, ORHASP 1997). However, when estimated results of air dispersion models were compared to the actual uranium air concentrations measured in Scarboro, the flat terrain model was the best predictor of estimated uranium air concentrations in Scarboro. The Task 6 report stated that "while other potentially exposed communities were considered in the selection process, the reference locations [Scarboro] represent residents who lived closest to the ORR facilities and would have received the highest exposures from past uranium releases…Scarboro is the most suitable for screening both a maximally and typically exposed individual" (ChemRisk 1999). ATSDR agrees with the commenters that the predominant wind direction at the Y-12 facility is southwest or northeast. According to the ORR meteorological monitoring, "prevailing winds are generally up-valley from the southwest and west-southwest or down-valley from the northeast and east-northeast… winds in the valleys tend to follow the ridge axes, with limited cross-ridge flow within local valley bottoms" (DOE 2002c). Therefore, most of the uranium would deposit up and down the valley in which the Y-12 plant is located. The Y-12 plant is located in Bear Creek valley, between Pine Ridge and Chestnut Ridge. These ridges extend to the northeast into Union valley. No one lives in Bear Creek valley or Union valley. The closest population living in the valley system between Pine Ridge and Chestnut Ridge is more than 3 miles away, across the Clinch River, in Wolf valley. The people living in Wolf valley would likely have been exposed to lower amounts of uranium than the people living in Scarboro because the majority of the uranium deposition would have been relatively close to the Y-12 plant. Aerial surveys performed since 1959 are sufficiently sensitive to detect radiation sources. Those sources outside the confines of Y-12 have been verified by the state not to constitute a health hazard. By implication, the aerial surveys will readily detect sources that do constitute a hazard and (except for a known few locations due to past or present operations within Y-12) the off-site areas such as the Bear Creek and Union valleys, including the residential areas of Oak Ridge, do not show any elevation of radiation above background. Thus, there is direct empirical evidence that the Oak Ridge neighborhoods have not been contaminated by Y-12 uranium releases. ATSDR acknowledges that it is possible that the Woodland community, also located within the city of Oak Ridge (near the gap in Pine Ridge), might have received higher uranium emissions than Scarboro. To evaluate this potential, ATSDR compared the ambient air monitoring data for Station 46 (Scarboro) to Station 40 (located on the Y-12 plant near the intersection of Bear Creek Road and Scarboro Road). While Station 40 is not located in Woodland, it is located in Bear Creek valley near the gap in Pine Ridge. ATSDR compared the average uranium air concentrations from 1986 to 2002

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		and found that the concentrations at Station 40 were, on average, 20% higher than those at Station 46. The average air concentrations at Station 40 ranged from being less than half those at Station 46 in 1997, to almost double those at Station 46 in 1990. For the years from 1986 to 1989, during higher production, the average uranium concentrations at Station 40 remained steady at 20% higher than those at Station 46. Assuming, therefore, that the Woodland community was exposed to the uranium air concentration at Station 40 in Bear Creek valley, they could have potentially received up to twice the amount of uranium emissions as Scarboro. If ATSDR doubled the estimated exposure calculated for Scarboro, the Woodland community could have received a past uranium radiation dose of up to 310 mrem over 70 years (based on an air monitoring station located at the Y-12 plant), which is well below the radiogenic cancer comparison value of 5,000 mrem over 70 years. The current uranium radiation dose is estimated to be less than one mrem, also well below the radiogenic cancer comparison value. Therefore, even if the Woodland community were to have received double the emissions of Scarboro (which is unlikely), the exposures are still too low to be of health concern. For perspective, ATSDR also compared the concentrations detected at Station 46 (Scarboro) to Station 41 (located in the city of Oak Ridge near the intersection of South Illinois Avenue and the Oak Ridge Turnpike) for the years in which both air monitors were in operation (1986 to 1991). The uranium air concentrations at Station 46 were, on average, 2.7 times higher than those at Station 41. In addition, the past uranium radiation doses used in the public health assessment are from the Task 6 report, which was a screening evaluation that routinely and appropriately used several layers of conservatism and protective assumptions and approaches in estimating concentrations and doses (see the list of conservative aspects of the screening evaluation on pages 48 and 92 of the PHA). The Task 6 report states that "some level of conservatism was maintained in the uranium concentration estimates used in Level II screening to ensure that hazards to a significant portion of the potentially exposed population were not underestimated" (ChemRisk 1999). Also, the internationally recognized expert technical reviewers hired by ATSDR to review the Task 6 report pointed out that "the estimates made in the report tend to be on the conservative side—one expects, therefore, that (when in error) the report would tend to *overestimate* the extent to which exposure to uranium is a problem in the Oak Ridge area. Further refinements to the study are likely to reveal that uranium exposures are actually *lower* than those currently estimated" (see page G-7 of the PHA).

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ATSDR's Health Guidelines for Radiation Effects		
17	The statement on p. D-1 that "the risk associated with a dose that approaches background, 0.36 rem/year…is essentially impossible to measure" is untrue as analytic epidemiology techniques have advanced substantially such as those being used to study U.S. nuclear workers and other occupationally-exposed cohorts.	The comment is noted. The risk is not being measured but is being calculated using a derived risk coefficient with the "quantitative" result having the appearance of precision and an associated true value. Further, the statement cannot be wrong, as the case of zero additional exposure is included.
18	The 5000 mrem cancer screening value is simply a fallacious recommendation for public health screening. This value is in direct conflict with ICRP, IAEA and EPA standards. These plus the disagreement between the ORHASP's criteria of 10^-4 health risk of cancer and ATSDR's cancer comparison value are in stark contrast. How did ATSDR selectively decide to use Task 6 results but not use the same endeavor's screening criteria?	ATSDR's radiogenic cancer comparison value of 5000 mrem over 70 years is in line with many of the recommendations of the organizations cited by the commenter. The following comparisons were made in ATSDR's response to comments 158 through 162. • The first approximation of ATSDR's radiogenic cancer comparison value of 5,000 mrem over 70 years is less than 100 mrem/year (5,000 mrem ÷ 70 years = 71 mrem/year). • The first approximation of the 100 mrem/year dose limit recommended by the International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurements (NCRP) roughly equates to a 7,000 mrem dose over 70 years (100 mrem/year × 70 years). This lifetime dose is higher than ATSDR's radiogenic cancer comparison value of 5,000 mrem over 70 years. The exposure doses calculated for Scarboro residents (155 mrem over 70 years for past exposures and <1 mrem over 70 years for current exposures) are more than 45 times lower than ICRP's and NCRP's guidance. Figure 12 of the PHA graphically displays NCRP's guidance and NRC's regulations for public exposure (100 mrem/year) in relation to the doses estimated for Scarboro. • The first approximation of EPA's cleanup level into a lifetime dose is roughly 1,050 mrem over 70 years (15 mrem/year × 70 years). The exposure doses calculated for Scarboro residents (155 mrem over 70 years for past exposures and <1 mrem over 70 years for current exposures) are more than 6 times lower than EPA's guidance.

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Agency	Lifetime (mrem over 70 years)	Yearly (mrem/year)
ATSDR's radiogenic cancer comparison value	5,000	71
ATSDR's MRL	7,000	100
EPA's cleanup level	1,050	15
ICRP's guidance	7,000	100
NCRP's guidance	7,000	100

ATSDR uses the public health assessment process to evaluate the potential for public health effects by comparing an estimate of the amount of uranium exposure (i.e., dose) that people might frequently encounter to conservative screening values and health effects levels documented in the scientific literature. To evaluate past uranium exposure to residents living near the Y-12 plant, ATSDR compared the Task 6 screening results (estimated doses, not the screening indices) to ATSDR's health based comparison values. ATSDR used only the basic release data of the Task 6 report and applies its own exposure pathways, dose calculations, and accepted screening levels during our evaluation. See the response to comment 127 for additional information distinguishing an EPA baseline risk assessment from an ATSDR public health assessment.

The Task 6 screening indices are a risk-based screening, as evidenced by the total detriment value of 0.073 in the task calculations. Current ATSDR policy does not allow for the use of risk coefficients in determining the impact on public health. As stated in the ATSDR Cancer Framework Policy, ATSDR recognizes the need for calculating risk during the assessment process. However, the agency acknowledge that, at present, no single, generally applicable procedure for exposure assessment exists, and, therefore, exposures to carcinogens must be assessed on a case-by-case or context-specific basis. While the need for, and reliance on, models and default assumptions is acknowledged, ATSDR strongly encourages the use of applicable empirical data (including ranges) in exposure assessment. For additional information, please review the framework policy that can be found at http://www.atsdr.cdc.gov/cancer.html.

However, if the Task 6 Level II screening indices and ORHASP decision criteria were used, the Level II screening index (8.3×10^{-5}) is 1.2 times less than the ORHASP decision guide (1×10^{-4}) and—therefore—below the threshold for consideration of more extensive health effects studies. Based on the ORHASP decision guides, the estimated Level II screening risk from off-site exposure to Y-12 uranium is so low

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		that further detailed study of exposures is not warranted. (See the Level II screening index on page 4-12 of the Task 6 report and the ORHASP Decision Guides on page 57 of the ORHASP report.)
19	For at least four reasons, ATSDR is flat-out wrong in alleging that its recommendation of a "radiogenic cancer comparison value" for public health assessment screening – of 5,000 mrem effective dose – is protective of public health. One reason is that there is evidence of genetic and chromosomal damage at levels of ionizing radiation lower than this level. Second, this 5,000 mrem level relies only on epidemiological data and ignores all the molecular-level evidence of increase risk from radiation below this level. Third, the ATSDR assumes that background radiation is harmless, and this fact is false, as evidenced by the fact that the UNSCEAR calculates that 40,000 annual cancers arise in the U.S., just from background radiation. Fourth, the 5,000 mrem level contradicts the explicit norms of the ICRP, the IAEA, and UNSCEAR, all of which accept the linear, no-threshold thesis, and all of which require that radiation does be kept ALARA (as low as reasonably achievable). In its report "Y-12 Uranium Releases: Public Comment Release," ATSDR in Appendix D states that epidemiological evidence from studies on cohorts exposed to chronic low doses of radiation have been inconclusive.	We agree that there are studies showing damage at doses lower than these. However, we are applying our screening value as a *long-term* screen. Many of the studies you may be referring to involve *acute* or short-term exposures. There is much disagreement in the scientific community as to the methods used to adjust long-term exposures to short-term exposures. With respect to the recent molecular studies, ATSDR is aware of those studies, many of which are cell culture studies and microbeam studies that indicate the bystander interactions, as well as direct and indirect actions. It is important to realize that many cellular processes mediate these molecular events. Background radiation studies are interesting, as it is not possible to measure the effect on human populations in the absence of background. The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) value, as you state, is a *calculated* number based on the current risk estimates. With respect to the ALARA concept, this is not applicable to a screening evaluation. The ALARA concept is used to minimize the dose potentially received. As pointed out it the PHA, the maximum doses we calculated for current exposure were less than 5 mrem, well within the ALARA concept and well below the standards and recommendations you cite. ATSDR derived the radiogenic comparison value of 5,000 mrem over 70 years after reviewing the peer-reviewed literature and other documents developed to review the health effects of ionizing radiation. ATSDR publicly discussed this issue in at least four PHAWG meetings and three ORRHES meetings. The Ionizing Radiation Toxicological Profile states: "the annual dose of 3.6 mSv per year has not been associated with adverse health effects or increases in the incidences of any type of cancers in humans or other animals" (ATSDR 1999b).
20	I would like to inform you that there are numerous examples of significant epidemiological findings where radiation doses have been received from chronic or fractionated exposures. Much of this is documented in NCRP Report No. 136 (2001) and the International Agency for Research on Cancer (IARC) Monographs on the Evaluation of Carcinogenic Risks to Humans (Vols. 75 and 78, of 2000 and 2001).	ATSDR agrees that there are numerous epidemiologic findings, however, many of these reports do not show uniform statistical significance in the dose range ATSDR is using for the assessment. Also, the NCRP report states that results vary, based on the end point being evaluated (please see page 210 in NCRP 136 as an example of their issues).
21	Additional information related to epidemiological findings due to occupational exposure was summarized by NIOSH at the recent May 19-20, 2003, meeting in Oak Ridge of the NIOSH Advisory Board on Radiation	Thank you for the additional information.

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	and Worker Health. An attachment containing these epidemiological summaries is included, which I hope you will find to be of interest.	
22	I believe that, upon reviewing these documents, you will find that there is substantial scientific evidence in support of the presence of radiogenic cancer risks at organ doses below an effective dose of 5,000 mrem. This ATSDR "cancer comparison value" of 5,000 mrem is too high to be used for screening for public health concerns regarding exposure to radioactive contamination released from historic operations within the Oak Ridge Reservation. The cancer comparison value selected by ATSDR lacks a sufficient margin of safety with respect to organ doses that are associated with epidemiologically significant findings, to serve as a public health screening limit that discriminates against false negative conclusions. The cancer comparison value essentially ignores substantial evidence supporting the extrapolation of radiogenic cancer risk below limits of epidemiological detection.	ATSDR agrees that there are cases where cancer may be evidenced at doses less than 5,000 mrem, usually delivered during a working lifetime at industrial sites. The radiogenic cancer comparison value, as has been discussed many times, is a dose over a 70-year period (an average of 71 mrem/year). Using the analogy of a 30-year work span, this is a dose of less than 2,500 mrem. When appropriate, ATSDR did calculate an organ-specific dose. Please see Table 15 and Table 19 for estimated doses to the lung and bone. In the case of organ doses, the cancer induction resulting from radiological exposures is not as rigorous as the radiological induction of soft tissue cancers such as leukemia. In that case, ATSDR agrees that the 5,000 mrem comparison value would not be an appropriate screening value.
23	The final statement on D-5 that 5 rem over 70 years is protective of human health at Oak Ridge is not substantially supported by the information presented in the appendix. This lifetime exposure may not even be at a level corresponding to de minimus risk if NCRP organ-specific factors are used.	The comment is noted.
24	The statement that excess cancer risks have not been observed at exposures of 5-10 rems is being challenged by the latest scientific evidence. The most recent analysis of solid cancers among atomic bomb survivors suggests that cancer risk is significantly elevated in doses of 5 rem (50 mSv), and is most consistent with a linear or supra-linear dose-response relationship (Pierce DA, Preston DL Radiation-related cancer risks at low doses among atomic bomb survivors. Radiat. Res. 154:178-186, 2000). Of particular note is that the "epidemiologically-detectable" risk from radiation exposure has decreased with each passing decade since follow up of the atomic bomb survivor cohort began. (Appendix D)	The cancer risks from the atomic bomb survivors show a 2% increase in cancer deaths in those who received essentially an instantaneous dose of 500 to 20,000 mrem. But there is still the issue of how one converts an instantaneous dose to a dose delivered over 70 years. ATSDR's annualized dose of approximately 71 mrem/year is much less than the atomic bomb survivor lowest reported dose of 500 mrem. For more information, please see the Web site of the bomb survivor studies: http://www.rerf.or.jp/top/healthe.htm
25	The statement on p. D-1 that effects have not been observed below 5 rem but "assumed to occur" is not accurate. Effects have been observed in many studies but statistical significance has not always been achieved.	The comment is noted. In many epidemiological studies, if the statistical significance is not present then consideration must be given that there is no cause and effect relationship.
26	Statement that "No studies exist for exposures or doses below this [0.01 Sv] limit" is inaccurate. Nearly all occupational studies include populations with cumulative exposure estimates less than 1 rem. (Appendix D)	The comment is noted. The text was changed in the final PHA.
27	The report relies heavily on 1994 and 2001 GAO reports which are not scientifically rigorous. More appropriate sources for radiation exposures	The GAO report was cited not as a scientific source, but as a reference to show that the scientific community has not reached a consensus on the effects of low level

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	would be reports available from the ICRP, UNSCEAR, NCRP and BEIR committees, some of which are mentioned later in the appendix. (Appendix D)	exposures and low dose levels.
28	Discussions of the literature surrounding the quest to detect risk from excess background exposure are selective. Most of these studies are ecologic, not analytic, and suffer from bias as a result. Properly conducted analytic epidemiology studies of household radon exposure (e.g., Field RW et al. Residential radon gas exposure and lung cancer- the Iowa Radon Lung Cancer Study. Am. J. Epidemiol. 151:1091-1102, 2000) have detected excess risk at low exposure levels.	ATSDR has sent the radon study out for further review to determine its applicability for uses in PHAs.
29	The summary of nuclear worker studies is very incomplete, and highly selective. For leukemia risk, suggest looking at Occupational Medicine: State of the Art review article published by Schubauer-Berigan and Wenzl. The British worker study reviewed is outdated. More recent studies of U.S. and Canadian nuclear workers are omitted entirely.	ATSDR has sent this study out for further review to determine its applicability for uses in PHAs. One issue that is evident in this review is that the dose response is expressed as excess relative risk (ERR) per 10 mSv (1,000 millirem) and the ERR varies considerably among the studies reported.
30	Reference to "initial wave of leukemia" should be changed to "some of the early deaths from leukemia."	The text has been changed in the final PHA, as recommended.
31	Last paragraph on D-3 states that ATSDR could not identify any studies with risks from background radiation yet residential radon studies have found effects, as stated above.	The text has been clarified in the final PHA.
32	On p. D-3, the fact that the assessment of leukemia risk was delayed by 5 years after exposure among atomic bomb survivors is evidence that risk may have been underestimated in this cohort. There is also ample evidence of the leukemia from alpha exposures as seen among workers at the Mayak facility and elsewhere.	Thank you for the information. The comment is noted. It is interesting, however, that several of these reports indicate that risks may be overstated. Please see the *International Journal of Radiation Biology*, January 2003, 79(1):1-13, and *Radiation Research*, June 2003, 159(6):787-98, for additional information.
33	It is also stated that SMR's less than one for all cancers or for specific cancers are evidence for no effect, which is true. However, SMR analysis is not the best and most sensitive measure of effect. Hence the finding by Cardis, et al that found an association between radiation exposure level and risk of leukemia mortality. (Appendix D)	ATSDR agrees that the standardized mortality Ratio (SMR) may not be the best measure of an effect because the SMR is an indirect method of comparison to evaluate causes of death within a given area against a common standard.
34	The purpose for estimating the average dose for the "English study" is not given. (Appendix D)	The text has been clarified in the final PHA.
35	The Task 6 Report and ATSDR incorrectly refer to estimated radiation doses for Scarboro as committed effective dose equivalents or CEDEs. The quantities *dose equivalent*, *committed dose equivalent*, and *committed effective dose equivalent* are based on the dosimetry system, radiation quality factors, and tissue weighting factors formerly recommended by the International Commission on Radiological Protection in Publication 26 (ICRP 1977) and Publication 30 (ICRP 1979, et seq.). For Level I and Level II assessments, the Task 6 team used the adult dose coefficients or dose	The term total effective dose (TEDE) is defined in 10 CFR 20 as the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalents (CEDE) (for internal exposures). The ATSDR calculations only included the dose to the internal tissues so the committed dose equivalent is the appropriate term for the current pathway evaluations. While the Task 6 team reported both internal and external exposures and doses for the past evaluation (for which the TEDEs would have been appropriate), ATSDR only calculated the dose resulting from internalization of the uranium isotopes. Thus, CEDEs are appropriate for the ATSDR

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	conversion factors (DCFs) for U 234, U 235, and U 238 taken from Publication 71 (ICRP 1995) for inhalation exposures, from Publication 72 (ICRP 1996) for ingestion exposures, and from Federal Guidance Report No. 12 (EPA 1995) for external exposures (see pp. 4-8 and 4-9 of the Task 6 Report (ChemRisk 1999)). Inhalation and ingestion DCFs are based on ICRP's latest dosimetry system, defined in Publication 60 (1991), for calculating age-dependent doses to members of the public from intakes of radionuclides. This system incorporates revised biokinetic and dosimetric models, radiation weighting factors, and tissue weighting factors. ICRP's current dosimetric quantities are the *equivalent dose*, *committed equivalent dose*, and *committed effective dose*. Calculations using inhalation and ingestion DCFs from ICRP 26/30 vs. ICRP 71/72 results in different radiation dose estimates for internal exposures. Strictly speaking, the radiation doses calculated by the Task 6 team, and used by ATSDR, represent the summation of the *committed effective doses* from internal exposures and the *effective doses* from external exposures. The resultant total dose may, perhaps, be best referred to as the *total effective dose*.	current dose assessment.
Miscellaneous Radiation Comments		
36	The first line on D-3 mentions "types of radiation" when the term has not been defined. Is the reference to photons, neutrons, alpha-emitters and similar types?	The text has been clarified in the final PHA.
37	The first paragraph indicates that the 70-year dose is assumed to be received all in the first year (committed effective dose equivalent). Yet the comparison value is assumed to apply over 70 years. Most public health standards and guidelines place the annual limit at 1 mSv with an intrinsic expectation that such exposures would be extremely rare, i.e. on the order once in a lifetime. (Appendix D)	The comment is noted. The CEDE makes the stipulation that the entire dose, although distributed over time, is assumed to be delivered in the first year. In the case of regulatory limits, these are expressed as annual limits, mostly for external exposures.
38	It is invalid to divide the total dose delivered over 70 years by 70 in order to determine the annual dose delivered. As evidenced by figures 11, 14 & 16, the uranium releases varied greatly from year to year. The dose delivered in each year should be calculated and compared to the MRL of 100 mrem/yr. (p. 5, lines 12 - 17)	ATSDR agrees that the commenter is technically correct. This issue was discussed at several PHAWG meetings and at the ORRHES meetings where the screening process was discussed. The reason for dividing the total dose by 70 years was to establish a first approximation of the dose, as this would allow for comparison to ATSDR's minimal risk level (MRL) (100 mrem/year). The first approximation values of 2.2 mrem/year for past exposures and 0.003 mrem/year for current exposures are 45 and 33,000 times less than the MRL. Because these approximated values are so much lower than the MRL during the screening-level evaluation, no further actions were necessary. Had the approximation shown an annual dose close to the MRL, ATSDR would have re-assessed the evaluation and conducted a full dose reconstruction.

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39	It appears that total dose from Y-12 in 70 years are being added to annual background. This needs to be explained.	The text was clarified in the final PHA.
40	Footnote 5 on p. 49 of the PHA report shows that the CEDE is a total dose, not a dose rate. On pp. 47 & 50 of the PHA, the value of the average annual background dose rate in the U.S. is given as 360 mrem/yr. The figure of 300 mrem/yr. for Scarboro, appearing in Fig. 9, appears to be either a misprint or a value from a different source. In any event, a CEDE for 70 years cannot simply be added to a one-year background dose rate, because it isn't. It's an upper bound to the maximum one-year dose. Assuming that the CEDE is all absorbed in one year, for purposes of conservatively estimating its effects, its an additional issue that apparently needs explaining here. To be correct, the upper right-hand label in Fig. 9 should be modified to read something like, "Typical, and Maximum Possible One-Year, Doses from Ionizing Radiation Sources". The labels for the past and current theoretical peak annual doses received in Scarboro need to be re-worded accordingly. The first numerical value given in these labels should be the value actually being plotted. (pp. 47 & 49-50)	ATSDR revised Figure 12 in the final PHA.
41	Is it true that background radiation is harmless? Is the scientific community in agreement on this matter? And if it isn't which criteria did ATSDR use to arrive at the conclusion that background radiation is harmless which includes exposure to indoor radon? None of these questions have been answered.	The scientific community is not in agreement on the effects of exposure to background radiation. There are locations on the planet where the background radiation is much higher than at Oak Ridge and these populations do not overtly exhibit any adverse health problems. The statements in the PHA are based on the ATSDR Toxicological Profile on Ionizing Radiation (ATSDR 1999b), which has been extensively reviewed. See the response to comment 156 for a discussion of ATSDR's MRL.
42	The conversion from mSv to mrem on p. D-4 is off by a factor of ten.	Thank you. The text has been corrected in the final PHA.
43	Reference to medical accidents in the 2nd paragraph on p. D-3 should be changed to medical treatments.	In some cases, there were miscalculations on the administration of medical radionuclides or radiotherapy. Nonetheless, ATSDR added medical treatments to the list in the final PHA.
Specific Activities and Isotopic Ratios		
44	On pages 69 and 75 and perhaps others ATSDR fouled up the Specific Activities of uranium isotopes. You should correct this error.	ATSDR disagrees. The specific activities listed are for pure uranium, taking into account their abundances in nature. Specific activities are defined as the curies per gram for the pure isotopes.
45	The uranium isotopic ratios of the Scarboro samples were obtained by methods less precise than the preferred mass spectrometer method. This has imposed a rather large, unavoidable scatter in the data greatly reducing the significance of the isotopic ratios to a point that no conclusion can be drawn	ATSDR agrees. Mass spectroscopy for uranium (more specifically, inductively coupled plasma-mass spectroscopy) is more sensitive than alpha spectroscopy, with the added benefit that it can detect other forms of uranium not possible with alpha spectroscopy. However, the process is more expensive than alpha spectroscopy and

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	that the isotopic ratios of the Scarboro uranium samples is other than normal.	may not have been readily available to the laboratories analyzing the samples from Scarboro. FAMU determined uranium isotopic content using alpha spectroscopy (FAMU 1998). EPA Region IV verified their results using gamma spectroscopy (EPA 2003). The EPA Region IV report on page vi states that "EPA's study results are in agreement with similar, more extensive, studies done in 1998 by FAMU." They further explain on pages 7 and 9 that "gamma spectroscopy was used as a screen. It was chosen to analyze gamma-emitting isotopes which indicate radioactive decay… The analysis of the information reveals that all results for gamma emitters were within their predicted background ranges for the United States and Oak Ridge-wide. None of the analytical values were elevated above background. Uranium is both naturally occurring and site related… none of the EPA values were above the PRG or background" (EPA 2003). From page 19 of EPA Region IV's report: EPA "does not propose to conduct any further environmental sampling in the Scarboro community" and from page 26 "based on EPA's results, the Scarboro community is safe. Therefore, additional sampling to determine current exposure is not warranted" (EPA 2003).
46	P85 Table 17 It is not clear how this table was constructed or what it means. Certainly 0.047 (.972) is not the isotopic ratio of U235/238 (U234/U238) in nature. I believe you mean the ratio of isotopic activities.	The text has been corrected in the final PHA.
47	P{86, l8: These are not the concentrations of uranium isotopes found in nature but are the isotopic percentages of natural uranium.	ATSDR agrees. The text has been clarified in the final PHA.
48	P88, Table 18: I believe the table is isotopic composition. While this table does indicate a slight U235 enrichment for Scarboro, it also indicates a slight depletion for U234 which is not consistent with the U235 trend. Both are explained by the imprecision of the measurements.	ATSDR agrees. The issue of precision is addressed by the uncertainty of the measurements; that is, the detection limits could have been lower resulting in a more precise measurement.
49	P84, l9: States that "enrichment is typically stated by percent by weight of U 235 in the uranium samples…". This is ambiguous and enrichment is in fact stated as the weight percent of U 235 based on total uranium, i.e., the weight of U235 divided by the weight of Total Uranium converted to percent. Often this is called the isotopic composition.	The text has been clarified in the final PHA.
Enriched Uranium		
50	While this section reaches the correct conclusion about U235 enrichment in Scarboro soils, it does not properly discuss the errors in the EPA and FAMU data; lay to rest alleged enrichment in the EPA and FAMU data and the spatial trends in the FAMU data. This section should emphasize the nature of the data errors as well as their impact on the significance of the marginal increases in U235 enrichment and total uranium levels. (p83-88)	The text has been modified in the final PHA.

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51	P86, L23-24 appears to be contradictory to P88, L20.	The text has been clarified in the final PHA.
52	P87 Figures 21,22: Units of "Percent U per gram" is not clear and may be wrong; Need units on bottom sub-tables.; Error bars do not seem to reflect the large 2sigma values of EPA Tables 2A-J.	Modifications were made to clarify the Figures 24 and 25 in the final PHA. The use of the logarithmic scale masks the magnitude of the error.
ATSDR's Health Guidelines for Chemical Effects		
53	Please explain why the MRL of the insoluble forms of uranium, rather than soluble. (p. 7, line 31)	As noted on page 58 of the PHA, the predominant chemical form of uranium released into the air from the Y-12 plant was highly insoluble uranium oxide (ChemRisk 1999).
54	Figure 9 shows a radiogenic cancer comparison value for internal radiation dose, stated in terms of mrem. Then, for airborne chemical exposure, and external concentration, designated an MRL, is given in units of mg/m**3. Then, for past soil and surface water contamination, an internal chemical dose rate, designated and MRL, is given in units of mg/kg/day. Technically, this discussion lacks logic, due to the unexplained difference in units used for the two MRLs for past chemical exposure. Table 25 could be used to good advantage to improve the explanation. Clearly the units of dose for radiation exposure and chemicals exposure cannot be the same. But why do the units associated with air as the pathway represent an external concentration, and then those associated with soil and surface water as the pathways represent an internal, mass-based, dose rate? Can't all the doses for internal chemical exposure be expressed in the same units? When communicating with the public, you can't just quote the techies' statements verbatim. You first have to make sure that they are internally consistent and make sense, both in terms of cause-and-effect, and with respect to the numbers and the units associated with those numbers. The main theme of the comments concerns the disparate units of measurement used to quantify chemical exposures, without efforts to either eliminate the disparity or to explain it. [The commenter provided a table that could not easily be inserted into this table. Therefore, it is provided as Table A at the end of this table.] **[ATSDR staff]** state that the units used for each pathway are those describing the quantities that have been experimentally correlated, directly or indirectly, with health effects. There seems to be inconsistencies between the interpretations of Figs. 16, 17, 25 & 26. Fig. 16 is interpreted to indicate that no adverse health effects due to airborne uranium were caused to occur in the past in residents of Scarboro, because the average airborne concentrations of uranium in	Because uranium has both radioactive and chemical properties, ATSDR evaluated both radiation and chemical aspects of uranium exposure. As explained in Appendix A (ATSDR's Glossary) the dose for chemicals that are not radioactive is the amount of a substance to which a person is exposed over some time period. It is often expressed as milligrams (a measure of quantity) per kilogram (a measure of body weight) per day (a measure of time). The dose for radioactive chemicals is the amount of energy from radiation that is actually absorbed by the body. The radiation dose is expressed in mrem and mrem/year. The corresponding screening values and health guidelines retain the same units. ATSDR's public health assessment process involves two levels of screening and a weight-of-evidence "decision-making" evaluation (see Figure 7). The first step in identifying contaminants that warrant further evaluation is to compare the concentrations detected in the environment to media-specific comparison values (such as the environmental media evaluation guides [EMEGs] and risk-based concentration [RBC] values given in Table 2). Each media-specific concentration is expressed in the appropriate units (µg/m^3 for air, µg/L for water, and mg/kg for soil and fish). As explained in the Evaluating Exposures section (Section III.A.2.), comparison values reflect concentrations that are much lower than those that have been observed to cause adverse health effects. Thus, comparison values are protective of public health in essentially all exposure situations. As a result, concentrations detected at or below ATSDR's comparison values are not considered to warrant health concern. Therefore, if the concentration in the environment is below the comparison value, no further evaluation is conducted. If the concentration exceeds the comparison value, ATSDR further evaluates the exposure potential by calculating exposure doses (defined above). During this second level of screening, ATSDR compares the calculated dose to a health guideline (such as the MRL values given in Table 3). While ATSDR's oral MRLs are expressed as a dose per unit of bodyweight (mg/kg/day), the inhalation MRLs are expressed as air

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	Scarboro were always less than the minimum risk level (MRL). Then, Fig. 17 is interpreted to indicate that, even thought dose rates for internal absorption in 6-year olds could have been higher than MRL between 1953 and 1973, still no adverse health effects due to soil and water contamination occurred in the past because the exposure levels were always less than the lowest observed adverse effect level (LOAEL). Then for evaluating current risks of adverse health effects due to soil contamination, by means of Figs. 25 and 26, you revert to using the MRL as a criterion, because all the calculated current doses rates are below it. Finally, for evaluating current risks of adverse health effects due to water contamination, yet another set of units is introduced. This time the units are for an external concentration, in mg/L, instead of the internal dose rate of mg/kg/day shown in Fig. 17. Furthermore, the safety criterion for water as the pathway changes from an MRL to an Environmental Media Evaluation Guide. These unexplained changes in units and criteria are exasperating, because they make it impossible to develop a perspective on the subject. Is there no discipline in the field of environmental science that prescribes an agreed-upon set of units and criteria for a given subject? You can't just switch back and forth between units and criteria and retain credibility, especially, in this case, between an MRL and a LOAEL. If the MRL means what it says, then any exposure above it creates some risk, whether or not any adverse health effects have yet been observed. Therefore, the answer to the last question on page 1 cannot be an unequivocal "no". You seem to have put yourselves between a rock and a hard place, by making a statement that doesn't agree with the numbers. Part of the problem involving criteria relates to their definitions, as given in Appendix A of the PHA. The ATSDR term Minimum Risk Level (MRL) is defined as a dose below which adverse (noncancerous) health effects are unlikely. But a statement is added to the effect that MRLs should not be used as predictors of adverse health effects, without saying whether or not there is supposed to be a margin between the MRL and the dose at which harmful effects become likely. Notwithstanding this warning, the text of the Brief implicitly uses MRLs as predictors of harmful health effects, if for no other reason than not stating a deliberate margin between and MRL and a LOAEL. Then there is an analogous term defined by EPA, using a deliberate safety factor, as a Reference Dose (RfD), which is a dose unlikely to cause harm in humans. In addition, there is the Lowest-Observed-Adverse-Effect Level (LOAEL), the definition of which is self-evident. Finally, there is the No-Observed-Adverse-Effect Level (NOAEL), the definition of which is also self-evident. This latter criterion in no used in the	concentrations (milligrams per cubic meter). As explained in the Evaluating Exposures section (Section III.A.2.), regardless of the media being evaluated, MRLs are an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure. They have built-in uncertainty or safety factors, making them considerably lower than levels at which health effects have been observed. Estimated doses that are less than the MRL are not considered to be of health concern. More information about the development of ATSDR's MRLs can be found in Appendix A of the Uranium and Ionizing Radiation Toxicological Profiles at the following Web site: http://www.atsdr.cdc.gov/toxpro2.html#-T-. If the calculated exposure dose is higher than the MRL, it does not automatically mean harmful health effects will occur. Rather, this is an indication that ATSDR should further examine the harmful effect levels reported in the scientific literature and more fully review exposure potential. In this "decision-making" step, ATSDR conducts a weight-of-evidence analysis to evaluate the public health implications. ATSDR uses the best medical and toxicologic information available to determine the health effects that may result from exposure to contaminants at a site (such as LOAELs [lowest observed adverse effect levels] and NOAELs [no observed adverse effect levels]). Such information is usually derived from ATSDR's chemical-specific Toxicological Profiles (available at the following Web site: http://www.atsdr.cdc.gov/toxpro2.html#-T-). The step in which the various uranium scenarios were screened out (as safe) dictates the guideline and units that are presented during the health evaluation. For example, as shown in Figure 27, the average uranium air concentrations for current chemical exposure were well below the MRL (appropriately given as a concentration). Therefore, no further evaluation was required and ATSDR did not calculate exposure doses. Even though the air concentrations can be converted into a dose, it is an unnecessary step. An interactive program that provides an overview of the public health assessment process ATSDR uses to evaluate whether people will be harmed by hazardous materials is available at: http://www.atsdr.cdc.gov/training/public-health-assessment-overview/html/index.html. The text on the public health assessment process has been clarified in the final PHA to assist in understanding the two levels of screening and a weight-of-evidence "decision-making" evaluation.

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	Brief. The various criteria discussed above should be identified by labels in Fig.9, or in another figure, and then these terms should be used in the brief only in strict accordance with their definitions. By so doing, the correct criteria for judging safety will be more evident and understandable.	
55	**[ATSDR staff]** further explained that, in the case of some but not all contaminates, relationships between external concentrations and internal doses do exist. From the viewpoint of the public, I believe that it would be desirable to use these relationships, if they exist, in order to create links that are as direct as possible between the quantities being discussed and their effects on human health. If such relationships do not exist, then at the least, a statement that correlations between external concentrations and health effects do exist, but relationships between external concentrations and internal doses don't, would be a helpful and clarifying addition to the brief. In the case of uranium, Section 8 of the Summary Report for the Oak Ridge Dose Reconstruction Project indicates that biokinetic models do exist by which environmental concentrations of uranium can be used to estimate body burdens of that element.	ATSDR will consider your suggestion.
56	In your discussion of chemical toxicity, you did not include the RfD of 0.6 micrograms per kg per day for uranium used in the Radionuclides in Drinking Water Final Regulation. See below: It should also be noted that ATSDR references an oral MRL of 2 micrograms of uranium per kilogram of body weight per day, a 1989 EPA RfD for uranium of 3.0 micrograms of uranium per kilogram of body weight per day. It also references a LOAEL of 0.05 milligrams per kilogram of body weight per day. These are both based on animal studies alone. In 1998, EPA sponsored a workshop in Washington, DC, attended by an ATSDR representative, among others. Based on data developed at this workshop, EPA used an RfD of 0.6 micrograms of uranium per kilogram of body weight per day in its Drinking Water Regulations (Part II Environmental Protection Agency, $0 CFR Parts 9, 141,and 142, National Primary Drinking Water Regulations: Radionuclides; Final Rule. Federal Register, Vol. 65 No. 236, pp. 76708-76753; Government Printing Office, Washington, DC; December 7, 2000.) This decision was supported by data from studies of two limited Canadian populations presented at the workshop. A more recent Finnish study of a larger population confirmed that uranium intake in water does have effects at these low exposure levels. (Kurttio, P., et al. Renal Effects of Uranium in Drinking Water, Environmental Health Perspectives, 110: 337-342, 2002). Kurttio, et al.	Scarboro uranium exposures are safe. As explained in several places in the PHA (see pages 71, 86, and 95), East Fork Poplar Creek (EFPC) is not used as a drinking water source. The city of Oak Ridge, including Scarboro, is served by municipal water, which must meet specific drinking water quality standards set by EPA. Under the authorization of the Safe Drinking Water Act, EPA has set national health-based standards to protect drinking water and its sources. Regardless of the fact that EFPC is not used as a drinking water source, the total uranium mean concentrations in surface water from Scarboro ditches and Lower EFPC are below EPA's maximum contaminant level (MCL) for uranium (30 µg/L). In addition, Table 16 shows that the mean total uranium concentrations for surface water samples collected from Scarboro ditches and Lower EFPC are below ATSDR's EMEG of 20 µg/L. Therefore, the concentrations of uranium that people might be exposed to are not of health concern. As explained in the response to comment 54, comparing the concentration of uranium detected in the water to the EMEG is the first level of the screening process. EMEGs reflect concentrations that are much lower than those that have been observed to cause adverse health effects and are protective of public health in essentially all exposure situations. As a result, concentrations detected at or below this concentration are not considered to warrant health concern. Therefore, because the concentrations were below the environmental guideline, the levels are considered safe. No further analysis is warranted (i.e., no doses need to be calculated and compared to the reference dose

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	Also reported a "....lack of an obvious threshold for the nephrotoxic effect and possible heterogeneity of effect within populations,...." This suggests a greater need for caution on the question of chemical toxicity than is evidenced in ATSDR's analysis. Scarboro Uranium exposures are not necessarily safe.	[RfD] or MRL). As is the case with ATSDR's MRLs, EPA's RfDs (Reference Dose: an EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans; see Appendix A) are screening values that represent an exposure dose considerably lower than levels at which health effects have been observed. If the calculated exposure dose is higher than the MRL or RfD, it does not automatically mean harmful health effects will occur. Rather, this is an indication that ATSDR should further examine the harmful effect levels reported in the scientific literature and more fully review exposure potential (see response to comment 54 for additional details). This is exactly what ATSDR did for past exposures to uranium through ingestion of soil and surface water (see the Past Exposure via Ingestion discussion under the Past Chemical Effects discussion (Section III.B.1.b.)). The following discusses the basis for EPA's and ATSDR's health guidelines mentioned by the commenter: • The RfD of 0.6 µg/kg/day (0.0006 mg/kg/day) is based on a LOAEL of 0.06 mg/kg/day in rats and LOAELs of 0.02 to 0.1 mg/kg/day in humans (Federal Register 2000). EPA applied an uncertainty factor of 100 (3 for intraspecies variability, 10 for interspecies variability, and 3 for use of a LOAEL) to estimate the RfD. • EPA's RfD according to the Integrated Risk Information System (IRIS) is 0.003 mg/kg/day based on a LOAEL of 2.8 mg/kg/day in rabbits, rats, and dogs (EPA 1989). An uncertainty factor of 1,000 was applied to the LOAEL to reflect 10 for both intraspecies and interspecies variability to the toxicity of the chemical in lieu of specific data and 10 for use with a LOAEL from an animal study. • As discussed on page 63, ATSDR's MRL (0.002 mg/kg/day) is based on a LOAEL of 0.05 mg/kg/day in rabbits (ATSDR 1999a). An uncertainty factor of 30 (3 for use of a minimal LOAEL and 10 for human variability) was applied to the LOAEL to derive the MRL. As mentioned in the response to comment 156, MRLs undergo a rigorous review process. All of the health effects levels (LOAELs) cited by EPA and ATSDR as the most appropriate for deriving their health guidance (RfDs and MRL) are higher than the doses calculated for past ingestion of uranium through the soil and surface water pathways (see Table 13 and Figure 20). Given the conservative nature of these estimates, ATSDR still concludes that Scarboro uranium levels were also safe in the

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		past.
Discussion of Health Outcome Data		
57	The report also neglects to explain why the Oak Ridge population remained constant in the 1960-2000 time frame, while the footprint of Oak Ridge Hospital zone quadrupled in size. The report neglects to tell the growth of the number of medical professionals in Oak Ridge, which would directly relate to the change in health impact on the region. My comments to make a proper report would be to provide with the population statistics of Oak Ridge, the same year to year data on the number of type of medical practitioners at Oak Ridge's Hospital and medical complex.	There are many factors relating to the number of medical professionals in a community. ATSDR does not believe there is a correlation between the number of medical professionals and health impacts on the region. As the 1960 Oak Ridge Hospital developed into the 2003 Methodist Medical Center, its drawing area has grown to include four rural counties to the northwest and its services have expanded into several spatiality areas. Any changes in health impacts due to these extensions are not related to the level of uranium in the environment.
58	The report also neglects news articles, which I saw in the mid-80's, that showed three times the death rates for specific illnesses at the Oak Ridge's Hospital compared to ones in Knoxville.	Based on a recommendation by the ORRHES, ATSDR is currently conducting a cancer incidence review for the eight counties surrounding the ORR. In Appendix B of the PHA, ATSDR summarizes two health statistics reviews conducted by the Tennessee Department of Health (TDOH): • In 1992, the TDOH conducted a health statistics review to compare the cancer incidence rates (during the period of 1988 to 1990) of counties surrounding the ORR to those from the rest of the state. Findings of the review are in a TDOH memorandum dated October 19, 1992, from Mary Layne Van Cleave to Dr. Mary Yarbrough. • In 1994, TDOH (in consultation with Peru Thapa, MD, MPH, from the Vanderbilt University School of Medicine) conducted a health statistics review of mortality rates for amyotrophic lateral sclerosis (ALS), multiple sclerosis (MS), and other selected health outcomes. The results of the review were reported by the TDOH at the ORHASP public meeting on August 18, 1994. It should be noted that the Methodist Medical Center draws from areas that are far removed from the ORR (see response to comment 58).
59	A large part of the reason for ATSDR to become involved in Oak Ridge was due to the exposure of the community of Scarboro in the Tennessean newspaper and the rates of illness in children, particularly asthma.	**ATSDR's Involvement at the ORR** ATSDR is involved with the ORR because it is listed on EPA's National Priorities List (NPL). Since 1986, ATSDR has been required by law to conduct a PHA at each of the sites on the NPL (as noted on page i of Foreword of the PHA). Additionally, ATSDR embraces the philosophy that community involvement is a key component of the public health assessment process.

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		Since the community members have a high interest and concern regarding health issues at the ORR, ATSDR and the Centers for Disease Control and Prevention (CDC) established ORRHES in 1999 to provide a forum for communication and collaboration between citizens and the agencies that are evaluating public health issues and conducting public health activities at the ORR. ATSDR's community involvement activities promote collaboration between ATSDR scientists, community members, and other agencies. These activities also provide opportunities for community members to have a role in ATSDR's public health assessment process. Figures 4 and 5 in the PHA depict the process whereby the ORRHES, the PHAWG, and the public participate and provide input into the ATSDR public health assessment process. Also, responding to community health concerns is an essential part of ATSDR's overall mission and commitment to public health. ATSDR actively gathers comments and other information from the people who live near the ORR and will be addressing these community health concerns in the ORR PHAs that are related to those concerns (see the Section VI of the PHA and response to comment 4 for more information about ATSDR's Community Health Concerns Database and ATSDR's response to community concern). **Scarboro Community Health Investigation** In response to a 1997 newspaper article describing the respiratory illness among children in Scarboro, the CDC and Tennessee Department of Health conducted the Scarboro Community Health Investigation. In Section II.F.3 of the PHA, ATSDR summarizes the Scarboro health investigation conducted in 1998 (by the CDC, TDOH, the Oak Ridge medical community, and the Morehouse School of Medicine) to investigate a reported excess of respiratory illness among children in the Scarboro community. Physical examinations were conducted and did not indicate any unusual pattern of illness among children in Scarboro. The illnesses that were detected were not more severe than would be expected and were typical of those that might be found in any community. The findings of examinations essentially confirmed the results of the community health survey. The newspaper allegations were not borne out by the Scarboro health investigation. In addition, the asthma rate among children in Scarboro was compared to national estimates among all children aged 0–18 years and among African American children aged 0–18 years. The wheezing rate among children in Scarboro was compared to international estimates.

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60	The news was largely connected to a Dr. Bill Reid, who saw elevated immune system parameters in Oak Ridge, and his wife Sandra that made these issues public. The plants have long polluted and damaged the workers health and the medical care for these workers awry with medical misdiagnosis and avoiding measurement of immune system parameters. It would then appear proper to look at the immune system effects and mechanisms in any health assessment.	In Appendix B, ATSDR summarizes the clinical laboratory analysis and review that were conducted in 1992 and 1993 by ATSDR and the National Center for Environmental Health (NCEH) in response to concerns raised by an Oak Ridge physician. ATSDR concluded that this case series did not provide sufficient evidence to associate low levels of metals with these diseases. The TDOH came to the same conclusion. Additionally, as summarized in Appendix B, the TDOH conducted two health statistics reviews (in 1992 and 1994) of cancer incidence rates for the period between 1988 and 1990. The review covered the counties surrounding the ORR and examined mortality rates for amyotrophic lateral sclerosis (ALS), multiple sclerosis (MS), and other selected health outcomes (see the response to comment 58).
61	My comments to make a proper report would be to…discuss that metals are connected to damage to the immune system that lead to varied pathogen presence in the body that add to health effects. The discussion of the cytokine factors in lung related illness is required for proper reporting. It is well established that fine particulates and chemicals set off lung immune factors and any additional environmental factors can trigger these effects to stronger degrees. In the community of Scarboro, this effect stems partially from uranium emissions. The uranium emissions stem from Y-12's uranium processing, the Y-12 coal plant, the K-25 plant, and the two large TVA coal plants used to power these DOE facilities. All these emissions are cause for concern and any single source additional exposures from Y-12 only exasperate these problems.	The following information was obtained from the Toxicological Profile for Uranium: "Animal studies in a number of species and using a variety of compounds confirm that uranium is a nephrotoxin… The kidneys have been identified as the most sensitive target of uranium toxicosis, consistent with the metallotoxic action of a heavy metal… All of the MRLs derived for uranium are based on renal effects, the most sensitive toxic end point" (ATSDR 1999a). "Although no studies were located that specifically tested immunological effects in humans following inhalation exposure to uranium, all epidemiologic studies of workers in uranium mines and fuel fabrication plants showed no increased incidence of death due to diseases of the immune system (Brown and Bloom 1987; Checkoway et al. 1988; Keane and Polednak 1983; Polednak and Frome 1981). Human studies that assessed damage to cellular immune components following inhalation exposure to uranium found no clear evidence of an immunotoxic potential for uranium. No association was found between the uranium exposure and the development of abnormal leukocytes in workers employed for 12–18 years at a nuclear fuels production facility (Cragle et al. 1988)… There is some evidence from animal studies that exposure to $\geq$90% enriched uranium may affect the immune system. Adverse effects reported from such exposures include damage to the interstitium of the lungs (fibrosis) and cardiovascular abnormalities (friable vessels). However, access to U 235 enriched or other high specific-activity uranium is strictly regulated by the NRC and the U.S. Department of Energy (DOE). Therefore, the potential for human exposure to this level of radioactivity is limited to rare accidental releases in the workplace… No information was located regarding the effects of uranium on the immune system in humans following oral exposure for any duration. In laboratory animals, oral exposure of rats, mice, and rabbits to uranium had no significant effect on immune system function" (ATSDR 1999a).

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		"Human and animal studies have shown that long-term retention in the lungs of large quantities of inhaled insoluble uranium particles (e.g., carnotite dust [4% uranium as uranium dioxide and triuranium octaoxide, 80–90% quartz, and <10% feldspar]) can lead to serious respiratory effects. However, animals exposed to high doses of purified uranium (as uranyl nitrate hexahydrate, uranium tetrachloride, uranium dioxide, uranium trioxide, uranium tetraoxide, uranium fluoride, or uranium acetate) through the inhalation or oral route in acute-, intermediate-, or chronic-duration exposures failed to develop these respiratory ailments. The lack of significant pulmonary injury in animal studies with insoluble compounds indicates that other factors, such as diverse inorganic particle abrasion or chemical reactions, may contribute to these effects" (ATSDR 1999a). Please also see the responses to comments 58 through 60.
62	The discussion for uranium should also go on to discuss lung retention and migration of uranium into the lymph nodes and also mentionable that uranium oxides retain in the sentinel lymph nodes for decades. The lymph nodes are the sensing zones of the immune system. It is here type 1 cytokine secretory cells, like stationery macrophages, are situated. It is not only that uranium that is pulled into these lymph nodes, it is a plethora of particles and chemicals that cause synergism to trigger inflammatory cytokine's of these immune cells. Failure to discuss this mechanism is scientific malpractice for health assessment. It is also scientific fraud and abuse. My comments to make a proper report would be to…include the information on the lymph node processes for uranium migration that directly relates to the immunity activation related illness in Scarboro and Oak Ridge town.	The following information was obtained from the Toxicological Profile for Uranium: "Once in the blood, uranium is distributed to the organs of the body. Uranium in body fluids generally exists as the uranyl ion (UO2)2+ complexed with anions such as citrate and bicarbonate. Approximately 67% of uranium in the blood is filtered in the kidneys and leaves the body in urine within 24 hours; the remainder distributes to tissues. Uranium preferentially distributes to bone, liver, and kidney. Half-times for retention of uranium are estimated to be 11 days in bone and 2–6 days in the kidney… [However,] the less soluble uranium particles may remain in the lungs and in the regional lymph nodes for weeks (uranium trioxide, uranium tetrafluoride, uranium tetrachloride) to years (uranium dioxide, triuranium octaoxide)… The human body burden of uranium is approximately 90 µg; it is estimated that 66% of this total is in the skeleton, 16% in the liver, 8% in the kidneys, and 10% in other tissues. The large majority of [ingested] uranium (>95%) that enters the body is not absorbed and is eliminated from the body via the feces. Excretion of absorbed uranium is mainly via the kidney." Please also see the responses to comments 58 through 61.
63	It would be a lie for ATSDR to claim there is "no" health concern for uranium from Y-12, as differential amounts can trigger immunity cytokine lung damage factors. My comments to make a proper report would be to…remove the comments that uranium causes "no" health effects.	In the Conclusion section (Section VIII.) of the PHA, ATSDR concluded that the levels of uranium released from the Y-12 plant in the past and currently would not result in harmful health effects for either adults or children living near the Y-12 plant, including the city of Oak Ridge and the Scarboro community. ATSDR has categorized this site as having *no apparent public health hazard* from exposure to uranium. ATSDR's category of no apparent public health hazard means that people could be or

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		were exposed, but the level of exposure would not likely result in adverse health effects. The Y-12 uranium releases are not a health hazard to the people living near the Y-12 plant.
64	It would be proper report technique to discuss the mechanisms for why asthma occurs in children and related occupation asthma information. This would mean that the report should discuss the effects of particulate's and chemical's, like HF, and how these deposit in the lungs and trigger immune system cytokine's and long term inflammation.	In Section II.F.3, ATSDR summarizes the Scarboro community health investigation conducted in 1998 (by the CDC, TDOH, the Oak Ridge medical community, and the Morehouse School of Medicine) to investigate a reported excess of respiratory illness among children in the Scarboro community. Physical examinations were conducted and did not indicate any unusual pattern of illness among children in Scarboro. The illnesses that were detected were not more severe than would be expected and were typical of those that might be found in any community. The findings of examinations essentially confirmed the results of the community health survey. As mentioned several times (e.g., pages 2 and 31), this PHA evaluates community health concerns and issues associated with the uranium releases from the Y-12 plant. The release and exposure to other contaminants of concern (such as mercury, iodine-131, PCBs, uranium from the K-25 facility, and fluorides) are not addressed in this document. These contaminants and other topics will be evaluated by ATSDR in separate PHAs.
65	The report also fails to mention that the State of Tennessee, in looking at the asthma rates, compared Scarboro to large polluted cities asthma rates.	As discussed in Section II.F. of the PHA, the asthma rate among children in Scarboro was compared to national estimates among all children aged 0–18 years and among African American children aged 0–18 years. The wheezing rate among children in Scarboro was compared to international estimates.
66	This has not even been mentioned in your sub-standard report that fails to follow standards and practice and standards of care for proper health assessment. Such an omission should be termed fraud and abuse.	ATSDR is required by law to conduct a PHA at the ORR because it is listed on the NPL. In 1980, the U.S. Congress created ATSDR to implement the health-related sections of the laws that protect the public from hazardous waste and environmental spills of hazardous substances. The Comprehensive Environmental Remediation, Compensation, and Liability (CERCLA), commonly known as the "Superfund" Act, provided a congressional mandate to clean up abandoned and inactive hazardous waste sites and to provide federal assistance in emergencies involving toxic substances. As the lead public health agency for implementing the health-related provisions of CERCLA, ATSDR is charged under the Superfund Act to assess the presence and nature of health hazards at specific Superfund sites, help reduce or prevent further exposure, and expand the knowledge base about health effects related to exposure to hazardous substances (as noted in the response to community concern #9). The procedures and evaluations conducted by ATSDR follow the guidelines set forth

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		in the Public Health Assessment Guidance Manual (available at the following Web site: http://www.atsdr.cdc.gov/HAC/HAGM/). The manual is a guidance document for health assessors both at ATSDR and in the states. It outlines the health assessment process and provides information to the health assessors on different technical and scientific aspects of performing PHAs. An interactive program that provides an overview of the public health assessment process ATSDR uses to evaluate whether people will be harmed by hazardous materials is available at: http://www.atsdr.cdc.gov/training/public-health-assessment-overview/html/index.html. Toxicological profiles are ATSDR documents that examine, summarize, and interpret information about a hazardous substance to determine harmful levels of exposure and associated health effects. ATSDR relied on the information presented in the Toxicological Profiles for Uranium (ATSDR 1999a) and Ionizing Radiation (ATSDR 1999b). Every toxicological profile is prepared in accordance with guidelines developed by ATSDR and EPA, is released for public comment, and undergoes a rigorous review process (Health Effects/MRL Workgroup reviews within the Division of Toxicology, expert panel peer reviews, and agency-wide MRL Workgroup reviews, with participation from other federal agencies, such as the EPA, and comments from the public).
67	I would recommend that ATSDR postpone making formal conclusions about the public health significance of atmospheric releases of uranium from the Y-12 facility at Oak Ridge without first considering the magnitude and uncertainty of the absorbed organ dose, as a function of year and age at time of exposure.	ATSDR did calculate organ-specific doses, when appropriate. Please see Table 15 and Table 19 for estimated doses to the lung and bone.
68	I would recommend that ATSDR postpone making formal conclusions about the public health significance of atmospheric releases of uranium from the Y-12 facility at Oak Ridge without first considering the magnitude and uncertainty associated with the conversion of organ dose to cancer and non-cancer health risk, including uncertainty in the tissue and radiation weighting factors, and the uncertainty in the low dose and low dose rate effectiveness factor for high LET radiation.	As we have previously stated, the Task 6 report was a screening evaluation that routinely and appropriately used several layers of conservatism and protective assumptions and approaches in estimating concentrations and doses. These estimated concentrations and doses are at a magnitude where we believe a quantitative uncertainty analysis is not warranted. For additional information on uncertainty analysis see ATSDR's response to comment 81.
69	The issues of metal oxides entering the body happens for multiple metals in Oak Ridge and examples are uranium from the DOE processes and from coal emissions, mercury from Y-12 Li-6 enrichment and coal emissions, and even beryllium metals from Y-12. Metal oxides cause problems because of their long internalization time in lymph nodes due to their insolubility.	ATSDR agrees that "less soluble uranium particles may remain in the lungs and in the regional lymph nodes for weeks (uranium trioxide, uranium tetrafluoride, uranium tetrachloride) to years (uranium dioxide, triuranium octaoxide)" (ATSDR 1999a). However, "animal studies in a number of species and using a variety of compounds confirm that uranium is a nephrotoxin… The kidneys have been identified as the most sensitive target of uranium toxicosis, consistent with the metallotoxic action of a

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		heavy metal… [and] all of the MRLs derived for uranium are based on renal effects, the most sensitive toxic end point" (ATSDR 1999a).
70	The long internalization effects also occur from fluoride'' exposures, which tend to form calcium-fluoride in the body and like long term internalization, similar to insoluble metal oxides. Fluorides exposure stem for the uranium processes at Y-12, K-25, the emissions from TVA's power plants, fluoridated public water, and rising levels in the food chain. My comments to make a proper report would be to…discuss the fluorides effects on increasing the metals and uranium retention due to reduction of macrophage activity that helps clear these metals. Discuss the effects of fluorides on the parathyroid gland, which change calcium and metal retention. The effects of metals and fluorides on cell mitochondria. Include the synergism effects of uranium with other metals and fluorides. Oak Ridge is known for thyroid damage connected to fluorides. Fluorides also causes higher retention of toxic metals, like uranium, due to damage to the macrophage processes. The report fails to mention these effects, and the fluoride synergism with uranium is a very serious oversight. The ATSDR report also makes use of the ORHASP panel studies, which also have a number of flaws. ORHASP has tried to loose the long term and extreme releases of UF-6 from the K-25 gas diffusion plant. These UF-6 releases add to the local uranium levels and the chemical exposure to HF and fluorides. Fluorides add to the thyroid damage factors, in addition to the multiple I-131 releases in the area. The K-25 analysis has yet to release the mass balance numbers for fluorides and uranium releases that not only damaged health, but the trees in the area.	As mentioned several times (e.g., pages 2 and 31), this PHA evaluates community health concerns and issues associated with the uranium releases from the Y-12 plant. The release and exposure to other contaminants of concern are not addressed in this document. Exposure to fluorides and uranium released from the K-25 facility and iodine-131 released from the X-10 site will be evaluated by ATSDR in separate PHAs. ATSDR scientists will also conduct PHAs on the following releases and issues: Y-12 releases of mercury, X-10 release of radionuclides from White Oak Creek, PCBs released from all three facilities, releases from the TSCA incinerator, and off-site groundwater. ATSDR is also screening current (1990 to 2003) environmental data to determine whether additional chemicals will require further evaluation.
71	The discussion of Y-12 uranium releases should also mention all the other sources for uranium emissions in the area.	As mentioned several times (e.g., pages 2 and 31), this PHA evaluates community health concerns and issues associated with the uranium releases from the Y-12 plant. As mentioned on pages 68 and 82 of the PHA, "fossil fuel plants, such as coal burning plants, release naturally occurring radioactive materials through their stacks. Because the Bull Run and Kingston Steam Plants are in the vicinity of Oak Ridge, these facilities could be impacting the uranium analyses performed in Oak Ridge. ATSDR could not locate specific information about these plants from the Tennessee Valley Authority. The agency did, however, locate information from a peer-reviewed publication that reported the typical concentrations of uranium in coal ash and fly ash. These values were 4 picocuries per gram (pCi/g) and 5.4 pCi/g, respectively (Stranden 1985)."

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		Exposure to uranium released from the K-25 facility will be evaluated by ATSDR in a separate PHA.
72	The uranium emissions are metal oxides and the toxic metal effects would dominate.	ATSDR agrees "natural and depleted uranium are only weakly radioactive and are not likely to cause cancer from their radiation…animal studies in a number of species and using a variety of compounds confirm that uranium is a nephrotoxin and that the most sensitive organ is the kidney… The chance of getting cancer is greater if you are exposed to enriched uranium, because it is more radioactive than natural uranium… Enriched uranium is considered to be more of a radiological than a chemical hazard" (ATSDR 1999a).
73	The ATSDR report mentions the TSCA incinerator's uranium emissions, but fails to mention the incinerator burns unary-fluorides to de-water them and in the 1994 time frame they burned some 5 million pounds of uranium. The incinerator emitted uranium, fluorides, and HF and in this same time frame all the downwind pine trees of in the incinerator died. The plant tried to field it was pine beetles, but when I pointed out to the DNFSB that this was fraud, these signs cam down quickly. Even Y-12 has reduced its HF emissions by changing the Y-12 salt shop or the HF uranium processing zone to total air scrubbing to reduce HF emissions that damage the workers, Scarboro and Oak Ridge health.	As mentioned several times (e.g., pages 2 and 31), this PHA evaluates community health concerns and issues associated with the uranium releases from the Y-12 plant. A separate PHA will be conducted to evaluate releases from the TSCA incinerator. ATSDR scientists will also conduct PHAs on the following releases and issues: Y-12 releases of mercury, X-10 release of iodine-131, X-10 release of radionuclides from White Oak Creek, K-25 releases of uranium and fluoride, PCBs released from all three facilities, and off-site groundwater. ATSDR is also screening current (1990 to 2003) environmental data to determine whether additional chemicals will require further evaluation.
74	I would recommend that ATSDR postpone making formal conclusions about the public health significance of atmospheric releases of uranium from the Y-12 facility at Oak Ridge without first considering the magnitude and uncertainty of the cumulative exposure to other sources of radiation released from the Oak Ridge Reservation or deposited in the Oak Ridge region during the same period of time.	As mentioned several times (e.g., pages 2 and 31), this PHA evaluates community health concerns and issues associated with the uranium releases from the Y-12 plant. However, ATSDR noted on pages 68 and 82 that the fossil fuel plants (such as coal burning plants) could impact the uranium analyses performed in Oak Ridge. The uranium analysis of Scarboro soil sampling and the ORR air monitoring would have included all other possible sources of uranium in the Oak Ridge area. In addition, ATSDR scientists will also conduct PHAs on the following releases and issues: Y-12 releases of mercury, X-10 release of iodine-131, X-10 release of radionuclides from White Oak Creek, K-25 releases of uranium and fluoride, PCBs released from all three facilities, and off-site groundwater. ATSDR is also screening current (1990 to 2003) environmental data to determine whether additional chemicals will require further evaluation. After all the individual assessments have been completed, ATSDR will evaluate cumulative exposures from significant sources of radiation at the ORR.
75	The document seriously underestimates the problems with releases and	As noted on page 49, the Task 6 team independently evaluated past Y-12 airborne

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	exposures at Oak Ridge, and indeed, does not even mention most of these problems. It needs to take account of the documented problems at U.S. nuclear facilities as detailed in US OTA 1991; US GAO 1998, 1999; US Congress 1994, 1998, 1999. Much of the document is at odds with these earlier reports, which are extraordinarily well documented. There are gaps in the uranium release estimates. The pertinent background information is that Y-12 has processed larger quantities of depleted uranium than enriched uranium under conditions that quite probably favored its release relative to enriched uranium. This makes any assumptions about the character of the release stream highly speculative. The document has not accounted for the environmental fate of the bulk of uranium released from Y-12.	uranium releases and generated release estimates much higher than those previously reported by DOE (see Figure 13 and Table 5). From pages 2-7 to 2-15, the Task 6 team describes how the Y-12 air release estimates were derived. As stated on page 2-12 in the Task 6 report, "To estimate releases for those periods for which monitoring data or reported releases were not found, Task 6 investigators used production data and release estimates for adjacent years. Production data for an unmonitored period was compared to production data for adjacent time periods for which release estimates were available. Release estimates for the unmonitored period were then calculated based on the differences in production data for the two time periods." They attributed the difference to DOE's use of incomplete sets of effluent monitoring data and release documents, along with their use of release estimates based on effluent monitoring data not adequately corrected to account for sampling biases (ChemRisk 1999). While the simultaneous release of depleted, normal, and enriched uranium makes the emission of specific isotopes difficult, it does not change the conclusion that the total effect was low. The total uranium release estimate calculated by the Task 6 team are over seven times higher than the release totals reported by DOE (ChemRisk 1999; see Figure 13). Some individual years are as much as 140 times higher than the original DOE estimates. The evaluation of past exposures is based on the higher Task 6 estimates.
76	The document has not accounted for the exposures of individuals and populations who are, as yet unidentified. I would recommend that ATSDR postpone making formal conclusions about the public health significance of atmospheric releases of uranium from the Y-12 facility at Oak Ridge without first considering the number of persons exposed.	The Scarboro community is used as a reference location because it represents an established community adjacent to the ORR where residents resided during the years of uranium releases. Consequently, if the Scarboro community—the population likely to have received the highest uranium exposures from the Y-12 plant—was not in the past and is not currently being exposed to harmful levels of uranium from the Y-12 plant, then other residents living near the Y-12 plant, including those within the city of Oak Ridge, are also not being exposed to harmful levels of uranium. As stated in the title, the Task 6 report was a "Screening Evaluation of Potential Off-Site Exposure." Since the screening evaluation, which contained conservative aspects (see list of conservative aspects of the screening evaluation on pages 48 and 92 of the PHA), resulted in a total past uranium dose below levels of health concern, ATSDR does not believe it is necessary to conduct further evaluation or identify the number of people exposed.
Discussion of Multiple Chemical and Pathway Exposures		
77	Will the dose from thorium releases also be estimated?	No. Thorium was evaluated during the Dose Reconstruction Feasibility Study, which was an initial screening that determined which chemicals required further evaluation (ChemRisk 1993b). In short, screening calculations were conducted to rank the

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		chemicals and radionuclides with respect to their potential to cause harmful health effects. Based on the ranking, four substances were identified as high priority chemicals for further study (radioactive iodine, radioactive cesium, mercury, and PCBs). Thorium was not identified as a high priority chemical for further study based on the relative magnitude of potential hazard. See the Oak Ridge Health Studies Phase I Reports on the Project-CD entitled, "The Oak Ridge Health Agreement Studies, Oak Ridge Dose Reconstruction."
78	A proper health assessment for a community close to Y-12, like Scarboro, [or for Oak Ridge] should mention all the sources of particulate's and chemicals that form long term insoluble particles in the body. The problems from Scarboro stem from the practice of emitting uranium oxide dusts and many other metal oxides dusts from not only Y-12, but the other DOE plants and the highly polluting TVA systems that power them. The burning of PCB cutting oils and DU at the Y-12 burn yard and the formation of uranium oxides and dioxin products also affected Scarboro. Toxic metals, fluorides, and dioxin are known to damage cell mitochondria.	In 1998 and 2001, FAMU and EPA Region IV, respectively, collected soil, sediment, and surface water samples from the Scarboro community (FAMU 1998; EPA 2003). All FAMU samples were analyzed for mercury, gross alpha/beta content, uranium, and gamma emitting radionuclides. About 10% of the FAMU samples were also analyzed for target compound list organics, target analyte list inorganics, strontium 90, uranium, thorium, and plutonium. All EPA Region IV samples were subjected to a full analytical scan, including inorganic metals, volatile organic compounds, semi-volatile organic compounds, radiochemicals, organochlorine pesticides, and PCBs. The EPA Region IV report concluded that "there is not an elevation of chemical, metal, or radionuclides above a regulatory health level of concern… the Scarboro community is not currently being exposed to substances from the Y-12 facility in quantities that pose an unreasonable risk to health or the environment… the Scarboro community is safe" (EPA 2003). ATSDR also evaluated the environmental sampling data in Scarboro (FAMU and EPA) and determined that none of the soil, sediment, or surface water samples collected from the Scarboro community contained chemicals at levels of health concern. As mentioned several times (e.g., pages 2 and 31), this PHA evaluates community health concerns and issues associated with the uranium releases from the Y-12 plant. The release and exposure to other contaminants of concern are not addressed in this document. ATSDR scientists will conduct additional PHAs on the following releases and issues: K-25 releases of fluorides and uranium, Y-12 releases of mercury, X-10 release of iodine-131, X-10 release of radionuclides from White Oak Creek, PCBs released from all three facilities, releases from the TSCA incinerator, and off-site groundwater. ATSDR is also screening current (1990 to 2003) environmental data to determine whether additional chemicals will require further evaluation.
79	ATSDR has not accounted for the total doses and risks from all pathways, bonined for all ages, and across all lifetimes. Its estimates are massively incomplete.	ATSDR evaluated past and current lifetime exposures to uranium through multiple pathways. The total past uranium dose across all media (see Tables 7, 9, and 10) is presented in Table 4 and discussed on pages 43–65. The current uranium dose from inhalation of the air, ingestion of soil, and ingestion of vegetables is summed in Table 14 and discussed on pages 66–87.

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Quantitative Risk Assessment and Uncertainty/Sensitivity Analyses		
80	The lack of a quantitative risk assessment associated in the PHA is another example of ATSDR's flat refusal to incorporate community concerns. In line with aforementioned observations about ATSDR selectively refusing to address multiple contaminants and risk assessment is the added fact that ATSDR selectively refused to incorporate neither a quantitative risk evaluation resulting from cumulative exposures to similar types of contaminants during similar time periods, nor has it carried out a quantitative uncertainty and sensitivity analysis, processes that have been integral to all previous dose reconstruction studies at DOE facilities. Once more these fall in contrast to release and risk analysis from weapons production e.g. the NCI-131 calculator that provides both dose and risk assessments for concerned individuals.	As explained in Section 2 of ATSDR's Public Health Assessment Guidance Manual (http://www.atsdr.cdc.gov/HAC/HAGM/) and in *A Citizen's Guide to Risk Assessments and Public Health Assessments at Contaminated Sites* (written jointly by ATSDR and EPA Region IV), there are deliberate differences between ATSDR's health assessments and EPA's risk assessments. The two agencies have distinct purposes that necessitate different goals for their assessments. An EPA risk assessment is used to support the selection of a remedial measure at a site. An ATSDR health assessment is a mechanism to provide the community with information on the public health implications of a specific site, identifying those populations for which further health actions or studies are needed. See the response to comment 127 for additional information distinguishing a risk assessment from a health assessment. Following the ATSDR Cancer Framework Policy, ATSDR does not perform risk assessments. The agency, however, does recognize the importance of EPA risk assessment and risk analysis to determine if levels of chemicals at hazardous waste sites pose an unacceptable risk as defined by regulatory standards and requirements and to help regulatory officials make decisions in support of cleanup strategies that will ensure overall protection of human health and the environment. ATSDR acknowledges that conservative safety margins are built into EPA risk assessments and that these assessments do not measure the actual health effects that hazardous chemicals at a site have on people. Current ATSDR policy does not allow for the use of risk coefficients in determining the impact on public health. The issue with applying a "quantitative" risk coefficient to any dose is that one can calculate any risk and this is "perceived" as a true value. As stated in the ATSDR Cancer Framework Policy, "this artificial appearance of precision can lead decision makers to rely heavily on numerical risk estimates. Although ATSDR recognizes the utility of numerical risk estimates in risk analysis, the Agency considers these estimates in the context of the variables and assumptions involved in their derivation and in the broader context of biomedical opinion, host factors, and actual exposure conditions." The agency acknowledges that, at present, no single generally applicable procedure for exposure assessment exists, and, therefore, exposures to carcinogens must be assessed on a case-by-case or context-specific basis. For additional information, please review the framework policy that can be found at http://www.atsdr.cdc.gov/cancer.html. Please see the response to comment 81 for a discussion about conducting uncertainty and sensitivity analyses.

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81	The document employs massively inadequate risk-assessment methodology, in large part because it is full of subjective guesses and estimates, employs no uncertainty analyses, and does no sensitivity analysis. All three failures are contrary to standard best risk-assessment practice and all three problems are specifically noted as ones to be avoided in the 1996 classic National Academy of Sciences document, <u>Science and Judgment in Risk Assessment</u>.	This issue of conducting an uncertainty analysis was raised by an ORRHES member at the April 22, 2003 meeting and addressed by ATSDR in a written response provided to ORRHES at the June 2, 2003 meeting. The following provides details from ATSDR's response: As discussed in the NCRP Commentary 14, *A Guide for Uncertainty Analysis in Dose and Risk Assessments Related To Environmental Contamination*, issued in 1996, if a conservatively based screening calculation is performed and this screening calculation indicates the risk is "clearly below regulatory or risk levels of concern," and the possible exposure is low, then a quantitative uncertainty analysis may not be necessary. By design, conservative screenings are "highly unlikely to underestimate the true dose or risk." This issue of uncertainty analyses and sensitivity analysis was evaluated by the Task 6 team, ATSDR's technical reviewers, and ATSDR scientists. As stated in the title, the Task 6 report was a "Screening Evaluation of Potential Off-Site Exposure," that routinely and appropriately used several layers of conservatism and protective assumptions and approaches in estimating concentrations and doses. Task 6 report states "some level of conservatism was maintained in the uranium concentration estimates used in Level II screening to ensure that hazards to a significant portion of the potentially exposed population were not underestimated" (page ES-9). Also, the Task 6 report states on page 2-13 that a level of conservatism was added by combining the uranium activity amounts for U 234 and U 235 and that this approach is considered reasonable for this screening assessment since the Task 6 estimates do not include a formal uncertainty analysis. On page D-3, the Task 6 authors state "although an uncertainty analysis of the Task 6 air source term was not within the scope of Task 6, experts interviewed during the project consider release estimates for enriched uranium to be suitable for the Task 6 screening assessment and are within an order of magnitude of actual releases" (ChemRisk 1999). The authors also state (on page 5-2) that based on the project team's experience in the Dose Reconstructions Feasibility Study and the Task 6 screening evaluation they identified areas they believe are significant contributors of the overall uncertainty of the results of the Task 6 screening evaluation. The authors state that "these areas should be examined if the evaluation of Oak Ridge uranium releases is to proceed beyond the conservative screening stage and on to nonconservative screening and possibly a stage of refined evaluation that would likely include uncertainty and sensitivity analyses to assist in the decision making process" (ChemRisk 1999). Also, the internationally recognized expert technical reviewers hired by ATSDR to review the Task 6 report pointed out that the report is somewhat lacking in uncertainty

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		and sensitivity analysis. However, "the estimates made in the report tend to be on the conservative side—one expects, therefore, that (when in error) the report would tend to *overestimate* the extent to which exposure to uranium is a problem in the Oak Ridge area. Further refinements to the study are likely to reveal that uranium exposures are actually *lower* than those currently estimated." Also, the technical reviewers stated the report is technically sound and applicable to decision-making (see page G-7 of the PHA). ATSDR scientists also identified other aspects of the Task 6 report that resulted in several additional layers of conservatism and protective assumptions and approaches (see list of conservative aspects of the screening evaluation on pages 48 and 92 of the PHA). Since the Task 6 screening evaluation of air, soil, and surface water pathways resulted in a total past uranium radiation CEDE (155 mrem over 70 years) well below (32 times less than) the ATSDR radiogenic cancer comparison value (5000 mrem over 70 years), ATSDR does not believe the evaluation of Y-12 uranium releases requires a further nonconservative screening or a refined evaluation with uncertainty and sensitivity analyses. In addition, the total past uranium radiation CEDE (155 mrem over 70 years) is also less than the average annual background radiation dose received by individuals living in Denver or the radiation dose an individual would receive during a computed tomography (CT) scan (1,000 mrem/scan) at a local hospital (see Figure 12). As shown in Table 15, ATSDR also calculated a radiological dose to the lung following the inhalation of uranium. This dose is not considered a dose of public health concern. Even using the conservative overestimated doses, people in the Scarboro community (as well as the Oak Ridge community) were not exposed to levels of uranium that are above levels of health concern. Additionally, the following is a list of conservative aspect of the screening evaluation that resulted in the overestimated doses. 1) The Task 6 report noted that the Y-12 uranium releases for some of the years may have been understated due to omission of some unmonitored release estimates. This would cause the empirical χ/Q values (used in the air dispersion model) to be overestimated and in turn would cause the air concentrations to be overestimated. 2) The majority of the total uranium radiation dose is attributed to frequently eating fish from the EFPC and eating vegetables grown in contaminated soil over several years. If a person did not regularly eat fish from the creek or homegrown

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		vegetables over a prolonged period of time (which is very probable), then that person's uranium dose would likely have been substantially lower than the estimated doses reported in this PHA. 3) According to ATSDR's regression analysis, the method that the Task 6 team used to estimate historical uranium air concentrations overestimated uranium 234/235 concentrations by as much as a factor of 5. Consequently, airborne uranium 234/235 doses based on this method were most likely overestimated. 4) In evaluating the soil exposure pathway, the Task 6 team used EFPC floodplain soil data to calculate doses instead of Scarboro soil. Actual measured uranium concentrations in Scarboro soil are much lower than the uranium concentrations in the floodplain soil. The estimated doses would be much lower if they were based on actual measured concentrations in Scarboro. As explained in Section 2 of ATSDR's Public Health Assessment Guidance Manual (http://www.atsdr.cdc.gov/HAC/HAGM/) and in *A Citizen's Guide to Risk Assessments and Public Health Assessments at Contaminated Sites* (written jointly by ATSDR and EPA Region IV), there are deliberate differences between ATSDR's health assessments and EPA's risk assessments. The two agencies have distinctly different purposes that necessitate different goals for their assessments. A risk assessment is used to support the selection of a remedial measure at a site. An ATSDR health assessment is a mechanism to provide the community with information on the public health implications of a specific site, identifying those populations for which further health actions or studies are needed. See the response to comment 127 for additional information distinguishing a risk assessment from a health assessment.
Data and Modeling		
82	The Summary should contain a paragraph listing the many types and sources of data that contribute to the estimation of uranium level around INCLUDING the sources that confirm the low levels by the absence of detection. (P8)	Thank you for the comment. The sources have been added to the summary in the final PHA.
83	ATSDR has not provided all the data sets used. The original EPA data is not included making verification very doubtful. (p84-88)	It is not ATSDR's policy to provide raw data from primary sources that are publicly available. But ATSDR does supply references to the data used; which is good technical practice. The past exposure evaluation primarily relied on data provided in the Task 6 report (ChemRisk 1999), which is available at the following Web site: http://www2.state.tn.us/health/CEDS/OakRidge/ORidge.html. The current exposure evaluation primarily relied on data supplied by OREIS, a

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		centralized, standardized, quality-assured, and configuration-controlled environmental data management system. It is a public data source available at the following Web site http://www-oreis.bechteljacobs.org/oreis/help/oreishome.html. ATSDR also supplemented the current exposure pathway with data from FAMU (1998) and EPA Region IV (2003). The FAMU data are available in OREIS. EPA Region IV's final report is available at the following Web site: http://www.epa.gov/Region4/waste/fedfac/doeorr.htm. All DOE sources are available at the DOE Information Center (475 Oak Ridge Turnpike, Oak Ridge TN 37830; phone: 865-241-4780; Web site: http://www.oakridge.doe.gov/info_cntr/index.html).
84	This entire section dwells on the EPA data and neglects the FAMU data which is more complete. (p84-88)	ATSDR focused the majority of the uranium enrichment evaluation using the EPA Region IV data because the FAMU data did not include isotopic analysis for U 234. The EPA Region IV and FAMU data did not differ significantly. However, the FAMU averages are included in Figures 24 and 25.
85	Please specify which modeling program(s) was used to estimate radiation exposure. Will the modeling program information be made available for review?	As mentioned in the PHA, ATSDR selected appropriate exposure parameters and values from EPA's *Exposure Factors Handbook* (EPA 1997). The equations used for the estimation of radiation exposure were those used in other types of assessments as well as those used in the Task 6 Report. ATSDR estimated the radiation **dose** and used the ICRP database of dose coefficients to estimate the CEDEs. The ICRP dose coefficients are copyrighted and can be obtained through many university and technical libraries. They are also available from the following Web site: http://www.icrp.org/.
86	The public comment section of the ATSDR uranium report includes some of my comments on Oak Ridge releases, but totally omits my comments on the fluorides effect on Oak Ridge and the principle health mechanism. This appears fraudulent in nature to omit a principle mechanism for uranium and metal oxides effects on the immune system. The principle mechanism, which I have told in public meetings and even the local newspaper, points out the migration of metals and fluorides into the lymph nodes. This triggering cytokine's that set off Th-1 type inflammation and in the long term, the leading to Th-2 mode and IL-10 dominated effects that shut down macrophage actions. Since I have made this very public and told **[ATSDR staff]** this directly, I can only assume he is intent on covering up the real health problems in Oak Ridge and needs to be removed from this project. It is inexcusable to not report this in the "Public Comment" section of the report.	As mentioned several times (e.g., pages 2 and 31), this PHA evaluates community health concerns and issues associated with the uranium releases from the Y-12 plant. Community concerns related to the release and exposures to other contaminants of concern are not addressed in this document. The commenter's community health concerns about fluorides will be addressed in a separate PHA that evaluates exposure to fluorides and uranium released from the K-25 facility. ATSDR scientists will conduct additional PHAs on the following releases and issues: Y-12 releases of mercury, X-10 release of iodine-131, X-10 release of radionuclides from White Oak Creek, PCBs released from all three facilities, releases from the TSCA incinerator, and off-site groundwater. ATSDR is also screening current (1990 to 2003) environmental data to determine whether additional chemicals will require further evaluation.

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87	Expand the response to indicate that fly overs have revealed the presence of relatively small amounts of contaminant, i.e., several Clinch River Cs137 hot spots at one half the action level by measurement, and Chattanooga shale outcrop on East Fork Ridge containing natural uranium. The method does more than detect large releases. (P128)	Thank you for the additional information, which has been added to the final PHA.
88	**[ATSDR staff]** and I also talked on June 5 about the potential value of writing a booklet to explain the various criteria being used for environmental protection and health assessments, and the deliberately chosen margins that exist between them. Such a booklet would be a valuable reference for people reading the PHA reports.	There are several ATSDR resources already available to the public that explain ATSDR's health assessment process: • An interactive program that provides an overview of the public health assessment process ATSDR uses to evaluate whether people will be harmed by hazardous materials is available at: http://www.atsdr.cdc.gov/training/public-health-assessment-overview/html/index.html. • ATSDR's Public Health Assessment Guidance Manual, which outlines the health assessment process, is available at: http://www.atsdr.cdc.gov/HAC/HAGM/). • Appendix A of ATSDR's chemical-specific Toxicological Profiles discuss the derivation of the each of the MRLs. These profiles are available at: http://www.atsdr.cdc.gov/toxpro2.html#-T-.
89	There is a wealth of valuable information contained in the appendices of the PHA, but the table of contents of the PHA does not list the titles of the appendices. This gives the impression that the appendices are not considered important (but they are) and that perhaps ATSDR would rather no have people to study them (which was probably not ATSDR's intent). It is therefore suggested that the appendices be listed in the table of contents, including the sub-parts of Appendix G.	A list of appendices, including their titles, is included on page vi.
90	While the Lower East Fork Poplar Creek was being remediated for mercury, sections were also remediated for uranium. This seems relevant to this report. (p. 14, lines 11 – 23)	Thank you for the additional information, which has been added to the final PHA.
91	The clean-up of Boneyard/Burnyard is complete with the waste buried in the EMWMF. (p. 14, lines 25 – 30)	Thank you for the additional information, which has been added to the final PHA.
92	Another former name for ETTP is the Oak Ridge Gaseous Diffusion Plant. (p. 15, line 11)	Thank you for the additional information, which has been added to the final PHA.
93	Uranium was also processed for use in commercial nuclear reactors. (p. 11, line 4)	Thank you for the additional information, which has been added to the final PHA.
94	It is not clear in this section that deer hunts are held on the Oak Ridge Reservation, in which case the deer are monitored for radiation prior to being released to the hunter. (p. 16, lines 13 – 17)	The text has been clarified in the final PHA.
95	What is the reference for the EPA CERCLA cleanup level of 15 mrem/yr?	EPA. 1997. *Establishment of Cleanup Levels for CERCLA Sites with Radioactive*

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		Contamination. Memorandum from Stephen Luftig, Director of the Office of Emergency and Remedial Response, and Larry Weinstock, Acting Director of the Office of Radiation and Indoor Air. August 22, 1997. OSWER No. 9200. 4-18.
96	The **[organization]** is a non-profit regional organization funded by the state of Tennessee and established to provide local government and citizen input into the environmental management, decision-making and operation of the DOE's Oak Ridge Reservation. The Board of Directors is composed of elected and appointed officials from the City of Oak Ridge and the seven counties surrounding and downstream of the ORR, and the chair of the Citizen's Advisory Panel. The **[organization]** is a stakeholder organization with up to 20 members with diverse backgrounds who represent the greater ORR region; the **[organization]** supports Board interests by reviewing and providing recommendations on DOE decisions and policies. The **[organization]** appreciates the opportunity to comment on ATSDR's PHA for Y-12 Uranium Releases.	You are welcome. ATSDR appreciates receiving comments from community members, civic organizations, and other government agencies interested in the public health activities at the ORR.
97	The charge of HHS and ATSDR is for public health protection and the piece-meal approach to a serious problem in Oak Ridge is not in the public's interest. ATSDR has a well established record of not implementing effective studies designed to get to the root of health problems and this current Y-12 uranium report and the techniques of **[ATSDR staff]** is one more prime example.	As noted in the response to comment 66, ATSDR is the lead public health agency for implementing the health-related provisions of CERCLA and is charged under the Superfund Act to assess the presence and nature of health hazards at specific Superfund sites, help reduce or prevent further exposure, and expand the knowledge base about health effects related to exposure to hazardous substances (as noted in the response to community concern #9). ATSDR scientists followed the guidance set forth in the Public Health Assessment Guidance Manual (available at the following Web site: http://www.atsdr.cdc.gov/HAC/HAGM/). The manual is a guidance document for health assessors both at ATSDR and in the states. It outlines the health assessment process and provides information to the health assessors on different technical and scientific aspects of performing PHAs. The Public Health Assessment Guidance Manual is the result of the combined efforts of ATSDR, Oak Ridge National Laboratory, and state health departments participating in the ATSDR Public Health Assessment Cooperative Agreement Program. The draft manual was made available for public comment through an announcement in the Federal Register and distributed to federal, state, and local entities, private consultants and corporations, and trade/professional organizations. ATSDR scientists will conduct additional PHAs on the following releases and issues: K-25 releases of fluorides and uranium, Y-12 releases of mercury, X-10 release of iodine-131, X-10 release of radionuclides from White Oak Creek, PCBs released from

	Public Comment	ATSDR's Response
		all three facilities, releases from the TSCA incinerator, and off-site groundwater. ATSDR is also screening current (1990 to 2003) environmental data to determine whether additional chemicals will require further evaluation. ATSDR decided to release each PHA as it is completed to be most responsive in addressing the community's concerns.
98	**[Organization]** believes this study is dangerously defective. **[Organization]** members desire only that the best science be imparted to such an important endeavor. At present we see no evidence of such by ATSDR.	As noted in the response to comment 97, this PHA follows guidance set forth by the Agency in the Public Health Assessment Guidance Manual. ATSDR is committed to updating the Public Health Assessment Guidance Manual as new technical information becomes available. The Agency welcomes comments from users of the manual. If there is a weakness in the methods and techniques employed during this PHA, please provide specific comments to the Agency, so that these issues can be addressed. In addition, the Y-12 Uranium Releases PHA underwent internal ATSDR review and an external peer review. All peer reviewers approved of the assessment and found no major flaws that would invalidate ATSDR conclusions and recommendations. In the words of one peer reviewer: "the assessment is very well done, clearly characterized and summarized. I could find no errors of fact of logic, nor were assumptions inappropriate or unrealistic."
99	We haven't found Osama, we haven't found Saddam, or his sons. We haven't found solid evidence of the weapons of mass destruction. And there does seem to be a search on for these men and weapons. But we also cannot find evidence that uranium releases from Y-12 caused health problems in the adjoining community, not now, not ever, according to the Agency for Toxic Substances and Disease Registry. None? Not ever? 5,920 claims have been filed for compensation due to radiation-induced cancers under the Energy Employees Occupational Illness Compensation Plan Act at Oak Ridge Operations alone. A large number were from Y-12. Are we supposed to assume that the "rad gremlins" know their place, and will not dare pass outside the plant's boundaries? With the proper spin on results of studies, the number may look low, but I find it irrational to qualitatively state that no harm at all has come to the community.	ATSDR's PHAs are evaluations of exposures to off-site populations. This PHA addresses community health concerns and issues associated with past and current uranium releases from the Y-12 plant. It is not an evaluation of people who were exposed while working on-site at the Y-12 plant. This responsibility is assigned to other agencies. ATSDR evaluated past and current off-site exposures to uranium contamination released from the Y-12 plant and found that the levels of uranium that people were exposed to (off-site) are not at levels expected to cause adverse radiation or chemical health effects. The conclusion of no apparent public health hazard for people living near the Y-12 plant is based on a conservative screening evaluation that did not underestimate the level of exposure (see list of conservative aspects on pages 48 and 92 of the PHA).
100	The document is seriously scientifically flawed in 3 major ways, as well as in 7 additional ways, and is an embarrassment to the U.S. government, to science, and to ATSDR. This document must be massively improved, prior to publication, or it will engender massive scientific criticism.	As noted in the response to comment 97, ATSDR scientists followed the guidance set forth in the Public Health Assessment Guidance Manual (available at the following Web site: http://www.atsdr.cdc.gov/HAC/HAGM/). The draft manual was made available for public comment through an announcement in the Federal Register and distributed to federal, state, and local entities, private consultants and corporations,

	Public Comment	ATSDR's Response
		and trade/professional organizations. On numerous occasions, the procedures and methods used in the PHA have been presented to the PHAWG and ORRHES, which include technical scientists from the Oak Ridge community. As noted in the response to comment 102, the PHAWG and ORRHES have provided many useful recommendations and discussions to ATSDR and their comments have been very helpful in improving the document. See Figure 5 for opportunities for the public to provide input into the ATSDR PHAs on the ORR. Additionally, the Y-12 Uranium Releases PHA underwent internal ATSDR review and an external peer review. All peer reviewers approved of the assessment and found no major flaws that would invalidate ATSDR conclusions and recommendations. In the words of one peer reviewer: "the assessment is very well done, clearly characterized and summarized. I could find no errors of fact of logic, nor were assumptions inappropriate or unrealistic." Throughout this process, ATSDR, ORRHES, and PHAWG have not identified a scientific flaw or technical challenge that would change our conclusions or warrant any further evaluation or study.
101	The ATSDR has failed in its radiation-dose calculations in the past, and I have carefully reviewed, line by line, at least two such examples of shoddy science. This appears to be the same.	ATSDR stands by the radiation dose calculations in this PHA. Without more specifics, ATSDR cannot respond further.

Note: The page, figure, and table numbers in the comments are in reference to the public comment release PHA (April 22, 2003). The page, figure, and table numbers in ATSDR's responses are in reference to the final PHA.

TABLE A
Units and Criteria IN the ORRHES Brief on Y-12
URANIUM RELEASES (PUBLIC COMMENT, 4/22/03)

Exposure	**Pathway**		**Units**	**Criterion**
Radiation	Past (P)		CEDE, 155 mrem In 70 years; (p. 1)	Radiogenic Cancer Comp. Value; 5000 (p.1, Fig 2)
	Current (C)		CEDE, 0.216 mrem In 70 years; (p. 3)	5000 (p.3)
Chemical (Combined)	Air	P C	mg/m^3 (p.2) mg/m^3 (p.3)	MRL, $8x10^3$, (Fig. 3) MRL, $8x10^3$, (Fig. 5)
	Soil	P C	mg/kg/day (p.2) mg/kg/day (p.4)	LOAEL (Fig. 4) MRL (Figs. 6&7)
	Water	P C	mg/kg/day (p.2) mg/L (p. 4)	LOAEL (Fig. 4) Env. Media Eval. Guide (p. 4)

ATSDR received the following comments from the U.S. Environmental Protection Agency (EPA) during the public comment period (April 22, 2003 to June 20, 2003) for the Y-12 Uranium Releases at the ORR PHA (April 2003). For comments that questioned the validity of statements made in the PHA, ATSDR verified or corrected the statements. The list of comments does not include editorial comments, such as word spelling or sentence syntax. Also attached are cover letters received from EPA regarding their comments.

	EPA Comment	ATSDR's Response
General Comments		
102	Overall, we believe that the current version of the *Public Health Assessment* (PHA) represents a substantial improvement over the initial draft released on December 31, 2002. In general, it is more readable, provides expanded discussions, and corrects previous numerical errors.	The Public Health Assessment Working Group (PHAWG) and Oak Ridge Health Effects Subcommittee (ORRHES) comments that ATSDR has received throughout the public health assessment process have been very helpful in improving the technical aspects and overall readability of the document.
103	EPA R4 concurs with the draft PHA conclusion that the available data does not indicate the presence of uranium releases that constitute concern for the Scarboro Community.	Even though ATSDR and EPA Region IV have distinct purposes that require different goals and processes for their assessments, the two agencies have both concluded that the releases of uranium from the Y-12 plant are not a public health hazard for the Scarboro Community (see the response to comment 127 for more details about the deliberate differences between ATSDR's public health assessment sand EPA's risk assessment).
Evaluation of Past Exposures		
104	At this time, we do not agree with ATSDR's final conclusions regarding past uranium exposures. Based on our review and evaluation of the PHA, we do not agree with ATSDR=s conclusions on past uranium exposures (pp. 138-139) that: "the levels of uranium released from the Y-12 plant in the past ... would not result in harmful health effects for either adults or children living near the Y-12 plant, including the city of Oak Ridge and the Scarboro community" (lines 6-8).	After reviewing and evaluating the public comments on the PHA, ATSDR made minor changes to the public health assessment report. However, ATSDR has not changed its conclusion that past and current off-site exposures to uranium released from the Y-12 pose no apparent public health hazard because the estimated doses are not at levels expected to cause adverse health effects. In addition, this particular comment by the EPA Office of Radiation and Indoor Air in Washington, DC contradicts EPA Region IV's overall conclusion on ATSDR's PHA. In the March 27, 2003 cover letter to ATSDR, EPA Region IV stated the following: "EPA concurs with the assessment's conclusion that the available data does not indicate the presence of uranium releases that constitute a past, current or future health threat for the Scarboro Community."

	EPA Comment	ATSDR's Response
105	We believe that ATSDR's assessment of past uranium exposures is incomplete and inadequate for several reasons. To support their conclusion, ATSDR should: (1) provide a range of exposures scenarios that includes reasonably maximally exposed individuals, along with the parameter values and equations used in the calculations; (2) calculate central estimates and confidence intervals for doses and risks, for each scenario, based on a quantitative uncertainty analysis; (3) verify and validate the empirical χ/Q model used to reconstruct historical uranium air concentrations for Scarboro; and (4) collect additional surface and subsurface soil samples in undisturbed areas in and around Scarboro and analyzed for isotopic uranium activity and mass concentration. For the assessment of past exposures, these samples are needed to develop a site-specific source term for the soil exposure pathways, validate the reconstructed air concentrations, and understand the depth profile and temporal migration pattern of uranium in soil.	ATSDR's responses to each of the four recommendations follow: (1) ATSDR used the results of the State of Tennessee's uranium screening evaluation in the Task 6 report to evaluate past uranium exposures to residents living near the Y-12 plant. The Task 6 screening evaluation used a two-tiered approach: a Level I assessment that focused on an individual with the highest potential for exposure to the releases (maximally exposed individual) and a Level II assessment on an average or more typically exposed individual. Task 6 states on pages ES-9 and 3-27 that "some conservatism was maintained in the uranium concentration estimates used in Level II screening to ensure that hazards to a significant portion of the potentially exposed population were not underestimated," and that the Level II screening "may be appropriately called a Refined Level I analysis" (ChemRisk 1999). See Tables 7, 9, and 10 in the PHA for the 20 human exposure routes evaluated in the Task 6 report. The equations and parameters that were used to calculate past uranium exposure doses are provided in the Task 6 report in Appendix J and Appendix K, respectively. In addition, the Task 6 report stated that "while other potentially exposed communities were considered in the selection process, the reference locations [Scarboro] represent residents who lived closest to the ORR facilities and would have received the highest exposures from past uranium releases… Scarboro is the most suitable for screening both a maximally and typically exposed individual" (ChemRisk 1999). (2) As stated in the title, the Task 6 report was a "Screening Evaluation of Potential Off-Site Exposure," that routinely and appropriately used several layers of conservatism and protective assumptions and approaches in estimating concentrations and doses (see ATSDR's response to recommendation 1 in comment 105 and the list of conservative aspects of the screening evaluation on pages 48 and 92 of the PHA). Task 6 states that "some level of conservatism was maintained in the uranium concentration estimates used in Level II screening to ensure that hazards to a significant portion of the potentially exposed population were not underestimated." Also, the internationally recognized expert technical reviewers hired by ATSDR to review the Task 6 report pointed out that "the estimates made in the report tend to be on the conservative side—one expects, therefore, that (when in error) the report would tend to *overestimate* the extent to which exposure to uranium is a problem in the Oak Ridge area. Further refinements to the study are likely to reveal that uranium exposures are actually *lower* than those currently estimated" (see page G-7 of the PHA).

	EPA Comment	ATSDR's Response
		Since the Task 6 screening evaluation resulted in overestimated total past uranium doses well below (32 times less than) the ATSDR radiogenic comparison value, ATSDR does not believe the evaluation of Y-12 uranium releases requires a further nonconservative screening or a refined evaluation with uncertainty and sensitivity analyses. As discussed in NCRP Commentary 14, A Guide *For Uncertainty Analysis In Dose And Risk Assessments Related To Environmental Contamination*, issued in 1996, if a conservatively based screening calculation is performed and this screening calculation indicates the risk is "clearly below regulatory or risk levels of concern," and the possible exposure is low, then a quantitative uncertainty analysis may not be necessary. By design, conservative screenings are "highly unlikely to underestimate the true dose or risk." Based on this document and the technical reviewers' comments, ATSDR agrees with the Task 6 authors that a quantitative uncertainty analysis is not needed for this portion of the Oak Ridge Dose Reconstruction Project. On page D-3, the Task 6 authors state "although an uncertainty analysis of the Task 6 air source term was not within the scope of Task 6, experts interviewed during the project consider release estimates for enriched uranium to be suitable for the Task 6 screening assessment and are within an order of magnitude of actual releases" (ChemRisk 1999). The response to comment 166 provides additional details about conducting uncertainty analyses. (3) The internationally recognized independent technical reviewers hired by ATSDR to review the Task 6 report evaluated the appropriateness of the empirical χ/Q model. They noted that this kind of calculation was appropriate for estimating past airborne uranium concentrations in Scarboro (see page G-8). Also, ATSDR evaluated the empirical χ/Q model used by the Task 6 team in Appendix E of the PHA. ATSDR believes the empirical χ/Q model is appropriate for screening because according to ATSDR's linear regression evaluation, the χ/Q model overestimates the likely annual average uranium air concentrations in Scarboro. In addition, Auxier & Associates, Inc. in a report dated November 1998, "Scarboro Community Sampling Results: Implications for Task 6 Environmental Projections and Assumptions," compared the results of the FAMU Scarboro sampling results with the deposition estimates based on the August 1998 Task 6

	EPA Comment	ATSDR's Response
		results (Prichard 1998). The Auxier report concluded that the Task 6 air pathway analysis is supported by the 1998 FAMU Scarboro soil data (Prichard 1998). The report stated that the agreement between deposition inferred from soil samples and deposition predicted on the basis of Task 6 air concentrations projections is well within the uncertainties of the parameters used in the calculations (Prichard 1998). The internationally recognized independent technical reviewers hired by ATSDR commented that the analysis and conclusions of the Auxier report are compelling. The Task 6 report also states on page 3-21 that the estimated air concentrations of uranium in Scarboro are likely to be overestimated. (4) In 1998 and 2001, FAMU and EPA Region IV, respectively, collected soil, sediment, and surface water samples in and around the Scarboro community (FAMU 1998; EPA 2003). Uranium isotopic content was conducted during both analyses. In addition, EPA Region IV collected uranium core samples from two locations in Scarboro. Also, as stated above in ATSDR's response to recommendation 2 in comment 105, ATSDR does not believe further nonconservative screening, refined evaluation, or additional sampling for uranium in Scarboro is warranted because the estimated total past and current uranium doses based on the Task 6 screening evaluation (which used several layers of conservative and protective assumptions and approaches) are well below doses expected to cause adverse health effects. In addition, page 19 of the EPA Region IV report states that EPA "does not propose to conduct any further environmental sampling in the Scarboro community." Page 26 of the same report states that "based on EPA's results, the Scarboro community is safe. Therefore, additional sampling to determine current exposure is not warranted" (EPA 2003). The PHA provides (on page 29) short summaries of the FAMU and EPA sampling. To expand the information presented, ATSDR added summary briefs of the EPA and FAMU reports in Appendix I of the final PHA. Also, as mentioned previously in ATSDR's response to recommendation #3 in comment 105, the Auxier report concluded that the Task 6 air pathway analysis is supported by the 1998 FAMU Scarboro soil data. The report stated that the agreement between deposition inferred from soil samples and deposition predicted on the basis of Task 6 air concentrations projections is well within the uncertainties of the parameters used in the calculations.

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		The PHA is the primary public health process ATSDR uses to evaluate the public health implications of people's exposure to environmental contaminants nearby communities. The purpose of the public health assessment process is to find out whether people have been exposed or are being exposed to hazardous substances and, if so, whether that exposure is harmful, or potentially harmful, and should therefore be stopped or reduced. ATSDR used the current data collected by EPA Region IV and FAMU to evaluate the public health implications of current exposure, not to validate the past screening dose reconstruction conducted by the State of Tennessee.
106	Based on our review and evaluation of the PHA, we do no agree with ATSDR's conclusions on past uranium exposures (pp. 138-139) that: "Despite several conservative parameters, exposure to uranium through both inhalation and ingestion pathways would result in doses below levels of health concern for radiation and chemical health effects" (lines 16-18). To the contrary, we believe that the parameter values used and the exposure pathways evaluated in the assessment of past exposures are not overly conservative, and that the doses and risks from historical exposures *may have* exceeded relevant radiation protection dose limits and EPA's accepted risk range.	ATSDR acknowledges that the use of the term "parameters" is misleading, in that it seems to refer to the specific parameter values used by the Task 6 team to calculate the past exposure doses. The word "aspects" was substituted in the final release of the PHA, to encompass a broader meaning for the conservative and protective features of the past evaluation, which are described on pages 48 and 92. ATSDR also acknowledges that the use of the term "overly" is misleading, in that it seems to imply that the conservative assumptions and approaches which led to an overestimation of concentrations and doses in Task 6 are inappropriate. ATSDR removed the word "overly" in these situations.
107	For past uranium exposures, ATSDR should address the recommendations of several previous reviewers and incorporate improvements, especially formal sensitivity and uncertainty analyses and additional soil core sampling data.	**ATSDR Technical Review Process** The Agency for Toxic Substances and Disease Registry (ATSDR) had each of the Phase II Oak Ridge Health Studies documents reviewed by a group of technical experts to evaluate the quality and completeness of the studies and to determine if the studies provide a foundation on which ATSDR can base follow-up public health actions or studies, and particularly, to support its congressionally mandated public health assessment of the ORR. ATSDR will use the information from the Oak Ridge Health Studies, as well as data from the technical reviews and other studies, to develop public health assessments for the ORR. ATSDR recognizes the great amount of oversight, technical peer review, and overall work that went into the Oak Ridge dose reconstruction project. However, ATSDR wanted an additional round of expert review of the Task 6 uranium screening evaluation to consider for its public health assessment for two reasons. First, ATSDR will not attempt to reproduce (*ab initio*) the work or results of the Task 6 uranium screening evaluation for its public health assessment. Such an attempt cannot be justified without substantial new information about past releases of uranium, or historic environmental sampling data or meteorological data, which ATSDR does not

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		presently have. Secondly, Task 6 uranium screening evaluation is a technical investigation fraught with uncertainty. ATSDR believes that an independent expert review of the methods and assumptions in the Task 6 uranium screening evaluation offers the best insight into the validity and usefulness of the results for making public health decisions. ATSDR contracted with Eastern Research Group, Inc. (ERG) of Lexington, Massachusetts, to select four expert reviewers to technically review the uranium screening evaluation Task 6 report: Melvin Carter, Nolan Hertel, Ronald Kathren, and Fritz Seiler. The reviewers were asked to comment on the study design, methods, and completeness of the uranium report, as well as the conclusions of the authors of the report. **ATSDR Note to Reader of Technical Reviewers Comments** ATSDR cautions the reader that some of the technical reviewers' comments are critical of the Task 6 uranium screening evaluation report. This does not mean that the uranium screening evaluation report is flawed or should not be used. The reviewers were not provided with a forum for group discussion or with formal access to the uranium Task 6 study authors to ask questions. Not all reviewers answered every question posed to them. Sometimes they acknowledged they were commenting outside their field of expertise and sometimes they acknowledged that they did not wish to comment outside their field of expertise. The reviewers brought their varied experience to the task, and not all reviewer comments are equally valid. Occasionally two opinions are conflicted. In such an instance (and other information being equal) ATSDR will tend to prefer comments from the reviewer who had the greater expertise in the subject area. Finally, the technical reviewers knew and acknowledged the Task 6 report was a screening evaluation of the uranium releases and not a complete dose reconstruction. ATSDR intends to evaluate each of the reviewer comments for its applicability and usefulness on its own merit and it encourages the reader to do the same. **Technical Reviewers Comments** The internationally recognized expert reviewers concluded that the uranium screening evaluation in the Task 6 report was "technically sound and applicable to decision-making," "supported by and developed on the basis of information in the reports," "conformed with established and generally accepted techniques," and had "no major or significant problems with respect to the study design or the scientific approaches used." Overall, the reviewers agreed that the screening assessment is adequate for public health decision-making (see page G-7). The technical reviewers agreed that **IF**

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		it is found necessary to evaluate beyond the screening stage, additional modifications such as uncertainty and sensitivity analyses would be required for a complete dose reconstruction. However, they noted that the dose estimates tend to *overestimate* the extent to which exposure to uranium is a problem in the Oak Ridge area and that further refinements to the study are likely to reveal that uranium exposures are actually *lower* than those currently estimated (see page G-7) **Task 6 Teams Comment Regarding the Use of the Task 6 Screening Evaluation** Also, the Task 6 team noted that there are areas identified throughout the report that contribute to the overall uncertainty of the results of the screening evaluation. They state: "these areas should be examined **IF** the evaluation of Oak Ridge uranium releases is to proceed beyond the conservative screening stage, and on to nonconservative screening and possibly a stage of refined evaluations" (see pages 5-2 and 5-3). **ATSDR Conclusion** ATSDR concluded that since the Task 6 uranium screening evaluation routinely and appropriately used several layers of conservatism and protective assumptions and approaches that resulted in overestimated total past uranium doses that are well below (32 times less than) the ATSDR radiogenic comparison value and levels expected to cause adverse health effects, ATSDR categorizes the Y-12 plant as having no apparent public health hazard from uranium exposure and does not believe the evaluation of Y-12 uranium releases requires a further nonconservative screening, a refined evaluation with uncertainty and sensitivity analyses, or additional sampling. Please see ATSDR's responses to comment 105 for more details on this issue.
108	As pointed out earlier, ATSDR relies entirely on the Y-12 airborne and surface water uranium release data, EFPC soil concentration data, and the Level II assessment in the Task 6 Report (ChemRisk 1999) to estimate pathway-specific and total uranium radiological and chemical doses to Scarboro residents from past Y-12 uranium releases. Although it adjusts for a 70-y exposure duration and makes several statements regarding the so-called conservatisms in the evaluation, ATSDR has not improved the assessment of past exposures at Scarboro as recommended by the Task 6 team (ChemRisk 1999, p. 5-3), the Oak Ridge Health Agreement Steering Panel (ORHASP 1999, pp. 71-74), and ATSDR's consultants (PHA Appendix G). We believe that ATSDR should incorporate these recommendations, summarized in Table 6 [ATSDR note: Table 6 is	**ATSDR Conclusion** Since the Task 6 uranium screening evaluation routinely and appropriately used several layers of conservatism and protective assumptions and approaches that resulted in overestimated total past uranium doses that are well below (32 times less than) the ATSDR radiogenic comparison value and levels expected to cause adverse health effects, ATSDR categorizes the Y-12 plant as having no apparent public health hazard from uranium exposure and does not believe the evaluation of Y-12 uranium releases requires a further nonconservative screening, a refined evaluation with uncertainty and sensitivity analyses, or additional sampling.

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	provided in the notes section at the end of this table.], before it completes its evaluation of past exposures and before it makes statements regarding potential health impacts due to these exposures.	**State of Tennessee's External Peer Review** The Task 6 uranium screening evaluation report underwent an external State of Tennessee's peer review prior to release by the State of Tennessee and ORHASP provided technical oversight throughout the project. The Task 6 report states that "some level of conservatism was maintained in the uranium concentration estimates used in Level II screening to ensure that hazards to a significant portion of the potentially exposed population were not underestimated." Regarding the Task 6 team's suggestions for possible follow-up work on page 5-3, the Task 6 team noted that they identified areas throughout the report that contribute to the overall uncertainty of the results of the screening evaluation. The Task 6 report states on pages 5-2 and 5-3 that "these areas should be examined **if** the evaluation of Oak Ridge uranium releases is to proceed beyond the conservative screening stage, and on to nonconservative screening and possibly a stage of refined evaluations" (ChemRisk 1999). **ATSDR Technical Review** Also, ATSDR had the Task 6 Report technically reviewed by an independent expert panel of internationally recognized scientists. These scientists pointed out that "the estimates made in the report tend to be on the conservative side—one expects, therefore, that (when in error) the report would tend to *overestimate* the extent to which exposure to uranium is a problem in the Oak Ridge area. Further refinements to the study are likely to reveal that uranium exposures are actually *lower* than those currently estimated" (see page G-7 of the PHA and response to comment 107). These reviewers also agreed that the screening assessment is adequate for public health decision-making (see page G-7). **ORHASP Recommendations** Of the eight recommendations presented by ORHASP on pages 71 to 74, #3, #4, and #7 pertain to uranium releases from the Y-12 plant: *ORHASP Recommendation #3* suggested that "a soil sampling program is vital to gain information relevant to the historical contamination levels in residential areas closest to the ORR plants. Any decision about additional dose reconstruction studies should be deferred until the results of the recommended soil sampling program have been obtained and carefully interpreted." As previously mentioned in ATSDR's response to comment 1, in 1998 and 2001 FAMU and EPA Region IV, respectively, collected soil, sediment, and surface water

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		samples from the Scarboro community (FAMU 1998; EPA 2003). These sampling programs were coordinated with stakeholders to satisfy their concerns. All FAMU samples were analyzed for mercury, gross alpha/beta content, uranium, and gamma-emitting radionuclides. About 10% of the FAMU samples were also analyzed for target compound list organics, target analyte list inorganics, strontium 90, uranium, thorium, and plutonium. All EPA Region IV samples were subjected to a full analytical scan, including inorganic metals, volatile organic compounds, semi-volatile organic compounds, radiochemicals, organochlorine pesticides, and PCBs. Uranium isotopic content was measured during both analyses. In addition, EPA Region IV collected uranium core samples from two locations in Scarboro. The results of the FAMU and EPA Region IV sampling programs in the residential areas closest to the Y-12 plant were evaluated and interpreted by Auxier, EPA Region IV, ATSDR's technical experts reviewing the Task 6 report, and ATSDR scientists. Auxier & Associates stated on page 1 of their report that "for the stated scope of the study [FAMU 1998], the number of samples met or exceeded the number recommended in the EPA Region IV guidance (USEPA, Region 4, Science and Ecosystem Support Division, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, May 1996)" (Prichard 1998). The Auxier report compared the results of the FAMU Scarboro sampling results with the deposition estimates based on the August 1998 Task 6 results. The Auxier report concluded that the Task 6 air pathway analysis is supported by the 1998 FAMU Scarboro soil data (Prichard 1998). The report stated that the agreement between deposition inferred from 1998 soil samples and deposition predicted in the 1950s on the basis of Task 6 air concentrations projections is well within the uncertainties of the parameters used in the calculations (Prichard 1998). The internationally recognized independent technical reviewers hired by ATSDR commented that the analysis and conclusions of the Auxier report are compelling. The Auxier report also concluded that the Task 6 Scarboro soil pathway that dominates the Task 6 screening index and uses uranium concentrations from EFPC sediment samples is not supported by their evaluation of the FAMU Scarboro soil samples (Prichard 1998). The concentrations of uranium in the EFPC sediment are about an order of magnitude larger than the uranium concentrations detected in the FAMU Scarboro soil samples data (Prichard 1998). Based on Auxier's analysis, the report concludes that the uranium concentrations in the EFPC sediment are unlikely to represent past uranium concentrations in Scarboro soil (Prichard 1998). The internationally recognized independent technical reviewers hired by ATSDR stated that the Auxier report presents convincing evidence that the FAMU soil sampling data are superior to the EFPC sediment data used as surrogates for soil data in the Task 6

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		soil pathway assessment (Prichard 1998). One reviewer indicated that the Auxier report convinced him that Scarboro uranium soil concentrations are 10 to 100 times lower than the values used in the Task 6 soil pathway assessment. All four of ATSDR's independent technical reviewers also expressed confidence in the soil sampling data collected by researches from FAMU. One technical reviewer considered the FAMU data clearly superior to the Task 6 EFPC sediment data for use in public health decision-making. From page 19 of their report: EPA Region IV "does not propose to conduct any further environmental sampling in the Scarboro community" and from page 26: "based on EPA's results, the Scarboro community is safe. Therefore, additional sampling to determine current exposure is not warranted" (EPA 2003). Page 29 in the PHA provides short summaries of the FAMU and EPA sampling. To expand the information presented, ATSDR added summary briefs of the FAMU and EPA reports in Appendix I of the final PHA. ATSDR's evaluation and the implication of the FAMU and EPA Region IV Scarboro sampling on the Task 6 screening evaluation are discussed in the Current Soil Exposure Pathway discussion under the Current Radiation Effects section (Section III.B.2.a.). *ORHASP Recommendation #4* suggested measuring atmospheric dispersion of controlled tracer releases from representative stacks and vents at Y-12 to develop more reliable estimates of dispersion of uranium released from Y-12 stakes and vents. This issue was evaluated by Auxier & Associates, ATSDR's independent technical reviewers, and ATSDR scientists. As previously stated, the Auxier report concluded that the Task 6 air pathway analysis is supported by the 1998 FAMU Scarboro soil data. The report stated that the agreement between deposition inferred from 1998 soil samples and deposition predicted in the 1950s (on the basis of Task 6 air concentrations projections) is well within the uncertainties of the parameters used in the calculations. Two of the technical reviewers hired by ATSDR to review the Task 6 report disagreed about whether or not the tracer dispersion study suggested in recommendation #4 by the ORHASP was warranted. One reviewer suggested that this experiment was warranted, citing the sparse distribution of air monitoring stations in the Oak Ridge area. The other reviewer thought the tracer release studies seemed somewhat excessive and suggested that the existing calculation be reworked. Also, the technical experts pointed out that "the estimates made in the report tend to be on the

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		conservative side—one expects, therefore, that (when in error) the report would tend to *overestimate* the extent to which exposure to uranium is a problem in the Oak Ridge area" (see page G-7 of the PHA). In appendix E of the PHA, ATSDR reworked the 1986 to 1995 Y-12 uranium air emissions data and the 1986 to 1995 uranium air radioactivity concentrations in Scarboro using a linear regression analysis and compared these linear regression results to the Task 6 air pathway analysis. ATSDR concluded that the annual average U 234/235 air concentrations and doses using the Task 6 analysis were probably overestimated by a factor of up to 5. Even using these overestimated uranium air concentrations, the estimated radiation dose from uranium is well below the ATSDR radiogenic cancer comparison value and would not likely result in adverse health effects. Since the conservative Task 6 screening evaluation (see list of conservative aspects of the screening evaluation on pages 48 and 92 of the PHA) reported a total past uranium dose that was overestimated yet still below levels of health concern, there is no need to conduct further air dispersion sampling for additional dose reconstruction studies. *Recommendation #7* suggests continued monitoring of uranium contamination, reported for each isotope. The following is from the *Oak Ridge Reservation Annual Site Environmental Report for 1995* (available from http://www.ornl.gov/sci/env_rpt). "In 1994, Y-12 Plant personnel issued *Evaluation of the Ambient Air Monitoring Program at the Oak Ridge Y-12 Plant* (Energy Systems 1994a) and worked with the DOE and TDEC [Tennessee Department of Environment and Conservation] in reviewing the ambient air program for applicability and usefulness of the data. There are no federal regulations, state regulations, or DOE orders that require this monitoring. All ambient air monitoring systems at the Y-12 Plant are operated as a best management practice. With the reduction of plant operations and improved emission and administrative controls, levels of measured pollutants have decreased significantly during the past several years. In addition, processes that result in the emission of enriched and depleted uranium are equipped with stack samplers that have been reviewed and approved by the EPA to meet requirements of the NESHAP regulations. ORR air sampling stations, operated by ORNL in accordance with DOE orders, are located around the reservation. Their locations ensure that areas of potentially high exposure to the public are monitored continuously for parameters of concern. With agreement from TDEC personnel, the ambient air sampling program at the Y-12 Plant has been significantly reduced, effective at the end of 1994. All fluoride, total

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		suspended particulates (TSP), and particulate matter less than 10 microns in diameter (PM10) sampling has been discontinued, and all but 3 of the 12 uranium samplers have been shut down. The mercury sampling program will continue to monitor ambient air level concentrations as a result of remediation and decommissioning and decontamination activities." "Prior to 1993, the samples were analyzed for gross alpha and beta and for activity levels of specific uranium isotopes; however, in 1993, the analysis program for radionuclides was revised as described in the *Environmental Monitoring Plan for the Oak Ridge Reservation* (EMP) to obtain total uranium particulate and the percentage of ^{235}U. In this manner, uranium concentrations in ambient air could be better correlated to stack emission data, which is also measured as total uranium."
109	In addition to these recommendations, we recommend that ATSDR: 1) calculate doses and risks for a range of exposure scenarios specific to Scarboro, but based on similar scenarios used to assess other ORR contaminants, such as I-131; 2) calculate doses to infants and children, not just adults, using the age-dependent dose coefficients in ICRP Publications 71 and 72; 3) calculate age-averaged lifetime cancer risks using EPA's radionuclide slope factors in the Agency's *Health Effects Assessment Summary Tables* (HEAST) (available at http://www.epa.gov/radiation/heast/download.htm), which are based on the risk coefficients in *Federal Guidance Report No. 13* (EPA 1999); and 4) re-evaluate the chemical effects of uranium using ICRP's revised lung model and physiologically-based biokinetic models to estimate kidney content, and use the evaluation criteria discussed in Appendix M of the Task 6 report (ChemRisk 1999).	The following are ATSDR's responses to each of the recommendations: (1) Not all contaminants behave the same in the environment, nor are the receptor populations the same for all ORR contaminants. The Task 6 team developed contaminant-specific exposure pathways for each contaminant evaluated. The relevant pathways chosen for exposure to uranium are different than the scenarios for the other ORR contaminants (see Tables 7, 9, and 10 for the uranium pathways considered by the Task 6 team). Some of the pathways evaluated for iodine-131, for example, are not applicable for exposure to uranium from the Y-12 plant. (2) In its dose assessment ATSDR primarily focused on two age groups: adults and 1-year-old children. These two groups represent the most likely impacted populations who might come in contact with potentially contaminated surface soils and surface waters. Additionally, during the evaluation of other intake pathways and taking into consideration ingestion rates and body weights, ATSDR determined there were no significant differences between adults and other age groups. For example, Table 19 lists radiation doses following soil ingestion doses by a 1-year-old child and Table 23 gives doses from ingestion of soil by adult males, adult females, 12-year-old children, and 6-year-old children. (3) Following the ATSDR Cancer Framework Policy, ATSDR does not perform risk assessments. The agency, however, does recognize the importance of EPA risk assessment and risk analysis to determine if levels of chemicals at hazardous waste sites pose an unacceptable risk (as defined by regulatory standards and requirements) and to help regulatory officials make decisions in support of cleanup strategies that will ensure overall protection of human health and the environment. ATSDR acknowledges that conservative safety margins are built

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		into EPA risk assessments and that these assessments do not measure the actual health effects that hazardous chemicals at a site have on people. For additional information, please review the framework policy that can be found at http://www.atsdr.cdc.gov/cancer.html. See the response to comment 127 for additional information distinguishing a risk assessment from a health assessment. (4) ATSDR used the most recent dose coefficients and transfer factors as published by the ICRP (supplied on their electronic database of dose coefficients) and those of the EPA (supplied on the Federal Guidance Report 13 Cancer Risk Coefficients for Environmental Exposure to Radionuclides: CD Supplement).
110	For past uranium exposures, we believe that ATSDR has underestimated the radiation dose from the inhalation pathway. [ATSDR note: The commenter provided several pages of tables and equations that could not easily be inserted into this table. Therefore, this comment has been truncated and the entire comment is provided in the notes section at the end of this table.] [ATSDR note: The commenter summarized "the Task 6 and ATSDR pathway-specific radiation doses to residents of Scarboro community from past releases of uranium from Y-12" reviewed the procedures ATSDR employed to arrive at "a total effective dose of 155 mrem for all pathways combined." The commenter also summarized the methods used by the Task 6 team "to calculate the doses for the inhalation pathway for both Level I and Level II screening assessments."] After reviewing the default assumptions used in these calculations, we conclude that the Level II parameter values used by the Task 6 team (and by ATSDR) for f_t (i.e., the fraction of time that a person is exposed) and f_t (i.e., the indoor/outdoor shielding factor) are not appropriate for a "typically" exposed individual. The current f_t value of 0.4 equates to an individual being exposed for only 40% of their time each day or 9.6 hr. The current f_s value of 0.3 means that the concentration of uranium isotopes in indoor air is only 1/3 of the concentration outdoors, and is based on assumption that the house is made of brick or stone. For residential exposures, EPA's *Exposure Factors Handbook* recommends 50^{th} percentile values of 16.4 hr per day indoors and 2 hr per day outdoors (EPA/600/P-95/002Fc, August 1997, p.15-17). Since f_t is the sum of the exposures times indoors (ET_i) and outdoors (ET_o), then $f_t = ET_i + ET_o = (16.4/24) + (2/24) = 0.683 + 0.083 = 0.77$. For the indoor/outdoor shielding factor, f_s, we believe that a value of 0.5 is more reasonable than the current	While it is possible to use standard default assumptions from EPA's *Exposure Factors Handbook*, the Task 6 team decided to use site-specific parameters they felt were most appropriate to the scenarios evaluated during the Level II screening analysis. • Local community members provided site-specific exposure information to the Task 6 team. • ORHASP provided technical oversight throughout the project. • The Task 6 report underwent an external technical peer review prior to release. • ATSDR had the report technically reviewed by an expert panel of internationally recognized scientists, who agreed that the screening assessment is adequate for public health decision-making. That said, even substituting these default parameters, EPA calculated a total effective dose of 242 mrem over 70 years, which is still well below the radiogenic cancer comparison value of 5,000 mrem over 70 years and the average annual U.S. background radiation does of 300 mrem per year from natural sources. Additionally, the one-year approximation for EPA's estimated total dose (3.5 mrem/year) is well below ATSDR's Minimal Risk Level (MRL), the NCRP guidance for public exposure of 100 mrem/year, and the EPA CERCLA cleanup level of 15 mrem/year. Therefore, even using EPA's suggested exposure parameters, the overall conclusion that the total past uranium dose is well below levels of health concern would not change. As a final note, this comment should have been provided to the Task 6 team during the 1998 public comment period for the Task 6 report. EPA Region IV staff attended many of the ORHASP meetings.

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	value of 0.3 and is consistent with the value used by the Task 6 team in the Level I assessment for wood houses. It is also consistent with other values reported in the literature (For example, see: BIOMASS (The IAEA Programme on Biosphere Modeling and Assessment Methods). 2000. Model Testing Using Chernobyl Fallout Data from the Iput River Catchment Area, Bryansk Region, Russia: Scenario "Iput." BIOMASS Theme 2, Environmental Releases, Dose Reconstruction Working Group. International Atomic Energy Agency, Vienna, BIOMASS/2DR/WD02.). [ATSDR note: The commenter then substituted these values for the current default values and modified the previous equation to account for ET_i and ET_o.] Using our suggested values for indoor and outdoor exposure times and shielding, we calculate a committed effective dose of 122 mrem for the inhalation pathway, compared with ATSDR's current value of 35 mrem. As shown in Table 1c [ATSDR note: Table 1c is provided in the notes section at the end of this table.], by adding in the doses from the other air pathways and summing the total doses for all exposure pathways, we compute a total effective dose of 242 mrem, compared with ATSDR's current value of 155 mrem.	
111	On page 6 (lines 9-13) of the Summary, ATSDR states: "it should be noted that several levels of conservatism were built into this evaluation of past exposures. The values ATSDR relied on to evaluate past exposure (those from the Task 6 report) came from a screening evaluation that routinely and appropriately used conservative and overly protective assumptions and approaches, which led to an overestimation of concentrations and doses." On page 54, ATSDR repeats these statements and presents a list of five "conservative aspects" of the evaluation, along with a sentence or two summarizing each conservatism. This list is a compilation of statements made in various places throughout Section III.B.1.a for past radiation exposures. Presumably, although not stated directly, some of these so-called conservatisms also would apply to the assessment of past chemical exposures since the Task 6 team used identical exposure equations and parameter values to calculate radionuclide and chemical intakes. Essentially, we disagree with ATSDR's assertions, some more than others. In general, we find most unsubstantiated. We address each assertion as follows: [ATSDR note: This comment is split into the following separate comments.]	The Task 6 report states on page 3-27 that "because of the scarcity of information regarding estimates of uranium concentrations in the environment over the period of interest, some conservatism was maintained in the uranium concentration estimates used in the Level II screening to ensure that hazards to a significant portion of the potentially exposed population were not underestimated" (ChemRisk 1999). In addition, ATSDR had the report technically reviewed by an expert panel of internationally recognized scientists. The technical reviewers pointed out that "the estimates made in the report tend to be on the conservative side—one expects, therefore, that (when in error) the report would tend to *overestimate* the extent to which exposure to uranium is a problem in the Oak Ridge area. Further refinements to the study are likely to reveal that uranium exposures are actually *lower* than those currently estimated" (see page G-7 of the PHA). See below for specific responses to each assertion.

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112	(1) <u>ATSDR states on page 54</u>: *The Task 6 values that ATSDR relied on to evaluate past exposures came from a screening evaluation that routinely and appropriately used conservative and overly protective assumptions, which led to an overestimation of concentrations and doses.* The Task 6 team performed two screening assessments, Level I and Level II. The Level I assessment addressed the maximally exposed individual—a hypothetical individual with the highest potential for exposure to releases—by assuming upper-bound values for intake rates, exposure frequencies, exposure duration, soil concentrations, and other exposure parameters. For Y-12 uranium releases to Scarboro, the Task 6 team calculated a Level I screening index (i.e., a cancer incidence risk) of 1.9 x 10^{-3} that exceeded the decision guide of 1 in 10,000 (1 x 10^{-4}) (ChemRisk 1999, p. 4-12). Consequently, the Task 6 team performed a Level II assessment designed to address an average or more typically exposed individual, assuming "considerably less conservative estimates" for various exposure parameters and uranium soil concentrations. An item-by-item comparison of the exposure parameter values used in the Level I and Level II assessments, presented in Table K-1 of Appendix K of the Task 6 report, confirms that many of the Level II values are substantially less than comparable Level I values. For soil concentrations, the Task 6 team used average values (i.e., 14 pCi/g U 234/235 and 12 pCi/g U 238) compared to maximum values (i.e., 76 pCi/g U 234/235 and 70 pCi/g U 238) for Level I, based on measurements of soil/sediment samples taken from the EFPC floodplain, assuming that the relative concentrations of uranium isotopes were equal to their natural abundances (ChemRisk 1999, p. 3-27). Even after these reductions in conservatisms, the calculated Level II screening index, 8.3 x 10^{-5}, was only slightly below the decision guide of 1 x 10^{-4} (ChemRisk 1999, p. 4-12). The only discussion of conservatism we could find in the Task 6 report regarding the Level II assessment was the statement made on page 3-27 (bottom) that "conservatism was probably also introduced by the use of 1980 EFPC flood measurements to represent concentrations at Scarboro, which is outside of the floodplain." The Task 6 team defends the use of average EFPC floodplain uranium concentrations as surrogates for actual Scarboro data due to insufficient and unreliable soil measurements at Scarboro and to the uncertainty concerning the level of U 235 enrichment in the soil (Presumably, this refers to the fact that, if the Task 6 team had assumed enriched rather than natural abundances of uranium isotopes, estimated soil activities and corresponding risks might be several times, and	While it is true that "the second level of screening was considerably less conservative than the Level I analysis," the Task 6 report states on the bottom of page 3-27 that "because of the scarcity of information regarding estimates of uranium concentrations in the environment over the period of interest, **some conservatism was maintained in the uranium concentration estimates used in the Level II screening to ensure that hazards to a significant portion of the potentially exposed population were not underestimated**. Conservatism was also introduced by the use of 1980 EFPC floodplain measurements to represent concentrations at Scarboro, which is outside of the floodplain. As such the second level of screening may be more appropriately called a Refined Level I analysis." As previously mentioned, the Auxier report also concluded that the Task 6 Scarboro soil pathway that dominates the Task 6 Level II screening index and uses 1980 uranium concentrations from EFPC sediment samples is not supported by their evaluation of the FAMU Scarboro soil samples (Prichard 1998). The concentrations of uranium in the EFPC sediment are about an order of magnitude greater than the uranium concentrations detected in the FAMU Scarboro soil samples. Based on Auxier's analysis, the report concludes that the uranium concentrations in the EFPC sediment are unlikely to represent past uranium concentrations in Scarboro soil (Prichard 1998). The internationally recognized independent technical reviewers hired by ATSDR stated that the Auxier report presents convincing evidence that the FAMU soil sampling data are superior to the EFPC sediment data used as surrogates for soil data in the Task 6 soil pathway assessment. One reviewer indicated that the Auxier report convinced him that Scarboro uranium soil concentrations are 10 to 100 times lower than the values used in the Task 6 soil pathway assessment. All four of ATSDR's independent technical reviewers also expressed confidence in the soil sampling data collected by researches from FAMU. One technical reviewer considered the FAMU data clearly superior to the Task 6 EFPC sediment data for use in public health decision-making. As such, the Task 6 report states, "the second level (Level II) of screening may be more appropriately called a Refined Level I analysis. The data that are currently available are not sufficient to support a defensible analysis of average or typical exposures to members of the Scarboro community during the years from the community's inception to the present" (ChemRisk 1999). The Task 6 report continues on the top of page 3-28, stating that "a significant factor in the decision to maintain a conservative value of soil concentration in Level II screening was the uncertainty concerning the level of U 235 enrichment in the soil… Because of this uncertainty, the concentration corresponding to… 26,000 pCi kg^{-1} total uranium was used. To illustrate how the overall results of the assessment would differ if lower soil concentrations were assumed, screening indices were also calculated for soil concentrations of 7,000 and 2,000 pCi kg^{-1} total uranium… This

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	estimated soil activities and corresponding risks might be several times, and perhaps orders of magnitude, higher, depending on the levels of enrichment assumed.) (ChemRisk 1999, p. 3-28, top). To illustrate how the overall results of the assessment would differ if lower soil concentrations were assumed, the Task 6 team calculated screening indices for total uranium soil concentrations of 7 pCi/g and 2 pCi/g, again assuming natural isotopic abundances (ChemRisk 1999, p. 3-28). The resulting screening indices were 5.8 x 10^{-5} assuming 7 pCi/g and 5.1 x10^{-5} assuming 2 pCi/g, corresponding to 30% and 40% reductions, respectively, compared to a screening index of 8.3 x 10^{-5} calculated for the Level II assessment assuming 26 pCi/g (ChemRisk 1999, p. 4-18). They note that soil reductions and screening indices do not scale proportionally because the soil pathways represent only 43% of the total screening index from U 234/235 and 51% from U 238, and because the contributions from the air and surface water pathways to the total screening index (57%) are unaffected by alternative soil concentrations (ChemRisk 1999, p. 4-19). Based on the discussions above, we conclude that ATSDR's statement that the Task 6 team "used conservative and overly protective assumptions and approaches, which lead to an overestimation of concentrations and doses" is unfounded. Since ATSDR's evaluation of past exposures at Scarboro is based on the Task 6 Level II, not Level I, assessment, then, by extension, ATSDR's dose estimates should not be overestimated because of several layers of conservatism.	discussion gives the reader an indication of how the overall results of the assessment would change if less conservative estimates of soil concentration were used" (ChemRisk 1999). As a note, similar language is also provided on page ES-9. As the commenter mentioned, even using the Task 6 uranium screening assessment, the Level II screening index (8.3 x 10^{-5}) is 1.2 times less than the ORHASP decision guide (1 x 10^{-4}) and; therefore, below the threshold for consideration of more extensive health effects studies. Based on the ORHASP decision guides, the estimated Task 6 Level II screening risk from off-site exposure to Y-12 uranium is so low that further detailed study of exposures is not warranted. (See the Level II screening index on page 4-12 of the Task 6 report and the ORHASP Decision Guides on page 57 of the ORHASP report.)
113	(2) <u>ATSDR states on page 54</u>: *The majority of the total uranium dose ...is attributed to frequently eating fish from East Fork Poplar Creek and vegetables grown in contaminated soil over several years. If a person did not regularly eat fish from the creek or homegrown vegetables over a prolonged period of time (which is very probable), then the person's uranium dose would likely have been substantially lower than the estimated doses reported in this public health assessment.* ATSDR's statement makes two points: first, that *frequent* fish and vegetable consumption accounts for the majority of the total uranium dose, and second, that if individuals *ate less* EFPC-contaminated fish and vegetables, *less frequently*, their total dose would be *substantially lower*. We address each point as follows: With respect to the first point, Table 2 [ATSDR note: Table 2 is provided in the notes section at the end of this table.] below, shows that fish and vegetable consumption combined accounts for 67% of the total effective	The Task 6 Level II screening analysis is an independent evaluation, and is not based on the parameters used during the Level I screening. ATSDR used the Task 6 Level II screening results to evaluate past uranium releases to the environment from the Y-12 plant and past uranium exposures to residents living near the Y-12 plant. Therefore, while it is a nice academic exercise to compare the differences between the Level I and Level II evaluation, it is irrelevant to the fact that the majority of the total uranium dose of the Level II assessment (54% of the total U 234/235 dose and 78% of the total U 238 dose) is attributed to frequently eating fish from the EFPC and eating vegetables grown in contaminated soil over several years. If a person did not regularly eat fish from the creek or homegrown vegetables over a prolonged period of time (which is very probable), then that person's uranium dose would likely have been substantially lower than the estimated doses reported in this PHA (as noted on pages 48 and 92 of the PHA). While it is true that "the second level of screening was considerably less conservative than the Level I analysis," the Task 6 report states on the bottom of page 3-27 that "because of the scarcity of information regarding estimates of uranium concentrations

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	dose from all exposure pathways and uranium isotopes for the Task 6 Level II (and ATSDR's) assessment of past Scarboro exposures, each contributing 29% and 38%, respectively. While we acknowledge that the combined dose from these pathways constitutes the majority (i.e., 67%) of the calculated total uranium dose, we nevertheless believe that this statistic is misleading, in that it overemphasizes the importance of these pathways, since, in our opinion, it is likely an artifact of variable exposure assumptions between Level I and Level II assessments. Our view is based on a comparison of the relative contributions of fish and vegetable consumption to the total doses calculated by the Task 6 team for the Level I and Level II assessment, shown in Table 3. [ATSDR note: Table 3 is provided in the notes section at the end of this table.] For fish consumption only, which depends solely on the water pathway exposure assumptions, we note that Level I and Level II doses remained constant, yet the relative contribution of the fish pathway to the total dose increased from 1% for Level I to 29% for Level II. This indicates to us that the apparent substantial increase in the contribution of fish consumption pathway to the total dose for the Level II assessment (i.e., 29%) is due not to a change in exposure assumptions or dose but to the reduction or elimination of doses from all other pathways. A review of the parameter values in Table K-1 of the Task 6 report (ChemRisk 1999) specific to the EFPC fish pathway confirms that the Task 6 team applied the same set of values for both assessments. As shown in Table 3 [ATSDR note: Table 3 is provided in the notes section at the end of this table.], the vegetable consumption pathway, which accounts for 38% of the Level II total dose, derives primarily from the soil pathways (35%) and, to a lesser extent, the air pathways (3%). Comparing Level I and Level II values for the part of the vegetable pathway that derives from the air pathways, we note that while the percent contribution to total dose remained constant at 3%, the dose dropped by a factor of 31 from Level 1 to Level II. Changes in the Level I to Level II exposure parameter values specific to vegetable consumption (see Table K-1, ChemRisk 1999) account for most of this reduction (i.e., a factor of 26). For the soil pathway-dependent component, comparing Level I to Level II assessments, we note that the vegetable pathway dose fell by a factor 44 (again, almost entirely due to changes in the exposure parameter values), yet the percent contribution to total dose dropped by only a factor of 2. Taking both	in the environment over the period of interest, **some conservatism was maintained in the uranium concentration estimates used in the Level II screening to ensure that hazards to a significant portion of the potentially exposed population were not underestimated**" (ChemRisk 1999).

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	components of the vegetable pathway together, we see rather substantial reductions in dose (factors of 31 and 44) and only small reductions (factors of 1 and 2) in the percent contribution to the total dose. That the vegetable pathway constitutes 38% of the Level II total dose belies the fact that the dose from this pathway is roughly 40 times less than it was under Level I.	
114	With respect to the second point—that if individuals *ate less* EFPC-contaminated fish and vegetables, *less frequently*, their total dose would be *substantially lower*—we point out that the exposure parameter values used in the Task 6 Level II and ATSDR assessments for fish and vegetable consumption are already vanishingly small, when compared to comparable mean, 95th percentile, and recommended values in EPA's *Exposure Factors Handbook (EFH) (Exposure Factors Handbook, Volume II, Food Ingestion Factors*, EPA/600/P-95/002Fb, U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC, August 1997*)*, as shown in Table 4, below. [ATSDR note: Table 4 is provided in the notes section at the end of this table.] For the fish consumption pathway, we note that the assumed daily intake rate for fish caught in EFPC (i.e., 4 g/d for both Level I and Level II assessments) is slightly less than the lower-bound of the range of mean daily intake values given in Table 10-84 of the *EFH* for freshwater anglers, and constitutes only 20% of the recommended mean value for total daily intake (i.e., 20 g/d, *EFH*, Table 10-81). Assuming a mean fish serving size of 129 g (*EFH*, Table 10-82) and an exposure frequency of 350 d/y (ChemRisk 1999, Table K-1), the Level II daily intake rate corresponds to ~11 servings per year of contaminated fish caught in the EFPC (i.e., 4 g/d * 350 d/y ÷ 129 g/serving), or about one meal of contaminated fish a month. Depending on the edible portion of the fish caught, it is conceivable that all 11 servings could come from only a few fish. On page 63, lines 11-13, of the PHA, ATSDR states: "It is ATSDR's understanding that EFPC is not a very productive fishing location and very few people actually eat fish from the creek." Yet on page 81, lines 7-9, of the PHA, ATSDR also states: "However, the creek appears to be too shallow for swimming, and the state has issued a fishing advisory for EFPC that warns people to avoid eating fish from the creek and to avoid contact with the water (ATSDR 1993)." Whether or not EFPC is or *was* a suitable fishing location is debatable; however, as the Task 6 team concludes: "Even though the consumption rate of fish from this source is relatively low, the concentration in EFPC and the accumulation of uranium in fish elevate the	While it is possible to use standard default assumptions from EPA's *Exposure Factors Handbook*, the Task 6 team decided to use site-specific parameters they felt were most appropriate to the scenarios evaluated during the Level II screening analysis. The Task 6 report underwent an external technical peer review prior to release, ORHASP provided technical oversight throughout the project, and community members provided site-specific exposure information. In addition, ATSDR had the report technically reviewed by an expert panel of internationally recognized scientists, who agreed that the screening assessment is adequate for public health decision-making (see page G-7). The following three paragraphs address issues raised in the comment and help illustrate why it is important to use site-specific parameters over standard default assumptions, when possible: • The recommendations in EPA's *Exposure Factors Handbook*, Table 10-81 give the mean intake of 20.1 g/day as the amount of *total* fish eaten by the general population. This daily intake includes eating 14.1 g/day of marine fish and 6.0 g/day of freshwater/estuarine fish (EPA 1997). EFPC is a freshwater creek. As noted on page 10-25 of EPA's *Exposure Factors Handbook*, "the recommended values are 6.6 g/day for freshwater/estuarine fish…" (EPA 1997). As noted on page K-7, the Task 6 team estimated that people eat 4.0 g/day of fish from EFPC because "activity is likely to be low due to limited access, the nature of the Creek, and the availability of higher quality fisheries nearby" (ChemRisk 1999). • The Task 6 team used a factor of 0.2 for the amount of vegetables consumed that are contaminated. However, as noted in Table 13-71 in EPA's *Exposure Factors Handbook*, people in the South generally tend to eat a lower fraction of home-produced vegetables (0.069) than what the Task 6 team assumed for the Scarboro community. • Scarboro is known to have private vegetable gardens. The community has not expressed any concern over consumption of homegrown fruits.

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	significance of this pathway" (ChemRisk, 1999). Similar comparisons and conclusions can be made for the vegetable consumption pathway. As shown in Table 4 [ATSDR note: Table 4 is provided in the notes section at the end of this table.], the assumed Level II consumption rate, 0.2 kg/d, is for vegetables only, not for vegetables and fruit, and is at the lower bound of the range of average values listed in the *EFH*. Moreover, for the air pathway-component of the vegetable pathway, the actual daily intake of uranium-contaminated vegetables is actually far less, i.e., ~0.01 kg/d, when adjusted for the fraction of consumed vegetables assumed to be contaminated (0.2) and the fraction of contamination remaining on vegetables after washing (0.2), calculated as, 0.2 kg/d * 0.2 * 0.2 = 0.008 or ~0.01 kg/d. Likewise, for the soil pathway-component of the vegetable pathway, the actual daily intake of uranium-contaminated vegetables is 0.04 kg/d, when adjusted for the fraction of assumed contaminated vegetables (0.2), calculated as, 0.2 kg/d * 0.2 = 0.04 kg/d. The combined, adjusted rate (i.e., 0.01 + 0.04 = 0.05 kg/d) for home-grown vegetable consumption is small and probably underestimates historical intake rates for residents of Scarboro and other Oak Ridge communities who most likely consumed both home- and locally-grown vegetables and fruits contaminated with uranium during the years of peak releases from Y-12.	
115	(3) <u>ATSDR states on page 54</u>: *The Task 6 report noted that late in the project it was ascertained that the Y-12 uranium releases for some years used to develop the empirical χ/Q (χ is chi) value may have been understated due to the omission of some unmonitored release estimates. This would cause the empirical χ/Q values to be overestimated and in turn would cause the air concentrations to be overestimated.* What the Task 6 report actually says is: (1) information gained late in the Task 6 project indicates that Y-12 uranium releases for some of the years used in the development of the empirical χ/Q value may have been understated due to omission of some unmonitored releases; (2) the Task 6 team was not able to evaluate this new data sufficiently to warrant its use in this assessment because of time constraints; (3) if Y-12 uranium releases during years used to develop the empirical χ/Q value were indeed under reported, that would mean that the associated empirical χ/Q values were overestimated, and concentrations at Scarboro that were estimated using that approach were in turn overestimated; and (4) it is impossible to gauge the magnitude of any biases potentially introduced by this possible under	The following is the actual quote from page 3-21 of the Task 6 report: "In addition, information was gained late in the project that indicated that Y-12 uranium releases for some of the years used for development of the empirical χ/Q value may have been understated due to omission of some unmonitored release estimates. It was not possible within the time frame of this project to evaluate the new data sufficiently to warrant its use in this assessment. If Y-12 uranium releases during years used to develop the empirical χ/Q value applied in this assessment were indeed under reported, that would mean that the associated empirical χ/Q were overestimated, and concentrations at Scarboro that were estimated using that approach were in turn overestimated. It is impossible to gauge the magnitude of any biases potentially introduced by this possible under reporting without closely evaluating the bases of the release estimates during the associated years in the 1980s and 1990s" (ChemRisk 1999). ATSDR agrees that the magnitude of the overestimation is not known. However, there is no doubt that if the release estimates were understated due to omission of some unmonitored release estimates, this would cause the empirical χ/Q values to be

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	reporting without closely evaluating the bases of the release estimates during the associated years in the 1980s and 1990s (ChemRisk 1999). As noted, the Task 6 team does not provide this new data or any supporting analyses, nor do they speculate on the magnitude of the suspected overestimate. Neither does ATSDR. Given the lack of data or analyses, it is not advisable to speculate on how the new data might reduce the empirical χ/Q value and thereby may or may not decrease reconstructed Scarboro air concentration estimates, doses, and risks. The Task 6 empirical χ/Q value is a scaling factorCincreasing or decreasing its value will affect air concentrations, doses, and risks proportionally. We agree with the Task 6 team that speculation about such changes are premature at this time, especially given that the uncertainties associated with all Y-12 uranium release estimates have not been quantified. Task 6 team did state that U 234/235 releases may be uncertain by a factor of about 10 and that U 238 releases may be even more uncertain.	overestimated and in turn would cause the air concentrations to be overestimated (as noted on pages 48 and 92 of the PHA). The empirical χ/Q is calculated by dividing the uranium air concentration by the uranium release rate (see page 3-17 in ChemRisk 1999). If the uranium release rate was increased from unmonitored release estimates being added to it, the χ/Q value would be lowered (for example, if the air concentration is 10 and the release rate is 1, χ/Q would be 10; if the air concentration is 10 but the release rate is increased to 2 due to the addition of unmonitored releases, χ/Q would be lowered to 5). Applying a lower χ/Q value to the uranium release estimates would result in lower estimated uranium air concentrations in Scarboro.
116	When this new information about potentially underestimated Y-12 uranium releases becomes available, we suggest that ATSDR, or others, should incorporate these data into a formal uncertainty analysis of radiation doses and risks. The analysis should account for the uncertainties associated with all pertinent variables, including the uranium release estimates, the measured Scarboro airborne uranium concentrations, and the empirical χ/Q values.	As stated in the title, the Task 6 report was a "Screening Evaluation of Potential Off-Site Exposure" that routinely and appropriately used several layers of conservatism and protective assumptions and approaches (see list of conservative aspects of the screening evaluation on pages 48 and 92 of the PHA). Additionally, as noted above, lowering the empirical χ/Q value by adding the omitted unmonitored release estimates would result in an overestimation of Scarboro air concentrations. Since the screening evaluation, which contained conservative aspects, resulted in a total past uranium dose below levels of health concern, ATSDR does not believe the evaluation of Y-12 uranium releases requires a further refinement with uncertainty and sensitivity analyses. In addition, based on the ORHASP decision guides, the estimated Task 6 Level II screening risk from off-site exposure to Y-12 uranium is so low that further detailed study of exposures is not warranted. The Level II screening index (8.3×10^{-5}) is 1.2 times less than the ORHASP decision guide (1×10^{-4}) and; therefore, below the threshold for consideration of more extensive health effects studies. (See the Level II screening index on page 4-12 of the Task 6 report and the ORHASP Decision Guides on page 57 of the ORHASP report.) As discussed in the NCRP Commentary 14, *A Guide For Uncertainty Analysis In Dose And Risk Assessments Related To Environmental Contamination* (issued in 1996), if a conservatively based screening calculation is performed and this screening calculation indicates the risk is "clearly below regulatory or risk levels of concern," and the possible exposure is low, then a quantitative uncertainty analysis may not be

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		necessary. By design, conservative screenings are "highly unlikely to underestimate the true dose or risk." Based on this document, ATSDR agrees with the Task 6 authors that a quantitative uncertainty analysis is not needed for this portion of the Oak Ridge Dose Reconstruction Project. On page D-3, the Task 6 authors state that "although an uncertainty analysis of the Task 6 air source term was not within the scope of Task 6, experts interviewed during the project consider release estimates for enriched uranium to be suitable for the Task 6 screening assessment and within an order of magnitude of actual releases" (ChemRisk 1999). The response to comment 166 provides additional details about conducting uncertainty analyses.
117	We also suggest that the Task 6 χ/Q approach or any other approach used to reconstruct historical uranium air and soil concentrations at Scarboro should be modified, as necessary, and should be verified and validated, perhaps using additional soil core sampling results and meteorological data for Scarboro, as recommended by several reviewers (see Appendix G).	Since the Task 6 Level II screening evaluation, which contained conservative aspects, resulted in a total past uranium dose below levels of health concern, ATSDR does not believe the evaluation of Y-12 uranium releases requires further validation. Additionally, in 2001, EPA Region IV collected and analyzed core samples from two locations in Scarboro. On page 19, the EPA Region IV report states that it "does not propose to conduct any further environmental sampling in the Scarboro community." On page 26, the report states that "based on EPA's results, the Scarboro community is safe. Therefore, additional sampling to determine current exposure is not warranted" (EPA 2003). Page 29 in the PHA provides a short summary of the EPA sampling. To expand the information presented, ATSDR added a summary brief of the EPA report in Appendix I of the final PHA. As previously stated, the Task 6 χ/Q approach was evaluated by Auxier & Associates, ATSDR's independent technical reviewers, and ATSDR scientists. (See ATSDR's response to ORHASP recommendation #4 in comment 108.)
118	(4) <u>ATSDR states on page 54</u>: *According to ATSDR's regression analysis, the method that the Task 6 team used to estimate historical uranium concentrations overestimated historical uranium 234/235 air concentrations in Scarboro by as much as a factor of 5. Consequently, airborne uranium 234/235 doses based on this method were most likely overestimated.* What ATSDR does not tell the reader is that: (a) The Task 6 team considered but rejected the use of a linear regression approach, because the ranks of the annual release estimates for U	Both the Y-12 uranium emission measurements and the station 46 (Scarboro) air concentration measurements are continuous distributions. That is, the data values may be any positive integer or non-integer number. Conversely, the annual ranking values used by the Task 6 investigators represent a discrete distribution and the values are represented by integers only. Consequently, use of the annual ranking values to assess the correlation between Y-12 uranium emissions and Scarboro uranium air concentrations is not an appropriate test and the results of that test are not valid. The uncertainty produced by that inappropriate test reflects the error of the test method rather than uncertainty in the emission and dispersion processes. The regression analyses of the U 235 and U 238 data indicate that the U 235 emission

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	234/235 and U 238, individually, did not always coincide with the ranks of their respective air concentrations measured at Scarboro (ChemRisk 1999, p. 3-17). (b) To account for this disparity in the ranks of releases and air concentrations, which they thought indicated some uncertainty associated with the air measurements and/or release estimates, the Task 6 team calculated 20 empirical values for χ/Q, 10 each for U 234/235 and U 238, based on the 10-y data set for uranium release estimates for Y-12 and associated measured uranium air concentrations at Scarboro, from1986 to 1995 (ChemRisk 1999, p. 3-18). (c) Because statistical analysis of the data proved inconclusive, the Task 6 team combined all 20 empirically-derived χ/Q values, assuming a normal distribution, and calculated a single χ/Q value of 3 x 10^{-7} s m^{-3} corresponding to the 95% upper confidence limit of the mean (i.e., 2 x 10^{-7} s m^{-3}) (ChemRisk 1999, p. 3-19). (d) The Task 6 team used this single, 95th UCL χ/Q value of 3 x 10^{-7} s m^{-3} and the Y-12 release estimates to reconstruct uranium air concentrations at Scarboro for the years 1944 to 1985 <u>and</u> for the years 1986 through 1995, to maintain consistency with prior years, even though measured airborne concentrations were available for this later period (ChemRisk 1999, p. 3-20). (e) The Task 6 team was aware of the limitations of their χ/Q approach, due to the fact that only 10 years of monitoring data were available from Scarboro, and that these reported values were for the period 1986-1995, during which time releases from Y-12 were considerably lower than in earlier years (ChemRisk 1999, p. 5-2) As described in Appendix E of the PHA, ATSDR performed two independent regression analyses, one each for the U 234/235 and U 238 data sets of estimated releases and measured air concentrations for the period 1986-1995. ATSDR used the resultant regression equations to predict new uranium air concentration values of U 234/235 and U 238, separately, *for the same time period*. Predictably, since its regression analyses are essentially "best fits" of the release and measurement data for 1986-1995, ATSDR found good agreement between their estimated values and measured values for U 234/235 and not as good agreement for the U 238 data. It concludes: "The coefficient of 0.9657 between Scarboro air concentrations and Y-12 U 234/235 emissions indicates that the regression is a very reliable estimator of historic Scarboro air radioactivity concentrations" (PHA, p. E-1, line 28 and p. E-2, lines 1-3). Conversely,	and Scarboro air concentrations are positively correlated, but that there is more variability in the U 238 data. The variability of the U 238 data may be associated with the contribution of background U 238 to measured Scarboro air concentrations or with the greater uncertainty of the U 238 emission estimates. The very high U 235 correlation coefficient indicates that the U 235 regression equation is a better estimator of the dispersion and transport processes of Y-12 emissions and the resulting Scarboro uranium air concentrations. Regardless of the source of the variation in the respective regression analyses, the regression equations for the U 235 and U 238 analyses clearly indicate a significant difference in the sample populations. Combining these populations into one statistical population (per the Task 6 χ/Q evaluation) is inappropriate and simply compounds the uncertainty regardless of its source. Our conclusion that the Task 6 χ /Q process overestimates Scarboro uranium air concentrations is well supported by Figures E-1 and E-4. Based on these figures and the correlation coefficient of nearly 1, the regression equation is a valid estimator of the emission and dispersion processes for the 10-year period of measurement. Figures E-1 and E-4 graphically plot the specific data values for the estimated Task 6 uranium air concentrations, the measured Scarboro uranium air concentrations, and the values estimated using the regression method. Relative to Figure E-4, the Task 6 χ/Q method both overestimates and underestimates the measured Scarboro concentrations and as such is not a reliable indicator of the measured values, much less the historic estimated values. As there is no reason to assume that those dispersion processes have changed from the period of measurement (1986 to 1995) relative to the earlier period (in which emissions were higher but Scarboro air concentrations were unmeasured), the regression estimation process should be a very reliable indicator of historic uranium air concentrations.

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	because their regression correlation coefficient for U 238 was "only 0.6377," ATSDR concludes that, "the regression equation based on U 238 emissions and measured Scarboro air concentrations is not considered a reliable estimator of historic air concentrations" (p. E-2, lines 18-21). Since Appendix E provides no data, figures, or analyses comparing measured and Task 6 estimated uranium air concentrations values for U 234/235 and U 238, we performed these comparisons, the results of which are provided in Table 5. [ATSDR note: Table 5 is provided in the notes section at the end of this table.] As shown in this table, Task 6 uranium air concentrations are indeed higher, on average, than comparable measured values by a factor of 4 for U 234/235 only, a factor of 3 for U 238 only, and a factor of 3 for U 234/235 and U 238 combined. However, these results are entirely predictable and consistent with the Task 6 team's stated intention, namely, to apply the 95th UCL χ/Q value to estimate air concentrations for the 1986-1995 period to maintain consistency with the estimates for 1994-1985, which are based only on the χ/Q approach. Since the period 1986-1995 accounts for such a small amount of the total Y-12 uranium releases (and corresponding air concentrations and air pathway-dependent radiation doses and risks), overestimation of the U 234/235 and U 238 air concentrations based on the χ/Q approach is of little consequence. Moreover, it also does not necessarily follow that, if estimates of the air concentrations for 1986-1995 are indeed overestimated, then the air concentrations estimated for 1944-1985 are also overestimated, along with associated doses and risks. Finally, we note that ATSDR's regression results are heavily dependent on 2 to 3 influential data points. Based on these considerations, we conclude that ATSDR's regression analysis: (1) only underscores the uncertainties in the release and measurement data and the limitations of any approach that uses these data to reconstruct historical uranium air concentrations at Scarboro; (2) is neither a "very reliable estimator" of historic Scarboro U 234/235 concentrations nor an unreliable estimator of U 238 concentrations, contrary to statements made; (3) is not a demonstrably better or worse approach than the Task 6 χ/Q approach; and (4) should not, by itself, be relied upon to determine whether or not the χ/Q approach either overestimates or underestimates air concentrations. Given ATSDR's conclusion regarding the superiority of its linear regression approach, we were surprised to discover that ATSDR *did*	

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	not apply it to derive revised uranium air concentrations and revised dose estimates for Scarboro.	
119	We suggest that ATSDR or others should do a more thorough analysis of the uncertainties for all uncertain variables, such as the uranium release estimates, the measured Scarboro airborne uranium concentrations, and the empirical χ/Q values. We also suggest that the Task 6 χ/Q approach, or any other approach used to reconstruct historical uranium air and soil concentrations at Scarboro, should be modified, as necessary, verified and validated, perhaps using additional soil core sampling results and meteorological data for Scarboro, as recommended by several reviewers (see Appendix G).	As stated in the title, the Task 6 report was a "Screening Evaluation of Potential Off-Site Exposure." Since the screening evaluation (which contained conservative aspects [see list of conservative aspects of the screening evaluation on pages 48 and 92 of the PHA]) resulted in a total past uranium dose below levels of health concern, ATSDR does not believe the evaluation of Y-12 uranium releases requires a further refinement with uncertainty and sensitivity analyses. As discussed in the NCRP Commentary 14, *A Guide For Uncertainty Analysis In Dose And Risk Assessments Related To Environmental Contamination* (issued in 1996), if a conservatively based screening calculation is performed and this screening calculation indicates the risk is "clearly below regulatory or risk levels of concern," and the possible exposure is low, then a quantitative uncertainty analysis may not be necessary. By design, conservative screenings are "highly unlikely to underestimate the true dose or risk." Based on this document, ATSDR agrees with the Task 6 authors that a quantitative uncertainty analysis is not needed for this portion of the Oak Ridge Dose Reconstruction Project. On page D-3, the Task 6 authors state: "although an uncertainty analysis of the Task 6 air source term was not within the scope of Task 6, experts interviewed during the project consider release estimates for enriched uranium to be suitable for the Task 6 screening assessment and are within an order of magnitude of actual releases" (ChemRisk 1999). The response to comment 166 provides additional details about conducting uncertainty analyses. Additionally, in 2001, EPA Region IV collected and analyzed core samples from two locations in Scarboro. Page 19 their report stated that EPA Region IV "does not propose to conduct any further environmental sampling in the Scarboro community." Page 26 of their report stated that "based on EPA's results, the Scarboro community is safe. Therefore, additional sampling to determine current exposure is not warranted" (EPA 2003). Page 29 in the PHA provides a short summary of the EPA sampling. To expand the information presented, ATSDR added a summary brief of the EPA report in Appendix I of the final PHA.
120	(5) ATSDR states on page 54: *Using the International Commission on Radiological Protection's dose conversation factors tends to overestimate the actual radiological doses due to the built-in conservative assumptions (i.e., selecting variables that typically overestimate the true but uncertain physical and biological interactions associated with radiation exposure)*	Thank you for your comment. ATSDR reevaluated the appendix and incorporated changes to reflect a more accurate discussion of this issue.

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	(for examples, see Harrison et al. 2001; Leggett 2001). ATSDR repeats this and similar statements at several locations throughout Section III the and directs readers to Appendix F "for additional information about the conservatism built into ICRP's dose conversion factors" (PHA, p. 62, lines 10-11). Appendix E, titled *A Conservative Approach in Radiological Dose Assessment, Issues Associated with Being Protective or Overestimating Radiological Dose,* is three pages long. It consists of very brief discussions of ICRP dose coefficients, radiation and tissue weighting factors, detriment coefficients for workers and members of the public, and a two-paragraph summary that concludes, in part, that (a) the establishment of dose coefficients or dose conversation factors involves much uncertainty in the parameters leading to the calculation of the coefficient, and (b) because of human variability, a standardized human commonly called a "reference man" is used to estimate the radiological dose. ATSDR provides no information from the two references it cites (i.e., Harrison et al. 2001 and Leggett 2001) to substantiate its claims. While we agree that ICRP's dose coefficients are uncertain (as pointed out Harrison et al. 2001 and Leggett 2001), we disagree with ATSDR's assertions that the ICRP intentionally incorporates overly conservative assumptions into all its models in order to derive coefficients that over predict radionuclide intakes and radiation doses. To the contrary, ICRP has, in fact, expended great effort to improve their intake, biokinetic, dosimetric, and risk models, and the reliability of their dose estimates for occupational and environmental exposures, as is clearly documented in the following ICRP Publications: • ICRP (1989) *Age-Dependent Doses to Members of the Public from Intake of Radionuclides, Part 1*, ICRP Publication 56. • ICRP (1991) *1990 Recommendations of the International Commission on Radiological Protection*, ICRP Publication 60. • ICRP (1992) *The Biological Basis for Dose Limitation in the Skin*, ICRP Publication 59. • ICRP (1993) *Age-Dependent Doses to Members of the Public from Intake of Radionuclides, Part 2*, ICRP Publication 67. • ICRP (1994a) *Human Respiratory Tract Model for Radiological Protection*, ICRP Publication 66. • ICRP (1994b) *Dose Coefficients for Intakes of Radionuclides by Workers*, ICRP Publication 68.	

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	• ICRP (1995a)*Age-Dependent Doses to Members of the Public from Intake of Radionuclides, Part 3,* ICRP Publication 69. • ICRP (1995b) *Age-Dependent Doses to Members of the Public from Intake of Radionuclides, Part 4*, ICRP Publication 71. • ICRP (1995c) *Basic Anatomical and Physiological Data for Use in Radiological Protection: The Skeleton*, ICRP Publication 70. • ICRP (1996) *Age-Dependent Doses to Members of the Public from Intake of Radionuclides, Part 5. Compilation of Ingestion and Inhalation Dose Coefficients*, ICRP Publication 72. Specifically, ICRP recently introduced a new respiratory tract model (ICRP 1994a) that involves considerably greater detail and physiological realism than previous models of the respiratory system. ICRP's current model of the gastrointestinal (GI) tract, which was originally developed for occupational intakes of radionuclides, has been adapted to account for environmental intakes of radionuclides by members of the public, with age-specific GI tract absorption values. ICRP's revised systemic biokinetic and dosimetry models involve parameter values that vary with age. Physiologically-based models are used for radioisotopes of calcium, iron, strontium, iodine, barium, lead, radium, thorium, **uranium**, neptunium, plutonium, americium, and curium, that depict loss of material by specific excretion pathways, feedback of material from organs to blood plasma, and certain physiological processes that are known to influence the distribution and translocation of the elements in the body. Dr. Keith EckermanCleader of the Dosimetry Research Group at Oak Ridge National Laboratory, member of several ICRP committees, including the Chair of the Task Group on Dosimetry, and principal author of all EPA Federal Guidance Documents on dose and risk coefficients confirms that the ICRP strives to use realistic models and parameter values in their calculations of dose coefficients to provide best estimates of radiation dose per unit intake or exposure (personal communication, April 2003). He notes that the degree of biological realism incorporated into each of the ICRP models is limited by practical considerations regarding the amount and quality of information available to determine actual paths of movement and parameter values for specific elements. However, he refutes ATSDR's contention that ICRP adds conservative assumptions to the dose conversion factor values to overestimate radiological doses.	
121	(6) <u>ATSDR states on page 54</u>: *In evaluating the soil exposure pathway, the Task 6 team used EFPC floodplain soil data to calculate doses. Actual*	ATSDR agrees with ORHASP that "any decision about additional dose reconstruction studies should be deferred until the results of recommended soil sampling program

	EPA Comment	ATSDR's Response
	measured soil concentrations in Scarboro are much lower than the uranium concentrations in the floodplain soil. Consequently, the uranium doses that were estimated for the residents were overestimated because of the use of the higher EFPC floodplain uranium concentrations. The estimated doses would be much lower if they were based on actual measured soil concentrations in Scarboro. We agree with the Oak Ridge Health Agreement Steering Panel (ORHASP 1999, pp. 52 and 72) that: (1) the results of recent sampling at Scarboro are not representative of earlier years because only surface soil was sampled; (2) collection and analysis of cores of soil from a variety of locations in and around Scarboro is needed to determine site-specific surface and subsurface soil concentrations and to check the validity of the screening calculation; (3) the depth of the core samples must be sufficient to encompass the region of downward migration of uranium in soil; (4) detailed profiles of uranium concentrations as a function of depth are necessary to understand historical patterns of contamination and migration; (5) sampling sites should be in undisturbed areas; and finally (6) any decision about additional dose reconstruction should be deferred until the results of the recommended soil sampling program have been obtained and carefully interpreted.	have been obtained and carefully interpreted" (ORHASP 1999 page 72). The Task 6 team, ATSDR scientists, Auxier & Associates, and ORHASP all agree that the EFPC floodplain concentrations used in the Task 6 soil pathway assessment are higher than soil concentrations found in Scarboro: • The Task 6 report stated on the bottom of page 3-27 that "conservatism was probably also introduced by the use of 1980 EFPC floodplain measurements to represent concentrations at Scarboro, which is outside of the floodplain" (ChemRisk 1999). • As shown in Figure 18 and Table 11 of ATSDR's PHA, the actual uranium radioactivity concentrations in Scarboro soil are approximately 8 to 22 times less than the EFPC floodplain soil concentrations. • In 1998, DOE hired Auxier & Associates to compare the results of the Scarboro survey with relevant aspects of the Task 6 report (Prichard 1998). The report stated on page 12 that "the results of the Scarboro soil sampling are clearly relevant to the Task 6 dose projections, and by extension, the screening indices…The agreement between deposition inferred from soil samples and deposition predicted on the basis of Task 6 air concentration projections is well within the uncertainties of the parameters used in these calculations. It is concluded that the 1998 soil sampling results are very supportive of the August, 1998 Task 6 projection of the historical average concentration of uranium in air in the Scarboro Community." Three of the technical reviewers hired by ATSDR commented on the Auxier report, describing its analysis and overall conclusions as compelling. Two reviewers stated that it presented convincing evidence that the Scarboro soil sampling data (FAMU 1998) are superior to the EFPC sediment samples used as surrogates for soil data in the Task 6 report. One reviewer indicated that the Auxier report convinced him that uranium soil concentrations are 10 to 100 times lower than the values listed in the Task 6 report. The reviewer described the Auxier report as "valuable work" that will "add the kind of information which will be needed for a risk assessment" (see page G-10 in PHA). • ORHASP stated on page 52: "estimates of soil concentrations from uranium deposition in Scarboro (*P. Voilleque, 1998*) suggest that the sediment sample concentration used may have been 10 times higher than the peak concentration in Scarboro soil. Collection and analysis of cores of soil from a variety of locations

	EPA Comment	ATSDR's Response
		have been recommended as a possible means to resolve this question and to check the validity of the screening calculation" (ORHASP 1999). In 2001, EPA Region IV collected and analyzed core samples from two locations in Scarboro. On page 19 of its report, EPA Region IV states that it "does not propose to conduct any further environmental sampling in the Scarboro community." On page 26, the report states that: "based on EPA's results, the Scarboro community is safe. Therefore, additional sampling to determine current exposure is not warranted" (EPA 2003). Page 29 in the PHA provides a short summary of the EPA sampling. To expand the information presented, ATSDR added a summary brief of the EPA report in Appendix I of the final PHA. In conclusion, ATSDR agrees that actual measured uranium soil concentrations in Scarboro are much lower than the uranium concentrations in the EFPC floodplain soil. Since the screening evaluation (which contained conservative aspects [see list on pages 48 and 92 of the PHA], including the use of the higher EFPC floodplain uranium concentrations to estimate exposure levels in Scarboro) resulted in a total past uranium dose well below levels of health concern, ATSDR does not believe the evaluation of Y-12 uranium releases requires additional dose reconstruction evaluation. ATSDR also agrees with EPA Region IV that additional sampling is not warranted. For additional discussion of the ORHAP recommendation #3, see ATSDR's response to comment 108. In addition, based on the ORHASP decision guides, the estimated Task 6 Level II screening risk from off-site exposure to Y-12 uranium is so low that further detailed study of exposures is not warranted. The Level II screening index (8.3×10^{-5}) is 1.2 times less than the ORHASP decision guide (1×10^{-4}) and; therefore, below the threshold for consideration of more extensive health effects studies. (See the Level II screening index on page 4-12 of the Task 6 report and the ORHASP Decision Guides on page 57 of the ORHASP report.)
Evaluation of Current Exposures		
122	Based on the limited information presented in the PHA, we agree with ATSDR's conclusion that the current uranium exposures at Scarboro are probably within acceptable limits. However, we recommend that ATSDR provide more detailed presentations and analyses, as discussed in Comment 6 [ATSDR note: the following comments].	Thank you for your comment. ATSDR concluded that current uranium exposure poses no apparent public health hazard to residents living near the Y-12 plant, including Scarboro residents. Current uranium exposure would not result in harmful health effects. The commenter's recommendations will be discussed in the following responses to public comments.

	EPA Comment	ATSDR's Response
123	For current uranium exposures, ATSDR should present missing data sources, provide explicit calculations of intakes and doses, modify selected exposure parameter values, include additional exposure pathways, and present cancer risk estimates. For the evaluations of current exposures, we found that, in many cases, the empirical data used in the dose calculations are incomplete or absent, exposure parameter values are not defined or explained, no equations are provided, and some relevant exposure pathways are omitted. For these reasons, we provide the following comments and suggestions: [ATSDR note: This comment is split into the following separate comments.]	It is not ATSDR's policy to provide raw data from primary sources that are publicly available. But ATSDR does supply references to the data used; which is good technical practice. The current exposure evaluation primarily relied on data supplied by OREIS, a centralized, standardized, quality-assured, and configuration-controlled environmental data management system. It is a public data source available at the following Web site http://www-oreis.bechteljacobs.org/oreis/help/oreishome.html. ATSDR also supplemented the current exposure pathway with data from FAMU (1998) and EPA (2003). The FAMU data are available in OREIS. EPA Region IV's final report is available at the following Web site: http://www.epa.gov/Region4/waste/fedfac/doeorr.htm. These data sources are also available at the DOE Information Center (475 Oak Ridge Turnpike, Oak Ridge TN 37830; phone: 865-241-4780; Web site: http://www.oakridge.doe.gov/info_cntr/index.html). Following the ATSDR Cancer Framework Policy, ATSDR does not perform risk assessments. The agency, however, does recognize the importance of EPA risk assessment and risk analysis to determine if levels of chemicals at hazardous waste sites pose an unacceptable risk as defined by regulatory standards and requirements and to help regulatory officials make decisions in support of cleanup strategies that will ensure overall protection of human health and the environment. ATSDR acknowledges that conservative safety margins are built into EPA risk assessments and that these assessments do not measure the actual health effects that hazardous chemicals at a site have on people. For additional information, please review the framework policy that can be found at http://www.atsdr.cdc.gov/cancer.html. See the response to comment 127 for additional information distinguishing a risk assessment from a health assessment. Any modified exposure scenarios are discussed within the document either in the main text or within the footnotes of the tables and figures, where the data are presented.
124	To assess radiological impacts via air pathways (pp. 78-80), ATSDR should show *all* uranium air concentration data used to calculate inhalation doses for Stations 1, 37, 38, 40, 46 (Scarboro), 51, and 52, along with a reference for the primary data source, and explain why doses are presented for the other monitoring stations.	It is not ATSDR's policy to provide raw data from primary sources that are publicly available. But ATSDR does supply references to the data used; which is good technical practice. ATSDR evaluated over 500 air samples from OREIS to assess current exposures through the air pathway. OREIS is a centralized, standardized, quality-assured, and configuration-controlled environmental data management system that is publicly available at the following Web site http://www-

	EPA Comment	ATSDR's Response
		oreis.bechteljacobs.org/oreis/help/oreishome.html. ATSDR added the source of the data to the legend in Figure 22. ATSDR clarified the text to indicate why data from the other monitoring stations were presented.
125	To assess radiological impacts via air pathways (pp. 78-80), ATSDR should show the equation or equations, parameters, and parameter values used, including exposures frequencies, duration, and ICRP dose coefficients (which are currently not provided).	Exposure scenarios and equations are discussed within the document either in the main text or within the footnotes of the tables and figures, where the data are presented. The ICRP dose coefficients are copyrighted and can be obtained through many university and technical libraries. They are also available from the following Web site: http://www.icrp.org/.
126	To assess radiological impacts via air pathways (pp. 78-80), ATSDR should explain whether average or 95th percentile Scarboro uranium air concentrations were used in the calculations, and whether or not background uranium air concentrations were subtracted from site-specific concentrations.	As noted in the footnote to Table 15, ATSDR used the average air concentrations to calculate uranium doses. The doses were not corrected for background. However, ATSDR also calculated exposure to background locations (Stations 51 and 52) so the reader could compare the Scarboro doses to the background doses.
127	To assess radiological impacts via air pathways (pp. 78-80), ATSDR should calculate *lifetime* cumulative radiological doses and risks for *all ages combined* for *all* of the air pathway-dependent exposure pathways, such as the air-to-pasture grass-to-meat/milk pathways, included in the assessment of past exposures. ATDR should discuss why EPA's accepted risk range for CERCLA sites should or should not be used for risk comparisons of the data and exposures. Discuss why ATSDR uses the dose criteria, and do not use, refer to, or at least compare this to EPA's risk range for CERCLA sites.	Livestock are only allowed within the city limits in limited zoning areas. Therefore, the air-to-pasture grass-to-meat/milk pathways are not realistic current exposure scenarios. To determine the public health implications (potential health hazard) from current exposure to uranium released from the Y-12 plant, ATSDR scientists conducted a realistic site-specific assessment. The estimated doses are based on daily exposure, up to an age of 70 years (i.e., lifetime). To understand why ATSDR scientists use doses in the public health assessment process (instead of the quantitative baseline risk assessments conducted by regulatory agencies, such as EPA) it is important to understand the deliberate differences between ATSDR's health assessments and EPA's risk assessments. The public health assessment is different from a risk assessment primarily in its purpose, goals, exposures evaluated, and the use of information. *The response to comment 127 is continued on the following pages.*

	EPA Comment	ATSDR's Response
127		

ATSDR Public Health Assessment vs. EPA Baseline Risk Assessment Issue

As explained in ATSDR's Public Health Assessment Guidance Manual (http://www.atsdr.cdc.gov/HAC/HAGM/), EPA's *Risk Assessment Guidance for Superfund – Human Health Evaluation Manual*, and in *A Citizen's Guide to Risk Assessments and Public Health Assessments at Contaminated Sites* (written jointly by ATSDR and EPA Region IV; see Appendix J), there are deliberate differences between ATSDR's health assessments and EPA's risk assessments. The two agencies have distinct purposes that necessitate different goals for their assessments. An EPA baseline risk assessment is used to support the selection of a remedial measure at a site. An ATSDR health assessment is a mechanism to provide the community with information on the public health implications of a specific site, identifying those populations for which further health actions or studies are needed.

Agency	**ATSDR**	**EPA**
Type of Assessment	**Public Health Assessment**	**Baseline Risk Assessment**
Description	The public health assessment process is an evaluation of data and information (environmental data, health outcome data, and community concerns) pertaining to the release of hazardous substances into the environment. Its purpose is to assess the likelihood of health effects from exposure to hazardous substances and to identify appropriate public health actions to evaluate or prevent health effects. In addition, ATSDR also uses the process to respond to site-specific community health concerns. It is qualitative, site-specific, and it focuses on medical and public health perspectives.	The quantitative baseline risk assessment, the framework of the EPA human health evaluation, is a numerical analysis of environmental data used to characterize the probability (theoretical risk) of adverse effects as defined by regulatory standards and the requirement for the remedial investigation/feasibility study (RI/FS) at Superfund sites. It is a quantitative, chemical-oriented characterization that use statistical models to estimate risk from a regulatory perspective.
Purpose	To provide community members and environmental and public health agencies with conclusions about the actual existence or level of the public health hazard posed by exposure to hazardous substances at a specific site and to identify populations for which further public health actions or studies are needed to evaluate or prevent health effects.	To assist risk management decision-making in the selection of remedial actions involving hazardous site cleanup strategies (the determination of permit levels for the discharge, storage, or transport of hazardous waste; the establishment of clean-up levels; the determination of allowable levels of contamination).
Goal	To determine whether or not harmful health effects are expected from contaminants in the environment and to make recommendations for actions needed to protect public health, which may include issuing health advisories.	To provide a framework for developing the risk information necessary to assist decision-making at remedial sites.
Objectives	To determine the nature and extend of contamination To define potential human exposure pathways To identify populations who may be or may have been exposed To determine the health implications and public health hazard of site-related exposures, using environmental, toxicological, medical, and health outcome data To address those public health implications by recommending relevant public health actions to prevent harmful exposures To identify and respond to community health concerns	To help determine whether additional remedial response action is necessary at a site To provide a basis for determining residual chemical levels that are adequately protective of health To provide a basis for comparing potential health impacts of various remedial alternatives To help support selection of the "no-action" remedial alternative To identify remedial actions that pose an acceptable risk as defined by regulatory standards

EPA Comment	ATSDR's Response	
Agency	**ATSDR**	**EPA**
Type of Assessment	**Public Health Assessment**	**Baseline Risk Assessment**
Exposures and Pathways Evaluated	To evaluate site-specific exposure conditions about actual or likely past, current, and future exposures.	To evaluate possible current or future exposures and consider all contaminated media regardless of whether exposures are occurring or likely to occur.
Result	The public health assessment report provides ATSDR's conclusion regarding the degree of public health hazard, if any, posed by a site or hazardous substances in the environment and recommends appropriate public health actions needed to limit, eliminate, or further study any potential harmful exposures. The report provides a qualitative description of whether exposures to hazardous substances are of sufficient nature and magnitude to be a public health hazard and trigger public health actions. Because of uncertainties, a definitive answer on whether health effects actually will or will not occur is not possible. However, the report puts exposures and the potential for harm in perspective.	The EPA baseline risk assessment provides a quantitative estimate of theoretical risk used to support the selection of a remedial measure at a site. These quantitative estimates of risk are based on default exposure and toxicity assumptions that represent a prudent conservative (protective) approach—that of prevention. These conservative assumptions ensure that remedial actions are amply safe and protective of health. The risk estimates are not intended to predict the incidence of disease or measure the actual health effects a site has on people.
Methods	The public health assessment process is an iterative and dynamic process. In the initial screening evaluation, similar techniques to those of the quantitative risk assessment methods may be used primarily as a screening tool to clearly rule out the existence of public health hazards. However, if during this screening assessment the estimated dose exceeds one or more media-specific comparison values (dose-base comparison values or quantitative risk estimates) the public health assessment process proceeds with a more in-depth health effects evaluation. ATSDR scientists conduct a health effects evaluation by carefully examining site-specific exposure conditions and comparing an estimate of the amount of chemical exposure (i.e., dose) that people might frequently encounter at a site to situations that have been associated with disease and injury. This health effects evaluation involves a balanced review and integration of site-related environmental data, site-specific exposure factors, and toxicologic, epidemiologic, radiologic, and medical information to help determine whether exposure to contaminant levels might result in harmful effects. The goal of the health effects evaluation is to decide whether or not harmful effects might be possible in the exposed population by weighing the scientific evidence and by keeping site-specific doses in perspective.	The quantitative theoretical risk estimates are based on statistical and biological models that include a number of protective assumptions about exposure and toxicity to ensure protection of the public. By design, they are conservative estimates that generally overestimate health risk. Therefore, people will not necessarily be affected even if they are exposed to materials at dose levels higher than those estimated by the risk assessment. For cancer effects, risks are expressed as probabilities. These probabilistic risks are not intended to predict the incidence of disease or measure the actual health effects a site has on people. For noncancer effects, exposure levels are compared to pre-established levels deemed to be safe.

The response to comment 127 is continued on the following pages.

	EPA Comment	ATSDR's Response
127		**Public Health Assessment** The public health assessment process serves as a triage for evaluating the public health implications of exposure to environmental contamination and for identifying appropriate public health actions for particular communities. PHAs are used to identify populations off the site who are exposed to hazardous substances; to determine how and when they were exposed; to determine whether these past, present, or future exposures are likely to lead to illness; and to recommend follow-up public health actions to address the exposure and ensure the protection of public health. The public health assessment process is iterative and dynamic and may lead to a variety of public health actions. The process also serves as a mechanism through which the agency responds to site-specific community health concerns. In the public health assessment process, similar techniques to those of the quantitative risk assessment methods (i.e., generating quantitative "risk estimates") may be used primarily as a screening tool to clearly rule out the existence of public health hazards or as a way of understanding regulatory concerns. However, if exposure at a site exceeds one or more media-specific comparison values (dose-based comparison values or quantitative risk estimates), the public health assessment process proceeds with a more in-depth health effects evaluation. ATSDR scientists conduct a health effects evaluation by carefully examining site-specific exposure conditions about actual or likely exposures; conducting a critical review of available toxicological, medical, and epidemiologic information to ascertain the substance-specific toxicity characteristics (levels of significant human exposure); and comparing an estimate of the amount of chemical exposure (i.e., dose) to which people might frequently encounter at a site to situations that have been associated with disease and injury. This health effects evaluation involves a balanced review and integration of site-related environmental data, site-specific exposure factors, and toxicological, radiological, epidemiologic, medical, and health outcome data to help determine whether exposure to contaminant levels might result in harmful effects. The goal of the health effects evaluation is to decide whether or not harmful effects might be possible in the exposed population by weighing the scientific evidence and by keeping site-specific doses in perspective. The output is a qualitative description of whether site exposure doses are of sufficient nature and magnitude to trigger a public health action to limit, eliminate, or further study any potential harmful exposures. The PHA report presents conclusions about the actual existence and level of the health threat (if any) posed by a site. It also recommends ways to stop or reduce exposures. The conclusions and recommendations are based on the professional knowledge and judgment of the health assessment team members. However, because of uncertainties regarding exposure conditions and adverse effects associated with environmental

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		levels of exposures, definitive answers on whether health effects actually will or will not occur are not possible. However, providing a framework that puts site-specific exposures and the potential for harm in perspective is possible. It is one of the primary goals of the public health assessment process. **Baseline Risk Assessment** The quantitative baseline risk assessment (the framework of the EPA human health evaluation) is a numerical analysis used to determine if levels of chemicals at hazardous waste sites pose an unacceptable risk as defined by regulatory standards and requirements. The risk assessment process is used by regulators as part of site remedial investigations to support risk management decisions and to define remedial actions involving hazardous site cleanup strategies (the determination of permit levels for the discharge, storage, or transport of hazardous waste; the establishment of clean-up levels; the determination of allowable levels of contamination) that ensure overall protection of human health and the environment. Remedial plans based on a quantitative risk assessment represent a prudent public health approach—that of prevention. The EPA risk assessment provides an estimate of theoretical risk from possible current or future exposures and considers all contaminated media regardless of whether exposures are occurring or are likely to occur. For cancer effects, risks are expressed as probabilities. For noncancer effects, exposure levels are compared to pre-established levels deemed to be safe. The quantitative risk estimates are not intended, however, to predict the incidence of disease or measure the actual health effects that hazardous substances at a site have on people. The estimated predictions are based on statistical and biological models that include a number of protective assumptions about exposure and toxicity to ensure protection of the public. By design they are conservative predictions that generally overestimate risk. For this reason, the risk estimates are very useful in deciding the extent to which a site needs to be cleaned up (and to what levels) to adequately protect public health. By design, risk assessment involves estimating exposure doses based on conservative (protective) standard (or default) exposure and toxicity assumptions (which often overestimate health risk) to ensure that remedial actions are amply safe and protective of health. Therefore, people will not necessarily be affected even if they are exposed to materials at dose levels higher than those estimated by the risk assessment. Therefore, EPA's quantitative risk assessment (which are used for regulatory purposes) do not provide perspective on what the risk estimates mean in the context of the site community and do not measure the actual health effects that hazardous substances have on people.

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		Thus, while a risk assessment conducted under EPA's Remedial Investigation/Feasibility Study (RI/FS) process is used to support the selection of a remedial measure at a site, an ATSDR health assessment is a mechanism to provide the community with information on the public health implications of a specific site, identifying those populations for which further health actions or studies are needed. The health assessment also makes recommendations for actions needed to protect public health, which may include issuing health advisories. An interactive program that provides an overview of the public health assessment process ATSDR uses to evaluate whether people will be harmed by hazardous materials is available at: http://www.atsdr.cdc.gov/training/public-health-assessment-overview/html/index.html. A comprehensive guide to the Superfund risk assessment process is available from EPA on the Internet at: http://www.epa.gov/superfund/programs/risk/rsk_sf1.htm. **ATSDR Cancer Framework Policy** Following the ATSDR Cancer Framework Policy, ATSDR does not perform risk assessments. The agency, however, does recognize the importance of EPA risk assessment and risk analysis to determine if levels of chemicals at hazardous waste sites pose an unacceptable risk as defined by regulatory standards and requirements and to help regulatory officials make decisions in support of cleanup strategies that will ensure overall protection of human health and the environment. ATSDR acknowledges that conservative safety margins are built into EPA risk assessments and that these assessments do not measure the actual health effects that hazardous chemicals at a site have on people. For additional information, please review the framework policy that can be found at http://www.atsdr.cdc.gov/cancer.html.
128	EPA uses Preliminary Remediation Goals [PRGs] to screen radiation sites, not RBCs [old name]. Should add the PRGs for Uranium isotopes or discuss why EPA's PRGs are not appropriate for screening sites [soil, water samples]. See Web site: http://epa-prgs.ornl.gov/radionuclides/.	ATSDR referenced EPA Region III's RBC for fish consumption. RBCs are health-based comparison values that are updated quarterly. From the October 15, 2003 Updated Risk Based Concentration Table Cover Memo: "The RBC Table contains Reference Doses (RfDs) and Cancer Slope Factors (CSFs) for 400-500 chemicals. These toxicity factors have been combined with "standard" exposure scenarios to calculate RBCs--chemical concentrations corresponding to fixed levels of risk (i.e., a Hazard Quotient (HQ) of 1, or lifetime cancer risk of 1E-6, whichever occurs at a lower concentration) in water, air, fish tissue, and soil." (EPA Region III 2003) The ATSDR radiogenic cancer comparison value of 5,000 mrem over 70 years was

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		used by ATSDR to evaluate the carcinogenic effects of radiation from uranium exposure. See the responses to comments 127 and 18 for additional information on the differences between an EPA risk assessment and an ATSDR health assessment and on ATSDR's radiogenic cancer comparison value.
129	To assess radiological impacts via air pathways (pp. 78-80), ATSDR should conduct a sensitivity and uncertainty analysis, assigning PDFs to all uncertain parameters, and present distributions of dose and risk estimates.	As stated in the title, the Task 6 report was a "Screening Evaluation of Potential Off-Site Exposure." It routinely and appropriately used several layers of conservatism and protective assumptions and approaches. (See the list of conservative aspects of the screening evaluation on pages 48 and 92 of the PHA.) Since the screening evaluation resulted in a total past uranium dose below levels of health concern, ATSDR does not believe the evaluation of Y-12 uranium releases requires a refined evaluation with uncertainty and sensitivity analyses. As discussed in the NCRP Commentary 14, *A Guide For Uncertainty Analysis In Dose And Risk Assessments Related To Environmental Contamination* (issued in 1996) if a conservatively based screening calculation is performed and this screening calculation indicates the risk is "clearly below regulatory or risk levels of concern," and the possible exposure is low, then a quantitative uncertainty analysis may not be necessary. By design, conservative screenings are "highly unlikely to underestimate the true dose or risk." Based on this document, ATSDR agrees with the Task 6 authors that a quantitative uncertainty analysis is not needed for this portion of the Oak Ridge Dose Reconstruction Project. On page D-3, the Task 6 authors state "although an uncertainty analysis of the Task 6 air source term was not within the scope of Task 6, experts interviewed during the project consider release estimates for enriched uranium to be suitable for the Task 6 screening assessment and are within an order of magnitude of actual releases" (ChemRisk 1999). The response to comment 166 provides additional details about conducting uncertainty analyses.
130	To assess radiological impacts via surface water pathways (pp. 80-82), ATSDR should show *all* uranium surface water concentration data, in units of isotopic uranium activities and mass concentrations, not just the average total uranium mass concentrations, along with a reference for the primary data source, and explain when, where, how, and by whom the measurements were made and how many were made.	It is not ATSDR's policy to provide raw data from primary sources that are publicly available. But ATSDR does supply references to the data used; which is good technical practice. ATSDR evaluated over 10,000 surface water samples from OREIS to assess current exposures through the surface water pathway. OREIS is a centralized, standardized, quality-assured, and configuration-controlled environmental data management system that is publicly available at the following Web site http://www-

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		oreis.bechteljacobs.org/oreis/help/oreishome.html. ATSDR added the source of the data to the legend in Figure 23 and Table 16. As noted on page 70 in the PHA, the surface water samples were collected from 1995 to 2002 at the two off-site locations and the three on-site locations depicted in Figure 23. Information about how and by whom the testing was conducted can be obtained from the primary reports available in OREIS.
131	To assess radiological impacts via surface water pathways (pp. 80-82), ATSDR should calculate age-dependent radiological and chemically-toxic doses for *all* of the surface pathway-dependent exposure pathways included in assessment of past exposures, and add an irrigation pathway.	ATSDR's current evaluation is based on site-specific assessment of realistic exposures. Human exposures via livestock, dairy cattle, and irrigation exposure pathways are not realistic current exposure routes for the EFPC surface water pathway. As noted on pages 70–72 and 86–87 of the PHA, the total uranium mean concentration in surface water from Scarboro ditches and Lower EFPC is below ATSDR's EMEG and EPA's MCL. ATSDR EMEGS are health-based comparison values developed for screening environmental contamination for further evaluation. EMEGS are protective of public health in essentially all exposure situations. Exposure to concentrations at or below ATSDR's EMEG is considered safe and not considered to warrant health concern. The MCL is a regulatory level of a contaminant that is allowed in drinking water. Therefore, the concentrations of uranium to which people might be exposed via incidental ingestion and immersion during recreation in the EFPC surface water are not a public health hazard.
132	To assess radiological impacts via surface water pathways (pp. 80-82), ATSDR should show the equation or equations, parameters, and parameter values used, including exposures frequencies, duration, and ICRP dose coefficients.	As a first step in the public health assessment process, ATSDR compared the surface water concentrations to the ATSDR EMEG of 20 µg/L for highly soluble uranium salts (see page 71 in the PHA). As described in the Evaluating Exposure section (Section III.A.2.), the EMEG is a nonenforceable, health-based comparison value developed for screening environmental contaminants for further evaluation. The EMEG is a concentration that is much lower than those that have been observed to cause adverse health effects and is protective of public health in essentially all exposure situations. As a result, concentrations detected at or below the EMEG are not considered to warrant health concern. As shown in Table 16, the off-site surface water concentrations were below the EMEG. Therefore, no further evaluation was required; ATSDR did not calculate doses. No equations, parameters, and parameter values need to be presented. More information about the development of ATSDR's EMEGs can be found in Section 5.6 and Appendix A of the Public Health Assessment Guidance Manual at the

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		following Web site: http://www.atsdr.cdc.gov/HAC/HAGM/.
133	To assess radiological impacts via surface water pathways (pp. 80-82), ATSDR should calculate lifetime cancer risks using EPA's radionuclide slope factors.	Following the ATSDR Cancer Framework Policy, ATSDR does not perform risk assessments. The agency, however, does recognize the importance of risk assessment and risk analysis. For additional information, please review the framework policy that can be found at http://www.atsdr.cdc.gov/cancer.html. See the response to comment 127 for additional information distinguishing a risk assessment from a health assessment. Additionally, as noted on page 71 of the PHA, the mean total uranium concentrations in the off-site locations are below EPA's MCL for uranium of 30 µg/L. This MCL, according to the Final Rule, is "protective of kidney toxicity and carcinogenicity with an adequate margin of safety" (Federal Register 2000).
134	To assess radiological impacts via surface water pathways (pp. 80-82), ATSDR should conduct a sensitivity and uncertainty analysis, assigning PDFs to all uncertain parameters, and present distributions of dose and risk estimates.	As stated in ATSDR's response to comment 131, 132, and 133, the mean total uranium concentrations in the off-site locations of the EFPC are below ATSDR's EMEG and EPA's MCL for uranium and are not considered to warrant public health concern or further evaluation. In addition, based on the ORHASP decision guides, the estimated Task 6 Level II screening risk from off-site exposure to Y-12 uranium is so low that further detailed study of exposures is not warranted. The Level II screening index (8.3×10^{-5}) is 1.2 times less than the ORHASP decision guide (1×10^{-4}). Therefore, it is below the threshold for consideration of more extensive health effects studies. (See the Level II screening index on page 4-12 of the Task 6 report and the ORHASP Decision Guides on page 57 of the ORHASP report.) As discussed in the NCRP Commentary 14, *A Guide For Uncertainty Analysis In Dose And Risk Assessments Related To Environmental Contamination*, issued in 1996, if a conservatively based screening calculation is performed and this screening calculation indicates the risk is "clearly below regulatory or risk levels of concern" and the possible exposure is low, then a quantitative uncertainty analysis may not be necessary. By design, conservative screenings are "highly unlikely to underestimate the true dose or risk." The response to comment 166 provides additional details about conducting uncertainty analyses.
135	To assess radiological impacts via soil pathways (pp. 84-94), ATSDR should show *all* uranium soil concentration data from DOE (1993), FAMU (1998), EPA (2002), studies of U.S. national background, and any other	It is not ATSDR's policy to provide raw data from primary sources that are publicly available. But ATSDR does supply references to the data used; which is good technical practice. ATSDR evaluated soil samples from DOE (1993), FAMU (1998),

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	sources (e.g., data collected from off-site areas along the EFPC floodplain). These data should be presented as isotopic uranium activities and mass concentrations, and ATSDR should explain when, where, how, and by whom the measurements were made and how many were made.	and EPA (2003) to assess current exposures through the soil pathway. Page 29 in the PHA provides short summaries of the FAMU and EPA sampling. To expand the information presented, ATSDR added summary briefs of the EPA and FAMU reports in Appendix I of the final PHA.
136	To assess radiological impacts via soil pathways (pp. 84-94), ATSDR should move the entire discussion on the question of uranium enrichment in soil to an appendix.	The comment is noted. Since the issue of enrichment is a community health concern, ATSDR has decided to keep the organization of the PHA in its current form.
137	To assess radiological impacts via soil pathways (pp. 84-94), ATSDR should explain that only a *limited number* (i.e., 40 samples by FAMU, plus 7 samples and 1 duplicate by EPA) of *surface* (i.e., zero to 3-inch deep (top 5 cm) soil samples from *disturbed* areas in Scarboro were collected and analyzed.	Auxier & Associates stated on page 1 of their report that "for the stated scope of the study [FAMU 1998], the number of samples met or exceeded the number recommended in the EPA Region IV guidance (USEPA, Region 4, Science and Ecosystem Support Division, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, May 1996)" (Prichard 1998). The FAMU soil sampling consisted of biased and random sampling throughout the Scarboro community in areas where potential airborne deposition could occur. The biased sampling included collecting samples in undisturbed areas along the perimeter of the Scarboro community near the ORR boundary (FAMU 1998). In 2001, EPA Region IV collected uranium core samples from two locations in Scarboro "to determine if uranium isotopes could be found at depth" (page 4). The report stated that "none of the analytical values for the uranium cores were elevated above the PRG or background…There is no evidence that the substance is present at levels 12 inches below ground surface" (pages 7 and 17). From page 19 of their report: EPA Region IV "does not propose to conduct any further environmental sampling in the Scarboro community" and from page 26: "based on EPA's results, the Scarboro community is safe. Therefore, additional sampling to determine current exposure is not warranted" (EPA 2003). Page 29 in the PHA provides a short summary of the EPA sampling. To expand the information presented, ATSDR added a summary brief of the EPA report in Appendix I of the final PHA.
138	To assess radiological impacts via soil pathways (pp. 84-94), ATSDR should explain that the FAMU study did not measure U 234 and the EPA samples show that the *combined* U 234/235 activity concentrations do show enrichment over the U 238 concentrations [Note: *Both* U 234 and U 235 are enriched during the production of weapons-grade and reactor fuel materials.].	Figure 21, 24, and 25 in the PHA show that FAMU did not measure for U 234. As stated on pages 73 to 77 of the PHA, ATSDR disagrees that there is evidence of significant enrichment. The sample that would suggest enrichment is SS EPA 1, a sample with a duplicate, which does not show this trend. The other samples do not show a significant difference once the uncertainties are taken into account. Furthermore, the method used to determine isotopic ratios has significant variability. Additionally, EPA Region IV concluded on page 11 of their report that "the uranium

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		results showed uncertainty of uranium enrichment due to the level of the uranium isotopes being at background levels and/or detection limits and uncertainty. The uranium-235 measurements, in particular, had results where the uncertainty was greater than the value measured. Therefore, determining uranium enrichment is uncertain as well. If there is some uranium enrichment potentially in the uranium isotopes in the Scarboro soil and sediment, the actual levels of uranium isotopes are still within the U.S. and Oak Ridge background ranges" (EPA 2003).
139	To assess radiological impacts via soil pathways (pp. 84-94), ATSDR should explain that the analytical method used, i.e., alpha spectrometry, is not sensitive enough to determine U 235 activities reliably near background concentrations, and that Inductively-Coupled Plasma (ICP)-mass spectrometry would have been a more precise and reliable method to ascertain uranium isotopic soil concentrations.	ATSDR agrees that the methods used by both FAMU and the EPA Region IV would not necessarily be sufficiently sensitive to determine U 235 activities near background. Nonetheless, from a public health perspective, the amount of uranium present in the community is below levels known to cause adverse health outcomes. FAMU determined uranium isotopic content using alpha spectroscopy (FAMU 1998). EPA Region IV verified their results using gamma spectroscopy (EPA 2003). The EPA Region IV report states (on page vi): "EPA's study results are in agreement with similar, more extensive, studies done in 1998 by FAMU." They further explain on pages 7 and 9 that "gamma spectroscopy was used as a screen. It was chosen to analyze gamma-emitting isotopes which indicate radioactive decay… The analysis of the information reveals that all results for gamma emitters were within their predicted background ranges for the United States and Oak Ridge-wide. None of the analytical values were elevated above background. Uranium is both naturally occurring and site related… none of the EPA values were above the PRG or background" (EPA 2003). EPA Region IV states on page 19 of their report: "The results of both the EPA and DOE sampling effort are consistent in their findings. There is not an elevation of chemical, metal, or radionuclides above a regulatory health level of concern. The EPA sample analysis supports that the Scarboro community is not currently being exposed to substances from the Y-12 facility in quantities that pose an unreasonable risk to health or the environment. The EPA does not propose to conduct any further environmental sampling in the Scarboro Community" (EPA 2003).
140	To assess radiological impacts via soil pathways (pp. 84-94), ATSDR should explain that that due to the potential migration of uranium into soil and the high uranium release estimates for the first half of the operation of the Y-12 complex... soil concentrations would have been higher before 1974 than when they were taken in Scarboro recently. Because subsurface soil samples may show elevated uranium soil concentrations, added surface samples and subsurface (core) soil samples in *undisturbed* areas in and around Scarboro are necessary before conclusions concerning the	The FAMU soil sampling consisted of biased and random sampling throughout the Scarboro community in areas where potential airborne deposition could occur. The biased sampling included collecting samples in undisturbed areas along the perimeter of the Scarboro community near the ORR boundary (FAMU 1998). In addition, EPA Region IV stated on page 5 of their Scarboro sampling report that "because of the large amount of soil needed for each sample, the EPA samples were collected from 0-6 inches" (EPA 2003). Uranium is not expected to migrate to a great

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	assessment of potential adverse health effects of are made.	degree. The predominant chemical form of uranium released into the air from the Y-12 plant was highly insoluble uranium oxide (ChemRisk 1999). Leaching is not expected to be a major loss mechanism for insoluble materials, which bind tightly to clay soil particles (Prichard 1998). Therefore, this sampling procedure would have detected elevated uranium in surficial soils from undisturbed areas. In 2001, EPA Region IV collected uranium core samples from two locations in Scarboro "to determine if uranium isotopes could be found at depth." (page 5, EPA 2003). The report stated that "none of the analytical values for the uranium cores were elevated above the PRG or background… There is no evidence that the substance is present at levels 12 inches below ground surface" (pages 7 and 17). From page 19 of their report: EPA Region IV "does not propose to conduct any further environmental sampling in the Scarboro community" and from page 26: "based on EPA's results, the Scarboro community is safe. Therefore, additional sampling to determine current exposure is not warranted" (EPA 2003). Page 29 in the PHA provides a short summary of the EPA sampling. To expand the information presented, ATSDR added a summary brief of the EPA report in Appendix I of the final PHA. The data collected by FAMU (1998) and EPA Region IV (2003) were evaluated for the current exposure pathway (1990 to 2002). The assertion that "soil concentrations would have been higher before 1974 than when they were taken in Scarboro recently" is not relevant to the current pathway evaluation. Please see the response to comments 105 and 121 regarding soil data used to evaluate the past soil exposure pathway.
141	To assess radiological impacts via soil pathways (pp. 84-94), ATSDR should show the equation or equations, parameters, and parameter values used to calculate the *soil ingestion pathway*, including exposures frequencies, duration, and ICRP dose coefficients, and calculate *lifetime* intakes, doses, and risks for *all ages combined*, not just the average radiological dose for a 1 yr old based on the ingestion of 100 milligrams of soil daily for the course of one year with a committed effective dose calculated to 70 years of age (PHA, p. 90, footnote to Table 19).	The ICRP dose coefficients are copyrighted and can be obtained through many university and technical libraries. They are also available from the following Web site: http://www.icrp.org/. The doses that ATSDR calculated were based on daily exposures, up to an age of 70 years (i.e., a lifetime). ATSDR primarily focused on two age groups: adults and 1-year-olds. The reasoning was that these would be the most likely impacted groups who might come in contact with potentially contaminated surface soils. Table 19 lists doses to a 1-year-old and Table 23 gives soil ingestion doses to adult males, females, 12-year-olds and 6-year-olds. During the evaluation of other intake pathways (taking into consideration ingestion rates and body weights) ATSDR determined that there were no significant differences between adults and other age groups. As explained in Section 2 of ATSDR's Public Health Assessment Guidance Manual (http://www.atsdr.cdc.gov/HAC/HAGM/) and in *A Citizen's Guide to Risk Assessments and Public Health Assessments at Contaminated Sites* (written jointly by ATSDR and EPA Region IV) there are deliberate differences between ATSDR's

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		health assessments and EPA's baseline risk assessments. The two agencies have distinct purposes that necessitate different goals for their assessments. A risk assessment is used to support the selection of a remedial measure at a site. An ATSDR health assessment is a mechanism to provide the community with information on the public health implications of a specific site, identifying those populations for which further health actions or studies are needed. See the response to comment 127 for additional information distinguishing a risk assessment from a health assessment. Following the ATSDR Cancer Framework Policy, ATSDR does not perform risk assessments. The agency, however, does recognize the importance of EPA risk assessment and risk analysis to determine if levels of chemicals at hazardous waste sites pose an unacceptable risk as defined by regulatory standards and requirements and to help regulatory officials make decisions in support of cleanup strategies that will ensure overall protection of human health and the environment. ATSDR acknowledges that conservative safety margins are built into EPA risk assessments and that these assessments do not measure the actual health effects that hazardous chemicals at a site have on people. For additional information, please review the framework policy that can be found at http://www.atsdr.cdc.gov/cancer.html.
142	To assess radiological impacts via soil pathways (pp. 84-94), ATSDR should show the DOE data on levels of uranium isotopes in homegrown vegetables collected from a resident of Scarboro from 1998 to 2000 and show the equation or equations, parameters, and parameter values used to calculate the *vegetable ingestion pathway*, including exposures frequencies, duration, and ICRP dose coefficients, and calculate *lifetime* intakes, doses, and risks for *all ages combined* for *fruits and vegetables combined*, not just the average radiological dose for vegetable ingestion "based on 80-kilogram adult eating 2.27 grams of produce per kilogram of body weight per day (EPA 1997)."	It is not ATSDR's policy to provide raw data from primary sources that are publicly available. But ATSDR does supply references to the data used; which is good technical practice. ATSDR evaluated over 450 vegetable samples from OREIS to assess current exposures through the ingestion of garden vegetables. OREIS is a centralized, standardized, quality-assured, and configuration-controlled environmental data management system that is publicly available at the following Web site http://www-oreis.bechteljacobs.org/oreis/help/oreishome.html. With regard to ingestion parameters, based on the EPA *Exposure Factors Handbook* (EPA 1997) and taking into account ingestion rates and body weights, the vegetable ingestion rate for adults was used as the most conservative scenario. During the evaluation of other intake pathways (and taking into consideration ingestion rates and body weights) we determined there were no significant differences between adults and other age groups. Scarboro is known to have private vegetable gardens. The community has not expressed any concern over consumption of homegrown fruits. As explained in Section 2 of ATSDR's Public Health Assessment Guidance Manual (http://www.atsdr.cdc.gov/HAC/HAGM/) and in *A Citizen's Guide to Risk*

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		Assessments and Public Health Assessments at Contaminated Sites (written jointly by ATSDR and EPA Region IV) there are deliberate differences between ATSDR's health assessments and EPA's risk assessments. The two agencies have distinct purposes that necessitate different goals for their assessments. A risk assessment is used to support the selection of a remedial measure at a site. An ATSDR health assessment is a mechanism to provide the community with information on the public health implications of a specific site, identifying those populations for which further health actions or studies are needed. See the response to comment 127 for additional information distinguishing a risk assessment from a health assessment. Following the ATSDR Cancer Framework Policy, ATSDR does not perform risk assessments. The agency, however, does recognize the importance of risk assessment and risk analysis. For additional information, please review the framework policy that can be found at http://www.atsdr.cdc.gov/cancer.html.
143	To assess radiological impacts via soil pathways (pp. 84-94), ATSDR should show and use the external exposure rate measurement data (in units of micro-rem per hr) presented in EPA's *Radiation Dose Survey Results* report, rather than simply state for the *external exposure pathway* that: "Uranium is a very weak emitter of radiation and is considered a health problem if internalized within the body. A comparison of dose factors using Federal Guidance documents (EPA 1988, 1993) indicates that the uranium in [the external exposure] soil pathway can be removed from any additional evaluation" (PHA, p. 94, lines 3-5).	The comment is noted. In a true dose reconstruction, this would be an appropriate approach. However, the PHA was used as a screening tool to determine if additional actions would be necessary. As shown in the document, the estimated doses are sufficiently low that even if one were to add the external exposures and resulting doses to the internal doses, the result of the screening would still be that the doses were below levels of public health hazard.
144	To assess chemical impacts via air pathways (pp. 94-96), ATSDR should show *all* uranium air concentration data, not just the average values, for Stations 1, 37, 38, 40, 46 (Scarboro), 51, and 52.	It is not ATSDR's policy to provide raw data from primary sources that are publicly available. But ATSDR does supply references to the data used; which is good technical practice. ATSDR evaluated over 500 air samples from OREIS to assess current exposures through the air pathway. OREIS is a centralized, standardized, quality-assured, and configuration-controlled environmental data management system that is publicly available at the following Web site http://www-oreis.bechteljacobs.org/oreis/help/oreishome.html. ATSDR added the source of the data to Figure 27.
145	To assess chemical impacts via air pathways (pp. 94-96), ATSDR should show the equation or equations, parameters, and parameter values used, including exposures frequencies, and duration.	ATSDR's inhalation MRLs are expressed as air concentrations (milligrams per cubic meter) rather than as a dose per unit of bodyweight. As discussed on page 37 of the PHA, the MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure. It has built-in uncertainty or safety factors, making it

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		considerably lower than levels at which health effects have been observed. Estimated doses that are less than the MRL are not considered to be of health concern. As shown in Figure 27, the average uranium air concentrations were well below the MRL. Therefore, no further evaluation was required; ATSDR did not calculate doses. No equations, parameters, and parameter values need to be presented. More information about the development of ATSDR's MRL can be found in Appendix A of the Uranium Toxicological Profile at the following Web site: http://www.atsdr.cdc.gov/toxprofiles/tp150.html.
146	To assess chemical impacts via air pathways (pp. 94-96), ATSDR should calculate *lifetime* cumulative intake of uranium for *all ages combined* for *all* of the air pathway-dependent exposure pathways included in assessment of past exposures.	As noted in comment 145, the average uranium air concentrations were well below the MRL, which have built-in uncertainty or safety factors, making them considerably lower than levels at which health effects have been observed. Estimated doses that are less than the MRL are not considered to be of health concern. Therefore, no further evaluation is required. ATSDR's current evaluation is a site-specific assessment of realistic exposure. Table 7 in the PHA identifies the air pathways considered by the Task 6 team. Livestock are only allowed within the city limits in limited zoning areas. Most cattle were intended for the beef market. Therefore, the air-to-pasture grass-to-meat/milk pathways are not realistic exposure scenarios. Exposures through inhalation of air and consumption of vegetables are evaluated.
147	To assess chemical impacts via air pathways (pp. 94-96), ATSDR should conduct a sensitivity and uncertainty analysis, assigning PDFs to all uncertain parameters, and present distributions of intakes.	As stated in ATSDR's response to comments 145 and 146, the average air concentrations are well below ATSDR's MRL for uranium and are not considered to warrant public health concern or further evaluation. In addition, based on the ORHASP decision guides, the estimated Task 6 Level II screening risk from off-site exposure to Y-12 uranium is so low that further detailed study of exposures is not warranted. The Level II screening index (8.3×10^{-5}) is 1.2 times less than the ORHASP decision guide (1×10^{-4}). Therefore, it is below the threshold for consideration of more extensive health effects studies. (See the Level II screening index on page 4-12 of the Task 6 report and the ORHASP Decision Guides on page 57 of the ORHASP report.) As discussed in the NCRP Commentary 14, *A Guide For Uncertainty Analysis In Dose And Risk Assessments Related To Environmental Contamination*, issued in 1996, if a conservatively based screening calculation is performed and this screening calculation indicates the risk is "clearly below regulatory or risk levels of concern," and the possible exposure is low, then a quantitative uncertainty analysis may not be

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		necessary. By design, conservative screenings are "highly unlikely to underestimate the true dose or risk."
148	To assess chemical impacts via soil pathways (pp. 96-99), ATSDR should show *all* uranium soil concentration data.	It is not ATSDR's policy to provide raw data from primary sources that are publicly available. But ATSDR does supply references to the data used; which is good technical practice. ATSDR evaluated soil samples from DOE (1993), FAMU (1998), and EPA Region IV (2003) to assess current exposures through the soil pathway. Page 29 in the PHA provides short summaries of the FAMU and EPA sampling. To expand the information presented, ATSDR added summary briefs of the EPA and FAMU reports in Appendix I of the final PHA.
149	To assess chemical impacts via soil pathways (pp. 96-99), ATSDR should calculate *lifetime* cumulative intake of uranium for *all ages combined* for *all* of the soil pathway-dependent exposure pathways, including the soil and vegetable ingestion pathways.	To determine the public health implications (potential health hazard) from current exposure to uranium released from the Y-12 plant, ATSDR scientists conducted a realistic site-specific assessment. The estimated doses are based on daily exposure, up to an age of 70 years (i.e., lifetime). The uranium doses following ingestion of soils and vegetables from a private garden in Scarboro are so low that even if the exposures from the two pathways are combined, the resulting dose is still lower than the MRL. As discussed on page 37 of the PHA, estimated doses that are less than the MRL are not considered to be of health concern and do not require further evaluation. For example, if the highest dose following ingestion of soil (1.4×10^{-5} mg/kg/day for a 6-year-old child) is added to the total intake from ingestion of vegetables grown in Scarboro (3.9×10^{-5} mg/kg/day from Plot 46), the total ingestion dose is 5.3×10^{-5} mg/kg/day, which is about two orders of magnitude below the MRL of 2.0×10^{-3} mg/kg/day. Therefore, the combined exposure from both pathways would not result in harmful health effects.
150	To assess chemical impacts via soil pathways (pp. 96-99), ATSDR should conduct a sensitivity and uncertainty analysis, assigning PDFs to all uncertain parameters, and present distributions of intakes.	As stated in ATSDR's response to comment 149, the combined uranium dose from ingestion of soil and vegetables grown in Scarboro is about two orders of magnitude below ATSDR's MRL. The MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure. It has built-in uncertainty or safety factors, making it considerably lower than levels at which health effects have been observed. Estimated doses that are less than the MRL are not considered to be of health concern and do not require any further evaluation. As shown in Figures 28 and 29, the uranium doses from ingestion of soil and vegetables are well below the MRL. Therefore, no further evaluation was required. More information about the development of ATSDR's MRL can be found in Appendix A of the Uranium Toxicological Profile at the following Web site:

	EPA Comment	ATSDR's Response
		http://www.atsdr.cdc.gov/toxprofiles/tp150.html.
Scarboro		
151	ATSDR's concluding categorization of the health impact of Y-12 uranium releases on the Scarboro community as posing *no apparent public health hazard* is misleading. It is clear that significant amounts of uranium have been released from Y-12 from 1944 to the present day, and that some portion of these releases have impacted and continue to impact the Scarboro community.	ATSDR agrees that significant amounts of uranium have been released from the Y-12 plant (see Figure 13 and Table 5) and that exposures are likely to have occurred. Table 25 summarizes the public health implications from exposures to Y-12 uranium. ATSDR concluded that exposures to uranium released from the Y-12 plant in the past and currently would not result in harmful health effects for either adults or children living near the Y-12 plant and assigned the site as having no apparent public health hazard. Therefore, the Y-12 uranium releases are not a public health hazard to the people living near the Y-12 plant. As described on page 117 and in Appendix A of the PHA, ATSDR's category of no apparent public health hazard means that people could be or were exposed, but the level of exposure would not likely result in adverse health effects. More information about ATSDR's conclusion categories can be found in Section 8 of the Public Health Assessment Guidance Manual at the following Web site: http://www.atsdr.cdc.gov/HAC/HAGM/.
152	Given the very small population size of this community, it is extremely unlikely that any associated *excess* radiation-induced cancer rates or chemically-induced toxic effects would be detectable; that is, there would be no apparent public *effects*. However, this is not same as concluding the levels of uranium released from the Y-12 plant in the past ***would not result in harmful health effects*** for either adults or children living near the Y-12 plant.	ATSDR evaluates the potential for public health effects by comparing an estimate of the amount of uranium exposure (i.e., dose) that people might frequently encounter to conservative screening values and health effects levels documented in the scientific literature. A PHA factors in information from the adjacent community about actual or likely exposures and information from the community about their health concerns. ATSDR's determination that exposure to the levels of uranium released from the Y-12 plant would not result in harmful health effects is based on the amount, frequency, and duration of exposure, not on the number of people exposed. ATSDR concluded that the Y-12 uranium releases are not a public health hazard. The size of the community is irrelevant to the conclusions that past and current exposures to uranium were too low to be of health concern. ATSDR's PHA is based on health effects data from radiation and chemical exposures to uranium. It is not an epidemiologic study that is impacted by a small population size.
153	Based on our review, we conclude that Scarboro may not be the most heavily impacted off-site area nor the most suitable reference location, even though it is the nearest community to the Y-12 plant. The air dispersion modeling which provided the primary reason for selecting Scarboro as the reference location was based on overly simplified and unrealistic assumptions, such as flat terrain between Y-12 releases and receptor locations. It could not account for the complex geography, release heights, and unique meteorological conditions surrounding the Y-12 plant and Oak Ridge, and was consequently rejected by the Task 6 team (ChemRisk 1999) as the method used to reconstruct historical uranium air concentrations for	ATSDR believes the city of Oak Ridge is the only established community adjacent to ORR that could have been impacted by Y-12 uranium releases and that Scarboro is a representative community for the city of Oak Ridge. Therefore, the conclusions are valid for the people living near the Y-12 Plant, including the city of Oak Ridge. As noted on page 43 of the PHA, the Task 6 team identified Scarboro as the reference location using the air dispersion modeling (USEPA 1995 as cited in ChemRisk 1999). The Task 6 team used the results of the flat terrain ISC dispersion model to identify the off-site housing area with the highest estimated uranium air concentrations. The Task 6 team understood the limitations of applying the flat terrain ISC dispersion

	EPA Comment	ATSDR's Response
	Scarboro. For these reasons, and the fact that the predominant wind direction at the Y-12 facility has been stated as being generally from the southwest or northeast (i.e., up- or down-valley, away from Scarboro and Oak Ridge), we are concerned that the atmospheric transport and environmental fate of the bulk of uranium released from Y-12 has not been adequately accounted for. If the intent of the PHA is to assess the off-site impact of Y-12 uranium releases, we believe that ATSDR, or others, should expand the scope of the assessment to include additional communities surrounding the Oak Ridge Reservation. Since Scarboro community is the sole focus of ATSDR's public health assessment, we suggest renaming the document to reflect this fact. However, it appears that the primary reason for selecting Scarboro as the reference location (and for rejecting all other nearby Oak Ridge communities) is based on the results of the air dispersion modeling conducted by the Task 6 team that included overly simplified and unrealistic assumptions. According to the Task 6 report (ChemRisk 1999, page 3-3), the modeling assumed <u>flat terrain</u> between Y-12 and Oak Ridge (i.e., no Pine Ridge). Such an assumption would understandably and predictably lead to the highest estimated air concentrations in the closest community, Scarboro. The Task 6 team was aware that the flat terrain approach would not account for the attenuation and redirection of wind flow away from Scarboro, and that the predominant wind direction at Y-12 is generally from the southwest or northeast (i.e., up-valley or down-valley). Moreover, the Task 6 team speculated that, even with additional algorithms, the air dispersion model would probably not adequately handle the majority of Y-12 release points, which were (are) at a lower altitude than Pine Ridge, and would also likely not account for the fact that the relative altitude of the Scarboro community is below the top of Pine Ridge, which further complicates the dispersion characteristics. Given these limitations, the Task 6 team concluded that modeling these characteristics would require substantially more effort, that was beyond the scope of their screening assessment, and that their air dispersion modeling approach was not appropriate for use at Y-12 and would overestimate air concentrations at the Scarboro. Therefore, to estimate historical air concentrations at Scarboro for all years for which release estimates were determined, the Task 6 team developed an empirical χ/Q model based on the relationship between recent measured air concentrations at the Scarboro monitoring station and Y-12 uranium release estimates.	model in the complex terrain surrounding the Y-12 facility and that the flat terrain model overestimated the air concentrations in Scarboro and other locations outside Bear Creek Valley (ChemRisk 1999, ORHASP 1997). However, when estimated results of air dispersion models were compared to the actual uranium air concentrations measured in Scarboro, the flat terrain model was the best predictor of estimated uranium air concentrations in Scarboro. The Task 6 report stated that "while other potentially exposed communities were considered in the selection process, the reference locations [Scarboro] represent residents who lived closest to the ORR facilities and would have received the highest exposures from past uranium releases…Scarboro is the most suitable for screening both a maximally and typically exposed individual" (ChemRisk 1999). ATSDR agrees with the commenters that the predominant wind direction at the Y-12 facility is southwest or northeast. According to the ORR meteorological monitoring, "prevailing winds are generally up-valley from the southwest and west-southwest or down-valley from the northeast and east-northeast… winds in the valleys tend to follow the ridge axes, with limited cross-ridge flow within local valley bottoms" (DOE 2002c). Therefore, most of the uranium would deposit up and down the valley in which the Y-12 plant is located. The Y-12 plant is located in Bear Creek valley, between Pine Ridge and Chestnut Ridge. These ridges extend to the northeast into Union valley. No one lives in Bear Creek valley or Union valley. The closest population living in the valley system between Pine Ridge and Chestnut Ridge is more than 3 miles away, across the Clinch River, in Wolf valley. The people living in Wolf valley would likely have been exposed to lower amounts of uranium than the people living in Scarboro because the majority of the uranium deposition would have been relatively close to the Y-12 plant. Aerial surveys performed since 1959 are sufficiently sensitive to detect radiation sources. Those sources outside the confines of Y-12 have been verified by the state not to constitute a health hazard. By implication, the aerial surveys will readily detect sources that do constitute a hazard and except for a known few locations due to past or present operations within Y-12, the off-site areas such as the Bear Creek and Union valleys (including the residential areas of Oak Ridge) do not show any elevations of radiation above background. Thus, there is direct empirical evidence that the Oak Ridge neighborhoods have not been contaminated by Y-12 uranium releases. ATSDR acknowledges that it is possible that the Woodland community, also located within the city of Oak Ridge near the gap in Pine Ridge, might have received higher uranium emissions than Scarboro. To evaluate this potential, ATSDR compared the ambient air monitoring data for Station 46 (Scarboro) to Station 40 (located on the Y-12 plant near the intersection of Bear Creek Road and Scarboro Road). While Station

	EPA Comment	ATSDR's Response
	For these reasons, we are concerned that the atmospheric transport and environmental fate of the bulk of uranium released from Y-12 has not been adequately accounted for. If the intent of the PHA is to assess the off-site impact of Y-12 uranium releases, we believe that ATSDR, or others, should expand the scope of the assessment to include additional communities surrounding the Oak Ridge Reservation. However, the representativeness of Scarboro data for releases to other areas should be more thoroughly described, including the uncertainty of the conclusions for any communities that may be more directly down-wind from the plant's air discharges. The representativeness of the Scarboro Community for offsite impact of past uranium releases is highly questionable. Approximately 85 stacks have emitted uranium particulates over the past 50 years. The prevailing down-wind direction parallels the valley and is not due north over the ridge. The offsite impacts to areas that fall in line with the prevailing wind directions should be more thoroughly considered and the uncertainties in the reports conclusions described. More explanation is needed in the document to explain why Scarboro is the reference location for assessing the impact of Uranium offsite form Y-12, and why other communities that may be more down-wind are not. Does air dispersion modeling indicate that the Scarboro area is in the prevailing down-wind direction? Any uncertainties in the conclusions regarding down-wind past and current exposures should be thoroughly discussed.	40 is not located in Woodland, it is located in Bear Creek valley near the gap in Pine Ridge. ATSDR compared the average uranium air concentrations from 1986 to 2002 and found that the concentrations at Station 40 were, on average, 20% higher than those at Station 46. The average air concentrations at Station 40 ranged from being less than half those at Station 46 in 1997, to almost double those at Station 46 in 1990. For the years from 1986 to 1989, during higher production, the average uranium concentrations at Station 40 remained steady at 20% higher than those at Station 46. Assuming, therefore, that the Woodland community was exposed to the uranium air concentration at Station 40 in Bear Creek valley, they could have potentially received up to twice the amount of uranium emissions as Scarboro. If ATSDR doubled the estimated exposure calculated for Scarboro, the Woodland community could have received a past uranium radiation dose of up to 310 mrem over 70 years (based on an air monitoring station located at the Y-12 plant), which is well below the radiogenic cancer comparison value of 5,000 mrem over 70 years. The current uranium radiation dose is estimated to be less than one mrem, also well below the radiogenic cancer comparison value. Therefore, even if the Woodland community were to have received double the emissions of Scarboro (which is unlikely), the exposures are still too low to be a public health hazard. For perspective, ATSDR also compared the concentrations detected at Station 46 (Scarboro) to Station 41 (located in the city of Oak Ridge near the intersection of South Illinois Avenue and the Oak Ridge Turnpike) for the years in which both air monitors were in operation (1986 to 1991). The uranium air concentrations at Station 46 were, on average, 2.7 times higher than those at Station 41. In addition, the past uranium radiation doses used in the public health assessment are from the Task 6 report which was a screening evaluation that routinely and appropriately used several layers of conservatism and protective assumptions and approaches in estimating concentrations and doses (see the list of conservative aspects of the screening evaluation on pages 48 and 92 of the PHA). The Task 6 report states that "some level of conservatism was maintained in the uranium concentration estimates used in Level II screening to ensure that hazards to a significant portion of the potentially exposed population were not underestimated" (ChemRisk 1999). Also, the internationally recognized expert technical reviewers hired by ATSDR to review the Task 6 report pointed out that "the estimates made in the report tend to be on the conservative side—one expects, therefore, that (when in error) the report would tend to *overestimate* the extent to which exposure to uranium is a problem in the Oak Ridge area. Further refinements to the study are likely to reveal that uranium exposures are actually *lower* than those currently estimated" (see page G-7 of the

	EPA Comment	ATSDR's Response
		PHA). Therefore, the Scarboro community is used as a reference location because it represents an established community adjacent to ORR where residents resided during the years of uranium releases. Consequently, if the Scarboro community—the population likely to have received the highest uranium exposures from the Y-12 plant—was not in the past and is not currently being exposed to harmful levels of uranium from the Y-12 plant, then other residents living near the Y-12 plant, including those within the city of Oak Ridge, are also not being exposed to harmful levels of uranium.
154	ATSDR should change the title of the PHA to reflect the principal subject (i.e., Scarboro) or expand the scope of the assessment to include other Oak Ridge communities. Can this be said of communities offsite other than Scarboro? Discuss any uncertainties in the report's conclusions regarding offsite areas in the prevailing own-wind direction from the past uranium air stack releases.	ATSDR's health assessment determined that people living near the Y-12 plant were not in the past and are not currently being exposed to harmful levels of uranium. Scarboro was chosen as a representative location and thus the conclusions are valid for the rest of Oak Ridge. As noted on page 43 of the PHA, the Task 6 team identified Scarboro as the reference location using air dispersion modeling (USEPA 1995 as cited in ChemRisk 1999). The Task 6 team was able to identify the off-site locations with the highest estimated uranium air concentrations. The Task 6 report stated that "while other potentially exposed communities were considered in the selection process, the reference locations [Scarboro] represent residents who lived closest to the ORR facilities and would have received the highest exposures from past uranium releases… Scarboro is the most suitable for screening both a maximally and typically exposed individual" (ChemRisk 1999). Based on this, ATSDR believes that Scarboro represents an established community adjacent to the ORR where residents resided during the years of uranium releases. The city of Oak Ridge is the community that would have been impacted the most by Y-12 uranium releases. Based on this, ATSDR believes the city of Oak Ridge is the only established community adjacent to the ORR that could have been impacted by Y-12 uranium releases and that Scarboro is a representative community for the city of Oak Ridge. The Scarboro community is used as a reference location because it represents an established community adjacent to ORR where residents resided during the years of uranium releases. Consequently, if the Scarboro community—the population likely to have received the highest uranium exposures from the Y-12 plant—was not in the past and is not currently being exposed to harmful levels of uranium from the Y-12 plant, then other residents living near the Y-12 plant, including those within the city of Oak Ridge, are also not being exposed to harmful levels of uranium. ATSDR presented data from other locations, when available. For example, Figure 22

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		presents air concentrations for several monitoring stations, Table 15 presents total radiation doses from inhalation for these same monitoring stations, and Table 22 presents uranium doses from ingestion of garden vegetables grown on and off the ORR.
ATSDR's Health Guidelines for Radiation Effects		
155	ATSDR's health evaluation criteria are less protective than current international, national, and federal radiation protection standards, and the bases for these criteria are inconsistent with widely-accepted radiation protection guidance.	The ATSDR radiogenic cancer comparison value of 5,000 mrem over 70 years is based on peer-reviewed literature and other documents developed to review the health effects of ionizing radiation. ATSDR's radiogenic cancer comparison values are used as a screening tool. If the screening were to indicate that past or current doses exceeded our comparison values, then additional in-depth health evaluation would be conducted to decide whether or not harmful effects might be possible. The 5,000 mrem is over a lifetime. If one annualizes this value, the dose increases the total average U.S. background dose (including medical sources) (360 mrem/year) by about 20% and would not induce any adverse health effects. As a matter of note, please recognize that as a first approximation, ATSDR's radiogenic cancer comparison value of 5,000 mrem over 70 years is less than 100 mrem/year (5,000 mrem ÷ 70 years = 71 mrem/year). This value is in line with many of the recommendations of the organizations cited by the commenter. The first approximation of the 100 mrem/year dose limit recommended by ICRP and NCRP roughly equates into a 7,000 mrem dose over 70 years (100 mrem/year × 70 years). This lifetime dose is higher than ATSDR's radiogenic cancer comparison value of 5,000 mrem over 70 years. The exposure doses calculated for Scarboro residents (155 mrem over 70 years for past exposures and <1 mrem over 70 years for current exposures) are more than 45 times lower than ICRP and NCRP's guidance. Figure 12 graphically displays NCRP's guidance and NRC's regulations for public exposure (100 mrem/year) in relation to the doses estimated for Scarboro. The first approximation of EPA's cleanup level into a lifetime dose is roughly 1,050 mrem over 70 years (15 mrem/year × 70 years). The exposure doses calculated for Scarboro residents (155 mrem over 70 years for past exposures and <1 mrem over 70 years for current exposures) are more than 6 times lower than EPA's guidance.

	EPA Comment	ATSDR's Response
		<table><tr><th>Agency</th><th>Lifetime (mrem over 70 years)</th><th>Yearly (mrem/year)</th></tr><tr><td>ATSDR's radiogenic cancer comparison value</td><td>5,000</td><td>71</td></tr><tr><td>ATSDR's MRL</td><td>7,000</td><td>100</td></tr><tr><td>EPA's cleanup level</td><td>1,050</td><td>15</td></tr><tr><td>ICRP's guidance</td><td>7,000</td><td>100</td></tr><tr><td>NCRP's guidance</td><td>7,000</td><td>100</td></tr></table> ATSDR believes the chronic ionizing radiation MRL of 100 mrem/year is below levels that might cause adverse health effects in people most sensitive to such effects. Further, the ATSDR MRL is the same value that is codified in 10 CFR 20 and other federal regulations. • An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure. • Most MRLs contain a degree of uncertainty because of the lack of precise toxicological information on the people who might be most sensitive to the effects of hazardous substances. • Proposed MRLs undergo a rigorous review process, including: Health Effects/MRL Workgroup reviews within the Division of Toxicology, expert panel peer reviews, and agency-wide MRL Workgroup reviews, with participation from other federal agencies, such as the EPA, and comments from the public. • ATSDR derived the chronic-duration, noncancer MRL of 100 mrem/year for ionizing radiation by dividing the average annual effective dose to the U.S. population (360 mrem/year) by three to account for human variability. The annual effective dose of 360 mrem/year has not been associated with adverse health effects in humans or animals.
156	ATSDR defines the MRL as "an estimate of daily human exposure to a substance that is unlikely to result in *noncancer* effects over a specific duration," which is derived "by dividing the average annual effective dose to the U.S. population (360 mrem/year) by three to account for human variability (i.e., ATSDR applied an uncertainty factor of 3)" (PHA, p. 50	As explained in the Evaluating Exposures section (Section III.A.2.), MRLs are derived when reliable and sufficient data exist to identify the target organ(s) of an effect or the most sensitive health effect(s) for a specific duration for a given route of exposure. An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health

	EPA Comment	ATSDR's Response
	and p. 104). It states that the MRL is "intended to serve only as a screening tool to assist in determining which contaminants should be more closely evaluated further in the public health assessment process," furthering stating that "exposure to estimated doses less than the MRL are not considered to be of health concern and exposure to estimated doses above the MRL does not necessarily mean that adverse health effects will occur". ATSDR bases the MRL, in part, on its conclusion that "the annual effective dose of 360 mrem/year has not been associated with adverse health effects or increases in the incidences of any type of cancers in humans or other animals" (PHA, p. 50). Minimal risk levels need to be better described and defended, including how they are "unlikely to result in non-cancer effects" versus potential cancer effects. Has the SAB or EPS peer reviewed this approach?	effects over a specified duration of exposure. MRLs are based on noncancer health effects only and are not based on a consideration of cancer effects. MRLs, which are intended to serve as screening levels, are substance-specific estimates used by ATSDR health assessors to identify contaminants and exposure pathways at hazardous waste sites that require further in-depth health effects evaluation. MRLs are derived for hazardous substances using the NOAEL/uncertainty factor approach. They are below levels that might cause adverse health effects in the people most sensitive to such effects. MRLs are generally based on the most sensitive end point considered to be of relevance to humans. Exposure to a level above the MRL does not mean that adverse health effects will occur. MRLs are intended only to serve as a screening tool to help public health professionals decide where to look more closely. They may also be viewed as a mechanism to identify those hazardous waste sites that are not expected to cause adverse health effects. Most MRLs contain a degree of uncertainty because of the lack of precise toxicological information on the people who might be most sensitive (e.g., infants, the elderly, those who are nutritionally or immunologically compromised) to the effects of hazardous substances. ATSDR uses a conservative (i.e., protective) approach to address this uncertainty, consistent with the public health principle of prevention. Therefore, estimated doses that are less than the MRL are not considered to be of health concern. Proposed MRLs undergo a rigorous review process, including: Health Effects/MRL Workgroup reviews within the Division of Toxicology, expert panel peer reviews, and agency-wide MRL Workgroup reviews, with participation from other federal agencies, such as the EPA, and comments from the public. ATSDR derived the chronic-duration, noncancer MRL of 100 mrem/year for ionizing radiation by dividing the average annual effective dose to the U.S. population (360 mrem/year) by three to account for human variability (that is, ATSDR applied an uncertainty factor of 3) (ATSDR 1999b). This annual effective dose to the U.S. population is obtained mainly from naturally occurring radioactive material, medical uses of radiation, and radiation from consumer products (BEIR V 1990 as cited in ATSDR 1999b). The annual effective dose of 360 mrem/year has not been associated with adverse health effects in humans or animals. ATSDR believes the chronic ionizing radiation MRL of 100 mrem/year is below levels that might cause adverse health effects in people most sensitive to such effects. Appendix A of the Toxicological Profile for Ionizing Radiation provides additional details on the derivation of the MRL (http://www.atsdr.cdc.gov/toxprofiles/tp149.html).

	EPA Comment	ATSDR's Response
157	Since cancer induction is the principal late-term health effect of interest at Scarboro for past and current exposures, ATSDR's "chronic-duration" MRL of 100 mrem/yr for *noncancer effects* is clearly irrelevant. However, throughout the PHA, ATSDR applies the MRL and the CEDE, indistinguishably, as protective levels at or below which no adverse health effects, whether cancer or noncancer effects, are assumed.	Although cancer is a concern in Scarboro as well as for other areas in and around Oak Ridge, exposure to uranium is also a chemical hazard to the kidneys resulting in renal toxicity. Application of the MRL to screen noncancer health effects resulting both from chemical hazards as well as radiological hazards is an appropriate method. As stated in the Toxicological Profile for Uranium, "natural and depleted uranium are only weakly radioactive and are not likely to cause cancer from their radiation… However, animal studies in a number of species and using a variety of compounds confirm that uranium is a nephrotoxin and that the most sensitive organ is the kidney…The chance of getting cancer is greater if you are exposed to enriched uranium, because it is more radioactive than natural uranium… Enriched uranium is considered to be more of a radiological than a chemical hazard" (ATSDR 1999a). Therefore, the use of the radiogenic cancer comparison value for screening cancer over a lifetime is an appropriate method that compliments the use of the MRL for screening noncancer health effects.
158	As used in this context, we believe that the MRL of 100 mrem/yr and the CEDE at 5,000 mrem for 70 years are clearly less protective than the dose and risk limits shown in Table 7. [ATSDR note: Table 7 is provided in the notes section at the end of this table.] The 100 mrem/yr dose limit recommended by ICRP and NCRP for members of the public applies to *all* man-made radiation sources and exposures, excluding medical and natural background exposures. In contrast, ATSDR applies the 100 mrem/yr MRL to evaluate Scarboro doses from one source, Y-12.	As explained on page D-1, for the evaluation of radiation doses at Oak Ridge, ATSDR used the concept of CEDE. The CEDE is a calculated dose arising from the one-time intake of radiological uranium, with the assumption that the entire dose (a 70-year dose, in this case) is received in the first year following the intake. The value used by ATSDR for the radiogenic cancer comparison value is 5,000 millirem (mrem) over 70 years. ATSDR derived this value after reviewing the peer-reviewed literature and other documents developed to review the health effects of ionizing radiation. The first approximation of the 100 mrem/year dose limit recommended by ICRP and NCRP roughly equates into a 7,000 mrem dose over 70 years (100 mrem/year × 70 years). This lifetime dose is higher than ATSDR's radiogenic cancer comparison value of 5,000 mrem over 70 years. The exposure doses calculated for Scarboro residents (155 mrem over 70 years for past exposures and <1 mrem over 70 years for current exposures) are more than 45 times lower than ICRP and NCRP's guidance. Figure 12 of the PHA graphically displays NCRP's guidance along with NRC's regulations in relation to the doses estimated for Scarboro.
159	To evaluate the public health implications of past and current radiological exposures of Scarboro residents to Y-12 uranium releases, ATSDR compares calculated doses with: ▪ a "chronic-duration" minimal risk level (MRL) for ionizing radiation of 100 mrem/yr for noncancer effects,	See the response to comment 156 for a discussion of ATSDR's MRL. ATSDR publicly discussed the 5,000 mrem radiogenic cancer comparison value in at least four PHAWG meetings and three ORRHES meetings. This comparison value is based on peer-reviewed literature and other documents developed to review the health effects of ionizing radiation.

	EPA Comment	ATSDR's Response
	▪ a committed effective dose equivalent (CEDE) of 5,000 mrem over 70 years for cancer effects, and ▪ an average U.S. background dose of 360 mrem/yr. ATSDR states that "the CEDE value of 5,000 mrem over 70 years was derived after reviewing the peer-reviewed literature and other documents developed to review the health effects of ionizing radiation," and refers the reader to Appendix D (PHA, p. 49). In Appendix D, ATSDR cites several sources, including the 1994 and 2000 reports of the General Accounting Office (GAO), Report No. 136 of the National Council on Radiation Protection and Measurements (NCRP 2001), ATSDR's 1999 *Toxicological Profile for Ionizing Radiation*, and the results of three epidemiological studies of radiation workers, as the basis for concluding that: • Between 10 rem and 5 rem, the data are not clear as to the health effects. Below 5 rem the effects are not observed, only assumed to occur. Therefore, the risk associated with a dose that approaches background, 0.36 rem/year (360 mrem or 3.6 millisieverts [mSv]) is essentially impossible to measure (PHA, p. D-1, lines 23-26), and • ATSDR believes that its reasoning in using a CEDE of 5,000 mrem over 70 years is protective of human health at Oak Ridge (PHA, p. D-5, 11-12).	We believe these statements are correct in general. However, we will modify the text to indicate studies suggest that when one considers radon, evidence suggests that elevated levels of indoor radon have been associated with elevated rates of lung cancer. Even taking into account the radon issues, our screening (when annualized over the 70-year period) is less than 100 mrem/year.
160	To the contrary, we believe that ATSDR's health evaluation criteria are substantially less protective than currently recommended national, international, and federal radiation protection standards (shown in Table 7 [ATSDR note: Table 7 is provided in the notes section at the end of this table.]), and that the bases for ATSDR's heath evaluation criteria are inconsistent with widely-accepted radiation protection guidance. We strongly recommend that ATSDR adopt the available radiation protection standards and guidance or explain how their health evaluation criteria are equally protective.	As explained to the community on multiple occasions, ATSDR's health evaluation criteria were used as a screening tool. If the screening were to indicate that past or current doses exceeded our screening, then additional public health evaluation would have been conducted. The response to comment 54 explains ATSDR's screening process in more detail. As a matter of note, please recognize that as a first approximation, ATSDR's radiogenic cancer comparison value of 5,000 mrem over 70 years is less than 100 mrem/year (5,000 mrem ÷ 70 years = 71 mrem/year). This value is in line with many of the recommendations of the organizations cited by the commenter.

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<tr><td>161</td><td>Both the MRL and the CEDE (which equates to ~ 71 mrem/yr) substantially exceed a variety of NRC and EPA annual dose limits by factors of 4 to 10, and both equate to lifetime cancer excess cancer risks that exceed the upper bound of EPA's acceptable risk range.</td><td>As noted on Figure 12, EPA's CERCLA cleanup level is 15 mrem/year. This effective dose equivalent corresponds to an individual's excess lifetime cancer risk of approximately 3×10^{-4} (i.e., 3 theoretical excess cases of cancer in 10,000 people). EPA deemed a risk of 3.0×10^{-4} to be essentially equivalent to that of 1.0×10^{-4}, which is the presumed safe level considered acceptable and protective under CERCLA (EPA Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination 1997).

This cleanup level is used in EPA's risk assessments to determine if levels of chemicals at hazardous waste sites pose an unacceptable risk. As explained in A Citizen's Guide to Risk Assessments and Public Health Assessments at Contaminated Sites (written jointly by ATSDR and EPA Region IV) "conservative safety margins are built into a risk assessment analysis to ensure the protection of the public... Therefore, people will not necessarily be affected even if they are exposed to materials at dose levels higher than those estimated by the risk assessment."

"A risk assessment does not measure the actual health effects that hazardous chemicals at a site have on people. Risk assessments are conducted without determination of actual exposure." A PHA "reviews site-related environmental data and general information about toxic chemicals. Then it compares an estimate of the amount of chemical exposure (i.e., dose) to which people might frequently encounter to the situations that have been associated with disease and injury. However, unlike a risk assessment, a PHA factors in information from the adjacent community about actual or likely exposures and information from the community about their health concerns." Therefore, it is not appropriate to base the decision of public health on risk assessment cleanup criteria. See the response to comment 127 for additional information distinguishing a risk assessment from a health assessment.

It should be noted that the first approximation of EPA's cleanup level into a lifetime dose is roughly 1,050 mrem over 70 years (15 mrem/year $\times$ 70 years). The exposure doses calculated for Scarboro residents (155 mrem over 70 years for past exposures</td></tr>
</table>

	EPA Comment	ATSDR's Response
		and <1 mrem over 70 years for current exposures) are more than 6 times lower than EPA's guidance.
162	By basing the MRL and CEDE on the lack of *observable* health effects below 5,000 mrem, including the annual background rate, ATSDR leads the reader to conclude incorrectly that there are *no effects* below this dose (i.e., a dose-response threshold). What the ATSDR does not tell the reader is that this inability to detect *excess* cancers attributed to low-dose radiation exposures is due to the practical limits of current epidemiological techniques. If excess risk is proportional to the radiation dose, then a population size of about 50,000 people is required to detect a statistically significant excess cancer incidence at 10,000 mrem, or a population size of about 5 million is required to detect a statistically significant excess cancer incidence at 1,000 mrem (E. E. Pochin, *Health Phys.* **31**, 148 (1976) and C. E. Land, *Science* **209**, 1197 (1980).). Even larger populations are necessary to detect changes in cancer rates due to variations in natural background radiation exposures. In other words, extraordinarily large studies are required to quantify the risks of very low doses of radiation.	ATSDR derived the radiogenic cancer comparison value of 5,000 mrem over 70 years after reviewing the peer-reviewed literature and other documents developed to review the health effects of ionizing radiation. ATSDR publicly discussed this issue, among others, in at least four PHAWG meetings and three ORRHES meetings. ATSDR's 5,000 mrem is over a lifetime. If one annualizes this value, the dose increases the total average U.S. background dose (including medical sources) (360 mrem/year) by about 20% and would not induce any adverse health effects. ATSDR agrees with the commenter's statements with the following caveat: The issue with applying a "quantitative" risk coefficient to any dose is that one can calculate any risk and this is "perceived" as a true value. As stated in the ATSDR Cancer Framework Policy, "this artificial appearance of precision can lead decision makers to rely heavily on numerical risk estimates. Although ATSDR recognizes the utility of numerical risk estimates in risk analysis, the Agency considers these estimates in the context of the variables and assumptions involved in their derivation and in the broader context of biomedical opinion, host factors, and actual exposure conditions." For additional information, please review the framework policy that can be found at http://www.atsdr.cdc.gov/cancer.html.
163	We note that ATSDR's health evaluation criteria exceed the limits of national and international radiation protection advisory organizations, the U.S. Nuclear Regulatory Commission, and EPA. Moreover, the bases for these criteria are inconsistent with widely-accepted radiation protection guidelines and risk estimation methods.	As explained to the community on multiple occasions, ATSDR's health evaluation criteria were used as a screening tool. If the screening were to indicate that past or current doses exceeded our screening, then additional public health evaluation would have been conducted. As a matter of note, please recognize that as a first approximation, ATSDR's radiogenic cancer comparison value of 5,000 mrem over 70 years is less than 100 mrem/year (5,000 mrem ÷ 70 years = 71 mrem/year). This value is in line with many of the recommendations of the organizations cited by the commenter.
164	At doses below those where significant risks have been demonstrated in human populations (i.e., 5,000 to 10,000 mrem for protracted exposures or 1,000 to 5,000 mrem for acute exposures), epidemiological data alone cannot be used to establish the shape of the dose-response relationship, but must also include radiobiological and biophysical data on the mutagenic, clastogenic (chromosome-damaging), and carcinogenic effects of low dose radiation. Based on an extensive, recent review of the relevant theoretical,	ATSDR agrees with this statement. As pointed out in NCRP 136, the issues surrounding the linear non-threshold (LNT) hypothesis are impacted by the end point selected in the experimental design and the system being evaluated (organism, cell, or organ, for example).

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	experimental and epidemiological data, the NCRP concluded in their 2001 Report No. 136 that "although other dose-response relationships for the mutagenic and carcinogenic effects of low-level radiation cannot be excluded, no alternative dose-response relationship appears to be more plausible than the linear-nonthreshold model on the basis of present scientific knowledge." All international and national radiation protection advisory organizations, and all U.S. federal government agencies, continue to use the LNT model to estimate low dose radiation risks.	
Discussion of Multiple Chemical and Pathway Exposures		
165	The external pathway for direct gamma radiation should be added here, and mention that dermal has virtually no pathway for radionuclides.	Thank you for the comment. This information has been added to the final PHA.
Quantitative Risk Assessment and Uncertainty/Sensitivity Analyses		
166	For past exposures, ATSDR's assertion that estimated doses are overestimated due to "conservative and overly protective assumptions and approaches" is not based on a quantitative sensitivity and uncertainty analysis, and is largely unsubstantiated. ATSDR should conduct a formal uncertainty analysis to determine the distribution of possible doses and risks to Scarboro residents. Sensitivity and uncertainty analyses should be conducted separately for radiological and chemical assessments. For radiological assessments, age-specific and age-averaged lifetime radiation doses and risks for *all exposure pathways combined* should be compared with the relevant dose and risk standards provided in Table 7 below (see Comment 7 [ATSDR note: comment 155]). For chemical assessments, age-specific and age-averaged lifetime intakes in mg/kg/d for *all exposure pathways combined* should be compared with EPA's reference dose (RfD) for uranium and used to calculate a Hazard Index.	This issue of conducting an uncertainty analysis was raised by an ORRHES member at the April 22, 2003 meeting and addressed by ATSDR in a written response provided to ORRHES at the June 2, 2003 meeting. The following provides details from ATSDR's response: As discussed in the NCRP Commentary 14, *A Guide for Uncertainty Analysis in Dose and Risk Assessments Related To Environmental Contamination*, issued in 1996, if a conservatively based screening calculation is performed and this screening calculation indicates the risk is "clearly below regulatory or risk levels of concern," and the possible exposure is low, then a quantitative uncertainty analysis may not be necessary. By design, conservative screenings are "highly unlikely to underestimate the true dose or risk." This issue of uncertainty analyses and sensitivity analysis was evaluated by the Task 6 team, ATSDR's technical reviewers, and ATSDR scientists. As stated in the title, the Task 6 report was a "Screening Evaluation of Potential Off-Site Exposure," that routinely and appropriately used several layers of conservatism and protective assumptions and approaches in estimating concentrations and doses. Task 6 report states "some level of conservatism was maintained in the uranium concentration estimates used in Level II screening to ensure that hazards to a significant portion of the potentially exposed population were not underestimated" (page ES-9). Also, the Task 6 report states on page 2-13 that a level of conservatism was added by combining the uranium activity amounts for U 234 and U 235 and that this approach is considered reasonable for this screening assessment since the Task 6 estimates do not include a formal uncertainty analysis. On page D-3, the Task 6 authors state "although an uncertainty analysis of the Task 6 air source term was not within the scope of Task 6, experts interviewed during the project consider release

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		estimates for enriched uranium to be suitable for the Task 6 screening assessment and are within an order of magnitude of actual releases" (ChemRisk 1999). The authors also state (on page 5-2) that based on the project team's experience in the Dose Reconstructions Feasibility Study and the Task 6 screening evaluation they identified areas they believe are significant contributors of the overall uncertainty of the results of the Task 6 screening evaluation. The authors state that "these areas should be examined if the evaluation of Oak Ridge uranium releases is to proceed beyond the conservative screening stage and on to nonconservative screening and possibly a stage of refined evaluation that would likely include uncertainty and sensitivity analyses to assist in the decision making process" (ChemRisk 1999). Also, the internationally recognized expert technical reviewers hired by ATSDR to review the Task 6 report pointed out that the report is somewhat lacking in uncertainty and sensitivity analysis. However, "the estimates made in the report tend to be on the conservative side—one expects, therefore, that (when in error) the report would tend to *overestimate* the extent to which exposure to uranium is a problem in the Oak Ridge area. Further refinements to the study are likely to reveal that uranium exposures are actually *lower* than those currently estimated." Also, the technical reviewers stated the report is technically sound and applicable to decision-making (see page G-7 of the PHA). ATSDR scientists also identified other aspects of the Task 6 report that resulted in several additional layers of conservatism and protective assumptions and approaches (see list of conservative aspects of the screening evaluation on pages 48 and 92 of the PHA). Since the Task 6 screening evaluation of air, soil, and surface water pathways resulted in a total past uranium radiation CEDE (155 mrem over 70 years) well below (32 times less than) the ATSDR radiogenic cancer comparison value (5000 mrem over 70 years), ATSDR does not believe the evaluation of Y-12 uranium releases requires a further nonconservative screening or a refined evaluation with uncertainty and sensitivity analyses. In addition, the total past uranium radiation CEDE (155 mrem over 70 years) is also less than the average annual background radiation dose received by individuals living in Denver or the radiation dose an individual would receive during a CT scan (1,000 mrem/scan) at a local hospital (see Figure 12). As shown in Table 15, ATSDR also calculated a radiological dose to the lung following the inhalation of uranium. This dose is not considered a dose of public health concern. Even using the conservative overestimated doses, people in the Scarboro community, as well as the Oak Ridge community, were not exposed to levels of uranium that are above levels of health concern.

	EPA Comment	ATSDR's Response
		Additionally, the following is a list of conservative aspect of the screening evaluation that resulted in the overestimated doses. 1) The Task 6 report noted that the Y-12 uranium releases for some of the years may have been understated due to omission of some unmonitored release estimates. This would cause the empirical χ/Q values (used in the air dispersion model) to be overestimated and in turn would cause the air concentrations to be overestimated. 2) The majority of the total uranium radiation dose is attributed to frequently eating fish from the EFPC and eating vegetables grown in contaminated soil over several years. If a person did not regularly eat fish from the creek or homegrown vegetables over a prolonged period of time (which is very probable), then that person's uranium dose would likely have been substantially lower than the estimated doses reported in this PHA. 3) According to ATSDR's regression analysis, the method that the Task 6 team used to estimate historical uranium air concentrations overestimated uranium 234/235 concentrations by as much as a factor of 5. Consequently, airborne uranium 234/235 doses based on this method were most likely overestimated. 4) In evaluating the soil exposure pathway, the Task 6 team used EFPC floodplain soil data to calculate doses instead of Scarboro soil. Actual measured uranium concentrations in Scarboro soil are much lower than the uranium concentrations in the floodplain soil. The estimated doses would be much lower if they were based on actual measured concentrations in Scarboro. As explained in the ATSDR Public Health Assessment Guidance Manual (http://www.atsdr.cdc.gov/HAC/HAGM/), EPA's *Risk Assessment Guidance for Superfund- Human Health Evaluation Manual*, and in *A Citizen's Guide to Risk Assessments and Public Health Assessments at Contaminated Sites* (written jointly by ATSDR and EPA Region IV), there are deliberate differences between ATSDR's health assessments and EPA's risk assessments. The two agencies have distinctly different purposes that necessitate different goals for their assessments. A risk assessment is used to support the selection of a remedial measure at a site. An ATSDR health assessment is a mechanism to provide the community with information on the public health implications of a specific site, identifying those populations for which further health actions or studies are needed. See the response to comment 127 for additional information distinguishing a risk assessment from a health assessment.

	EPA Comment	ATSDR's Response
Data and Modeling		
167	ATSDR should provide concise summaries of primary data sources and more detailed discussions of its own assessments and conclusions.	The Task 6 report is discussed throughout the past exposure evaluation. The FAMU (1998) and EPA Region IV (2003) reports are summarized on page 29 of the PHA. A description of OREIS has been added to the final PHA To expand the information presented, ATSDR added summary briefs of the EPA and FAMU reports in Appendix I of the final PHA. ATSDR provided detailed discussions of our own evaluations throughout the PHA and in the Appendices. For examples, see the uranium enrichment discussion on pages 73–77 and the linear regression analysis in Appendix E.
168	To assess past and current uranium exposures, ATSDR relies on empirical data and analyses provided by other investigators. Throughout the PHA, ATSDR presents these data and analyses in summary form, either as a single data point or as multiple values in data tables, often with only cursory discussions of the original information. Instead of providing detailed discussions, ATSDR frequently refers the reader to the source documents, sometimes citing the relevant sections or appendices, most times not. Such an approach has several drawbacks: it assumes that the reader is already familiar with the original data, or has, or can obtain the specific reference, and has the technical expertise to evaluate the material; it also places the onus on the reader to compare and contrast data sets, assessments, results, and conclusions in the original documents and the PHA; and, overall, it is a laborious, time intensive, and tedious process. We believe that this approach is largely unnecessary and that most of the associated drawbacks can be avoided, if ATSDR provides more detailed data summaries, discussions, and comparisons, and makes it easier for the reader to obtain key references. We suggest that, at a minimum, ATSDR should provide or refer readers to electronic copies of the following references: • *Uranium Releases from the Oak Ridge Reservation*CA *Review of the Quality of Historical Effluent Monitoring Data and a Screening Evaluation of Potential Off-Site Exposures, The Report of Project Task 6, Reports of the Oak Ridge Dose Reconstruction, Vol. 5 (ChemRisk 1999);* • *Release of Contaminants from Oak Ridge Facilities and Risks to Public Health, Final Report of the Oak Ridge Health Agreement Steering Panel (ORHASP 1999);*	After receiving comments on the data validation version of the PHA from the ORRHES in March 2003, ATSDR clarified the data sources in the public comment version and during two public presentations to the ORRHES (April 22, 2003) and the DOE Site-specific Advisory Board (SSAB) (May 14, 2003) (two Federal Citizen's Advisory Committees). ATSDR's calculations and exposure parameters were also discussed in detail during the PHAWG and ORRHES meetings. All the data ATSDR used to evaluated health concerns from Y-12 uranium releases are publicly available: • The final reports of the TDOH Oak Ridge Health Studies, including the Task 6 report (ChemRisk 1999), the *Final Report of the Oak Ridge Health Agreement Steering Panel* (ORHASP 1999), and the *Oak Ridge Dose Reconstruction Project Summary Report* (ChemRisk 2000) are available at the following Web site: http://www2.state.tn.us/health/CEDS/OakRidge/ORidge.html. In addition, documents released by the Oak Ridge Health Studies are kept at the DOE Information Center (475 Oak Ridge Turnpike, Oak Ridge TN 37830; phone: 865-241-4780; Web site: http://www.oakridge.doe.gov/info_cntr/index.html). • OREIS is available at the following Web site http://www-oreis.bechteljacobs.org/oreis/help/oreishome.html. The data from the *Scarboro Community Environmental Study* (FAMU 1998) are included in OREIS. • EPA's *September 2001 Sampling Report for the Scarboro Community* final 2003 report is available at the following Web site: http://www.epa.gov/Region4/waste/fedfac/doeorr.htm.

	EPA Comment	ATSDR's Response
	• *Oak Ridge Dose Reconstruction Project Summary Report, Reports of the Oak Ridge Dose Reconstruction, Vol. 7 (ChemRisk 2000);* • *Final Report on the Background Soil Characterization Project at the Oak Ridge Reservation, Oak Ridge, Tennessee, DOE/OR/01-1175-V1 (DOE 1993);* • *Sampling Approach for Characterization of the Scarboro Community, Oak Ridge, Tennessee (JE/EM-52/RI, 1998);* • *Scarboro Community Environmental Study (FAMU 1998);* • *Scarboro Community Sampling Results: Implications for Task 6 Environmental Projections and Assumptions (Prichard 1998); and* • *September 2001 Sampling Report for the Scarboro Community, Oak Ridge, Tennessee (Draft Report) (EPA 2002).*	The sources of data mentioned in comment 168 are available at the DOE Information Center (475 Oak Ridge Turnpike, Oak Ridge TN 37830; phone: 865-241-4780; Web site: http://www.oakridge.doe.gov/info_cntr/index.html).
Miscellaneous Comments		
169	Thank you for the opportunity to review and provide comments on the subject document.	You are welcome. ATSDR appreciates receiving comments from community members, civic organizations, and other government agencies interested in the public health activities at the ORR.
170	We believe ATSDR should address these issues before the public health assessment process is concluded.	It is ATSDR's policy to address all comments collected during the public comment period. All comments have been addressed in this appendix (see above).

Notes**:** The page, figure, and table numbers in the comments are in reference to the public comment release PHA (April 22, 2003). The page, figure, and table numbers in ATSDR's responses are in reference to the final PHA.

The following are comments and tables EPA provided:

For past uranium exposures, we believe that ATSDR has underestimated the radiation dose from the inhalation pathway.

Table 1a presents a summary of the Task 6 and ATSDR pathway-specific radiation doses[25] to residents of Scarboro community from past releases of uranium from Y-12.

Table 1a. Pathway-specific Radiation Doses From Past Releases from Y-12

Exposure Pathways	Task 6 Level II doses*			ATSDR 70-y adjusted doses	
	U 234/235 (Sv)	U 238 (Sv)	Total U (mrem)	Total U (mrem)	Percent of total dose
Air	2.5E-04	4.3E-05	29	40	26%
Surface Water	2.0E-04	1.6E-04	36	49	31%
Soil	2.8E-04	2.1E-04	49	66	43%
All pathways	7.3E-04	4.1E-04	114	**155**	100%

*Data taken from Tables 4-8 through 4-13 (pp. 4-15 to 4-17) of the Task 6 report (ChemRisk 1999).

To adjust for a 70-y exposure duration, ATSDR multiplied the Task 6 Level II-derived total uranium dose for each pathway (i.e., air, surface water, and soil) by a factor of 1.35 (i.e., 70 y/52 y) and summed these values to arrive at a total effective dose of 155 mrem for all pathways combined. ATSDR made no other modifications to the dose equations or exposure assumptions used by the Task 6 team in their Level II assessment.

As shown in Table 1b below, the total effective dose from the air exposure pathways represents the sum of the uranium doses from six sub-pathways. Of these, the inhalation pathway accounts for 35 mrem, the majority (88%) to the total dose.

[25]The Task 6 Report and ATSDR incorrectly refer to estimated radiation doses for Scarboro as committed effective dose equivalents or CEDEs. The quantities *dose equivalent*, *committed dose equivalent*, and *committed effective dose equivalent* are based on the dosimetry system, radiation quality factors, and tissue weighting factors formerly recommended by the International Commission on Radiological Protection in Publication 26 (ICRP 1977) and Publication 30 (ICRP 1979, et seq.). For Level I and Level II assessments, the Task 6 team used the adult dose coefficients or dose conversion factors (DCFs) for U 234, U 235, and U 238 taken from Publication 71 (ICRP 1995) for inhalation exposures, from Publication 72 (ICRP 1996) for ingestion exposures, and from Federal Guidance Report No. 12 (EPA 1995) for external exposures (see pp. 4-8 and 4-9 of the Task 6 Report [ChemRisk 1999]). Inhalation and ingestion DCFs are based on ICRP=s latest dosimetry system, defined in Publication 60 (1991), for calculating age-dependent doses to members of the public from intakes of radionuclides. This system incorporates revised biokinetic and dosimetric models, radiation weighting factors, and tissue weighting factors. ICRP=s current dosimetric quantities are the *equivalent dose*, *committed equivalent dose*, and *committed effective dose*. Calculations using inhalation and ingestion DCFs from ICRP 26/30 vs. ICRP 71/72 result in different radiation dose estimates for internal exposures. Strictly speaking, the radiation doses calculated by the Task 6 team, and used by ATSDR, represent the summation of the *committed effective doses* from internal exposures and the *effective doses* from external exposures. The resultant total dose may, perhaps, be best referred to as the *total effective dose*.

Table 1b. Air Exposure Pathway Doses

Air Exposure Pathways	Task 6 Level II doses*			ATSDR 70-y adjusted doses	
	U 234/235 (Sv)	U 238 (Sv)	Total U (mrem)	Total U (mrem)	Percent of total dose, all air pathways
Inhalation of airborne particulates	2.2E-04	4.0E-05	26	35	88%
Immersion in airborne particulates	7.6E-10	7.7E-14	0.0001	0.0001	>0.01%
Air to livestock, meat ingestion	1.4E-09	2.7E-10	0.0002	0.0002	>0.01%
Air to dairy cows, milk consumption	4.3E-09	8.4E-10	0.001	0.001	>0.01%
Air to vegetables, consumption	2.8E-05	2.1E-06	3	4	10%
Air to pasture to livestock to beef	1.3E-06	1.5E-07	0.1	0.2	0.5%
Air to pasture to dairy cows to milk	3.1E-06	3.6E-07	0.3	0.5	1.2%
Sum of doses from air pathways	2.5E-04	4.3E-05	29	40	100%

*Data taken from Tables 4-8 thru 4-13 (pp. 4-15 to 4-17) of the Task 6 report (ChemRisk 1999).

To calculate the doses for the inhalation pathway for both Level I and Level II screening assessments, the Task 6 team used the following equation (which represents the combination of two equations presented on pages J-4 and 4-9 of ChemRisk 1999):

$$D_{air} = C_{air} * U_{air} * f_t * f_s * B_{inh} * EF * ED * CF_1 * DCF_i$$

where:

Parameter	Definition (units)		Task 6 Report Parameter Values		
			Level I	**Level II**	**Citation**
D_{air}	Committed effective dose from intake of uranium isotopes in air (Sv)		(calculated)	(calculated)	---
C_{air}	Average concentration of uranium isotopes in air (pCi m^{-3})	U 234/235	1.42E-02	1.42E-02	Calculated using data from Table 3-15, p. 3-22.
		U 238	3.06E-03	3.06E-03	
U_{air}	Average volume of air inhaled per day (m^3 d^{-1})		20	20	Table K-1, p. K-4
f_t	Fraction of time that a person is exposed (unitless)		0.8	0.4	Table K-1, p. K-4
f_s	Indoor/outdoor shielding factor (unitless)		0.5	0.3	Table K-1, p. K-4
B_{inh}	Bioavailability (inhalation) (unitless)		1	1	Not provided, assumed value
EF	Exposure frequency		365	350	Table K-1, p. K-4
ED	Exposure duration		52	52	Not provided, assumes value
CF_1	Conversion factor (Bq pCi^{-1})		0.037	0.037	Not provided, assume value
DCF_i	Dose conversion factor for inhalation of uranium isotopes	U 234/235	9.4E-06	9.4E-06	Table 4-5, p.4-9
		U 238	8.0E-06	8.0E-06	

Substituting the Level II values into the equation above yields the following inhalation doses:

<u>U 234/235</u>
D_{air} = (1.4E-02) * (20) * (0.4) * (0.3) * (1) * (350) * (52) * (0.037) * (9.4E-06)
D_{air} = 2.2E-04 Sv (Task 6 value, 52-y)
D_{air} = 22 mrem (Task 6 value, 52-y)
D_{air} = 29 mrem (ATSDR value, 70-y)

<u>U 238</u>
D_{air} = (3.06E-03) * (20) * (0.4) * (0.3) * (1) * (350) * (52) * (0.037) * (8.0E-06)
D_{air} = 4.0E-05 Sv (Task 6 value, 52-y)
D_{air} = 4 mrem (Task 6 value, 52-y)
D_{air} = 5 mrem (ATSDR value, 70-y)

Total U = U-234/235 + U-238
D_{air} = 2.2E-04 Sv + 4.0E-05 Sv
D_{air} = 2.6E-04 Sv (Task 6 value, 52-y)
D_{air} = 26 mrem (Task 6 value, 52-y)
D_{air} = 35 mrem (ATSDR value, 70-y)

All of the calculated values above match those shown in Table 1b.

After reviewing the default assumptions used in these calculations, we conclude that the Level II parameter values used by the Task 6 team (and by ATSDR) for f_t (i.e., the fraction of time that a person is exposed) and f_t (i.e., the indoor/outdoor shielding factor) are not appropriate for a "typically" exposed individual. The current f_t value of 0.4 equates to an individual being exposed for only 40% of their time each day or 9.6 hr. The current f_s value of 0.3 means that the concentration of uranium isotopes in indoor air is only 1/3 of the concentration outdoors, and is based on assumption that the house is made of brick or stone.

For residential exposures, EPA=s *Exposure Factors Handbook* recommends 50th percentile values of 16.4 hr per day indoors and 2 hr per day outdoors (EPA/600/P-95/002Fc, August 1997, p.15-17). Since f_t is the sum of the exposures times indoors (ET_i) and outdoors (ET_o), then $f_t = ET_i + ET_o = (16.4/24) + (2/24) = 0.683 + 0.083 = 0.77$. For the indoor/outdoor shielding factor, f_s, we believe that a value of 0.5 is more reasonable than the current value of 0.3 and is consistent with the value used by the Task 6 team in the Level I assessment for wood houses. It is also consistent with other values reported in the literature[26].

Substituting these values for the current default values and modifying the previous equation to account for ET_i and ET_o, yields the following revised inhalation doses:

U-234/235
$D_{air} = C_{air} * U_{air} * [ET_o + (ET_i * f_s)] * B_{inh} * EF * ED * CF_1 * DCF_i$
D_{air} = 1.4E-02 * (20) * [0.083 + (0.683 * 0.5)] * (1) * (350) * (52) * (0.037) * (9.4E-06)
D_{air} = 7.6E-04 Sv (Task 6 value, 52-y)
D_{air} = 76 mrem (Task 6 value, 52-y)
D_{air} = 103 mrem (ATSDR value, 70-y)

U-238
$D_{air} = C_{air} * U_{air} * [ET_o + (ET_i * f_s)] * B_{inh} * EF * ED * CF_1 * DCF_i$
D_{air} = 3.06E-03 * (20) * [0.083 + (0.683 * 0.5)] * (1) * (350) * (52) * (0.037) * (8.0E-06)
D_{air} = 1.4E-04 Sv (Task 6 value, 52-y)
D_{air} = 14 mrem (Task 6 value, 52-y)
D_{air} = 19 mrem (ATSDR value, 70-y)

[26] For example, see: BIOMASS (The IAEA Programme on Biosphere Modeling and Assessment Methods), 2000. Model Testing Using Chernobyl Fallout Data from the Iput River Catchment Area, Bryansk Region, Russia: Scenario "Iput." BIOMASS Theme 2, Environmental Releases, Dose Reconstruction Working Group. International Atomic Energy Agency, Vienna, BIOMASS/2DR/WD02.

Total U = U-234/235 + U-238
D_{air} = 9.0E-04 Sv (Task 6 value, 52-y)
D_{air} = 90 mrem (Task 6 value, 52-y)
D_{air} = 122 mrem (ATSDR value, 70-y)

Using our suggested values for indoor and outdoor exposure times and shielding, we calculate a committed effective dose of 122 mrem for the inhalation pathway, compared with ATSDR=s current value of 35 mrem. As shown in Table 1c, by adding in the doses from the other air pathways and summing the total doses for all exposure pathways, we compute a total effective dose of 242 mrem, compared with ATSDR=s current value of 155 mrem.

Table 1c. ATSDR and Revised Pathway-specific Doses for Y-12

Exposure Pathways	ATSDR 70-y adjusted doses		Revised doses	
	Total U (mrem)	Percent of total dose	Total U (mrem)	Percent of total dose
Air	40	26%	127	53%
Surface Water	49	31%	49	20%
Soil	66	43%	66	27%
All pathways	**155**	100%	**242**	100%

Table 2. Contribution of Fish and Vegetable Consumption to the Total Dose for the Task 6 Level II Assessment*

Exposure pathway	Total U dose (Sv)	% Contribution to total dose**
Water to fish, consumption	3.3×10^{-4}	29%
Air to vegetables, consumption	3.0×10^{-5}	3%
Soil to vegetables, consumption	4.0×10^{-4}	35%
Total		67%

*Data taken from Tables 4-8 thru 4-13 of the Task 6 report (ChemRisk 1999, pp. 4-15 to 4-17) for the Level II assessment for Scarboro.

**Total effective dose from all pathways and uranium isotopes = 1.2E-03 Sv.

Table 3. Relative Contribution of Fish and Vegetable Consumption to Total Doses for Task 6 Level I and Level II Assessments*

Exposure pathway	Level I		Level II		Dose reduction**
	Total U dose (Sv)	% of total	Total U dose (Sv)	% of total	
All water pathways	6.3×10^{-4}	2%	3.6×10^{-4}	31%	2
fish only	3.3×10^{-4}	1%	3.3×10^{-4}	29%	1
All air pathways	2.0×10^{-3}	7%	3.0×10^{-4}	26%	6
vegetables only	9.2×10^{-4}	3%	3.0×10^{-5}	3%	31
All soil pathways	2.4×10^{-2}	90%	4.9×10^{-4}	43%	49
vegetables only	1.7×10^{-2}	66%	4.0×10^{-4}	35%	44
	2.7×10^{-2}		1.2×10^{-3}		

* Data taken from Tables 4-8 thru 4-13 of the Task 6 report (ChemRisk 1999, pp. 4-15 to 4-17) for the Level II assessment for Scarboro.
** Calculated as the ratio of Level I to Level II doses, i.e., Level I dose divided by Level II dose.

Table 4. Comparison of Fish and Vegetables Exposure Parameter Values: Task 6 Level I and Level II Assessments and EPA*

Parameter	Level I	Level II	EPA 1997					
			mean		95th%		recommended	
Fish intake rates								
Average daily consumption of fish, EFPC (g/d)	4	4	5 - 17 freshwater anglers		13-19 freshwater anglers		20 total fish intake	
Average daily consumption of fish, Clinch River/Poplar Creek (g/d)	10	10						
Fraction of fish consumed that is contaminated	1 (unitless)	1 (unitless)	Not available		Not available		Not available	
Vegetable intake rates and other parameters								
Average daily consumption of vegetables (kg/d wet weight)	0.5 veg. plus some fruit	0.2 veg. only	0.3 veg. only adult, 70 kg	0.2 fruit only adult, 70 kg	0.7 veg. only adult, 70 kg	0.9 fruit only adult, 70 kg	0.3 mean veg. adult, 70 kg	0.2 mean fruit adult, 70 kg
Fraction of vegetables consumed that is contaminated	0.6 unitless)	0.2 (unitless)	Not available		Not available		Not available	
Fraction of contamination remaining on vegetables after washing	0.7 (unitless)	0.2 (unitless)	Not available		Not available		Not available	

* Data taken from Table K-1, Task 6 report (ChemRisk 1999) and EPA’s *Exposure Factors Handbook, Volume II, Food Ingestion Factors* (EPA/600/P-95/002Fb, August 1997).

Table 5. Comparison of Measured and Task 6 Report Predicted Uranium Air Concentrations at Scarboro for the period 1986-1995*

Year	Measured uranium air concentrations at Scarboro (fCi/m^3)		Task 6 report estimated uranium air concentrations (fCi/m^3)		Ratio of Task 6 to measured concentrations	
	U 234/235	U 238	U 234/235	U 238	U 234/235	U 238
1986	0.62	0.08	3.40	0.69	6	9
1987	1.11	0.16	5.70	0.48	5	3
1988	0.60	0.11	2.90	0.47	5	4
1989	0.38	0.05	1.40	0.02	4	.05
1990	0.24	0.03	0.77	0.01	3	0.5
1991	0.17	0.03	0.38	0.06	2	2
1992	0.26	0.03	0.36	0.02	1	1
1993	0.11	0.02	0.29	0.01	3	1
1994	0.05	0.02	0.31	0.08	6	5
1995	0.03	0.01	0.17	0.01	6	1
Based on individual estimates			Mean		4	3
			Std. dev.		2	3
			min.		1	0.5
			max.		6	9
Based on combined U 234/235 plus U 238 estimates			Mean		3	
			Std. dev.		2	
			min.		0.5	
			max.		9	

*See text for data sources and analytical details.

Table 6. Summary of Recommendations for Improving Historic Dose and Risk Reconstruction Studies for Scarboro Community From Past Y-12 Uranium Releases.

Component	Recommendations
Y-12 uranium airborne release estimates	$ Additional searching for and review of effluent monitoring data for Y-12 electromagnetic enrichment operations from 1944 to 1947 and data relating to (unmonitored) depleted uranium operations in the 1950s through 1990s $ Provide error terms/probability distribution functions (PDFs) and conduct sensitivity and uncertainty analyses
Y-12 uranium surface water release estimates	$ Account for seasonal variability in surface water flow rates and uranium release rates $ Account for variable levels of uranium enrichment (instead of assuming natural isotopic abundance) $ Provide error terms/PDFs and conduct sensitivity/uncertainty analyses
Scarboro uranium air concentrations	$ Evaluate the effects of the ridges and valleys that dominate the local terrain surrounding Y-12 and Scarboro and investigate alternative approaches to estimate air concentrations at Scarboro, with an emphasis on using additional monitoring data $ Use historical data from other air sampling stations in and around Oak Ridge area near Scarboro to validate Scarboro data and assess doses and risks in neighboring communities $ Revise and validate the empirical χ/Q approach, or other approaches, using release and air measurement data, historical wind rose information, and/or measurements of atmospheric dispersion of controlled tracer releases from representative stacks and vents at Y-12. $ Provide error terms/PDFs and conduct sensitivity/uncertainty analyses
Scarboro uranium soil concentrations	$ Base analyses on measured uranium soil concentrations from core samples (at least 1 meter deep) from selected undisturbed areas in and around Scarboro $ Validate against estimated uranium soil deposition rates from reconstructed air concentrations or by other means $ Provide error terms/PDFs and conduct sensitivity/uncertainty analyses
Receptor populations	$ Include other Oak Ridge communities near Y-12 (e.g., Woodland) $ Identify areas surrounding ORR more likely and more heavily impacted by Y-12 uranium releases than Scarboro
Exposure assessment	$ Include region-specific consumption habits and lifestyles $ Identify likely exposure scenarios instead of hypothetical upper bound and typical assessments $ Use dynamic models to account for the temporal distribution and fate of uranium released to the environment $ Provide error terms/PDFs and conduct sensitivity/uncertainty analyses

Table 7. National, International, and Federal Radiation Protection Guidelines and Standards.

Agency	Numerical standard	Approximate lifetime excess cancer risk*	Description	Citation
ICRPNCRP	100 mrem/yr	2×10^{-3}	Limit for public exposure from all man-made sources, excluding medical natural background exposures.	ICRP Pub. 60 (1991); NCRP Report 116 (1993)
NRC	25 mrem/yr	5×10^{-4}	Radiological criteria for license termination, limit for public exposures. All doses must be kept as low as reasonably achievable (ALARA)	10 CFR 20, Subpart E
EPA	15 mrem/yr	3×10^{-4}	Individual protection limit for public exposures to radionuclide releases from the Waste Isolation Pilot Plant (WIPP) and Yucca Mountain.	40 CFR 194.51-194.57 40 CFR 197.20, 197.27
EPA	10 mrem/yr	2×10^{-4}	National Emission Standards for Hazardous Air Pollutants (NESHAPs) for airborne emissions from Federal Facilities and licensed NRC facilities.	40 CFR 60, Subparts H and I
EPA	10^{-6} to 10^{-4} lifetime cancer risk	---	National Oil and Hazardous Substances Pollution Contingency Plan (NCP) cancer risk range for cleanup of CERCLA sites.	40 CFR 300.430 (e)(2)(i)(A)(2)

*Based on EPA=s 30-y lifetime exposure duration and cancer mortality coefficient of 5.75×10^{-2} for low-dose, low-LET, uniform whole-body irradiation. See: S. D. Luftig and L. Wienstock, *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination*, OSWER directive No. 9200.4-18, Aug. 22, 1997. (Available at http://www.epa.gov/superfund/resources/radiation/radarars.htm)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
61 Forsyth Street
Atlanta, Georgia 30303

March 27, 2003

RECEIVED
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ATSDR/DHAC/PERISB

4WD-FFB

Mr. Max M. Howie, Jr.
Chief, Program Evaluation, Records
and Information Services Branch
Division of Health Assessment
and Consultation

SUBJ: Initial Release - Draft Public Health Assessment
Y-12 Uranium Releases
U.S. Department of Energy - Oak Ridge Reservation

Mr. Howie:

The Environmental Protection Agency (EPA) has completed its review of the subject document and is forwarding the enclosed comments. EPA concurs with the assessment's conclusion that the available data does not indicate the presence of uranium releases that constitute a past, current or future health threat for the Scarboro Community. However, the representativeness of Scarboro data for other communities should be thoroughly described, including the uncertainty of the conclusions for those communities that are more directly down-wind from the plant's air discharges. The enclosed comments also address concerns pertaining to the methodologies used for determining carcinogenic risk.

If you have any questions regarding this matter, please contact me at (404) 562-8546, or Mr. Jon Richards at (404) 562-8648.

Sincerely,

Jeff Crane, FFA Project Manager
DOE Section
Federal Facilities Branch
Waste Management Division
Environmental Protection Agency Region 4

cc: Dave Adler, DOE-OR
Randy Young, TDEC
Jack Hanley, ATSDR

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
61 Forsyth Street
Atlanta, Georgia 30303

June 20, 2003

4WD-FFB

Max M. Howie, Jr., M.S., Chief
Program Evaluation, Records
and Information Services Branch
Division of Health Assessment
and Consultation
ATSDR, Mailstop E-60
1600 Clifton Road, NE
Atlanta, GA 30333

SUBJ: Draft Public Health Assessment - Public Comment Release (April 22, 2003)
Y-12 Uranium Releases
U.S. Department of Energy - Oak Ridge Reservation

Dear Mr. Howie:

The Environmental Protection Agency (EPA) Region 4 (R4) has completed its review of the subject document and is forwarding the enclosed comments. EPA R4 previously reviewed the December 31, 2002, "Initial Release" draft Public Health Assessment (PHA) and forwarded comments on March 27, 2003. EPA finds that the April 22, 2003 "Public Comment Release" draft PHA did not fully address our comments. Accordingly, EPA R4 is forwarding the comments, with minor revisions, that had been previously raised during our review of the "Initial Release" draft PHA. EPA R4 appreciated the opportunity to discuss these comments with Mr. Jack Hanley and Mr. Paul Sharp on June 19, 2003, and would be happy to further discuss these matters if you have additional questions.

EPA R4 concurs with the draft PHA conclusion that the available data does not indicate the presence of uranium releases that constitute concern for the Scarboro Community. However, the representativeness of Scarboro data for releases to other areas should be more thoroughly described, including the uncertainty of the conclusions for any communities that may be more directly down-wind from the plant's air discharges.

If you have any questions regarding this matter, please contact me at (404) 562-8546, or Mr. Jon Richards at (404) 562-8648.

Sincerely,

Jeff Crane, FFA Project Manager
DOE Section
Federal Facilities Branch
Waste Management Division
Environmental Protection Agency Region 4

cc: Dave Adler, DOE-OR
Randy Young, TDEC
Jack Hanley, ATSDR

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
SAM NUNN ATLANTA FEDERAL CENTER
61 FORSYTH STREET, S.W.
ATLANTA, GEORGIA 30303

December 1, 2003

4WD-FFB

Jack Hanley, M.P.H.
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry
1600 Clifton Rd., NE, Bldg. 31 E32
Atlanta, GA 30329

SUBJ: **Responses to Comments on the**
Public Health Assessment, Y-12 Uranium Releases
Oak Ridge Reservation (USDOE), Oak Ridge, Anderson County, Tennessee

Dear Mr. Hanley:

The Environmental Protection Agency (EPA) Region 4 has completed its review of the draft responses to comments provided informally by the Agency for Toxic Substances and Disease Registry (ATSDR) for the subject document. Although EPA's Office of Indoor Air and Radiation (ORIA) provided more detailed comments, the two sets of comments were consistent on the primary issues raised regarding the uncertainty in the conclusions and the risk methodology used by ATSDR in the subject document. For the comments originating from EPA Region 4, we conclude that ATSDR has provided adequate responses. EPA Region 4 notes that some of the ATSDR comment responses to the detailed comments provided by ORIA may require further consultation between ATSDR and ORIA. We encourage your staff to contact ORIA to address any of these technical comments.

The ATSDR's Public Health Assessment (PHA) confirms the conclusions from EPA's sampling study of the Scarboro area, that there are no public health concerns to the community. In accordance with the milestones in the Federal Facility Agreement, the Department of Energy will complete a preliminary assessment/site investigation of off-site areas pending completion of the ATSDR PHA's. Any necessary follow-on activities will be addressed during this assessment.

Although EPA agrees with ATSDR that there are no apparent adverse health effects, as documented in the subject report, EPA does not agree with the dose or risk criteria ATSDR uses for assessing potential long-term chronic cancer risks, (i.e., 5000 mrem/year over 70 years). We understand that ATSDR currently uses the Superfund risk range for chemical carcinogens but not for radionuclides. Although EPA risk assessments and ATSDR public health assessments are not equivalent, EPA believes that ATSDR should be consistent and use the Superfund risk range for both chemical and radiation risks. Based on your response to comments, we understand ATSDR is using an external panel of epidemiologists and radiation experts and are willing to change based on their input. We highly recommend these experts include representatives from EPA's Office of Radiation and Indoor Air, the Office of Solid Waste and Emergency Response, and EPA's Science Advisory Board, Subcommittee on Radiation.

If you have any further questions, please contact me at 404/562-8546, or our radiation support contact, Jon Richards, at 404/562-8648.

Sincerely,

Jeffrey L. Crane
Federal Facility
Agreement Project Manager,
Oak Ridge Reservation
Federal Facilities Branch

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JAN 9 2004

OFFICE OF
AIR AND RADIATION

Kowetha A. Davidson, Ph.D
Chair, Oak Ridge Reservation Health Effects Subcommittee
c/o ATSDR Oak Ridge Field Office
P.O. Box 5088
Oak Ridge, TN 37831-5088

Dear Dr. Davidson:

Thank you for your letter dated November 21, 2003 inviting a representative from the U.S. Environmental Protection Agency (EPA) Headquarters to attend your subcommittee meeting on December 3, 2003. Unfortunately, there was not enough time following receipt of your letter to arrange for a representative to attend.

In your letter you raise concerns about separate comments from EPA Region 4 and EPA Headquarters. I agree that, ideally, one set of comments from EPA is desirable and apologize for any confusion this caused the subcommittee. We coordinated closely with Region 4 and I can assure you that there is no disagreement between EPA Region 4 and Headquarters over either the content of the letters or the technical comments provided to the Agency for Toxic Substances and Disease Registry (ATSDR).

We have reviewed the draft responses to comments provided informally by the ATSDR for the Public Comment Release of the public health assessment for the Y-12 Uranium Releases at the Oak Ridge Reservation. We have also discussed our comments with ATSDR and agree that there are no current public exposure concerns from releases from the Y-12 facility in Scarboro.

In general, we understand the differing purposes between ATSDR's Public Health Assessment (PHA) process and EPA site-specific risk assessments; however, as Region 4 stated in its December 1, 2003 letter to Jack Hanley, "EPA does not agree with the dose or risk criteria ATSDR uses for assessing potential long-term chronic cancer risks, (i.e., 5000 mrem/year over 70 years). We understand that ATSDR currently uses the Superfund risk range for chemical carcinogens but not for radionuclides. Although EPA risk assessments and ATSDR public health assessments are not equivalent, EPA believes that ATSDR should be consistent and use the Superfund risk range for both chemical and radiation risks."

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We also continue to believe that uncertainty analysis is essential to support the conclusions reached in this assessment. We understand that ATSDR plans to use an external panel of epidemiologists and radiation experts to review the PHA and will consider changes based on their input. Along with region 4, we support this approach and look forward to seeing the results of their review.

Please feel free to contact Frank Marcinowski at 202-343-9437 if you have questions or need additional information.

Sincerely,

Elizabeth Cotsworth

Elizabeth Cotsworth, Director
Office of Radiation and Indoor Air

APPENDIX I

Summary Briefs

ORRHES Brief

Oak Ridge Reservation Health Effects Subcommittee

ATSDR
AGENCY FOR TOXIC SUBSTANCES

Public Health Consultation, Y-12 Weapons Plant Chemical Releases into East Fork Poplar Creek, Oak Ridge, Tennessee, April 5, 1993

Site: Oak Ridge Reservation

Conducted by: Agency for Toxic Substances and Disease Registry

Time Period: Early 1990s

Location: East Fork Poplar Creek and Floodplain Area

Purpose

The purpose of the health consultation was to evaluate published environmental data and to assess health risks associated with Y-12 Weapons Plant releases at the Oak Ridge Reservation.

Background

Between 1950 and 1963, the Department of Energy (DOE) Y-12 Weapons Plant used mercury in a lithium separation process. DOE officials estimate that 110 metric tons of mercury were released to the East Fork Poplar Creek (EFPC), and that an additional 750 metric tons of mercury used during that period could not be accounted for. Releases of mercury to the creek contaminated instream sediments, and periodic flooding contaminated floodplain soils along the creek. Land uses along the floodplain are residential, commercial, and recreational. Furthermore, residents used the sediment to enrich private gardens, and the city of Oak Ridge used creek sediment as fill material on sewer belt lines. In 1983, the state of Tennessee publicly disclosed that sediment and soil in the EFPC floodplain were contaminated with mercury. That same year, the Oak Ridge Task Force initiated remediation of public and private lands within the city of Oak Ridge.

In 1992, during Phase IA of the EFPC remedial investigation, DOE conducted preliminary sampling of soil, sediment, surface water, and groundwater from the EFPC floodplain area. During 1990 and 1991, DOE sampled for contaminants in EFPC fish through its Biological Monitoring and Abatement Program.

Study design and method

This was a health consultation conducted by the Agency for Toxic Substances and Disease Registry (ATSDR). An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, chemical release, or the presence of hazardous material. In this case, DOE requested that ATSDR comment on the health threat posed by past and present chemical releases from the Y-12 Weapons Plant to the East Fork Poplar Creek. To conduct the consultation, ATSDR evaluated DOE's preliminary environmental sampling data for metals, volatile and semivolatile organic compounds, radionuclides, and polychlorinated biphenyls (PCBs).

Health consultations may lead to specific actions, such as environmental sampling, restricting site access, or removing contaminated material, or ATSDR may make recommendations for other activities to protect the public's health.

Study group

ATSDR did not conduct a study.

Exposures

ATSDR estimated human exposure to contaminated EFPC floodplain soil, sediments, surface water, groundwater, fish, and air.

Outcome measure

ATSDR did not review health outcome data.

Results

Only mercury in soil and sediment, and PCBs and mercury in fish, are at levels of public health concern. Other contaminants, including radionuclides found in soil, sediment, and surface water, are not at levels of public health concern. Data were not available on radionuclides in fish.

Elevated levels of mercury, up to 2,240 parts per million (ppm), were found in a few soil and sediment samples from all three creek areas sampled. The mercury in the EFPC soil consisted primarily of some relatively insoluble inorganic forms of mercury (mercury salts and metallic mercury), with less than 1% of the mercury in organic form.

Mercury Salts in Soil

The primary routes of inorganic mercury exposure for people (particularly for children) who fish, play, or walk along the creek and floodplain, are through ingestion of soil from hand-to-mouth activities and from excessive dermal exposure. Following ingestion, absorption of inorganic mercury compounds across the gastrointestinal tract to the blood is low in both people and animals. Long-term exposure to the EFPC floodplain soil containing elevated levels of mercury may result in body burdens of mercury that could result in adverse health effects. The kidney is the organ most sensitive to the effects of ingestion of inorganic mercury salts. Effects on the kidney include increased urine protein levels and, in more severe cases, a reduction in the glomerular filtration rate, which is a sign of decreased blood-filtering capacity.

Metallic Mercury in Soil

The metallic mercury vapor levels in the ambient air at the three creek areas sampled are not at levels of public health concern. However, excavation of contaminated soil may result in mercury vapor being released from the soil, especially as the air temperature increases. Such releases may increase ambient air levels of mercury vapor, which could pose a health risk to unprotected workers and the public. Once inhaled, metallic mercury vapors are readily absorbed across the lungs into the blood; however, metallic mercury is poorly absorbed through dermal and oral routes. Exposure to mercury vapor may elicit consistent and pronounced neurologic effects.

Organic Mercury in Fish

Organic mercury is the primary form of mercury found in fish. Frequent ingestion of EFPC fish over the long term may result in neurotoxic effects. Concentrations of mercury in EFPC fish samples ranged from 0.08 ppm to 1.31 ppm. Studies on the retention and excretion of mercury have shown that approximately 95% of an oral dose of organic mercury is absorbed across the gastrointestinal tract. Neurodevelopmental effects have been seen in infants following prenatal exposure via maternal ingestion of organic mercury in fish.

PCBs in Fish

Frequent and long-term ingestion of EFPC fish could result in a moderate increased risk of developing cancer. Concentrations of PCBs in EFPC fish samples ranged from 0.01 ppm to 3.86 ppm. PCBs are widely distributed environmental pollutants commonly found in blood and fat tissue of the general population. PCBs are classified as a probable human carcinogen by the U.S. Environmental Protection Agency. PCBs have been shown to produce liver tumors in mice and rats following intermediate and chronic oral exposure. Groundwater samples collected from shallow monitoring wells along the EFPC floodplain were shown to contain elevated levels of metals and volatile organic compounds. There was no evidence, however, that groundwater from shallow aquifers was being used for domestic purposes. The municipal water system, which is used by most Oak Ridge residents, receives water from Clinch River upstream of the DOE reservation.

Conclusions

In some locations along the creek, mercury levels in soil and sediment pose a threat to people (especially children) who ingest, inhale, or have dermal contact with contaminated soil, sediment, or dust while playing, fishing, or taking part in other activities along the creek's floodplain.

Mercury and PCBs were found in fish fillet samples collected from the creek. Although people who eat fish from the creek are not at risk for acute health threats, people who frequently ingest contaminated fish over a prolonged period have a moderate increased risk of (1) adverse effects to the central nervous system and kidney and (2) developing cancer.

ATSDR did not have enough information on groundwater use along the East Fork Poplar Creek to comment on the contamination of groundwater in shallow, private wells along the creek. However, contamination detected in wells along the creek does not pose a threat to people who receive municipal water.

ATSDR made the following recommendations.

- Determine the depth and extent of mercury contamination in the EFPC sediments and floodplain soil.
- As an interim measure, restrict access to the contaminated soil and sediment, or post advisories to warn the public of the hazards.
- Continue the Tennessee Department of Environment and Conservation EFPC fish advisory.
- Continue monitoring fish from the creek for the presence of mercury and PCBs.
- Complete the survey of well water use along the EFPC floodplain.
- Sample shallow private wells near the creek for PCBs, volatile organic compounds, and total and dissolved metals.

ATSDR
AGENCY FOR TOXIC SUBSTANCES

ORRHES Brief
Oak Ridge Reservation Health Effects Subcommittee

Health Consultation, U.S. DOE Oak Ridge Reservation, Lower Watts Bar Operable Unit, February 1996

Site: Oak Ridge Reservation
Study authors: Agency for Toxic Substances and Disease Registry
Time period: 1980s and 1990s
Target population: Lower Watts Bar Reservoir Area

Purpose

This health consultation was conducted to evaluate the public health implications of chemical and radiological contaminants in the Watts Bar Reservoir and the effectiveness of the Department of Energy's proposed remedial action plan for protecting public health.

Background

In March 1995, the Department of Energy (DOE) released a proposed plan for addressing contaminants in the Lower Watts Bar Reservoir. The plan presented the potential risk posed by contaminants and DOE's preferred remedial action alternative. DOE's risk assessment indicated that consumption of certain species of fish from the Lower Watts Bar Reservoir and the transfer of sediment from deeper areas of the reservoir to areas on land where crops were grown could result in unacceptable risk to human health.

The September 1995 Record of Decision for the Lower Watts Bar Reservoir presented DOE's remedial action plan for the reservoir. This remedial action included maintaining the fish consumption advisories of the Tennessee Department of Environment and Conservation (TDEC), continuing environmental monitoring, and implementing institutional controls to prevent disturbance, resuspension, removal, or disposal of contaminated sediment. The U.S. Environmental Protection Agency (EPA) and TDEC concurred with the remedial action plan.

Concerned about the sufficiency of DOE's plan, local residents asked the Agency for Toxic Substances and Disease Registry (ATSDR) to evaluate the health risk related to contaminants in the Lower Watts Bar Reservoir. These residents asked ATSDR to provide an independent opinion on whether DOE's selected remedial actions would adequately protect public health.

Methods

ATSDR agreed to provide a health consultation. A health consultation is conducted in response to a specific request for information about health risks related to a specific site, a specific chemical release, or the presence of other hazardous material. The response from ATSDR may be verbal or written.

To assess the current and recent past health hazards from the Lower Watts Bar Reservoir contamination, ATSDR evaluated environmental sampling data. ATSDR evaluated reservoir studies conducted by DOE and the Tennessee Valley Authority during the 1980s and 1990s. ATSDR also evaluated TVA's 1993 and 1994 Annual Radiological Environmental Reports for the Watts Bar nuclear plant. ATSDR first screened the voluminous environmental data to determine whether any contaminants were present at levels above health–based comparison values. ATSDR next estimated exposure doses for any contaminants exceeding comparison values. It is important to note that the fact that a contaminant exceeds comparison values does not necessarily mean that the contaminant will cause adverse health effects. Comparison values simply help ATSDR determine which contaminants to evaluate more closely.

ATSDR estimated exposure doses, using both worst case and realistic exposure scenarios, to determine if current chemical and radiological contaminant levels could pose a health risk to area residents. The worst case scenarios assumed that the most sensitive population (young children) would be exposed to the highest concentration of each contaminant in each media by the most probable exposure routes.

Target population

Individuals living along the Watts Bar Reservoir and individuals visiting the area.

Exposures

The exposures investigated were those to metals, radionuclides, volatile organic compounds, polychlorinated biphenyls (PCBs), and pesticides in surface water, sediment, and fish.

Outcome measure

ATSDR did not review health outcome data.

Results

Reservoir Fish and Other Wildlife: Using a realistic exposure scenario for fish consumption that assumed an adult weighing 70 kilogram (kg) consumed one 8-ounce sport fish meal per week, or per month, for 30 years, ATSDR determined that PCB levels in reservoir fish were at levels of health concern. ATSDR estimated ranges of PCB exposure doses from 0.099 to 0.24 micrograms of PCBs per kilogram of human body weight every day (µg/kg/day) for the one fish meal a week scenario and 0.023 to 0.055 µg/kg/day for the one fish per month scenario.

At these exposure doses, ATSDR estimates that approximately one additional cancer case might develop in 1,000 people eating one fish meal a week for 30 years and three additional cancer cases might develop in 10,000 people eating one fish meal a month for 30 years.

At these exposure doses, ATSDR also determined that ingestion of reservoir fish by pregnant women and nursing mothers might cause adverse neurobehavioral effects in infants. Although the evidence that PCBs cause developmental defects in infants is difficult to evaluate and inconclusive, ATSDR's determination was made on the basis of the special vulnerability of developing fetuses and infants.

Using a worst case scenario that assumed adults and children consumed two 8-ounce fish meals a week, containing the maximum concentration of each radioactive contaminant, ATSDR determined that the potential level of radiological exposure, which was less than 6 millirem per year (mrem/yr), was not a public health hazard.

Reservoir Surface Water: Using a worst case exposure scenario that assumed a child would daily ingest a liter of unfiltered reservoir water containing the maximum level of contaminants, ATSDR determined that the levels of chemicals in the reservoir surface water were not a public health hazard.

Levels of radionuclides in surface water were well below the levels of the current and proposed EPA drinking water standards. In addition, the total radiation dose to children from waterborne radioactive contaminants would be less that 1 mrem/yr, which is well below background levels. The radiation dose was estimated using the conservative assumption that a 10-year-old child would drink and shower with unfiltered reservoir water and swim in the reservoir daily.

Reservoir Sediment: ATSDR determined that the maximum chemical and radioactive contaminant concentrations reported in the recent surface sediments data (mercury, Co-60, Sr–89/90, and Cs-137) would not present a public health hazard. The estimated dose from radioactive contaminants was less than 15 mrem/yr, which is below background levels.

ATSDR also evaluated the potential exposure a child might receive if the subsurface sediments were removed from the deep reservoir channels and used as surface soil in residential properties. Using a worst case exposure scenario that included ingestion, inhalation, external, and dermal contact exposure routes, ATSDR determined that the potential radiation dose to individuals living on these properties (less than 20 mrem/yr) would not pose a public health hazard.

Conclusions

ATSDR found that only PCBs in the reservoir fish were of potential public health concern. Other contaminants in the surface water, sediment, and fish were not found to be a public health hazard.

On the basis of current levels of contaminants in the water, sediment, and wildlife, ATSDR concluded the following.

- The levels of PCBs in the Lower Watts Bar Reservoir fish posed a public health concern. Frequent and long-term ingestion of fish from the reservoir posed a moderately increased risk of cancer in adults and increased the possibility of developmental effects in infants whose mothers consumed fish regularly during gestation and while nursing. Turtles in the reservoir might also contain PCBs at levels of public health concern.

- Current levels of contaminants in the reservoir surface water and sediment were not a public health hazard. The reservoir was safe for swimming, skiing, boating, and other recreational purposes. It is safe to drink water from the municipal water systems, which draw surface water from tributary embayments in the Lower Watts Bar Reservoir and the Tennessee River upstream from the Clinch River and Lower Watts Bar Reservoir.

- DOE's selected remedial action was protective of public health.

ATSDR made the following recommendations.

- The Lower Watts Bar Reservoir fish advisory should remain in effect to minimize exposure to PCBs.

- ATSDR should work with the state of Tennessee to implement a community health education program on the Lower Watts Bar fish advisory and the health effects of PCB exposure.

- The health risk from consumption of turtles in the Lower Watts Bar Reservoir should be evaluated. The evaluation should investigate turtle consumption patterns and PCB levels in edible portions of turtles.

- Surface and subsurface sediments should not be disturbed, removed, or disposed of without careful review by the interagency working group.

- Sampling of municipal drinking water at regular intervals should be continued. In addition, at any time a significant release of contaminants from the Oak Ridge Reservation is discharged into the Clinch River, DOE should notify municipal water systems and monitor surface water intakes.

ORRHES Brief

Oak Ridge Reservation Health Effects Subcommittee

ATSDR
AGENCY FOR TOXIC SUBSTANCES

September 2001 Sampling Report for the Scarboro Community, Oak Ridge, Tennessee, April 2003

Site: Oak Ridge Reservation
Conducted by: U.S. EPA
Time Period: 2001
Location: Scarboro, Tennessee

Purpose

The purpose of the U.S. Environmental Protection Agency (EPA) sampling event was to re-sample 20% of the sampling locations investigated by the Environmental Sciences Institute at Florida Agricultural and Mechanical University (FAMU) for the U.S. Department of Energy (DOE) in 1998. The results of these samples were to be compared to those collected by FAMU. By comparing the results, EPA would:

- Verify the 1998 chemical, metal, and radiological data collected and analyzed by DOE,
- Identify any substance(s) not analyzed by DOE and evaluate those analytical data gaps,
- Determine the source(s) of uranium and other radionuclides, and
- Evaluate whether unreasonable risk to human health may be present.

Background

Beginning in 1997, the Scarboro Chapter of the National Association for the Advancement of Colored People (NAACP) contacted EPA with concerns that the Scarboro community was possibly being exposed to emissions from the Y-12 plant located at DOE's Oak Ridge Reservation (ORR). They were concerned that the community could be experiencing negative health impacts.

In May 1998, DOE responded to the concerns of the citizens by contracting with FAMU to conduct the *Scarboro Community Environmental Study*. FAMU and its contractual partners at the Environmental Radioactivity Measurement Facility at Florida State University, the Bureau of Laboratories of the Florida Department of Environmental Protection, and the Neutron Activation Analysis Group at the Oak Ridge National Laboratory collected and analyzed samples from 48 locations in the Scarboro community. Forty soil and eight sediment and/or surface water samples were collected. The results of the *Scarboro Community Environmental Study* were released in September 1998. However, EPA states they did not receive the DOE sampling and analysis plan for review prior to its implementation nor was EPA able to participate in or observe the FAMU and DOE field sampling. Therefore, to verify the FAMU and DOE's sampling, EPA developed a draft sampling plan, *EPA Proposed Sampling and Analysis Plan for the Scarboro Community*, in July 1999, and presented it to the Oak Ridge Site Specific Advisory Board at its September 1, 1999, meeting. The EPA solicited and received comments from the Oak Ridge community-at-large.

Methods

On September 25, 2001, representatives of the EPA (specifically, Region 4, Science and Ecosystem Division (SESD), Enforcement Investigation Branch (EIB) personnel) collected a total of 10 environmental samples from eight separate properties within the Scarboro community. Six surface soil samples (6 inch interval), two sediment samples, and two surface water samples were collected from nine separate locations (two samples were collected at one of the eight properties). Additionally, at the request of local residents, core soil samples (12 inch interval) were taken from two locations to determine the depth at which uranium is present. Sample sites were selected based on:

- The May 1998 DOE study,
- Reconnaissance performed in February 23, 1999, by SESD-EIB personnel,
- Information gathered during the February 1999 and September 2001 public meetings held in Oak Ridge, and
- Professional judgment regarding where an unreasonable risk to human health might be found, if such were to exist.

All samples were collected and handled in accordance with the EPA, Region 4, SESD's *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, May 1, 1996. Surface soil was collected using a pre-cleaned 3-inch diameter stainless steel hand auger from the interval of 0-6 inches. Core samples were taken at a depth of 0-12 inches to determine the presence of uranium. Samples for volatile organic compounds (VOCs) were not homogenized prior to being placed in the sample container. Because wading was possible in each surface water body, surface water samples were collected directly into the sample container, prior to taking sediment samples. Surface water samples were not filtered in the field. Sediment samples were collected with a stainless steel scoop or spoon and were homogenized.

The samples were analyzed by the EPA National Air and Radiation Environmental Laboratory (NAREL) located in Montgomery, Alabama, for the following contaminants: radionuclides, metals (including mercury), VOCs, semi-volatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyls (PCBs). In order to evaluate the presence of lithium in the samples, the laboratory Lithium Internal Standard for trace metal analysis was used as evidence that there is little, if any, lithium present in the samples collected by EPA.

In addition, personnel from the EPA, Region 4, Office of Technical Services conducted a radiation walkover (a qualitative screening) of the areas selected for sampling to determine whether radiation existed above background levels. The survey was performed using a sodium iodide detector and GM Pancake probe to identify the presence of uranium isotopes and other gamma-emitting isotopes.

Study Subjects: No groups were studied.

Exposures: No exposures were studied.

Outcome Measures: Health outcomes were not studied.

Results: To evaluate the results of the analytical sampling EPA used the following guidance and standards:

- Under the *Safe Drinking Water Act (SDWA)* standards were created to control the level of contaminants that are in drinking water. EPA used this guidance for the surface water samples that were collected. Maximum contaminant limits (MCLs) are legally enforceable health protective standards (National Primary Drinking Water Standards). National Secondary Drinking Water Standards (NSDWS) are non-enforceable standards that provide guidance on cosmetic effects a contaminant might have on the quality of the water.
- *Preliminary Remediation Goals (PRGs)* are risk-based values used for screening soil and sediment samples at contaminated sites. The PRG is a number that represents the lowest risk level of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) protective risk range (1×10^{-6} to 1×10^{-4}) for cancer effects. For non-cancer effects the PRG represents the Hazard Index (HI) value of 1.0 (see next bullet).
- The *Hazard Quotient/Hazard Index (HQ/HI)* is a ratio of the exposure level for a single toxic substance to the reference dose of that substance over the same exposure period.

The HI is the sum of all HQ values from all toxic substances that a person is exposed to from a common source. A HQ or HI less than 1.0 indicates that the exposure is not sufficient to yield a health concern for a lifetime (70 years) of daily exposure.

- *Gamma Spectroscopy* was used as a screen to analyze gamma-emitting isotopes which indicate radioactive decay.

- *Gross Alpha/Gross Beta* levels were used as a screen to determine if individual radionuclides should be sampled.

Radionuclides

The qualitative walkover screening did not detect radiation above background levels. None of the radionuclide analytical values exceeded normal background levels, MCLs, or PRGs. The two core samples collected from 0 to 12 inches below the ground surface indicate that uranium levels are below the PRG or background levels within the U.S.

The uranium results indicated that there was uncertainty associated with uranium enrichment due to the uranium isotope levels being at either background levels and/or detection limits. However, even if there is potentially some uranium enrichment in the uranium isotopes in the Scarboro soil and sediment, the actual levels of uranium isotopes are still within the U.S. and Oak Ridge background ranges.

Lithium. The laboratory results could not support a positive presence of lithium in the samples collected by EPA. The evidence indicates there is little, if any, lithium present in the samples.

Metals

All metals, including mercury, in the surface water, sediment, and soil samples were undetected or below MCLs, NSDWS, or PRGs with the following exceptions:

- *Aluminum.* The NSDWS of 50-200 µg/L for aluminum was exceeded in both surface water samples (1,030 µg/L and 1,640 µg/L).

- *Arsenic.* The PRG of 0.39 mg/kg for arsenic was exceeded in both sediment samples (1.62 mg/kg and 5.17 mg/kg) and four soil samples (5.64 mg/kg, 3.66 mg/kg, 4.68 mg/kg, and 6.39 mg/kg).

- *Iron.* The NSDWS of 300 µg/L for iron was exceeded in both surface water samples (769 µg/L and 1,160 µg/L). The PRG of 23,000 mg/kg for iron was exceeded in three soil samples (23,100 mg/kg, 25,400 mg/kg, and 25,400 mg/kg).

- *Manganese.* The NSDWS of 50 µg/L for manganese was exceeded in one of the surface water samples (65.5 µg/L). The PRG of 1,800 mg/kg for manganese was exceeded in one soil sample (1,930 mg/kg).

VOCs and SVOCs

No VOCs were detected in the surface water samples. The following VOCs were detected in the soil and/or sediment samples: cyclotetrasiloxane, benzoic acid, acetic acid, 1R-alpha-pinene, and dodecane. The following SVOCs were detected in the surface water, soil, or sediment samples: butyl benzyl phthalate, di-n-butyl phthalate, and dibutyl phthalate. These VOCs and SVOCs are generally attributed to sampling and/or laboratory activities and are not considered to be related to the ORR or the Scarboro area.

Pesticides and PCBs

All pesticides and PCBs in the surface water, sediment, and soil samples were undetected or below MCLs, NSDWS, or PRGs with the following exceptions:

Alpha-chlordane and gamma-chlordane were detected in one sediment sample (0.50 J µg/kg and 0.75 J µg/kg, respectively). Alpha-chlordane was detected in two soil samples (11 µg/kg and 14 µg/kg). Gamma-chlordane was also detected in two soil samples (12 µg/kg and 30 µg/kg). Heptachlor was detected in one soil sample (13 µg/kg). Heptachlor epoxide was detected in one soil sample (11 µg/kg).

Conclusions

EPA stated that the results of the analysis did not reveal any chemicals or radionuclides at levels that warrant a health or environmental concern.

- The level of radiation was below background levels and the radionuclide analytical values did not indicate a level of health concern. Uranium levels in the core soil samples were also below background levels. There is no indication that lithium was present in the analyzed samples at levels that would warrant health concern.
- Aluminum, iron, and manganese are naturally occurring in the geologic formations of the Oak Ridge area, indicating that these are not related to releases from DOE operations. Regardless, they are not present at levels of health hazard.
- Arsenic has both carcinogenic and noncarcinogenic health effects. The HI value for arsenic indicates that an assumed exposure level could be above the protective level for noncarcinogenic effects. However, the value did not exceed the CERCLA protective risk range (1×10^{-4}) for its carcinogenic effects.
- The detected VOCs and SVOCs are plasticizers, solvents, softening agents, and/or column artifacts and their presence is generally attributed to sampling and/or laboratory activities. Therefore, they are not considered to be site related and no further evaluation was conducted.
- The presence of pesticides indicates possible past use by the homeowner/resident. They are not considered to be site related and no further evaluation was conducted.

The results of both the EPA and DOE sampling effort are consistent in their findings. These results confirm that existing soil, sediment, and surface water quality pose no risk to human health within the Scarboro community. There is not an elevation of chemical, metal, or radionuclides above a regulatory health level of concern. The Scarboro community is not currently being exposed to substances from the Y-12 facility in quantities that pose an unreasonable risk to health or the environment. The EPA does not propose to conduct any further environmental sampling in the Scarboro community.

If additional environmental information becomes available, EPA proposes that the following recommendations be implemented:

1. DOE should develop a written procedure to receive citizen and community complaints regarding discharges, emissions, or other releases originating from the ORR. The procedure should identify and provide for a timely response and follow-up action. Additionally, DOE should develop a communication strategy to inform the residents and other community members or stakeholders of its findings.

2. If additional environmental information becomes available regarding Scarboro that warrants an investigation by DOE, the sampling plan, if developed, should be reviewed and approved by the EPA and the Tennessee Department of Environment and Conservation (TDEC), as regulatory oversight agencies to the Federal Facility Agreement (FFA).

3. Any future health investigations conducted by DOE of the impacts of its operations on the Scarboro or the greater Oak Ridge community should be coordinated with the Oak Ridge Reservation Health Effects Subcommittee (ORRHES) of the Agency for Toxic Substances and Disease Registry (ATSDR).

4. Upon the release of recommendations by the ORRHES to the ATSDR, DOE, EPA, and TDEC with stakeholder involvement will scope the off-site (off DOE reservation) operable unit. The results of this activity will be the preparation of a Preliminary Assessment/Site Inspection, which is currently planned for September 30, 2005. This commitment is a DOE FFA milestone.

ORRHES Brief

Oak Ridge Reservation Health Effects Subcommittee

ATSDR
AGENCY FOR TOXIC SUBSTANCES

Scarboro Environmental Study

Site: Oak Ridge Reservation

Conducted by: Environmental Sciences Institute at Florida Agricultural and Mechanical University, Environmental Radioactivity Measurement Facility at Florida State University, Bureau of Laboratories of the Florida Department of Environmental Protection, Jacobs Engineering, DOE subcontractors in the Neutron Activation Analysis Group at Oak Ridge National Laboratory

Time Period: 1998

Location: Scarboro, Tennessee

Purpose

The purpose of the study was to address community concerns about environmental monitoring in the Scarboro neighborhood.

Background

This study was conducted in response to Scarboro community residents' concern about the validity of measurements taken at air monitoring station 46 located in the Scarboro community and external radiation results from past aerial surveys.

The study was designed to incorporate community input and meet the requirements of an EPA investigation of this type. The analytical component of the study was conducted by the Environmental Sciences Institute at Florida Agriculture and Mechanical University (FAMU) and its contractual partners at the Environmental Radioactivity Measurement Facility at Florida State University and the Bureau of Laboratories of the Florida Department of Environmental Protection, and by DOE subcontractors in the Neutron Activation Analysis Group at the Oak Ridge National Laboratory.

Method

Soil, sediment and surface water samples were collected in the Scarboro neighborhood and analyzed for mercury, radionuclides, and organic and inorganic compounds. Initial radiological walkover surveys were conducted to identify hot spots prior to sample collection, and some samples were collected from these areas with the highest radiological counts.

A total of 48 samples were collected; 40 were surface soil samples (within top 2 inches) and 8 were sediment/surface water samples. All samples were analyzed for mercury, gross alpha/beta content, uranium, and gamma emitting radionuclides. Gross alpha-beta content was conducted to screen samples for further analysis. Gamma-ray spectroscopy measurements were made to check for the presence of naturally occurring and man made radionuclides. Neutron activation analysis was used to analyze all soil and sediment samples for uranium isotopes (U-238 and U-235).

Approximately 10% of the samples collected (4 soil, 1 sediment and 1 surface water sample) were tested for the presence of analytes on the target compound list (TCL), the target analyte list (TAL), and Strontium-90. Alpha spectroscopy was also used to test these samples for isotopes of uranium, plutonium, and thorium.

To determine whether a sample measurement was within normal background levels, the value was compared to the 95th percentile of the distribution of results obtained in the Background Soils Characterization Project (BSCP) study. Scarboro data were specifically compared to results from the Chickamauga Bethel Valley group in the BSCP study because this geologic formation best approximates the geologic formation underlying the Scarboro community.

[1] The 95th percentile value is the value at or below which 95% of the samples fall in a distribution. For example, if 100 soil samples were collected and tested for mercury, and the 95th percentile value was found to be 0.5 parts per billion (ppb), 95 of the samples would have a value of 0.5 ppb or less.

Study Subjects
No groups were studied.

Exposures
Exposures studied included mercury, gamma-ray emitting radionuclides, TCL organics, TAL inorganics, Strontium-90, and uranium, thorium, and plutonium isotopes.

Outcome Measures
Health outcomes were not studied.

Results
Mercury: Mercury values in the Scarboro soil samples ranged from 0.021 milligrams per kilogram (mg/kg) to 0.30 mg/kg, with a median value of 0.11 mg/kg. Two samples (192 S. Benedict Ave and Parcel 570, Wilberforce) exceeded the 95th percentile value for mercury for the Bethel Valley Chickamauga Group, but were less than the 95th percentile for the K-25 Chickamauga Group.

Mercury was not detected in surface water samples. Mercury values in Scarboro sediment ranged from 0.018 mg/kg to 0.12 mg/kg. Comparison of sediment values to BSCP data was not possible.

Gamma-ray spectroscopy measurements: Most gamma-ray emitting radionuclides fell within the range of expected values. In a few cases the radioisotopes U-238 (Th-234) and U-235 exceeded the 95th percentile values for the BSCP formations; however, the mean values for U-235 and U-238 were within one standard deviation of the BSCP medians. This means that, on average, it is unlikely that uranium was present in Scarboro soil at elevated concentrations.

Uranium Isotopic Analysis by Neutron Activation Analysis: The average Uranium-238 value (1.39 PicoCurie per microgram (pCi/µg) for the Scarboro samples fell within the range of values determined by both alpha spectroscopy and gamma-ray spectroscopy in the BSCP study. The mean ratio of uranium-235 to uranium-238 was 0.0093 + 0.0021. Five soil samples (4 in Parcel 570, and 117/119 Spellman Ave) contained U-235/U-238 weight ratios greater than might be expected, suggesting enrichment in uranium-235.

10% samples: Antimony, selenium, silver, sodium and thallium were rarely detected in any of the samples. Lead and zinc concentrations in one soil sample (117/119 Spellman Avenue) exceeded the 95th percentile for all BSCP geologic formations.

The pesticides alpha-chlordane (1700 ppb), gamma-chlordane (2800 ppb), heptachlor (190 ppb), and heptachlor epoxide (970 ppb) were detected in one soil sample (117/119 Spellman Avenue). No other organic contaminants were detected in Scarboro samples.

The maximum Strontium-90 value fell within the 95th percentile from the BSCP study.

Using alpha-spectroscopy analysis, most of the concentrations and ratio values for uranium, thorium, and plutonium isotopes were within expected ranges when compared to results from the BSCP study. However, one soil sample (117/119 Spellman Avenue) showed enrichment of both U-234 and U-235 relative to U-238.

Conclusions
Mercury concentrations measured in this study ranged from 0.021 mg/kg to 0.30 mg/kg. These values are generally within the range of values given in the BSCP report.

Radionuclide results including total uranium concentrations were within expected ranges. However, approximately 10% of soil samples showed evidence of enrichment in uranium-235.

One of 6 samples contained organic compounds on the TCL (alpha- and gamma-chlordane, heptachlor and heptachlor epoxide) above detection limits. In this same sample, lead and zinc concentrations exceeded typical values obtained in the BSCP study by a factor of two.

ATSDR
AGENCY FOR TOXIC SUBSTANCES

ORRHES Brief

Oak Ridge Reservation Health Effects Subcommittee

An Analysis of Respiratory Illnesses Among Children in the Scarboro Community

Site: Oak Ridge Reservation

Conducted by: Center for Disease Control and Prevention, National Center for Environmental Health, the Tennessee Department of Health, and the Scarboro Community Environmental Justice Council

Time Period: 1997–1998

Location: Scarboro

Purpose

The purpose of this study was to determine whether rates of pediatric respiratory illnesses were higher in Scarboro than elsewhere in the United States and whether exposure to various factors increased residents' risk for health problems.

Background

In November 1997, a Nashville newspaper *(The Tennessean)* article suggested that an unusual number of respiratory illnesses were present among children living in the Scarboro community, a predominantly African American community in Oak Ridge, Tennessee, located near the Y-12 plant at the Oak Ridge Reservation. The article stated that 16 children had repeated episodes of "severe ear, nose, throat, stomach and respiratory illnesses," and implied that contaminants from the Y-12 plant caused the illnesses. Among those respiratory illnesses were asthma, bronchitis, sinusitis, allergic rhinitis, and otitis media. The newspaper article generated considerable community concern, and as a result the Tennessee Commissioner of Health requested Centers for Disease Control and Prevention's (CDC) assistance in investigating the matter.

Study design and methods

The study was a cross-sectional prevalence survey and a follow-up medical evaluation of children under 18 years of age. The authors conducted a community-based door-to-door health survey to assess the prevalence of pediatric respiratory illnesses and other diseases in Scarboro, and compared these rates to national rates obtained from several population-based surveys and published reports.* They identified case subjects as children reported to have ever had a physician's diagnosis of the illnesses of interest, as well as symptoms of the illnesses within the previous year.

The authors also performed medical examinations on a subset of children who had poorly controlled or undiagnosed respiratory illnesses. Medical examinations were conducted to confirm the results of the community survey, to determine whether children with respiratory illnesses were getting the medical care they needed, and to determine whether the children reported in the newspaper to have respiratory medical problems really had these problems.

The questionnaire was developed through a combined effort involving the National Center for Environmental Health, the Scarboro Community Environmental Justice Council, and the Tennessee Department of Health. It was

* The Behavioral Risk Factor Surveillance System (a telephone survey of the U.S. population less than 18 years of age designed to assess the prevalence of behaviors and practices associated with the leading causes of death in the United States), the National Health Interview Survey (NHIS), and the International Study of Asthma and Allergies in Childhood (ISAAC).

based on well-established questionnaires used in national and international health surveys. Although the focus of the survey was child respiratory health, the study also assessed adult health concerns and occupational exposures. Community residents provided substantial input into the development of the questionnaire and the data collection processes.

The National Center for Environmental Health attempted to conduct face-to-face interviews with individuals from every Scarboro home. They identified 264 Scarboro households from an address list obtained from the local utility company and a DOE street directory and map. Trained interviewers administered the questionnaires at the homes of the individuals and at a health fair.

Study subjects

Study subjects included 119 children and 358 adults living in 220 homes. No comparison group was selected.

Exposures

This study evaluated the relationship between self-reported asthma and wheezing illness and indoor (household) and occupational exposures associated with triggering asthma symptoms. This study did not evaluate the relationship between measured environmental contaminants and health outcomes because it was not designed to study the causes of identified illnesses.

Outcome measures

The outcome measures included self-reported information related to general health status and health concerns; health care utilizations, symptoms specific to respiratory illnesses and frequency of episodes; physician diagnoses of hay fever, sinusitis, ear infections, asthma, and bronchitis in children. A subset of children also received medical exams, lung function tests, and blood work.

Data analysis

The authors generated frequency distributions to characterize health concerns and health care utilization; calculated prevalence rates for reported symptoms and illnesses among pediatric participants; and calculated prevalence rate ratios to assess the relationship between asthma and wheezing and identified environmental triggers or occupational exposures.

Results

Of the 264 households identified in Scarboro, questionnaires were completed for 220 households (response rate of 83%); 119 questionnaires were completed for children and 358 for adults.

Half of the residents reported living in Scarboro for at least 40 years. Half of the residents reported living in their current residence for at least 25 years. Fifty-eight percent reported having an annual household income of $20,000 or less. Forty-three percent reported a smoker in the home, and 10% reported pets in the home. Seven percent of respondents (16 households) reported using a gas stove for cooking; 56% of these stoves had an exhaust fan near the stove.

Children’s ages ranged from 6 months to 18 years (average: 8 years). Nearly all children were black, and 55% were girls. Eighty-four percent of the children were reported to be under routine care by a physician or health care provider.

Fifty-three percent of the children were reported to have had hay fever symptoms within the previous year, with 9% receiving a physician’s diagnosis of hay fever. Thirteen percent receiving a diagnosis of eczema. Thirty-nine percent were reported to have had sinusitis symptoms within the previous year, with 9% receiving a physician’s diagnosis of sinus infection. Fifty-eight percent of all the children were reported to have been diagnosed at sometime in their lives with an ear infection, and 29% were reported to have had symptoms of ear infection within the past 12 months.

Forty-eight percent of children were reported as having had a dry cough at night; 35% were reported to have experienced wheezing within the previous year. Fifteen percent had been diagnosed with asthma by a physician. Thirteen percent had received a physician's diagnosis of asthma within their lifetime and had experienced symptoms within the previous year. The only environmental exposure associated with wheezing in children was living in a household with an unvented gas stove used for cooking. This relationship was statistically significant.

Also, children who wheezed were more likely to have been exposed to environmental tobacco smoke and pets in the home than children who did not wheeze. However, these differences were not statistically significant. This means that, although children with wheezing were more likely to have environmental household exposures, differences of this kind, in a study of this size, could have arisen by chance even if the exposure had no impact on these children.

Of the 34 children invited to have medical examinations, only 23 were physically examined. All of the children examined appeared healthy with no problems requiring urgent medical management; however, 22 had some form of respiratory illness. None were wheezing. Only one had an abnormal lung finding on examination.

Lung function tests were completed on 19 children; 11 had normal results, 5 had results consistent with asthma, and 3 had indeterminate results. Four children had respiratory illness that appeared to be well controlled; all had normal breathing tests.

A team of physicians representing the CDC, TDOH, the Oak Ridge medical community, and the Morehouse School of Medicine thoroughly reviewed the findings of the physical examination and the community survey.

Public health nurses conducted follow-up telephone calls to the parents and provided assistance to a few patents in getting medicines for nasal allergies.

Conclusions

The reported prevalence rate of asthma among children in Scarboro (13%) was higher than the estimated national rate (7% in all children and 9% in black children). Few studies have been conducted on communities similar to Scarboro, and without asthma prevalence information from these communities; it was not possible to determine whether the prevalence of asthma was higher than would be expected. The Scarboro rate was, however, within the range of rates reported in similar studies throughout the United States and internationally. The reported rate of wheezing among children in Scarboro (35%) was also higher than most national and international estimated rates (which range from 1.6% to 36.8%).

The prevalence rates of hay fever and sinus infections in children were comparable to national estimated rates.

No unusual pattern of illness emerged among the children receiving medical exams. The illnesses that were detected were not more severe than would be expected in any community. The findings of the medical exams were consistent with the findings of the community survey.

Because the investigation was not designed to detect associations, and a relatively small group of children was studied, it was not possible to identify causes of the respiratory illnesses.

ORRHES Brief
Oak Ridge Reservation Health Effects Subcommittee

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

Dose Reconstruction Feasibility Study
Oak Ridge Health Study Phase I Report

Site: Oak Ridge Reservation
Study area: Oak Ridge Area
Time period: 1942–1992
Conducted by: Tennessee Department of Health and the Oak Ridge Health Agreement Steering Panel

Purpose

The Dose Reconstruction Feasibility Study had two purposes: first, to identify past chemical and radionuclide releases from the Oak Ridge Reservation (ORR) that have the highest potential to impact the health of the people living near the ORR; and second, to determine whether sufficient information existed about these releases to estimate the exposure doses received by people living near the ORR.

Background

In July 1991, the Tennessee Department of Health initiated a Health Studies Agreement with the U.S. Department of Energy (DOE). This agreement provides funding for an independent state evaluation of adverse health effects that may have occurred in populations around the ORR. The Oak Ridge Health Agreement Steering Panel (ORHASP) was established to direct and oversee this state evaluation (hereafter called the Oak Ridge Health Studies) and to facilitate interaction and cooperation with the community. ORHASP was an independent panel of local citizens and nationally recognized scientists who provided direction, recommendations, and oversight for the Oak Ridge Health Studies. These health studies focused on the potential effects from off-site exposures to chemicals and radionuclides released at the reservation since 1942. The state conducted the Oak Ridge Health Studies in two phases. Phase 1 is the Dose Reconstruction Feasibility Study described in this summary.

Methods

The Dose Reconstruction Feasibility Study consisted of seven tasks. During Task 1, state investigators identified historical operations at the ORR that used and released chemicals and radionuclides. This involved interviewing both active and retired DOE staff members about past operations, as well as reviewing historical documents (such as purchase orders, laboratory records, and published operational reports). Task 1 documented past activities at each major facility, including routine operations, waste management practices, special projects, and accidents and incidents. Investigators then prioritized these activities for further study based on the likelihood that releases from these activities could have resulted in off-site exposures.

During Task 2, state investigators inventoried the available environmental sampling and research data that could be used to estimate the doses that local populations may have received from chemical and radionuclide releases from the ORR. This data, obtained from DOE and other federal and state agencies (such as the U.S. Environmental Protection Agency, Tennessee Valley

Authority, and the Tennessee Division of Radiological Health), was summarized by environmental media (such as surface water, sediment, air, drinking water, groundwater, and food items). As part of this task, investigators developed abstracts which summarize approximately 100 environmental monitoring and research projects that characterize the historical presence of contaminants in areas outside the ORR.

Based on the results of Tasks 1 and 2, investigators identified a number of historical facility processes and activities at ORR as having a high potential for releasing substantial quantities of contaminants to the off-site environment. These activities were recommended for further evaluation in Tasks 3 and 4.

Tasks 3 and 4 were designed to provide an initial, very rough evaluation of the large quantity of information and data identified in Tasks 1 and 2, and to determine the potential for the contaminant releases to impact the public's health. During Task 3, investigators sought to answer the question: How could contaminants released from the Oak Ridge Reservation have reached local populations? This involved identifying the exposure pathways that could have transported contaminants from the ORR site to residents.

Task 3 began with compiling a list of contaminants investigated during Task 1 and Task 2. These contaminants are listed in Table 1. The contaminants in the list were separated into four general groups: radionuclides, nonradioactive metals, acids/bases, and organic compounds. One of the first steps in Task 3 was to eliminate any chemicals on these lists that were judged unlikely to reach local populations in quantities that would pose a health concern. For example, acids and bases were not selected for further evaluation because these compounds rapidly dissociate in the environment and primarily cause acute health effects, such as irritation. Likewise, although chlorofluorocarbons (Freon) were used in significant quantities at each of the ORR facilities, they were judged unlikely to result in significant exposure because they also rapidly disassociate. Also, some other contaminants (see Table 2) were not selected for further evaluation because they were used in relatively small quantities or in processes that are not believed to be associated with significant releases. Investigators determined that only a portion of contaminants identified in Tasks 1 and 2 could have reached people in the Oak Ridge area and potentially impacted their health. These contaminants, listed in Table 3, were evaluated further in Tasks 3 and 4.

The next step in Task 3 was to determine, for each contaminant listed in Table 3, whether a complete exposure pathway existed. A complete exposure pathway means a plausible route by which the contaminant could have traveled from ORR to offsite populations. Only those contaminants with complete exposure pathways would have the potential to cause adverse health effects. In this feasibility study, an exposure pathway is considered complete if it has the following three elements:

- A source that released the contaminant into the environment;
- A transport medium (such as air, surface water, soil, or biota) or some combination of these media (e.g., air ➔ pasture ➔ livestock milk) that carried the contaminant off the site to a location where exposure could occur; and
- An exposure route (such as inhalation, ingestion, or—in the case of certain radionuclides that emit gamma or beta radiation—immersion) through which a person could come into contact with the contaminant.

In examining whether complete exposure pathways existed, investigators considered the characteristics of each contaminant and the environmental setting at the ORR. Contaminants that lacked a source, transport medium, or exposure route were eliminated from further consideration because they lacked a complete exposure pathway. Through this analysis, investigators identified a number of contaminants with complete exposure pathways.

During Task 4, investigators sought to determine qualitatively which of the contaminants with complete exposure pathways appeared to pose the greatest potential to impact off-site populations. They began by comparing the pathways for each contaminant individually. For each contaminant, they determined which pathway appeared to have the greatest potential for exposing off-site populations, and they compared the exposure potential of the contaminant's other pathways to its most significant pathway. They then divided contaminants into three categories—radionuclides, carcinogens, and noncarcinogens—and compared the contaminants within each category based on their exposure potential and on their potential to cause health effects. This analysis identified facilities, processes, contaminants, media, and exposure routes believed to have the greatest potential to impact off-site populations. The results are provided in Table 4.

The Task 4 analysis was intended to provide a preliminary framework to help focus and prioritize future quantitative studies of the potential health impacts of off-site contamination. These analyses are intended to provide an initial approach to studying an extremely complex site. However, care must be taken in attempting to make broad generalizations or draw conclusions about the potential health hazard posed by the releases from the ORR.

In Task 5, investigators described the historical locations and activities of populations most likely to have been affected by the releases identified in Task 4. During Task 6, investigators compiled a summary of the current toxicologic knowledge and hazardous properties of the key contaminants. Task 7 involved collecting, categorizing, summarizing, and indexing selected documents relevant to the feasibility study.

Study Group

A study group was not selected.

Exposures

Seven completed exposure pathways associated with air, six completed exposure pathways associated with surface water, and ten completed exposure pathways associated with soil/sediment were evaluated for radionuclides and chemical substances (metals, organic compounds, and polycyclic aromatic hydrocarbons) released at the ORR from 1942 to 1992.

Outcome Measures

No outcome measures were studied.

Conclusions

The feasibility study indicated that past releases of the following contaminants have the greatest potential to impact off-site populations.

- **Radioactive iodine**
  The largest identified releases of radioactive iodine were associated with radioactive lanthanum processing from 1944 through 1956 at the X-10 facility.

- **Radioactive cesium**
  The largest identified releases of radioactive cesium were associated with various chemical separation activities that took place from 1943 through the 1960s.

- **Mercury**
  The largest identified releases of mercury were associated with lithium separation and enrichment operations that were conducted at the Y-12 facility from 1955 through 1963.

- **Polychlorinated biphenyls**
  Concentrations of polychlorinated biphenyls (PCBs) found in fish taken from the East Fork Poplar Creek and the Clinch River have been high enough to warrant further study. These releases likely came from electrical transformers and machining operations at the K-25 and Y-12 plants.

State investigators determined that sufficient information was available to reconstruct past releases and potential off-site doses for these contaminants. The steering panel (ORHASP) recommended that dose reconstruction activities proceed for the releases of radioactive iodine, radioactive cesium, mercury, and PCBs. Specifically they recommended that the state should continue the tasks begun during the feasibility study, and should characterize the actual release history of these contaminants from the reservation; identify appropriate fate and transport models to predict historical off-site concentrations; and identify an exposure model to use in calculating doses to the exposed population.

The panel also recommended that a broader-based investigation of operations and contaminants be conducted to study the large number of ORR contaminants released that have lower potentials for off-site health effects, including the five contaminants (chromium VI; plutonium 239, 240, and 241; tritium; arsenic; and neptunium 237) that could not be qualitatively evaluated during Phase 1 due to a lack of available data. Such an investigation would help in modifying or reinforcing the recommendations for future health studies.

Additionally, the panel recommended that researchers explore opportunities to conduct epidemiologic studies investigating potential associations between exposure doses and adverse health effects in exposed populations.

TABLE 1

LIST OF CONTAMINANTS INVESTIGATED DURING TASK 1 AND TASK 2

X-10	K-25	Y-12
Radionuclides		
Americium-241 Argon-41 Barium-140 Berkelium Californium-252 Carbon-14 Cerium-144 Cesium-134,-137 Cobalt-57,-60 Curium-242,-243,-244 Einsteinium Europium-152,-154,-155 Fermium Iodine-129, -131, -133 Krypton-85 Lanthanum-140 Niobium-95 Phosphorus-32 Plutonium-238, -239, -240, -241 Protactinium-233 Ruthenium-103, -106 Selenium-75 Strontium-89, -90 Tritium Uranium-233,-234, -235, -238 Xenon-133 Zirconium-95	Neptunium-237 Plutonium-239 Technetium-99 Uranium-234, -235, -238	Neptunium-237 Plutonium-239, -239, -240, -241 Technetium-99 Thorium-232 Tritium Uranium-234, -235, -238
Nonradioactive Metals		
None Initially Identified	Beryllium Chromium, (trivalent and hexavalent) Nickel	Arsenic Beryllium Chromium, (trivalent and hexavalent) Lead Lithium Mercury
Acids/Bases		
Hydrochloric acid Hydrogen peroxide Nitric acid Sodium hydroxide Sulfuric acid	Acetic acid Chlorine trifluoride Fluorine and fluoride compounds Hydrofluoric acid Nitric acid Potassium hydroxide Sulfuric acid	Ammonium hydroxide Fluorine and various fluorides Hydrofluoric acid Nitric acid Phosgene
Organic Compounds		
None Initially Identified	Benzene Carbon tetrachloride Chloroform Chlorofluorocarbons (Freons) Methylene chloride Polychlorinated biphenyls 1,1,1-Trichloroethane Trichloroethylene	Carbon tetrachloride Chlorofluorocarbons (Freons) Methylene chloride Polychlorinated biphenyls Tetrachloroethylene 1,1,1-Trichloroethane Trichloroethylene

TABLE 2

CONTAMINANTS NOT WARRANTING FURTHER EVALUATION IN TASK 3 AND TASK 4

Radionuclides
Americium-241
Californium-252
Carbon-14
Cobalt-57
Cesium-134
Curium-242, -243, -244
Europium-152, -154, -155
Phosphorus-32
Selenium-75
Uranium-233
Berkelium
Einsteinium
Fermium
Nonradioactive Metals
Lithium
Organic Compounds
Benzene
Chlorofluorocarbons (Freons)
Chloroform
Acids/Bases
Acetic acid
Ammonium hydroxide
Chlorine trifluoride
Fluorine and various fluoride compounds
Hydrochloric acid
Hydrogen peroxide
Hydrofluoric acid
Nitric acid
Phosgene
Potassium hydroxide
Sulfuric acid
Sodium hydroxide

TABLE 3
CONTAMINANTS FURTHER EVALUATED IN TASK 3 AND TASK 4

Radionuclides	Nonradioactive Metals	Organic Compounds
Argon-41	Arsenic	Carbon tetrachloride
Barium-140	Beryllium	Methylene chloride
Cerium-144	Chromium (trivalent and hexavalent)	Polychlorinated biphenyls
Cesium-137	Lead	Tetrachloroethylene
Cobalt-60	Mercury	1,1,1-Trichloroethane
Iodine-129, -131, -133	Nickel	Trichloroethylene
Krypton-85		
Lanthanum-140		
Neptunium-237		
Niobium-95		
Plutonium-238, -239, -240, -241		
Protactinium-233		
Ruthenium-103, -106		
Strontium-89, 90		
Technetium-99		
Thorium-232		
Tritium		
Uranium-234 -235, -238		
Xenon-133		
Zirconium-95		

TABLE 4

HIGHEST PRIORITY CONTAMINANTS, SOURCES, TRANSPORT MEDIA, AND EXPOSURE ROUTES

Contaminant	Source	Transport Medium	Exposure Route
Iodine-131, -133	X-10 Radioactive lanthanon (RaLa) processing (1944-1956)	Air to vegetable to dairy cattle milk	Ingestion
Cesium-137	X-10 Various chemical separation processes (1944-1960s)	Surface water to fish Soil/sediment Soil/sediment to vegetables; livestock/game (beef); dairy cattle milk	Ingestion Ingestion Ingestion
Mercury	Y-12 Lithium separation and enrichment operations (1955-1963)	Air Air to vegetables; Livestock/game (beef); dairy cattle milk Surface water to fish Soil/sediment to livestock/game (beef); vegetables	Inhalation Ingestion Ingestion Ingestion
Polychlorinated biphenyls	K-25 and Y-12 Transformers and machining	Surface water to fish	Ingestion

ORRHES Brief

Oak Ridge Reservation Health Effects Subcommittee

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Uranium Releases from the Oak Ridge Reservation—a Review of the Quality of Historical Effluent Monitoring Data and a Screening Evaluation of Potential Off-Site Exposures, Report of the Oak Ridge Dose Reconstruction, Vol. 5 The Report of Project Task 6

Site: Oak Ridge Reservation

Conducted by: ChemRisk/ORHASP for the Tennessee Department of Health

Time Period: 1999

Location: Oak Ridge, Tennessee

Purpose

The purpose of the Task 6 study was to further evaluate the quality of historical uranium operations and effluent monitoring records, to confirm or modify previous uranium release estimates for the period from 1944 to 1995 for all three complexes on the Oak Ridge Reservation (ORR), and to determine if uranium releases from the ORR likely resulted in off-site doses that warrant further study. The main results of the study are revised uranium release estimates from the Y-12 plant, K-25 gaseous diffusion plant, and the S-50 liquid thermal diffusion plant and screening-level estimates of potential health effects to people living near the ORR. These results, which are called "screening indices," are conservative estimates of potential exposures and health impacts and are intended to be used with the decision guide established by Oak Ridge Health Agreement Steering Panel (ORHASP) to determine if further work is warranted to estimate the human health risks from past uranium releases.

Background

The 1993 Oak Ridge Health Studies, Phase I Dose Reconstruction Feasibility Study by the Tennessee Department of Health indicated that uranium was not among the list of contaminants that warranted highest priority for detailed dose reconstruction investigation of off-site health effects. After receiving comments from several long-term employees at the ORR uranium facilities, a number of ORHASP members recommended that past uranium emissions and potential resulting exposures receive closer examination. In 1994, the Task 6 uranium screening evaluation was included in the Oak Ridge Dose Reconstruction project.

The Oak Ridge Y-12 plant was built in 1945, as part of the Manhattan project. Located at the eastern end of Bear Creek Valley, the Y-12 complex is within the corporate limits of the city of Oak Ridge and is separated from the main residential areas of the city by Pine Ridge. The Y-12 plant housed many operations involving uranium, including the preparation, forming, machining, and recycling of uranium for Weapon Component Operations.

Construction of the K-25 uranium enrichment facility began in 1943, and the facility was operational by January 1945. The K-25 site is located near the western end of the ORR, along Poplar Creek near where it meets the Clinch River. The primary mission of K-25 was to enrich uranium by the gaseous diffusion process.

Located along the Clinch River near the K-25 site was a liquid thermal diffusion plant (the S-50 site) that operated from October 1944 to September 1945. Because of their close proximity, the K-25 and S-50 complexes were generally discussed together in the Task 6 report.

The X-10 facility, which conducted chemical processing of reactor fuel and other nuclear materials, was not a primary focus of the Task 6 study.

Methods

An extensive information gathering and review effort was undertaken by the project team in searching for information related to historical uranium operations at the Y-12, K-25, and S-50 sites. Thousands of documents were searched and many active and retired workers were interviewed.

The Task 6 investigation followed these basic steps:

- Information that described uranium uses and releases on the ORR was collected.
- Effluent monitoring data were evaluated for quality and consistency with previous U.S. Department of Energy (DOE) historical uranium release reports.
- Updated estimates of airborne uranium releases over time were generated using the more complete data available to the project team.
- Air dispersion models were used to estimate uranium air concentrations at selected reference locations near each ORR facility. The reference locations were:
  - — the Scarboro community (for Y-12),
  - — the Union/Lawnville community (for K-25/S-50), and
  - — Jones Island area along the Clinch River (for X-10).

  Because the terrain surrounding the Y-12 facility has complex topography, air dispersion modeling techniques were not employed. Instead, an empirical relative concentration (?/Q) relationship was established between measured releases of uranium from Y-12 and measured airborne concentrations of uranium at Scarboro. The ?/Q relationship was then used to extrapolate airborne uranium concentrations for times in which it was not directly measured.

- The screening evaluation of potential off-site exposures to waterborne uranium was based on environmental measurements of uranium at local surface waters. The sampling sites were: White Oak Dam, downstream of New Hope Pond, and the confluence of Poplar Creek and the Clinch River.
- A screening-level evaluation of the potential for health effects was performed by calculating intakes and associated radiation doses. A two-tiered exposure assessment methodology was employed, which provided both upper bound and more typical results. Because of the scarcity of information regarding estimates of uranium concentrations in the environment over the period of interest, some conservatism was maintained in the uranium concentrations used in the Level II screening.
- Annual radiation doses from uranium intake and external exposure were calculated for the adult age group for each screening assessment and then converted to screening indices using a dose-to-risk coefficient of 7.3% Sv^{-1}.
- Estimates of annual-average intakes of uranium by inhalation and ingestion were also used to evaluate the potential for health effects due to the chemical toxicity of uranium compounds, specifically for damage to the kidneys. Uranium was assumed to be in its most soluble form and safety factors were included to minimize the potential for underestimation of the potential for toxic effects.

Study Subjects

The screening evaluation estimated potential off-site exposure and screening indices for hypothetical individuals in three reference locations (Scarboro, Union/Lawnville, and Jones Island). These reference locations represent residents who lived closest to the ORR facilities and would have received the highest exposures from past uranium releases. Thus, they are associated with the highest screening indices derived by the screening evaluation.

Exposures

The following potential air exposure pathways were evaluated:

1. Air to humans-direct inhalation of airborne particulates
2. Air to humans (immersion in contaminated air)
3. Air to livestock (via inhalation) to beef to humans
4. Air to dairy cattle (via inhalation) to milk to humans
5. Air to vegetables (deposition) to humans
6. Air to pasture (deposition) to cattle beef to humans
7. Air to pasture (deposition) to dairy cattle to milk to humans

The following potential water exposure pathways were evaluated:

1. Incidental ingestion by humans during recreation
2. Water to livestock (ingestion) to beef to humans
3. Water to dairy cattle (ingestion) to milk to humans
4. Water to fish to humans
5. Water to humans via immersion during recreation

The following potential soil exposure pathways were evaluated:

1. Soil to air (dust resuspension) to humans
2. Soil incidental ingestion
3. Soil to livestock (soil ingestion) to beef to humans
4. Soil to dairy cattle (soil ingestion) to milk to humans
5. Soil to vegetables (root uptake) to humans
6. Soil to pasture (root uptake) to livestock to beef to humans
7. Soil to pasture (root uptake) to dairy cattle to milk to humans
8. Soil to humans via external radiation

Outcome Measures

Health outcomes were not studied.

Results

Airborne uranium releases from the Y-12, K-25, and S-50 sites were found to be greater than previously reported. DOE estimated that the amount of uranium released from the Y-12 plant was 6,535 kilograms. The Task 6 team estimated that 50,000 kilograms of uranium was released to the air by the Y-12 plant. DOE estimated that the amount released from the K-25 and S-50 plants (combined) was 10,713 kilograms. The Task 6 team estimated that 16,000 kilograms were released to the air by the K-25/S-50 complex.

The Scarboro community was associated with the highest total screening index attributable to uranium releases from the Y-12 plant. The screening indices were 1.9×10^{-3} for the Level I assessment and 8.3×10^{-5} for the Level II assessment. While the overall Level I screening index for the Scarboro community is above the ORHASP decision guide of 1.0×10^{-4} (1 in 10,000), the Level II value is below that guide value. This indicates that the Y-12 uranium releases are candidates for further study, but that they are not high priority candidates for further study.

For the K-25/S-50 assessment, the total screening index for Union/Lawnville from the Level I assessment (2.7×10^{-4}) exceeded the ORHASP decision guide. The less conservative Level II screening result (4.0×10^{-5}) did not exceed the guide. This indicates that the K-25/S-50 uranium releases are also candidates for further study, but that they are not high priority candidates for further study.

The X-10 Level I assessment yielded a screening index for Jones Island (7.6×10^{-5}) below the decision guide. This indicates that releases from the X-10 site warrant lower priority, especially given the pilot-plant nature and relatively short duration of most X-10 uranium operations.

The Scarboro community was selected for the initial chemical toxicity evaluation since its screening index for radiological exposures was the highest. Estimated kidney burdens resulting from simultaneous intake of uranium by ingestion and inhalation under the Scarboro assessment do not exceed an effects threshold criterion (1 microgram per gram of kidney tissue) proposed by some scientists, but they do exceed an effects threshold criterion (0.02 micrograms per gram of kidney tissue) proposed by other scientists. The Task 6 team also evaluated the average-annual intakes using a reference dose/Hazard Index approach and concluded that further study of chemical toxicity from past ORR uranium exposures did not warrant high priority.

Conclusions

The Task 6 team reached the following general conclusions:

- Estimates of uranium releases previously reported by DOE are incomplete and; therefore, were not used in the Task 6 screening evaluation.
- Historical uranium releases from the Y-12 plant are likely significantly higher (over seven times higher) than totals reported by DOE. There are several reasons why previous estimates were so much lower.
- Historical uranium releases from the K-25/S-50 complex are likely higher than totals reported by DOE.
- Operations at the S-50 plant are poorly documented.
- The Scarboro community had the highest total screening index from uranium releases at the ORR, specifically the Y-12 plant. Since the Level II screening index is just below the ORHASP decision criterion, with most of the conservative assumptions regarding source term and exposure parameters removed, potential exposure to uranium releases could have been of significance from a health standpoint and should; therefore, be considered for dose reconstruction.
- The Union/Lawnville community evaluation (releases from the K-25/S-50 complex) had a Level II screening index below the ORHASP criterion. However, without quantification of the uncertainties associated with the release estimates and the exposure assessment, it is not possible to say that these releases do not warrant further characterizations.
- The Level I screening index for the Jones Island area (releases from the X-10 site) are below the ORHASP decision criterion.
- Because Pine Ridge separates the Y-12 plant from Scarboro, an alternate approach (?/Q) was used to estimate uranium air concentrations in Scarboro.
- The concentrations of uranium in soil are a major factor in the screening analyses. Because limited soil data are available for the reference locations, alternative approaches should be considered for future analyses.
- While the estimated uranium intake from ingestion and inhalation exceed one effects threshold criterion, they do no exceed another. Calculated hazard indices indicate that further study of chemical effects of the kidneys rank as a low priority.

If the evaluation of ORR uranium releases is to proceed beyond a conservative screening stage and on to a nonconservative screening with uncertainty and sensitivity analyses, activities that should be evaluated for possible follow-up work include:

- Additional records research and data evaluation regarding S-50 plant operations and potential releases.
- Additional searching for and review of effluent monitoring data for Y-12 electromagnetic enrichment operations from 1944 to 1947 and data relating to releases from unmonitored depleted uranium operations in the 1950s through the 1990s.
- Uncertainty analysis of the Y-12 uranium release estimates derived in this study.
- Review of additional data regarding unmonitored K-25 uranium releases.
- Refinement of the approach used to evaluate surface water and soil-based exposure concentrations.
- Evaluation of the effects of the ridges and valleys that dominate the local terrain surrounding Y-12 and Scarboro and investigation of alternative approaches to estimate air concentrations at Scarboro with an emphasis on identifying additional monitoring data.
- Performance of a bounding assessment of the amounts of uranium that were handled at the X-10 site.
- Improvement of the exposure assessment to include region-specific consumption habits and lifestyles, identification of likely exposure scenarios instead of hypothetical upper bound and typical assessments, and inclusion of uncertainty analysis to provide statistical bounds for the evaluation of risk.
- Refinement of the chemical toxicity evaluation, possibly to include other approaches and models, as well as an uncertainty analysis.

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ORRHES Brief

Oak Ridge Reservation Health Effects Subcommittee

Screening-Level Evaluation of Additional Potential Materials of Concern, July 1999—Task 7

Site: Oak Ridge Reservation
Study area: Oak Ridge Area
Time period: 1942–1990
Conducted by: Tennessee Department of Health and the Oak Ridge Health Agreement Steering Panel

Purpose

The purpose of this screening-level evaluation was to determine whether additional contaminants that existed at Oak Ridge Reservation (ORR), other than the five already identified in the Oak Ridge Dose Reconstruction Feasibility Study (iodine, mercury, polychlorinated biphenyls [PCBs], radionuclides, and uranium), warrant further evaluation of their potential for causing health effects in off-site populations.

Background

In July 1991, the Tennessee Department of Health in cooperation with the U.S. Department of Energy initiated a Health Studies Agreement to evaluate the potential for exposures to chemical and radiological releases from past operations at ORR. The Oak Ridge Dose Reconstruction Feasibility Study was conducted from 1992 to 1993 to identify those operations and materials that warranted detailed evaluation based on the risks posed to off-site populations. The feasibility study recommended that dose reconstructions be conducted for radioactive iodine releases from X-10 radioactive lanthanum processing (Task 1), mercury releases from Y-12 lithium enrichment (Task 2), PCBs in the environment near Oak Ridge (Task 3), and radionuclides released from White Oak Creek to the Clinch River (Task 4). In addition, the study called for a systematic search of historical records (Task 5), an evaluation of the quality of historical uranium effluent monitoring data (Task 6), and additional screening of materials that could not be evaluated during the feasibility study (Task 7).

The Oak Ridge Health Agreement Steering Panel (ORRHES) was established to direct and oversee the Oak Ridge Health Studies and to facilitate interaction and cooperation with the community. This group is comprised of local citizens and nationally recognized scientists.

Methods

During the Task 7 Screening-Level Evaluation, three different methods (qualitative screening, the threshold quantity approach, and quantitative screening) were used to evaluate the importance of materials with respect to their potential for causing off-site health effects. Twenty-five materials or groups of materials were evaluated. Please see Table 1 for a summary of the methods used to evaluate each material/group of materials.

- Qualitative Screening—All materials used on ORR were qualitatively screened for quantities used, forms used, and/or manners of use. If it was unlikely that off-site releases were sufficient to pose an off-site health hazard, then these materials were not evaluated quantitatively. If off-site exposures were likely to have occurred at harmful levels, then the materials were evaluated quantitatively.

- Threshold Quantity Approach—When information was insufficient to conduct quantitative screening, inventories of materials used at ORR were estimated based on historical records and interviews of workers. These estimated inventories of materials were determined to be either above or below a conservatively calculated health-based threshold quantity. If the estimates for a material were below the calculated threshold quantity, then it was determined to be highly unlikely to have posed a risk to human health through off-site releases.

- Quantitative Screening—The quantitative screening used a two-level screening approach to identify those materials that could produce health risks (i.e., doses) to exposed people that are clearly below minimum levels of health concern (Level I Screen) and above minimum levels of health concern (Refined Level I Screen). Health-based decision guides were established by the Oak Ridge Health Agreement Steering Panel and represent minimum levels of health concern.

  — The Level I Screening calculates a screening index for a maximally exposed reference individual who would have received the highest exposure. This conservative (protective) screening index is not expected to underestimate exposure to any real person in the population of interest. If the estimated Level I screening index was below the ORRHES decision guide, then the hazard to essentially all members of the population, including the maximally exposed individual, would be below the minimum level of health concern. In addition, the Level I screening index would be so low that further detailed study of exposures is not warranted because the screening index is below the threshold for consideration of more extensive health effects studies. However, if during the Level I Screening, the screening index was above the ORRHES decision guide, then the contaminant was further evaluated using Refined Level I Screening.

  — The Refined Level I Screen calculates a less conservative, more realistic screening index by using more reasonable exposure parameters than the Level I Screen. In addition, depending upon the contaminant, a less conservative environmental concentration was sometimes used. However, the transfer factors and toxicity values remained the same for both screening levels. The Refined Level I Screening maintains considerable conservatism because of these conservative transfer factors and toxicity values.

  If the Refined Level I screening index was below the ORRHES decision guide, then the hazard to most members of the population would be below minimum levels of health concern. In addition, the Refined Level I screening index would be so low that further detail study of exposure is not warranted because the screening index is below the threshold for consideration of more extensive health effects studies and was given a low priority for further study. However, if during the Refined Level I Screening, the screening index was above the ORRHES decision guide, then the contaminant was determined to be of high priority for a detail evaluation.

Study Group

The screening evaluation focuses on the potential for health effects to occur in off-site residents. The Level I Screen estimates a dose for the hypothetical maximally exposed individual who would have received the highest exposure and would have been the most at-risk. The Refined Level I Screen estimates a dose for a more typically exposed individual in the targeted population. The study group for exposure from lead were children because they are particularly sensitive to the neurological effects of lead.

Exposures

Quantitative screening used mathematical equations to calculate a screening index (theoretical estimates of risk or hazard) from multiple exposure pathways, including inhalation; ground exposure (for radionuclides); ingestion of soil or sediment; and ingestion of vegetables, meat, milk, and/or fish.

Outcome Measures

No outcome measures were studied.

Results

Screening-level analyses were performed for seven carcinogens. They were evaluated according to source, resulting in 10 separate analyses. Three of the Level I Screen analyses (Np-237 from K-25, Np-237 from Y-12, and tritium from Y-12) yielded results that were below the decision guides. Refined Level I Screens were performed on the other seven carcinogenic assessments. The results of five separate analyses (beryllium from Y-12, chromium VI from ORR, nickel from K-25, technetium-99 from K-25, and technetium-99 from Y-12) were below the decision guides, and two analyses (arsenic from K-25 and arsenic from Y-12) were above the decision guides.

Arsenic was released into the air from the burning of coal at several coal-fired steam plants located on the Oak Ridge Reservation and into the soil, sediment, and surface water from coal piles and disposal of fly ash from the steam plants. Lead was likely released into soil, sediment, and surface water from the disposal of liquid waste into the Y-12 storm sewers and may have been released into the air from process stacks and the plant ventilation system.

Screening-level analyses were performed for seven noncarcinogens. These, too, were evaluated according to source, resulting in eight separate analyses. One Level I Screen analysis (beryllium from Y-12) yielded results that were below the decision guide. Refined Level I Screens were performed on the other seven noncarcinogenic assessments. Four analyses (chromium VI from ORR, copper from K-25, lithium from Y-12, and nickel from K-25) were below the decision guides and three analyses (arsenic from K-25, arsenic from Y-12, and lead from Y-12) were above the decision guides.

Three materials (niobium, zirconium, and tetramethylammoniumborohydride [TMAB]) were evaluated using the threshold quantity approach because information was insufficient to perform quantitative screening. None of the three was determined to be present in high enough quantities at the Y-12 Plant to have posed off-site health hazards.

Conclusions

Based on the qualitative and quantitative screening, the materials were separated into three classes in terms of potential off-site health hazards: not candidates for further study, potential candidates for further study, and high priority candidates for further study. (as shown in Table 2).

- Not Candidates—Five materials at the K-25 and 14 materials used at the Y-12 Plant were determined to not warrant further study. All of these chemicals were eliminated because either (1) quantitatively, they fell below Level I Screening decision guides; (2) not enough material was present to have posed an off-site health hazard according to the threshold quantity approach; or (3) qualitatively, the quantities used, forms used, and/or manners of usage were such that off-site releases would not have been sufficient to cause off-site health hazards.
- Potential Candidates—Three materials at the K-25 (copper powder, nickel, and technetium-99), three materials used at the Y-12 Plant (beryllium compounds, lithium compounds, and technetium-99), and one material used at ORR (chromium VI) were determined to be potential candidates for further study. These materials were identified as potential candidates because (1) their Level I Screening indices exceeded the decision guides and (2) their Refined Level I Screening indices did not exceed the decision guides.
- High Priority Candidates—One material used at the K-25 (arsenic) and two at the Y-12 Plant (arsenic and lead) were determined to be high priority candidates for further study. They were chosen as high priority materials because their Refined Level I Screening indices exceeded the decision guides.

Two issues remaining from the Dose Reconstruction Feasibility Study were evaluated during Task 7: the possible off-site health risks associated with asbestos and the composition of plutonium formed and released to the environment.

- Asbestos—Asbestos could not be fully evaluated during the feasibility study; therefore, it was qualitatively evaluated during this task for the potential for off-site releases and community exposure. Available information on the use and disposal of asbestos, as well as, off-site asbestos monitoring was summarized. None of the investigations performed to date have identified any asbestos-related exposure events or activities associated with community exposure, making it very unlikely that asbestos from ORR has caused any significant off-site health risks.

- Plutonium—The records that documented the rate of plutonium release did not specify the isotopic composition of the product formed. As a result, during the feasibility study, the project team made the assumption that the plutonium that was formed and released was plutonium-239. If incorrect, this assumption could have significant ramifications on the screening of past airborne plutonium releases. Therefore, the composition of the plutonium formed and released was evaluated further during this task. Plutonium inventory from X-10 was calculated, and plutonium-239 was found to comprise at least 99.9% of the plutonium present in Clinton Pile fuel slugs. This result confirmed that the assumptions made in the feasibility study did not introduce significant inaccuracy into the screening evaluation that was conducted.

TABLE 1

Summary of Screening Methods Used for Each Material

Qualitative Screening		
Material	**Source**	**Notes**
Boron carbide, boron nitride, yttrium boride, titanium boride, rubidium nitrate, triplex coating, carbon fibers, glass fibers, and four-ring polyphenyl ether	ORR	Evaluated based on quantities used, forms used, and manners of usage.
Tellurium	Y-12	Evaluated based on quantities used, forms used, and manners of usage.

Threshold Quantity Approach			
Material	**Source**	**Media**	**Threshold Values**
Niobium	Y-12 Used in production of two alloys, mulberry and binary	Air Surface Water	Evaluated using a reference dose derived from an LD50, an empirically derived dispersion factor for airborne releases from Y-12 to Scarboro, and estimated average East Fork Poplar Creek (EFPC) flow rates.
Tetramethylammoniumboro-hydride (TMAB)	Y-12 Use classified	Air Surface Water	Inventory quantities and specific applications remain classified.
Zirconium	Y-12 Used in production of an alloy, mulberry	Air Surface Water	Evaluated using a reference dose derived from an ACGIH Threshold Limit Value for occupational exposure, an empirically derived dispersion factor for air released from Y-12 to Scarboro, and estimated average EFPC flow rates.

TABLE 1
Summary of Screening Methods Used for Each Material (continued)

Quantitative Screening			
Material	**Source**	**Media**	**Exposure Values**
Arsenic Level I Screen and Refined Level I Screen	K-25 Y-12 Released as a naturally occurring product in coal, which was used in coal–fired steam plants	Air	Based on coal use and dispersion modeling to Union/Lawnville (K-25) and Scarboro (Y-12).
		Surface Water	Used maximum in Poplar Creek (K-25) and the 95% upper confidence limit (UCL) on the mean concentration in McCoy Branch (Y-12).
		Soil/Sediment	Used sediment core concentration detected in Poplar Creek to represent the early 1960s (K-25) and the 95% UCL on the mean concentration in McCoy Branch (Y-12).
		Food Items	Based on concentrations in air, soil, and water and NCRP biotransfer and bioconcentration factors.
Beryllium compounds Level I Screen and Refined Level I Screen	Y-12 Used in production	Air	Used Y-12 stack monitoring data and an empirical dispersion factor for releases to Scarboro.
		Surface Water	Used maximum concentration measured in EFPC.
		Soil	Used maximum concentration measured in EFPC.
		Food Items	Based on concentrations in air, soil, and water and NCRP biotransfer and bioconcentration factors.
Copper Level I Screen and Refined Level I Screen	K-25 Use of copper powder is classified	Air	Based on airborne concentrations measured at the most-affected on-site air sampler that were adjusted according to the ratio of dispersion model results at that sampler to those at Union/Lawnville.
		Surface Water	Used maximum concentration measured during the Clinch River Remedial Investigation.
		Soil/Sediment	Used highest mean concentration in Clinch River.
		Food Items	Based on concentrations in air, soil, and water and NCRP biotransfer factor and an ATSDR bioconcentration factor.

TABLE 1
Summary of Screening Methods Used for Each Material (continued)

Quantitative Screening (continued)			
Material	**Source**	**Media**	**Exposure Values**
Hexavalent chromium (Chromium VI) Level I Screen and Refined Level I Screen	ORR Used in cooling towers to control corrosion	Air	Based on modeling of emission and drift from K-25 cooling towers to Union/Lawnville.
		Surface Water	Used maximum concentration measured in Poplar Creek before 1970.
		Soil	Used average concentration of total chromium measured during the EFPC Remedial Investigation; assumed to be 1/6 (16.7%) chromium VI.
		Food Items	Based on concentrations in air, soil, and water and NCRP biotransfer and bioconcentration factors.
Lead EPA's Integrated Exposure Uptake Biokinetic model	Y-12 Used in production of components, in paints, and as radiation shielding	Air	Estimated from background concentrations of lead prior to mid-1970s.
		Surface Water	Used maximum concentration measured in EFPC (a higher concentration was detected near Y-12; however it was considered to be anomalous).
		Soil/Sediment	Used maximum concentration measured in the EFPC Remedial Investigation, the 95% UCL, and the 95% UCL multiplied by 3.5 for a higher past concentration.
		Food Items	Based on concentrations in air, soil, and water and biotransfer and bio-concentration factors from literature.
Lithium Level I Screen and Refined Level I Screen	Y-12 Used in lithium isotope separation, chemical, and component fabrication	Air	Used stack sampling data from two lithium processing buildings and an empirical dispersion factor for releases to Scarboro.
		Surface Water	Used highest quarterly average measured in EFPC.
		Soil/Sediment	Used maximum concentration measured in the EFPC floodplain.
		Food Items	Based on concentrations in air, soil, and water and NCRP biotransfer and bioconcentration factors.

TABLE 1
Summary of Screening Methods Used for Each Material (continued)

Quantitative Screening (continued)			
Material	**Source**	**Media**	**Exposure Values**
Neptunium-237 Level I Screen	K-25 Y-12 Found in recycled uranium	Air	Based on levels in recycled uranium, an estimated release fraction, and dispersion modeling to Union/Lawnville (K-25) and Scarboro (Y-12).
		Surface Water	Based on reported releases to Clinch River (K-25) and EFPC (Y-12), corrected for dilution.
		Soil/Sediment	Used maximum concentrations detected in Clinch River (K-25) and EFPC (Y-12).
		Food Items	Based on concentrations in air, soil, and water and NCRP biotransfer and bioconcentration factors.
Nickel Level I Screen and Refined Level I Screen	K-25 Used in the production of barrier material for the gaseous diffusion process	Air	Based on the 95% UCL for the year of the highest measured concentrations in on-site air samplers and dispersion modeling to Union/Lawnville.
		Surface Water	Used 95% UCL for the year of the highest concentrations in Clinch River.
		Soil/Sediment	Used highest mean concentration in Clinch River.
		Food Items	Based on concentrations in air, soil, and water and NCRP biotransfer and bioconcentration factors.
Technetium-99 Level I Screen and Refined Level I Screen	K-25 Y-12 Product of fission of uranium atoms and from neutron activation of stable molybdenum-98	Air	Used an average of concentrations modeled to Union/Lawnville (K-25) and Scarboro (Y-12).
		Surface Water	Used maximum concentration detected in Clinch River (K-25) and EFPC (Y-12).
		Soil/Sediment	Used maximum concentration from the K-25 perimeter and EFPC (Y-12).
		Food Items	Based on concentrations in air, soil, and water and biotransfer and bioconcentration factors from literature.

TABLE 1
Summary of Screening Methods Used for Each Material (continued)

Quantitative Screening (continued)			
Material	**Source**	**Media**	**Exposure Values**
Tritium Level I Screen	Y-12 Used in deuterium gas production and lithium deuteride recovery operations	Surface Water	Evaluated based on deuterium inventory differences and the peak tritium concentration in the deuterium that was processed at Y-12; the release estimate was used with the International Atomic Energy Agency method for tritium dose assessment, assuming all the tritium that escaped was released to EFPC.

TABLE 2
Categorization of Materials Based on Screening Results

Contaminant Source	Not Candidates for Further Study (Level I result was below the decision guide)	Potential Candidates for Further Study (Refined Level I result was below the decision guide)	High Priority Candidates for Further Study (Refined Level I result was above the decision guide)
K-25	Neptunium-237 (cancer) Evaluated qualitatively (quantities, forms, and manner of use were not sufficient): • Carbon fibers • Four-ring polyphenyl ether • Glass fibers • Triplex coating	• Copper powder (noncancer) • Nickel (cancer) • Nickel (noncancer) • Technetium-99 (cancer)	• Arsenic (cancer) • Arsenic (noncancer)
Y-12 Plant	• Beryllium compounds (noncancer) • Neptunium-237 (cancer) • Tritium (cancer) Evaluated using Threshold Quantity Approach (not enough material was present): • Niobium (noncancer) • TMAB • Zirconium (noncancer) Evaluated qualitatively (quantities, forms, and manner of use were not sufficient): • Boron carbide • Boron nitride • Rubidium nitrate • Rubidium bromide • Tellurium • Titanium boride • Yttrium boride • Zirconium	• Beryllium compounds (cancer) • Lithium compounds (noncancer) • Technetium-99 (cancer)	• Arsenic (cancer) • Arsenic (noncancer) • Lead (noncancer) Arsenic was released into the air from the burning of coal at several coal-fired steam plants located on the Oak Ridge Reservation and into the soil, sediment, and surface water from coal piles and disposal of fly ash from the steam plants. Lead was likely released into soil, sediment, and surface water from the disposal of liquid waste into the Y-12 storm sewers and may have been released into the air from process stacks and the plant ventilation system."
ORR (all complexes)		• Chromium VI (cancer) • Chromium VI (noncancer)	