

PUBLIC HEALTH ASSESSMENT
Evaluation of Current (1990 to 2003) and Future Chemical
Exposures in the Vicinity of the Oak Ridge Reservation

U. S. Department of Energy Oak Ridge Reservation
Oak Ridge, Anderson County, Tennessee
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Foreword

The Agency for Toxic Substances and Disease Registry, ATSDR, was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the Superfund law. This law set up a fund to identify and clean up our country's hazardous waste sites. The Environmental Protection Agency, EPA, and the individual states regulate the investigation and cleanup of the sites.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the sites on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by scientists from ATSDR and from states with which ATSDR has cooperative agreements. The public health assessment program allows flexibility in the format or structure of their response to the public health issues at hazardous waste sites. For example, a public health assessment could be one document or it could be a compilation of several health consultations—the structure may vary from site to site. Whatever the form of the public health assessment, the process is not considered complete until public health issues at the site are addressed.

Exposure

As the first step in the evaluation, ATSDR scientists review environmental data to see what chemicals are present, where the chemicals were found, and how people might come into contact with the chemicals. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When environmental data do not allow ATSDR to fully evaluate exposure, the report will indicate what further sampling data are needed.

Health Effects

If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists evaluate whether or not these exposures may result in harmful effects. ATSDR recognizes that developing fetuses, infants, and children can be more sensitive to exposures than are adults. As a policy, unless data are available to suggest otherwise, ATSDR considers children to be more sensitive and vulnerable than adults. Thus, the health impact to the children is considered first when evaluating exposure and the potential adverse effects to a community. The health impacts to other groups within the community (such as the elderly, chronically ill, and people engaging in high-exposure practices) also receive special attention during the evaluation.

ATSDR uses existing scientific information, which can include the results of medical, toxicologic, and epidemiologic studies and the data collected in disease registries, to determine the likelihood of health effects that may result from exposures. The science of environmental health is still developing, and sometimes scientific information on the health effects of certain substances is not available. In this case, this report suggests what further public health actions are needed.

Conclusions

This report presents conclusions about the public health threat, if any, posed by a site. Any health threats that have been determined for high-risk groups (such as children, the elderly, chronically ill people, and people engaging in high-risk practices) are summarized in the Conclusions section of the report. Ways to stop or reduce exposure are recommended in the Public Health Action Plan section.

ATSDR is primarily an advisory agency, so its reports usually identify what actions are appropriate to be undertaken by EPA, other responsible parties, or the research or education divisions of ATSDR. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the danger. ATSDR can also authorize health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

Community

ATSDR also needs to learn what people in the area know about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for their comments. All the comments received from the public are responded to in the final version of the report.

Comments

If, after reading this report, you have questions or comments, we encourage you to send them to us. Letters should be addressed as follows:

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Contents

I.	Summary.....	1
II.	Background	3
II.A.	Site Description.....	3
II.B.	Operational History.....	3
	<i>Y-12 Plant</i>	<i>3</i>
	<i>X-10 Site.....</i>	<i>3</i>
	<i>K-25 Site.....</i>	<i>5</i>
	<i>S-50 Site</i>	<i>5</i>
II.C.	Remedial and Regulatory History.....	5
II.D.	Land Use and Natural Resources.....	6
II.E.	Demographics	7
II.F.	Public Health Activities.....	9
II.G.	Past Screening Evaluation.....	11
III.	Evaluation of Environmental Contamination and Potential Exposure Pathways.....	13
III.A.	Introduction.....	13
	<i>What Does Exposure Mean?.....</i>	<i>13</i>
	<i>How Does ATSDR Determine Which Exposure Situations to Evaluate?</i>	<i>13</i>
	<i>If People Are Exposed, Will They Get Sick?.....</i>	<i>14</i>
III.B.	Methodology.....	14
	<i>Comparing Environmental Concentrations to Comparison Values</i>	<i>14</i>
	<i>Comparing Estimated Exposure Doses to Screening Guideline Values.....</i>	<i>16</i>
	<i>Comparing Estimated Exposure Doses to Health Effect Levels.....</i>	<i>20</i>
	<i>Sources for Health-Based Guidelines.....</i>	<i>20</i>
III.C.	Environmental Data	20
III.D.	Screening Results.....	24
	<i>Off-Site Soil.....</i>	<i>24</i>
	<i>Off-Site Sediment</i>	<i>25</i>
	<i>Off-Site Surface Water</i>	<i>25</i>
	<i>Biota.....</i>	<i>27</i>
	<i>Air</i>	<i>31</i>
IV.	Public Health Implications.....	33
IV.A.	Introduction.....	33
IV.B.	Children’s Health Considerations.....	34
	<i>Arsenic</i>	<i>35</i>
	<i>Iron.....</i>	<i>35</i>
	<i>Lead.....</i>	<i>37</i>
IV.C.	Public Health Evaluation	38
	<i>Aldrin/Dieldrin.....</i>	<i>40</i>
	<i>Antimony.....</i>	<i>41</i>
	<i>Arsenic</i>	<i>42</i>
	<i>Benzidine.....</i>	<i>44</i>
	<i>Cadmium.....</i>	<i>45</i>

<i>Chromium</i>	48
<i>Dibenzo(a,h)anthracene</i>	50
<i>2,4-Dinitrophenol</i>	50
<i>4,6-Dinitro-o-Cresol</i>	51
<i>Dioxin (Chlorinated Dibenzo-p-Dioxins)</i>	51
<i>Heptachlor Epoxide</i>	53
<i>Alpha-Hexachlorocyclohexane (Alpha-HCH)</i>	55
<i>Iron</i>	55
<i>Manganese</i>	57
<i>Thallium</i>	58
<i>Toxaphene</i>	59
<i>Multiple Chemical Exposures</i>	60
IV.D. Pregnant and Breast-Feeding Women’s Health Considerations.....	61
V. Health Outcome Data Evaluation.....	62
VI. Community Health Concerns	64
VI.A. Chemical Mixtures.....	64
VI.B. Future Land Use.....	64
VI.C. General Concerns.....	65
VI.D. Odor/Stench/Public Nuisance	65
VI.E. Ongoing Activities of Health Concern	66
VI.F. Screening Issues.....	66
VI.G. Soil, Sediment, and Surface Water Concerns	66
VI.H. Scarboro Concerns.....	67
VI.I. Cancer Concerns	72
VI.J. Private Vegetable Gardens.....	72
VII. Conclusions.....	73
VIII. Recommendations.....	74
IX. Public Health Action Plan.....	75
X. Preparers of Report	76
XI. References.....	77

List of Tables

Table 1. Population of Counties Surrounding the ORR from 1940 to 2000.....	7
Table 2. Population of Cities Surrounding the ORR from 1940 to 2000	7
Table 3. Parameters Used in the Exposure Dose Calculations for ORR	19
Table 4. Estimated Pica Child Exposure Doses for Chemicals Detected in Off-Site Soil Compared to Acute Screening Guidelines	36
Table 5. Summary of Completed and Potential Exposure Pathways for Contaminants Above Screening Guidelines	39
Table 6. Estimated Exposure Doses for Aldrin and Dieldrin	40
Table 7. Estimated Exposure Doses for Arsenic	42
Table 8. Estimated Exposure Doses for Cadmium	46
Table 9. Estimated Exposure Doses for Chromium.....	49
Table 10. Exposure Doses for Dioxin.....	52
Table 11. Estimated Exposure Doses for Heptachlor Epoxide.....	54
Table 12. Estimated Exposure Doses for alpha-HCH	55
Table 13. Estimated Exposure Doses and Daily Intake Rates for Iron.....	56
Table 14. Estimated Exposure Doses for Thallium	58
Table 15. Estimated Exposure Doses for Toxaphene	59
Table 16. Estimated Exposure Doses for Chemicals in Off-Site Soil Compared to Noncancer Screening Guidelines	87
Table 17. Estimated Exposure Doses for Chemicals in Off-Site Soil Compared to Cancer Screening Guidelines	88
Table 18. Estimated Exposure Doses for Chemicals in Off-Site Sediment Compared to Noncancer Screening Guidelines.....	89
Table 19. Estimated Exposure Doses for Chemicals in Off-Site Sediment Compared to Cancer Screening Guidelines	91
Table 20. Estimated Exposure Doses for Chemicals in Off-Site Surface Water Compared to Noncancer Screening Guidelines.....	92
Table 21. Estimated Exposure Doses for Chemicals in Off-Site Surface Water Compared to Cancer Screening Guidelines.....	95
Table 22. Estimated Exposure Doses for Chemicals in Fish Caught in EFPC Compared to Noncancer Screening Guidelines.....	97
Table 23. Estimated Exposure Doses for Chemicals in Fish Caught in EFPC Compared to Cancer Screening Guidelines	99
Table 24. Estimated Exposure Doses for Chemicals in Fish Caught in the Clinch River Compared to Noncancer Screening Guidelines	100
Table 25. Estimated Exposure Doses for Chemicals in Fish Caught in the Clinch River Compared to Cancer Screening Guidelines	102
Table 26. Estimated Exposure Doses for Chemicals in Fish Caught in WBR Compared to Noncancer Screening Guidelines.....	104
Table 27. Estimated Exposure Doses for Chemicals in Fish Caught in WBR Compared to Cancer Screening Guidelines	106
Table 28. Estimated Exposure Doses for Chemicals in Fish Caught On Site Compared to Noncancer Screening Guidelines.....	108
Table 29. Estimated Exposure Doses for Chemicals in Fish Caught On Site Compared to Cancer Screening Guidelines	111

Table 30. Estimated Exposure Doses for Chemicals in Game Caught On Site Compared to Noncancer Screening Guidelines.....	113
Table 31. Estimated Exposure Doses for Chemicals in Vegetation Species Collected Off Site Compared to Noncancer Screening Guidelines.....	114
Table 32. Estimated Exposure Doses for Chemicals in Vegetation Collected Off Site Compared to Cancer Screening Guidelines.....	115
Table 33. Chemicals Detected at Air Monitoring Stations.....	116
Table 34. Chemicals Detected in the Soil in the Scarboro Community.....	117
Table 35. Chemicals Detected in the Sediment in the Scarboro Community.....	119
Table 36. Chemicals Detected in the Surface Water in the Scarboro Community.....	120
Table 37. Estimated Exposure Doses for Chemicals in Scarboro Compared to Noncancer Screening Guidelines.....	121
Table 38. Estimated Exposure Doses for Chemicals in Scarboro Compared to Cancer Screening Guidelines.....	122

List of Figures

Figure 1. Location of the Oak Ridge Reservation.....	4
Figure 2. Demographics Within a 5-Mile Radius of the ORR.....	8
Figure 3. State of Tennessee Screening Process for Past Exposure.....	12
Figure 4. ATSDR Chemical Screening Process.....	15
Figure 5. Possible Exposure Situations Evaluated.....	22
Figure 6. ORRHES Area of Interest.....	23
Figure 7. Results from ATSDR’s Chemical Screening Process.....	32
Figure 8. ATSDR Chemical Screening Process for Scarboro.....	69

List of Appendices

Appendix A. ATSDR Glossary of Environmental Health Terms.....	A-1
Appendix B. Off-site Chemicals Without a Comparison Value.....	B-1
Table B-1. Chemicals Detected in Off-site Soil.....	B-3
Table B-2. Chemicals Detected in Off-site Sediment.....	B-4
Table B-3. Chemicals Detected in Off-site Surface Water.....	B-5
Table B-4. Chemicals Detected in Fish Collected Off-site.....	B-6
Table B-5. Chemicals Detected in Off-site Game.....	B-7
Table B-6. Chemicals Detected in Scarboro.....	B-8
Appendix C. Summary Briefs.....	C-1
TDOH’s Phase I Dose Reconstruction Feasibility Study	
TDOH’s Task 7 Study: Screening-Level Evaluation of Additional Potential Materials of Concern	
EPA and ATSDR’s A Guide to Healthy Eating of the Fish You Catch	
Appendix D. Media Maps.....	D-1
Appendix E. Responses to Public Comments.....	E-1
Appendix F. Responses to Peer Review Comments.....	F-1

Acronyms

AI	adequate intake
AMRL	acute minimal risk level
ATSDR	Agency for Toxic Substances and Disease Registry
CDC	Centers for Disease Control and Prevention
CDD	chlorinated dibenzo-p-dioxin
CEL	cancer effect level
CEMEG	chronic environmental media evaluation guide
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMRL	chronic minimal risk level
CREG	cancer risk evaluation guide
CSF	cancer slope factor
CV	comparison value
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DOE	U.S. Department of Energy
DRI	dietary reference intake
EFPC	East Fork Poplar Creek
EMEG	environmental media evaluation guide
EPA	U.S. Environmental Protection Agency
FAMU	Florida Agriculture and Mechanical University
FDA	U.S. Food and Drug Administration
HCDD	hexachlorodibenzo-p-dioxin
HCH	hexachlorocyclohexane
IEMEG	intermediate environmental media evaluation guide
IMRL	intermediate minimal risk level
IRIS	Integrated Risk Information System
L/day	liters per day
LOAEL	lowest-observed-adverse-effect level
LTHA	lifetime health advisory
MCLG	maximum contaminant level goal
MCPA	2-methyl-4-chlorophenoxyacetic acid
MCPP	2-(2-methyl-4-chlorophenoxy) propionic acid
MRL	minimal risk level
mg/day	milligram per day
mg/kg	milligram per kilogram
mg/kg/day	milligram per kilogram per day
mg/L	milligram per liter
NAAQS	national ambient air quality standard
NAS	National Academy of Sciences
NOAEL	no-observed-adverse-effect level
NPL	National Priorities List
NTIS	National Technical Information Service
OREIS	Oak Ridge Environmental Information System
ORR	Oak Ridge Reservation

ORRHES	Oak Ridge Reservation Health Effects Subcommittee
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PHA	public health assessment
PHAWG	public health assessment work group
ppb	parts per billion
ppm	parts per million
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RDA	recommended dietary allowance
RfD	reference dose
RMEG	reference dose media evaluation guide
TCDD	tetrachlorodibenzo-p-dioxin
TDEC	Tennessee Department of Environment and Conservation
TDOH	Tennessee Department of Health
TEF	toxic equivalency factor
TEQ	toxic equivalent
TSCA	Toxic Substances Control Act
µg/day	microgram per day
µg/dL	microgram per deciliter
µg/L	microgram per liter
µg/m ³	micrograms per cubic meter
WBR	Watts Bar Reservoir
WHO	World Health Organization

I. Summary

In 1942, the federal government established the Oak Ridge Reservation (ORR) in Anderson and Roane Counties in Tennessee as part of the Manhattan Project to research, develop, and produce special nuclear materials for nuclear weapons. In 1989, the ORR was added to the U.S. Environmental Protection Agency's (EPA's) National Priorities List because over the years, ORR operations have generated a variety of radioactive and nonradioactive wastes that are present in old waste sites or that have been released to the environment. The U.S. Department of Energy (DOE) is cleaning up the ORR under a Federal Facility Agreement with EPA and the Tennessee Department of Environment and Conservation (TDEC). DOE, EPA, and TDEC are working together to investigate and remediate site-related chemical releases and waste sites from past and present activities at the site.

Since 1992, the Agency for Toxic Substances and Disease Registry (ATSDR) has responded to requests and addressed health concerns of community members, civic organizations, and other government agencies by working extensively to determine whether levels of environmental contamination at and near the ORR present a public health hazard to communities surrounding the ORR. ATSDR has identified and evaluated several public health issues and has worked closely with many parties. ATSDR is the principal federal public health agency charged with evaluating human health effects of exposure to hazardous substances in the environment. Whereas the Tennessee Department of Health (TDOH) conducted the Oak Ridge Health Studies to evaluate whether off-site populations have been exposed in the past, ATSDR's activities have focused on current public health issues related to Superfund cleanup activities at the site.

To expand on the efforts of TDOH, ATSDR scientists conducted a review and a screening analysis of TDOH's Phase I and Phase II screening-level evaluation of past exposure (1944 to 1990) to identify contaminants of concern for further evaluation. Based on this review, ATSDR scientists have completed or are conducting public health assessments (PHAs) on iodine 131 releases from the X-10 site, mercury releases from the Y-12 plant, polychlorinated biphenyls (PCBs), radionuclide releases from White Oak Creek, uranium releases from the Y-12 plant, uranium and fluoride releases from the K-25 site, and other topics such as contaminant releases from the Toxic Substances Control Act (TSCA) Incinerator and contaminated off-site groundwater. In conducting these PHAs, ATSDR scientists evaluate and analyze the information and findings from previous studies and investigations to assess the public health implications of past and current exposure. This PHA documents ATSDR's screening of recent (1990 to 2003)¹ environmental data, addresses whether additional chemicals require further evaluation, and discusses the public health implications related to potential exposures. PCBs and mercury, as well as the groundwater pathway, are not addressed in this PHA; these topics are being evaluated individually in separate PHAs.

According to the information reviewed for this PHA, ATSDR concludes that current and future exposures to ORR site-related chemicals (individually or in combination) in soil, sediment, surface water, biota (other than fish), and air do not pose a public health hazard. Very limited "dioxin" data exist for fish; therefore, ATSDR cannot determine whether exposure to dioxins in

¹ Data from before 1990 were evaluated during TDOH's past screening evaluation. Because ATSDR began the current screening evaluation in 2003, this was used as the cut-off year for "current" data.

fish poses a public health hazard. The available data on dioxins in fish are for fish of an unidentified species from a pond near the K-25 site. In the absence of additional data on dioxins in fish near the ORR, ATSDR recommends following the current State of Tennessee fish advisories. Following current fish advisories will reduce exposure to contaminants in fish.

II. Background

II.A. Site Description

In 1942, the federal government established the Oak Ridge Reservation (ORR) in Anderson and Roane Counties in Tennessee as part of the Manhattan Project to research, develop, and produce special radioactive materials for nuclear weapons (ChemRisk 1993a; TDOH 2000). Four facilities were built at that time. The Y-12 plant, the K-25 site, and the S-50 site were created to enrich uranium. The X-10 site was created to demonstrate processes for producing and separating plutonium (TDOH 2000). The Clinch River forms the southern and western boundaries of the reservation, and most of the property is within the Oak Ridge city limits (EUWG 1998). (See Figure 1 for the location of the ORR.)

When the federal government acquired the ORR in 1942, the reservation consisted of 58,575 acres (91.5 square miles). Since that time, the federal government has transferred 24,340 acres (38.0 square miles) to other parties, such as the city of Oak Ridge and the Tennessee Valley Authority. The U.S. Department of Energy (DOE) continues to control the remaining 34,235 acres (53.5 square miles) (ORNL 2002). Most of the contamination is located at the three main facilities. These areas are heavily guarded and fenced, and access to them requires a clearance badge.

II.B. Operational History

Y-12 Plant

The Y-12 plant was built in 1943 to house equipment for electromagnetically enriching uranium. The atomic bomb that was dropped in Hiroshima, Japan, contained uranium produced at the Y-12 plant (TDOH 2000). In 1952, the Y-12 facilities were converted to fabricate nuclear weapon components (ChemRisk 1999). During the Cold War, a column-exchange process (Colex) that used large quantities of mercury as an extraction solvent to enrich lithium in lithium 6 was built and operated (TDOH 2000). At the end of the Cold War, the Y-12 missions were curtailed. In 1992, the major focus of the Y-12 plant was the remanufacture of nuclear weapon components and the dismantlement and storage of strategic nuclear materials from retired nuclear weapons systems. The Y-12 plant is now known as the Y-12 National Security Complex and is primarily used for disassembling nuclear weapons and for storing highly enriched uranium (TDOH 2000).

X-10 Site

The X-10 site (formerly known as the Clinton Laboratories and now part of what is referred to as the Oak Ridge National Laboratory) was built in 1943, as a pilot plant to produce and separate plutonium. The government had intended to operate the facility for only 1 year; however, operations were continued and expanded (ChemRisk 1993a; TDOH 2000). Over time, operations at the X-10 site grew to include non-weapons-related activities, such as nuclear fission product separation, nuclear reactor safety and development, and radionuclide production for worldwide use in the medical, industrial, and research fields. Today, the Oak Ridge National Laboratory receives worldwide recognition as a facility for research and development in several areas of science and technology (ChemRisk 1993a). In addition, the Oak Ridge National Laboratory produces numerous radioactive isotopes that have significant uses in medicine and research (TDEC 2002).

K-25 Site

From 1945 to 1964, the main objective of the K-25 site (formerly known as the Oak Ridge Gaseous Diffusion Plant) was to use gaseous diffusion to enrich weapons-grade uranium (ChemRisk 1999; EPA 2002a). From 1965 to 1985, the site used uranium hexafluoride in the gaseous diffusion process to manufacture commercial-grade uranium (EUWG 1998). All gaseous diffusion operations ceased at the site in 1985 (ChemRisk 1993a; ORHASP 1999). Since the K-25 site was officially closed in 1987, many activities have been conducted to clean up wastes and to restore the environment around the site. Since 1996, reindustrialization has been the focus of the K-25 site, which has been renamed the East Tennessee Technology Park (ORHASP 1999; TDOH 2000). The site also maintains the Toxic Substances and Control Act (TSCA) Incinerator, which is the only facility in the country authorized to incinerate wastes with radioactive and hazardous contaminants that contain polychlorinated biphenyls (PCBs) (TDEC 2002).

S-50 Site

Construction of the former S-50 liquid thermal diffusion plant began on June 6, 1944, and operations were underway by October 1944. The purpose of the plant was to assess the financial and scientific feasibility of separating uranium 235 from uranium 238 through liquid thermal diffusion. Because of several equipment malfunctions and contaminant releases to the Clinch River and to the air, the plant operated for less than a year and was closed in September 1945 (ChemRisk 1999). Because all of the facility's buildings were destroyed and buried in 1946, there are no physical remains of the S-50 site (ChemRisk 1999; TDEC 2002).

II.C. Remedial and Regulatory History

Because ORR operations have generated a variety of radioactive and chemical wastes, the ORR was added to U.S. Environmental Protection Agency's (EPA's) National Priorities List (NPL) in 1989 (EPA 2002b). DOE is conducting cleanup activities at the ORR under a Federal Facility Agreement, which is an interagency agreement with EPA and the Tennessee Department of Environment and Conservation (TDEC). This agreement allows for input from the public. These parties are working together to investigate and remediate hazardous waste from past and present activities at the site. DOE is integrating required measures from the Resource Conservation and Recovery Act (RCRA) with response actions under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

The Federal Facility Agreement, which was implemented on January 1, 1992, is a legally binding agreement that established timetables, procedures, and documentation for remedial actions at the ORR. The Federal Facility Agreement is available online at http://www.bechteljacobs.com/ettp_ffa.shtml.

Contaminants such as uranium and mercury are present in old waste sites, which occupy 5 to 10 percent of the ORR. The abundant rainfall (an annual average of 55 inches) and high water tables (for example, 0 to 20 feet below ground surface) on the reservation contribute to leaching of these contaminants, resulting in contaminated soil, surface water, sediments, and groundwater (EUWG 1998).

Since 1986 (when initial cleanup activities commenced), DOE has initiated approximately 50 response actions under the Federal Facility Agreement that address contamination and disposal issues on the reservation. To consolidate investigation and remediation of environmental contamination, the contaminated areas were divided into five large tracts of land, generally associated with the major hydrologic watersheds (EUWG 1998). The annual *Remediation Effectiveness Reports for the U.S. Department of Energy Oak Ridge Reservation* documents the progress of ongoing remedial actions and future planned actions at the site (e.g., SAIC 2004). The Remediation Effectiveness Reports are available at the DOE Information Center.

II.D. Land Use and Natural Resources

The ORR currently occupies a little over 34,000 acres. The three major DOE installations—the East Tennessee Technology Park (formerly the K-25 site and the Oak Ridge Gaseous Diffusion Plant), the Oak Ridge National Laboratory (formerly the X-10 site), and the Y-12 National Security Complex (formerly the Y-12 plant)—occupy about 30 percent of that acreage. The remaining 70 percent was established as a National Environmental Research Park in 1980, to provide protected land for environmental science research and education, and to demonstrate that energy technology development can coexist with a quality environment. Large portions of the reservation have grown into full forests over the past several decades. Some of this land includes areas known as “deep forest” that contain ecologically significant flora and fauna; portions of the ORR are considered to be biologically rich (SAIC 2002).

The ORR also includes an area set aside for residential, commercial, and support services. The city of Oak Ridge, created in 1942 to provide housing to the employees of the ORR, was originally controlled by the military (Friday and Turner 2001). The self-governing portion of the city of Oak Ridge comprises about 14,000 acres and contains housing, schools, parks, shops, offices, and industrial areas. The urban population of Oak Ridge continued to grow over several decades, and some residential properties are next to the ORR boundary line. Outside the urban areas, much of the region (about 40 percent) is still a pattern of farms and small communities, as it was historically (ChemRisk 1993b).

A number of maps of this area indicate a wide range of land types (including urban or built-up land, agricultural land, rangeland, forestland, water, and wetlands) and land uses (including residential, commercial, public and semi-public, industrial, transportation, communication, utility, and extractive [e.g., mining]) (ChemRisk 1993b).

Agriculture (beef and dairy cattle) and forestry had been the two predominant land uses in the area around the ORR; however, both of these uses are currently declining. For many years, milk was produced, bottled, and distributed locally. Corn, tobacco, wheat, and soybeans were the major crops grown in the area. Small game and waterfowl are hunted in the area (both on and off the ORR), and deer are hunted during certain periods (ChemRisk 1993b). Radiological monitoring is performed during the annual deer hunts to “provide assurance that harvested animals do not contain levels of radionuclides which would result in significant internal exposure to humans consuming meat from the animals” (Teasley 1995). Fishing is not permitted on site, but fish from the ORR can move into publicly accessed areas.

II.E. Demographics

Demographic data provide information on the size and characteristics of a given population. ATSDR examined demographic data to determine the number of people living in the vicinity of the ORR and to determine the presence of sensitive populations, such as children (age 6 years and younger), women of childbearing age (age 15 to 44 years), and the elderly (age 65 years and older). According to the 2000 U.S. Census, 153 children, 403 women of childbearing age, and 423 elderly persons live within a quarter mile of the ORR; 778 children, 1,935 women of childbearing age, and 1,681 elderly persons live within a mile of the ORR (see Figure 2).

Demographics also provide details on population mobility and residential history in a particular area. This information helps ATSDR evaluate how long residents might have been exposed to environmental contaminants. The numbers of people living in the counties surrounding the ORR from 1940 to 2000 are listed in Table 1. The numbers of people living in the main cities within these counties from 1940 to 2000 are listed in Table 2.

Table 1. Population of Counties Surrounding the ORR from 1940 to 2000

<i>County</i>	<i>1940</i>	<i>1950</i>	<i>1960</i>	<i>1970</i>	<i>1980</i>	<i>1990</i>	<i>2000</i>
Anderson County	26,504	59,407	60,032	60,300	67,346	68,250	71,330
Blount County	41,116	54,691	57,525	63,744	77,770	85,969	105,823
Knox County	178,468	223,007	250,523	276,293	319,694	335,749	382,032
Loudon County	19,838	23,182	23,757	24,266	28,553	31,255	39,086
Meigs County	6,393	6,080	5,160	5,219	7,431	8,033	11,086
Morgan County	15,242	15,727	14,304	13,619	16,604	17,300	19,757
Rhea County	16,353	16,041	15,863	17,202	24,235	24,344	28,400
Roane County	27,795	31,665	39,133	38,881	48,425	47,227	51,910

Sources: Bureau of the Census 1900–1990, 2000

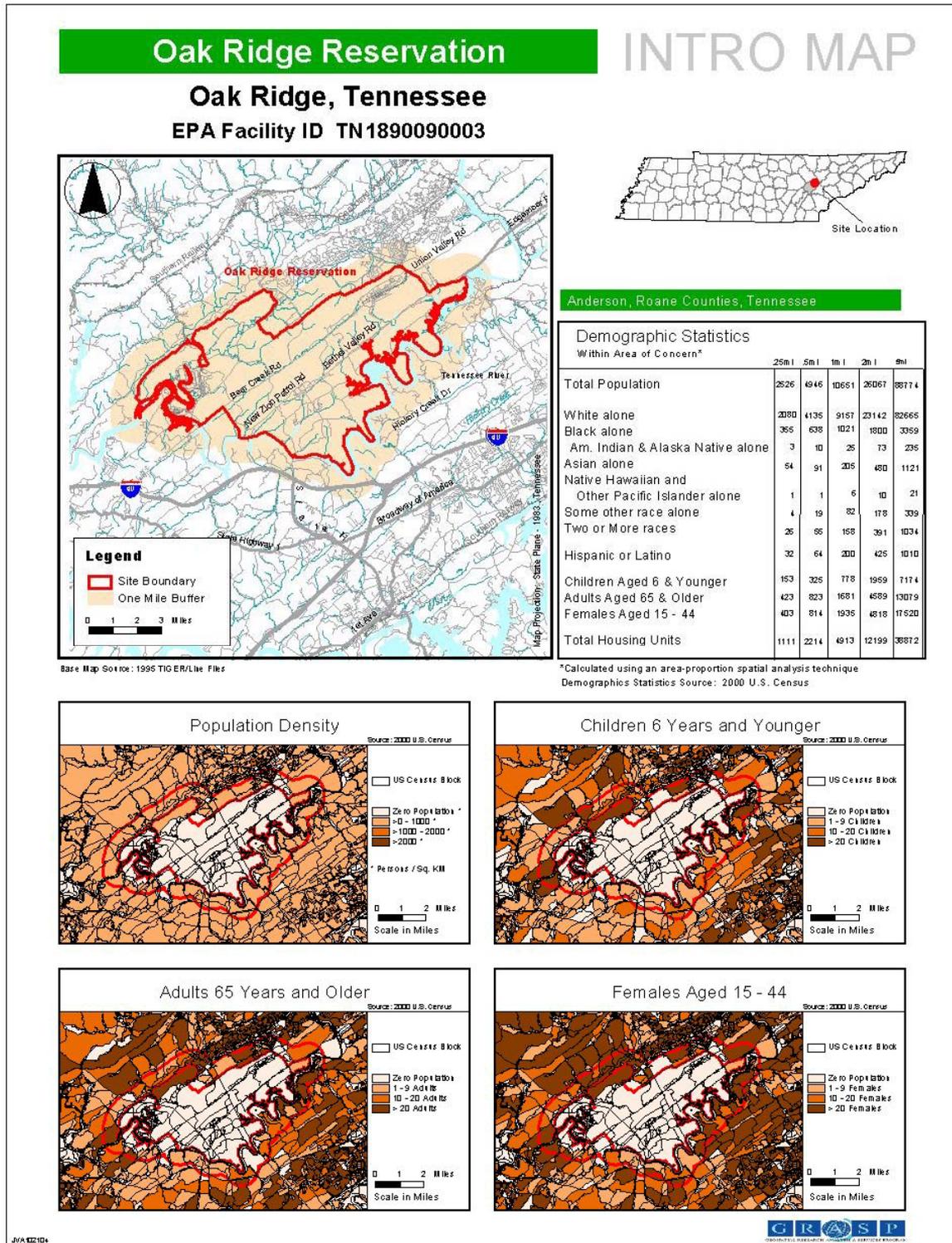
Table 2. Population of Cities Surrounding the ORR from 1940 to 2000

	<i>1940</i>	<i>1950</i>	<i>1960</i>	<i>1970</i>	<i>1980</i>	<i>1990</i>	<i>2000</i>
Clinton	2,761	3,712	4,943	4,794	7,790	8,972	9,409
Harriman	5,620	6,389	5,931	8,734	8,303	7,119	6,744
Kingston	880	1,627	2,010	4,142	4,561	4,552	5,264
Knoxville	111,580	124,769	111,827	174,587	175,045	165,121	173,890
Lenoir City	4,373	5,159	4,979	5,324	5,505	6,147	6,819
Loudon	3,017	3,567	3,812	3,728	4,199	4,026	4,476
Maryville	5,609	7,742	10,348	13,808	17,480	19,208	23,120
Oak Ridge	3,000*	30,229	27,169	28,319	27,662	27,310	27,387
Oliver Springs	—	189	1,163	3,405	3,659	3,433	3,303
Rockwood	3,981	4,272	5,345	5,259	5,695	5,348	5,774
Spring City	1,569	1,725	1,800	1,756	1,951	2,199	2,025

Sources: Bureau of the Census 1940, 1950, 1960, 1970, 1980, 1990, 2000; ChemRisk 1993b; City of Oak Ridge 1989; Convention and Visitors Bureau 2003

* Combined population on land that was established as Oak Ridge in 1942, with 13,000 initial residents.

Figure 2. Demographics Within a 5-Mile Radius of the ORR



Population Density

Source: 2000 U.S. Census

Children 6 Years and Younger

Source: 2000 U.S. Census

Adults 65 Years and Older

Source: 2000 U.S. Census

Females Aged 15 - 44

Source: 2000 U.S. Census

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By presenting decade-by-decade size comparison for the available census intervals, Table 2 understates the city of Oak Ridge's dramatic population growth in contrast with the growth of its neighbors. Oak Ridge was established for the 13,000 people expected to work at the ORR (Friday and Turner 2001); by July 1944, its population had increased to 50,000. The population peaked at 75,000 in 1945, but decreased to 30,229 by 1950, and then to 27,169 by 1960; however, it was relatively stable thereafter (see Table 2) (City of Oak Ridge 1989). In 1959, about 14,000 acres within the city of Oak Ridge became self-governing (ChemRisk 1993b). Almost since its establishment, the city of Oak Ridge has been one of the largest population centers in eastern Tennessee (ChemRisk 1993b).

II.F. Public Health Activities

Since 1992, ATSDR has addressed the health concerns of community members, civic organizations, and other government agencies by working extensively to determine whether levels of environmental contamination at and near the ORR present a public health hazard. During this time, ATSDR has identified and evaluated several public health issues and has worked closely with many parties, including community members, civic organizations, physicians, and several federal, state, and local environmental and health agencies. Since the Tennessee Department of Health (TDOH) conducted the Oak Ridge Health Studies to evaluate whether off-site populations experienced exposures in the *past*, ATSDR's activities have focused on *current* and *future* public health issues. The ATSDR ORR Web site (<http://www.atsdr.cdc.gov/HAC/oakridge/phact/index.html>) highlights the major public health activities conducted by ATSDR at the ORR.

Oak Ridge Reservation Health Effects Subcommittee (ORRHES). The ORRHES was established in 1999, by ATSDR and the Centers for Disease Control and Prevention (CDC) under the authority of the Federal Advisory Committee Act, and as a subcommittee of the U.S. Department of Health and Human Services' Citizens Advisory Committee on Public Health Service Activities and Research at DOE sites. The subcommittee consisted of people who represented diverse interests, expertise, backgrounds, and communities, as well as liaison members from federal and state agencies. It was created to provide a forum for communication and collaboration between the citizens and the agencies that are evaluating public health issues and conducting public health activities at the ORR. To help ensure citizen participation, the meetings of the subcommittee's work groups were open to the public and everyone could attend and present their ideas and opinions. The subcommittee performed the following functions:

- Served as a citizen advisory group to CDC and to ATSDR and made recommendations on matters related to public health activities and research at the ORR.
- Gave citizens an opportunity to collaborate with agency staff members and to learn more about the public health assessment process and other public health activities.
- Helped to prioritize the public health issues and community concerns being evaluated by ATSDR.

The ORRHES created various work groups to conduct in-depth exploration of specific issues and present findings to the subcommittee for deliberation. Work group meetings were also open to all who wished to attend and participate.

ATSDR Field Office. From 2001 to 2005, ATSDR maintained a field office in the city of Oak Ridge. The office was opened to promote collaboration between ATSDR and the communities surrounding the ORR by providing community members with opportunities to become involved in ATSDR's public health activities at the ORR.

Other Public Health Activities. ATSDR, CDC's National Center for Environmental Health and National Institute for Occupational Safety and Health, TDOH, TDEC, and DOE have responded over the years to workers and communities concerned about potential exposures and reported unexplained illnesses afflicting workers and residents. The *Compendium of Public Health Activities* (ATSDR et al. 2000) outlines the past and present strategies used to address and evaluate public health issues related to chemical and radioactive substances released from the ORR. The compendium can be found on the ATSDR ORR Web site at http://www.atsdr.cdc.gov/HAC/oakridge/phact/c_toc.html.

Where Can One Obtain More Information on ATSDR's Activities at the ORR?

ATSDR has conducted several analyses that are not documented here, as have other agencies that have been involved with this site. Community members can find more information on ATSDR's past activities in the following three ways:

1. *Visit one of the records repositories.* Copies of ATSDR's publications on the ORR, along with publications from other agencies, can be viewed in records repositories at public libraries and the DOE Information Center (located at 475 Oak Ridge Turnpike, Oak Ridge, Tennessee; 865-241-4780). For directions to these repositories, please contact ATSDR at 1-800-CDC-INFO (1-800-232-4636).
2. *Visit the ATSDR or ORRHES Web sites.* These Web sites include past publications, schedules of future events, and other materials. ATSDR's ORR Web site is at <http://www.atsdr.cdc.gov/HAC/oakridge>. The most comprehensive summary of past activities can be found at http://www.atsdr.cdc.gov/HAC/oakridge/phact/c_toc.html.
3. *Contact ATSDR directly.* Residents can contact representatives from ATSDR directly by dialing the agency's toll-free number, 1-800-CDC-INFO (1-800-232-4636).

II.G. Past Screening Evaluation

In 2001, ATSDR scientists reviewed and analyzed TDOH's Oak Ridge Health Studies to identify contaminants that required further public health evaluation. One major aspect of the Health Studies was a pair of screening evaluations, called the Phase I and Phase II screening evaluations. During the Phase I and Phase II screening evaluations, TDOH conducted extensive reviews of available information and conducted qualitative and quantitative analyses of past (1944 to 1990) releases and off-site exposures to hazardous substances from the entire ORR (see Figure 3).

- *Phase I* of the Oak Ridge Health Studies was a dose reconstruction feasibility study. This study evaluated all past releases of hazardous substances and operations at the ORR. Its objective was to determine the quantity, quality, and potential usefulness of the available information on past releases and subsequent exposure pathways. Phase I began in May 1992 and was completed in September 1993. A brief summarizing Phase I is provided in Appendix C.
- *Phase II (also referred to as the Oak Ridge Dose Reconstruction)* of the Oak Ridge Health Studies began in mid-1994 and was completed in early 1999. Phase II primarily consisted of a dose reconstruction study focusing on past releases of radioactive iodine, radionuclides from White Oak Creek, mercury, and PCBs. In addition to the full dose reconstruction analyses, the Phase II effort included additional detailed screening analyses for releases of uranium and several other toxic substances that had not been fully characterized during Phase I. (A brief in Appendix C summarizes the Screening-Level Evaluation of Additional Potential Materials of Concern. The full report is available at <http://www2.state.tn.us/health/CEDS/OakRidge/ORidge.html>.)

On the basis of ATSDR's review and analysis of TDOH's Phase I and Phase II screening evaluations, ATSDR scientists have completed or are conducting public health assessments on Y-12 plant uranium releases; K-25 site uranium and fluoride releases; White Oak Creek radionuclide releases; Y-12 plant mercury releases; X-10 site iodine 131 releases; X-10 site, Y-12 plant, and K-25 site PCB releases; and other issues of community concern, such as contaminant releases from the TSCA Incinerator and contaminated off-site groundwater. The public health assessment is the primary public health process ATSDR is using to further evaluate these contaminants.

TDOH conducted the Oak Ridge Health Studies to evaluate whether off-site populations have been exposed in the past. Task 7 of the Oak Ridge Dose Reconstruction was a screening-level evaluation of potential chemicals of concern, using data through 1990. This public health assessment documents ATSDR's screening of environmental data from 1990 to 2003, and addresses whether additional chemicals (not identified by Task 7) require further evaluation.

This public health assessment documents ATSDR's screening of recent (1990 to 2003)² environmental data to address whether additional chemicals require further evaluation and discusses the public health implications related to estimated exposure doses.

² Data from before 1990 were evaluated during TDOH's past screening evaluation. Because ATSDR initiated the current screening evaluation in 2003, this was used as the cut-off year for "current" data.

Figure 3. State of Tennessee Screening Process for Past Exposure

Oak Ridge Health Study Phase I Report—
Dose Reconstruction Feasibility Study

Task 1 and Task 2

Process



Results

Not a Contaminant of Concern

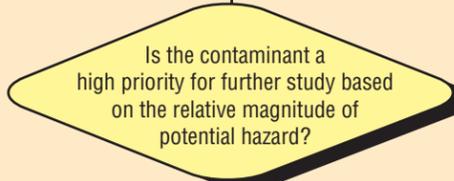
Americium 241* Californium 252 Carbon 14* Cobalt 57 Cesium 134 Curium 242, 243, 244 Europium 152, 154,* 155 Phosphorus 32*	Selenium 75 Uranium 233 Berkelium Einsteinium Fermium Lithium Benzene Chloroform	Acetic acid Ammonium hydroxide Chlorofluorocarbons (Freons) Chlorine trifluoride Fluorine and various fluoride compounds Hydrochloric acid Hydrogen peroxide Hydrofluoric acid	Nitric acid Phosgene Potassium hydroxide Sulfuric acid Sodium hydroxide Polyaromatic hydrocarbons Asbestos Pesticides
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Type of Screening/Rationale

Qualitative Evaluation

- Used in small quantities.
- Not believed to be associated with significant off-site releases.

Task 3 and Task 4



Carbon tetrachloride Methylene chloride Tetrachloroethylene 1,1,1-Trichloroethane Trichloroethylene Argon 41	Iodine 129 Krypton 85 Ruthenium 103 Thorium 232 Protactinium 233 Plutonium 238, 239,* 240* Xenon 133
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Relative Hazard Ranking Evaluation

- The relative potential hazard is less than 1% of the screening hazard calculated for the contaminant that poses the greatest potential to impact off-site populations.
- All but two contaminants had a relative potential hazard of less than 0.03%.

Dose
Reconstruction

Tasks 1-5



Highest Priority Contaminants

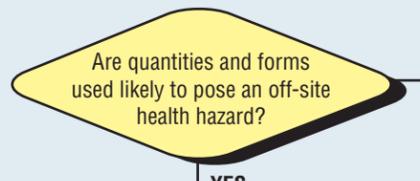
Iodine 131—X-10 radioactive lanthanum process
Radionuclide releases from White Oak Creek—X-10 chemical separation processes
Mercury—Y-12 lithium separation and enrichment operations
PCBs—K-25/Y-12 transformers/machining
Uranium—K-25/Y-12 gaseous diffusion operations/production operations

Dose Reconstruction

- Described and quantified past releases.
- Characterized environmental concentrations.
- Defined potential human exposure pathways.
- Described potentially exposed populations.
- Estimated historical human exposures and doses.
- Estimated human health hazards.

Oak Ridge Dose Reconstruction—Task 7 Report—
Screening-Level Evaluation of Additional Potential Materials

Qualitative Screening



Not a Contaminant of Concern

Boron carbide Boron nitride Yttrium boride Titanium boride Rubidium bromide Rubidium nitrate	Tellurium Triplex coating Carbon fibers Glass fibers Four-ring polyphenyl ether Zirconium
---	--

Qualitative Evaluation

- Evaluated for quantities used, forms used, and manners of use.
- Unlikely that off-site releases of materials could have been sufficient to pose an off-site health hazard.

Threshold
Quantity Approach

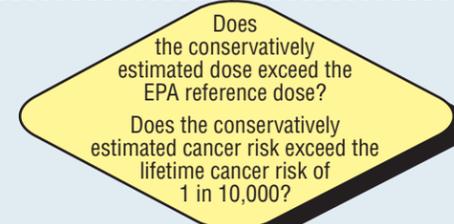


Niobium TMAB Zirconium

Threshold Quantity Approach

- Estimated inventories of materials were determined to be below a conservatively calculated health-based threshold quantity.
- On-site quantities have little likelihood of being released off site in quantities that could pose a health hazard.

Quantitative Screening



Tritium* (cancer) Neptunium 237 (cancer) Beryllium (noncancer)
--

Quantitative Two-Level Evaluation

- Estimated doses or cancer risks for a maximally exposed reference individual were compared to the EPA reference dose or the lifetime cancer risk of 1 in 10,000.
- Identified materials for which doses or risks are clearly below a minimum level of health concern.

Candidates for
Further Study



Potential Candidates

Beryllium (cancer) Chromium (cancer, noncancer) Copper (noncancer)	Lithium (noncancer) Nickel (cancer, noncancer) Technetium 99 (cancer)
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High Priority Candidates

Arsenic (cancer, noncancer) Lead (noncancer)

Quantitative Two-Level Evaluation

- Estimated doses or cancer risks for a typically exposed reference individual were compared to the EPA reference dose or the lifetime cancer risk of 1 in 10,000.
- Identified materials for which doses or risks are above a minimum level of health concern.
- Potential and high priority candidates will be evaluated using ATSDR's screening process.

III. Evaluation of Environmental Contamination and Potential Exposure Pathways

III.A. Introduction

What Does Exposure Mean?

Chemicals released into the environment have the potential to cause harmful health effects, but a release does not always result in exposure. If no one comes in contact with a chemical—if there is no completed exposure pathway—then exposure does not occur, and thus adverse health

A completed exposure pathway has five elements: (1) a source of contamination, (2) an environmental medium (such as soil, water, or air) through which a chemical is transported, (3) a point of exposure, (4) a route of exposure, and (5) an exposed population (receptor population). The source is the place where the chemical was released. The environmental media transport the chemicals. The point of exposure is the place where persons come in contact with the media. The route of exposure (for example, ingestion, inhalation, or dermal contact) is the way the contaminant enters the body. The people exposed are called the receptor population. A potential exposure pathway exists when one or more of the elements is missing, but available information suggests that exposure is possible.

effects do not result. Often the general public does not have access to the source area of contamination or areas where contaminants are moving through the environment. Understanding how people have access to these areas becomes important in determining whether people could come in contact with the contaminants.

The route a chemical takes from its source (where it began) to its exposure point (where it ends), and how people can contact it (how people get exposed) is called the exposure pathway. An exposure pathway could involve air, surface water, groundwater, soil, sediment, or even plants and animals. Exposure can occur by breathing, eating, drinking, or by skin contact with a substance containing the chemical contaminant.

How Does ATSDR Determine Which Exposure Situations to Evaluate?

ATSDR scientists evaluate site-specific conditions to determine whether people are being exposed to site-related chemicals. When evaluating exposure pathways, ATSDR identifies whether exposure to contaminated media (soil, water, air, or biota) is occurring through ingestion, dermal (skin) contact, or inhalation.

If exposure is possible, ATSDR scientists then consider whether environmental contamination is present at levels that might affect public health. ATSDR evaluates environmental contamination using available environmental sampling data and, in some cases, modeling studies.

More information about the ATSDR evaluation process can be found in ATSDR's *Public Health Assessment Guidance Manual* at <http://www.atsdr.cdc.gov/HAC/PHAManual/toc.html> or by contacting ATSDR at 1-800-232-4636. 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>.

If People Are Exposed, Will They Get Sick?

Chemical exposure does not always result in harmful health effects. The type and degree of health effects that occur in an individual as the result of contact with a chemical depend on the exposure concentration (how much), the frequency of exposure (how often), the duration of exposure (how long), the route or pathway of exposure (breathing, eating, drinking, or skin contact), and potentially the combination of chemicals. Once exposure occurs, factors such as age, gender, genetics, lifestyle, nutritional status, and health status influence how a person absorbs, distributes, metabolizes, and excretes the contaminant. Taken together, these factors and characteristics determine the health effects that can occur as a result of exposure to a chemical.

III.B. Methodology

ATSDR screened all available current chemical data to determine whether concentrations were above ATSDR's comparison values (see the description below). Figure 4 illustrates ATSDR's chemical screening process. ATSDR also reviewed relevant toxicologic and epidemiologic data to obtain information about the toxicity of the chemicals to more completely understand the public health implications of exposure.

Comparing Environmental Concentrations to Comparison Values

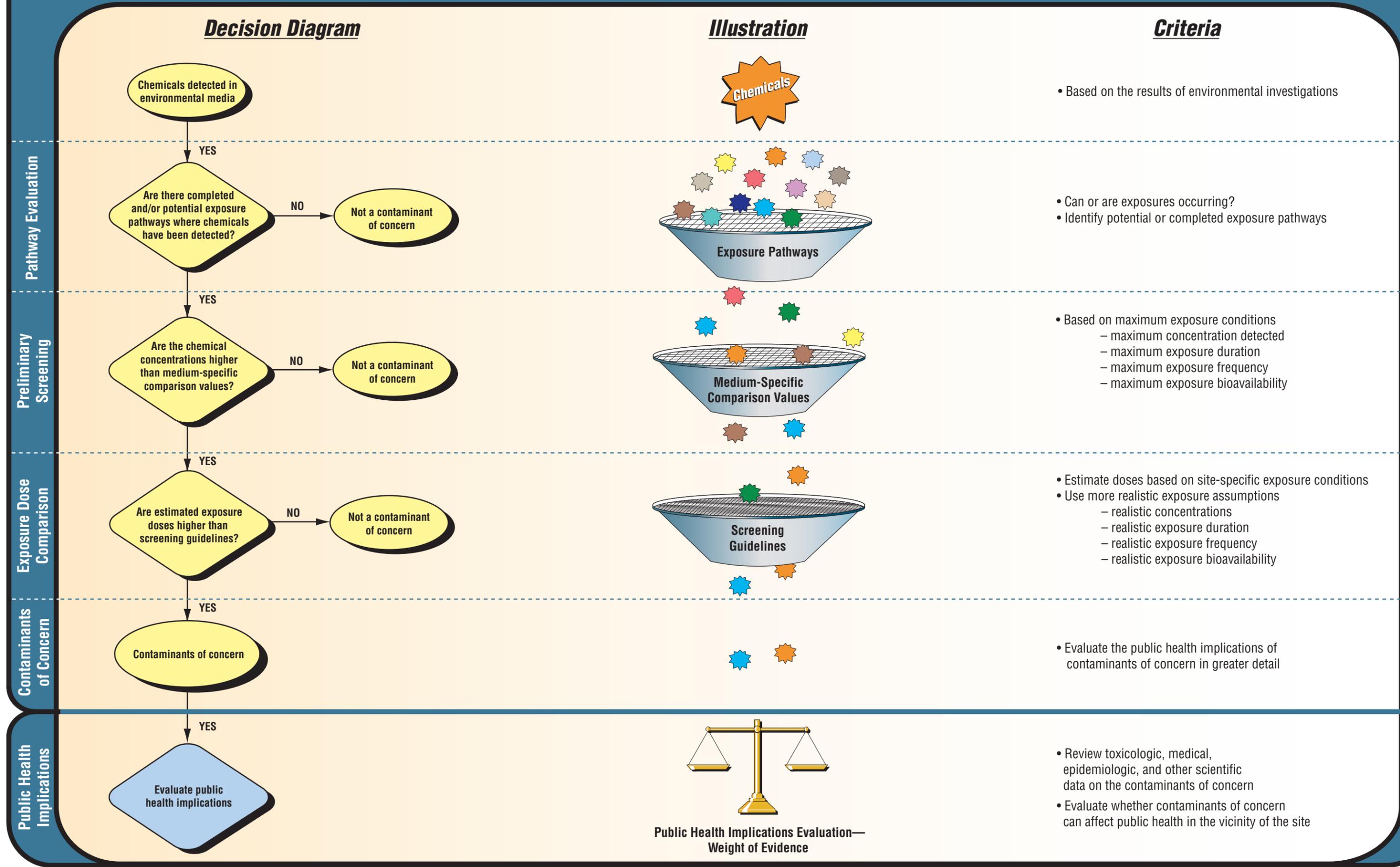
ATSDR selects chemicals for further evaluation by comparing the maximum environmental concentrations against media-specific health-based comparison values. The maximum concentrations are used at this step of the screening process as a conservative measure even though we know that people are exposed to a range of concentrations and not just to the maximum reported levels. Comparison values are developed by ATSDR from available scientific literature concerning exposure and health effects. Comparison values are derived for soil/sediment, water, and air³ and reflect a concentration that is not expected to cause harmful health effects for a given contaminant, assuming a standard daily contact rate (for example, the amount of water or soil consumed or the amount of air breathed) and representative body weight (child or adult). Because they reflect concentrations that are much lower than those that have been observed to cause adverse health effects, comparison values are protective of public health in essentially all exposure situations. As a result, **exposures to chemical concentrations detected at or below ATSDR's comparison values are not expected to cause health effects in people. Therefore, levels below media-specific comparison values do not pose a public health hazard and are not evaluated further for a given medium.**

ATSDR uses comparison values to screen chemicals that require additional evaluation.

ATSDR uses the term "conservative" to refer to values that are protective of public health in essentially all situations.

³ ATSDR has not derived comparison values for biota.

Figure 4. ATSDR Chemical Screening Process



ATSDR's cancer risk evaluation guides (CREGs), environmental media evaluation guides (EMEGs), and reference dose media evaluation guides (RMEGs) are conservative, health-based comparison values developed for screening environmental concentrations for further evaluation. EPA's risk-based concentration (RBC) is a health-based comparison value developed to screen sites not yet on the NPL, respond rapidly to citizens' inquiries, and spot-check formal baseline risk assessments. Please see Appendix A for a glossary of these and other terms used in this public health assessment.

While concentrations at or below the respective comparison value can be considered safe, it does not automatically follow that any environmental concentration exceeding a comparison value would be expected to produce adverse health effects. Comparison values are not health effect thresholds. ATSDR comparison values represent concentrations that are many times lower than levels at which no effects were observed in studies on experimental animals or in human

Weight-of-evidence is the extent to which the available scientific information supports the hypothesis that a substance causes an adverse effect in humans. For example, factors that determine the weight-of-evidence that a chemical poses a hazard to humans include the number of tissue sites affected by the agent; the number of animal species, strains, genders, and number of experiments and doses showing a response; the dose-response relationship; statistical significance in the occurrence of the adverse effect in treated subjects compared with untreated controls; and the timing of the occurrence of the adverse effect.

epidemiologic studies. The likelihood that adverse health outcomes will actually occur depends on site-specific conditions, individual differences, and factors that affect the route, magnitude, and duration of actual exposure. **If contaminant concentrations are above comparison values, ATSDR further analyzes exposure variables (such as site-specific exposure duration and frequency) for health effects, including the toxicity of the chemical, epidemiology studies, and the weight-of-evidence.**

Essential nutrients (e.g., calcium, magnesium, phosphorus, potassium, and sodium) are minerals that maintain basic life functions; therefore, certain doses are recommended on a daily basis. Because these chemicals are necessary for life, comparison values do not exist for them. They are found in many foods, such as milk, bananas, and table salt. For example, the Food and Nutrition Board of the Institute of Medicine of the National Academy of Sciences has recommended the following adequate intakes (AI) and recommended dietary allowance (RDA) for phosphorus: For infants 0 to 6 months and 7 to 12 months old, the AIs are 100 and 275 milligrams per day (mg/day), respectively. For children 1 to 3 years and 4 to 8 years old, the RDAs are 460 and 500, respectively. For children 9 to 18 years old, the RDA is 1,250 mg/day. Adults 19 years and older have an RDA of 700 mg/day. A no-observed-adverse-effect level (NOAEL) for phosphorus for adults is 10.2 grams/day—or more than 10,000 mg/day. Therefore, calcium, magnesium, phosphorus, potassium, and sodium were not considered for further evaluation.

A **NOAEL** is the highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals in a study.

Comparing Estimated Exposure Doses to Screening Guideline Values

If chemical concentrations are above comparison values, ATSDR further evaluates the chemical and potential exposure. ATSDR does this by calculating exposure doses and comparing the doses to protective screening guideline values, including ATSDR's minimal risk levels (MRLs) and

EPA's reference doses (RfDs). **Estimated exposure doses that are less than screening guideline values pose no public health hazard and are not evaluated further.**

An exposure dose, expressed in milligrams per kilogram per day (mg/kg/day), is the estimated amount of chemical a person is exposed to over time.

When estimating hypothetical exposure doses, health assessors evaluate chemical concentrations to which people could have been exposed, and assess the length of time (duration) and the frequency of exposure to these contaminant concentrations. Collectively, these factors influence an individual's physiological response to chemical exposure and potential outcomes. Where possible in this public health evaluation, ATSDR used site-specific information regarding the frequency and duration of exposures. When site-specific information was not available, ATSDR employed several protective assumptions to estimate exposures.

The following general equation was used to calculate exposure doses:

$$\text{Estimated exposure dose} = \frac{C \times IR \times EF \times ED}{BW \times AT}$$

where:

- C = Concentration of chemical
- IR = Intake rate
- EF = Exposure frequency, or number of exposure events per year of exposure
- ED = Exposure duration, or the duration over which exposure occurs
- BW = Body weight
- AT = Averaging time, or the period over which cumulative exposures are averaged

Environmental concentrations of most soil and sediment contaminants are log-normally distributed; meaning that a few samples have high concentrations while most of the samples have much lower concentrations (Shacklette and Boergen 1984). EPA's soil screening guidance (EPA 1996a, 2002c) recommends use of a spatially averaged concentration (i.e., the 50th percentile concentration over the exposure area). However, ATSDR chose to use a more conservative second-tier screening concentration⁴ (defined as one standard deviation above the average concentration) to estimate exposure doses during this phase of the screening process (i.e., to identify chemicals for further evaluation) to account for the variability of the samples. Use of the second-tier screening concentration is a health-protective estimate of the concentration; it results in a more protective screening process because the exposure doses are calculated using a concentration that is higher than the average concentration.

Using the general equation given above, the exposure parameters listed in Table 3, and the second-tier screening concentration, ATSDR derived hypothetical exposure doses for residents living near the site. ATSDR compared these estimated site-specific exposure doses against noncancer and cancer screening guideline values. ATSDR's MRLs and EPA's RfDs are estimated doses of daily human exposure to substances that are likely to be without appreciable

⁴ For chemicals detected in at least 10 percent of the samples, the second-tier screening concentrations were calculated using detected concentrations only and do not take into account nondetected values. For chemicals detected in less than 10 percent of the samples, ATSDR calculated second-tier screening concentrations using half the detection limit for nondetected samples.

risk of adverse *noncancer* health effects over a specified duration of exposure. MRLs and RfDs are derived for chemicals using the NOAEL/lowest-observed-adverse-effect level (LOAEL)/uncertainty factor approach. They are derived when reliable and sufficient human or animal data exist to identify the most sensitive health effect for a given route of exposure. MRLs and RfDs are generally based on the most sensitive end point considered to be of relevance to humans. Because of the lack of precise toxicologic information on people who might be most sensitive (for example, infants, the elderly, or persons who are nutritionally or immunologically compromised) to the effects of hazardous substances, MRLs and RfDs have built-in safety factors, making them considerably lower than doses at which health effects have been observed. Therefore, these screening guideline values are below doses that cause adverse health effects in people most sensitive to such effects. Consistent with the public health principle of prevention, ATSDR uses this conservative (protective) approach to maximize human health protection and to address the uncertainty in toxicologic information.

These chemical-specific guideline values, which serve as screening levels, are used to identify chemicals for further consideration. It is important to note that MRLs and RfDs are not thresholds for health effects and are not intended to define cleanup or action levels. They are intended only to serve as a screening tool to help public health professionals decide what chemicals and pathways to look at more closely. While estimated exposure doses that are less than MRLs or RfDs are not considered to be a public health hazard, exposure to doses above these screening values does not automatically imply that adverse health effects will occur. Rather, it is an indication that ATSDR should further examine the health effect levels reported in the scientific literature and more fully review potential exposures.

In addition, to screen for cancer effects, ATSDR multiplied estimated chronic-exposure doses (30-year exposure averaged over 70 years) by EPA's cancer slope factors (CSFs), which estimate the relative potency of carcinogens. This calculation estimated a theoretical excess cancer risk expressed as the proportion of a population that might be affected by a carcinogen during a lifetime of exposure. For example, an estimated cancer risk of 1×10^{-6} predicts the probability of one additional cancer over background in a population of 1 million. Because conservative models are used to derive CSFs, the doses associated with these hypothetical risks are typically orders of magnitude lower than doses reported in the toxicologic literature to cause carcinogenic effects. As such, a low cancer risk estimate indicates that the toxicologic literature would support a finding that no excess cancer risk is likely. A higher cancer risk estimate, however, indicates that ATSDR should carefully review the scientific literature before making conclusions about potential cancer risks.

Table 3. Parameters Used in the Exposure Dose Calculations for ORR

	<i>Soil</i>	<i>Sediment</i>	<i>Surface Water</i>	<i>Biota</i>			
				<i>Fish</i>	<i>Game</i>	<i>Vegetation</i>	
Intake Rate				<i>Subsistence</i>	<i>Recreational</i>		
P Adult	0.00005 kg/day	0.0001 kg/day	0.5 liter/day*	0.065 kg/day	0.008 kg/day	0.002 kg/day	0.0016 kg/kg/day [§]
P Child	0.0002 kg/day	0.0001 kg/day	0.5 liter/day*	0.02 kg/day	0.003 kg/day	0.001 kg/day	0.0016 kg/kg/day [§]
P Pica child	0.005 kg/day	NA	NA	NA	NA	NA	NA
Exposure Frequency							
P Adult	291.2 days/year	12 days/year			365 days/year		
P Child	291.2 days/year	12 days/year			365 days/year		
P Pica child	52 days/year	NA			NA		
Exposure Duration							
P Adult				30 years			
P Child				6 years			
P Pica child				3 years			
Body Weight							
P Adult				70 kg			
P Child				13 kg			
P Pica child				10 kg			
Averaging Time		<i>Noncancer</i>			<i>Cancer/Lifetime</i>		
P Adult		365 days/year × 30 years			365 days/yr × 70 years		
P Child		365 days/year × 6 years			NA		
P Pica child		365 days/year × 3 years			NA		

*The surface water intake rate was changed to 0.15 liter/day for the public health evaluation (see Section IV.C) to represent a three-hour swimming event (EPA 1999).

[§]The body weight parameter is built into the intake rate for the vegetation dose equation (EPA 1999; Table 13-63).

Exposure doses are not calculated for the air pathway. Screening guidelines are reported in concentrations.

Cancer doses assume a 30-year exposure averaged over a 70-year lifetime.

kg = kilogram

NA = not applicable

Intake Rates	Rough Equivalent
0.005 kg of soil	1 teaspoon
0.00005 kg of soil	1/100 th of a teaspoon
0.0001 kg of sediment	1/50 th of a teaspoon
0.5 liter of water	2 cups
0.065 kg of fish	2 ounces
0.008 kg of fish	1/4 th of an ounce
0.002 kg of game	1/16 th of an ounce
0.0016 kg/kg/day of vegetation	90 lbs/year (adult)

Comparing Estimated Exposure Doses to Health Effect Levels

If the MRLs or RfDs are exceeded, ATSDR determines the public health implications of estimated exposures by examining the effect levels discussed in the scientific literature and more fully reviews exposure potential. ATSDR reviews available human studies as well as experimental animal studies. This information is used to understand the disease-causing potential of a chemical and to compare site-specific exposure dose estimates with doses shown to cause health effects. This process enables ATSDR to weigh the available evidence in light of uncertainties and offer perspective on the plausibility of harmful health outcomes under site-specific conditions.

Sources for Health-Based Guidelines

By Congressional mandate, ATSDR prepares toxicological profiles for hazardous substances found at contaminated sites. Toxicological profiles were used to evaluate potential health effects at the ORR. ATSDR's toxicological profiles are available on the Internet at <http://www.atsdr.cdc.gov/toxpro2.html> or by contacting the National Technical Information Service (NTIS) at 1-800-553-6847. EPA also develops health effects guidelines, and in some cases, ATSDR relied on EPA's guidelines to evaluate potential health effects. These guidelines are found in EPA's Integrated Risk Information System (IRIS)—a database of human health effects that could result from exposures to various substances found in the environment. IRIS is available on the Internet at <http://www.epa.gov/iris>. For more information about IRIS, please call EPA's IRIS hotline at (202) 566-1676 or send an e-mail to hotline.iris@epa.gov.

III.C. Environmental Data

As discussed earlier, exposure to a contaminant is an important factor in ATSDR's evaluation. If no one comes in contact with a contaminant, then no exposure occurs, and thus no health effects could occur. Therefore, this screening of current and future chemical exposures focuses primarily on contaminants detected in off-site locations, where exposures are more likely to occur (as opposed to on-site locations, where access is restricted).⁵ However, because there are limited off-site air samples, and people have access to on-site fish and game, on-site exposures to these media are also included. See Figure 5 for the exposure pathways ATSDR evaluated in this health assessment. ATSDR evaluated exposures to chemicals detected in off-site groundwater in a separate, pathway-specific public health assessment. (Copies of the document can be obtained from ATSDR's Web site: <http://www.atsdr.cdc.gov/HAC/oakridge/phact/groundwater/index.html>.) Appendix D contains maps depicting the number of samples collected from and the number of chemicals sampled at each location in each media.

It is important to note that ATSDR is assuming exposure to the contaminated media. The location of each detection was not individually evaluated to determine whether anyone is actually being exposed.

For this public health evaluation, ATSDR used environmental sampling data collected within the ORRHES Area of Interest (see Figure 6) from 1990 to 2003. The Oak Ridge Environmental

⁵ Most of the site-related contamination is at the three main ORR facilities (X-10, Y-12, and K-25). These areas are heavily guarded, fenced, and access requires a clearance badge.

Information System (OREIS)—a centralized, standardized, quality-assured, and configuration-controlled environmental data management system—supplied the data. DOE created OREIS to integrate the abundant environmental data on the ORR into one database, facilitating public and government access to environmental operations data while maintaining data quality. DOE's objective was to ensure that the database had long-term retention of the environmental data and useful methods to access the information. OREIS contains data on compliance, environmental restoration, and surveillance activities. Information from all key surveillance activities and environmental monitoring efforts is entered into OREIS. As new studies are completed, the environmental data are entered as well.

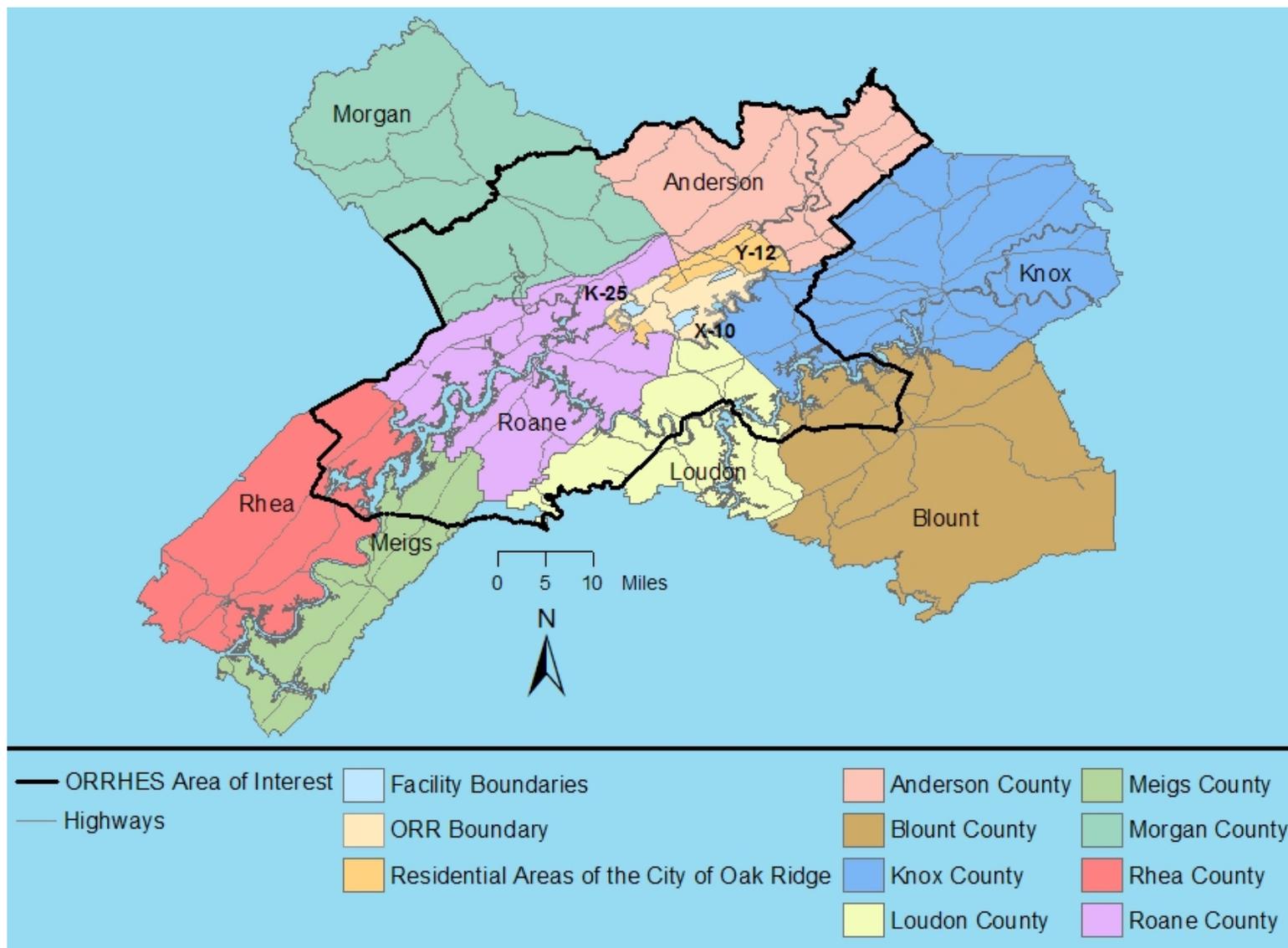
ATSDR's database manager scrutinized the data evaluated in this public health assessment to ensure proper quality assurance/quality control. ATSDR did not use any data in this evaluation that were deemed unreliable. For example, surface water data are typically reported in micrograms per liter ($\mu\text{g/L}$) or milligrams per liter (mg/L). Some surface water data in OREIS were reported in milligrams per kilogram (mg/kg). ATSDR suspected that the media code had been interpreted incorrectly and these data were actually fish data. Since this could not be confirmed, the data were not used in this evaluation.

Scenarios for past, current, and future exposure to PCBs and mercury will be addressed in chemical-specific public health assessments. Two of ATSDR's public health assessments address exposure to uranium from the ORR: one on uranium releases from the Y-12 plant (already released; available at <http://www.atsdr.cdc.gov/HAC/oakridge/phact/y12/index.html>) and another, still being prepared, that addresses past and current exposure to uranium and fluoride releases from the K-25 site. ATSDR scientists have also released or are conducting public health assessments on the following issues associated with the ORR: iodine 131 releases from the X-10 site, radionuclide releases from White Oak Creek, mercury releases from the Y-12 plant, contaminated off-site groundwater, PCB releases from the X-10 site, the Y-12 plant, and the K-25 site, and contaminant releases from the TSCA Incinerator. The documents released to date are available at <http://www.atsdr.cdc.gov/HAC/oakridge/phact/index.html> and can also be ordered through a toll-free ATSDR telephone number, 1-800-232-4636.

Figure 5. Possible Exposure Situations Evaluated



Figure 6. ORRHES Area of Interest



III.D. Screening Results

Off-Site Soil

OREIS contains almost 10,000 records⁶ of chemicals sampled in off-site soil from November 5, 1990, to September 1, 2001. These samples were analyzed for a total of 286 chemicals.⁶ See Figures D-1 and D-2 in Appendix D for the number of off-site soil samples collected from and the number of chemicals sampled at each location.

ATSDR compared the maximum concentration for each chemical detected off site to that chemical's conservative health-based comparison value. The maximum concentrations for 22 chemicals were detected above comparison values. ATSDR calculated exposure doses for these 22 chemicals, using the equation described in Section III.B, "Methodology," and the exposure parameters listed in Table 3. ATSDR then compared these exposure doses to the acute and chronic noncancer and cancer screening guidelines (see Table 4, Table 16, and Table 17). Four chemicals exceeded noncancer and/or cancer screening guidelines, and are further evaluated in Section IV, "Public Health Implications." Figure 7 shows the results of ATSDR's chemical screening process. Chemicals without screening guidelines are discussed in Appendix B. Pica child exposures are evaluated in Section IV.B, "Children's Health Considerations."

Chemicals Detected Above Comparison Values in Off-Site Soil (22 Chemicals)

<u><i>Inorganics</i></u>	<u><i>Organics</i></u>	<u><i>Organics (continued)</i></u>
<ul style="list-style-type: none"> ▪ Arsenic ▪ Cadmium ▪ Chromium ▪ Iron ▪ Lead 	<ul style="list-style-type: none"> ▪ Benzidine ▪ Benzo(a)anthracene ▪ Benzo(a)pyrene ▪ Benzo(b)fluoranthene ▪ Benzo(k)fluoranthene ▪ bis(2-Chloroethyl) ether ▪ Chrysene ▪ trans-Chlordane ▪ Dibenzo(a,h)anthracene 	<ul style="list-style-type: none"> ▪ 3,3'-Dichlorobenzidine ▪ Heptachlor epoxide ▪ Hexachlorobenzene ▪ Hexachlorodibenzo-p-dioxin (HCDD) ▪ Indeno(1,2,3-cd)pyrene ▪ n-Nitroso-di-n-butylamine ▪ n-Nitrosodi-n-propylamine ▪ 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)

Chemicals with Exposure Doses Above Cancer/Noncancer Screening Guidelines in Off-Site Soil (4 Chemicals)

<u><i>Inorganics</i></u>	<u><i>Organics</i></u>
<ul style="list-style-type: none"> ▪ Arsenic ▪ Iron ▪ Lead 	<ul style="list-style-type: none"> ▪ Benzidine

⁶ Records for mercury, uranium, and PCBs are not included in the total because ATSDR has evaluated or is evaluating them in separate, chemical-specific public health assessments.

Off-Site Sediment

OREIS contains about 56,000 records⁷ of chemicals sampled in off-site sediment from January 15, 1990, to September 1, 2001. These samples were analyzed for a total of 319 chemicals.⁷ See Figures D-3 and D-4 in Appendix D for the number of off-site sediment samples collected from and the number of chemicals sampled at each location.

ATSDR compared the maximum concentration for each chemical detected off-site to that chemical's conservative health-based comparison value. The maximum concentrations for 33 chemicals were detected above comparison values. ATSDR calculated exposure doses for these 33 chemicals, using the equation described in Section III.B, "Methodology," and the exposure parameters listed in Table 3. ATSDR then compared these exposure doses to the noncancer and cancer screening guidelines (see Table 18 and Table 19). None of the chemicals detected in off-site sediment exceeded noncancer or cancer screening guidelines. Therefore, exposure to off-site sediment is not a health hazard. Figure 7 shows the results of ATSDR's chemical screening process. Chemicals without screening guidelines are discussed in Appendix B.

Chemicals Detected Above Comparison Values in Off-Site Sediment (33 Chemicals)

Inorganics

- Arsenic
- Cadmium
- Copper
- Iron
- Lead
- Manganese

Organics

- Aldrin
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- bis(2-Chloroethyl) ether
- cis-Chlordane
- trans-Chlordane
- DDD, p,p'-
- DDE, p,p'-
- DDT, p,p'-
- di(2-Ethylhexyl)phthalate
- Dibenzo(a,h)anthracene
- 3,3'-Dichlorobenzidine

Organics (continued)

- Dieldrin
- Heptachlor
- Heptachlor epoxide
- Hexachlorobenzene
- Hexachlorocyclohexane (HCH), alpha-
- HCH, beta-
- HCH, delta-
- HCH, gamma-
- HCDD
- Indeno(1,2,3-cd)pyrene
- n-Nitrosodi-n-propylamine
- Pentachlorophenol
- Toxaphene

Off-Site Surface Water

OREIS contains more than 93,000 records⁷ of chemicals sampled in off-site surface water from January 8, 1990, to September 10, 2002. These samples were analyzed for a total of 310 chemicals.⁷ See Figures D-5 and D-6 in Appendix D for the number of off-site surface water samples collected from and the number of chemicals sampled at each location.

ATSDR compared the maximum concentration for each chemical detected off site to that chemical's conservative health-based comparison value. The maximum concentrations for 75

⁷ Records for mercury, uranium, and PCBs are not included in the total because ATSDR has evaluated or is evaluating them in separate, chemical-specific public health assessments.

chemicals were detected above comparison values. ATSDR calculated exposure doses for these 75 chemicals, using the equation described in Section III.B, “Methodology,” and the exposure parameters listed in Table 3. ATSDR then compared these exposure doses to the noncancer and cancer screening guidelines (see Table 20 and Table 21). None of the chemicals detected in off-site surface water exceeded noncancer or cancer screening guidelines. Therefore, exposure to off-site surface water is not a health hazard. Figure 7 shows the results of ATSDR’s chemical screening process. Chemicals without screening guidelines are discussed in Appendix B.

Chemicals Detected Above Comparison Values in Off-Site Surface Water (75 Chemicals)

<u><i>Inorganics</i></u>	<u><i>Organics</i></u>	<u><i>Organics (continued)</i></u>
▪ Aluminum	▪ Aldrin	▪ HCDD
▪ Ammonia	▪ Benzene	▪ Heptachlor
▪ Antimony	▪ Benzo(a)anthracene	▪ Heptachlor epoxide
▪ Arsenic	▪ Benzo(a)pyrene	▪ Hexachlorobenzene
▪ Barium	▪ Benzo(b)fluoranthene	▪ Hexachlorobutadiene
▪ Beryllium	▪ Benzo(k)fluoranthene	▪ alpha-HCH
▪ Boron	▪ Bis(2-chloroethyl) ether	▪ beta-HCH
▪ Cadmium	▪ Bromodichloromethane	▪ delta-HCH
▪ Chlorine	▪ Bromoform	▪ Hexachloroethane
▪ Chromium	▪ Carbazole	▪ Indeno(1,2,3-cd)pyrene
▪ Copper	▪ Carbon tetrachloride	▪ Methoxychlor
▪ Iron	▪ cis-Chlordane	▪ Methylene chloride
▪ Lead	▪ trans-Chlordane	▪ 2-Nitroaniline
▪ Lithium	▪ Chlorodibromomethane	▪ 3-Nitroaniline
▪ Manganese	▪ Chloroethane	▪ 4-Nitroaniline
▪ Nickel	▪ Chloromethane	▪ Nitrobenzene
▪ Nitrate	▪ Chrysene	▪ n-Nitrosodi-n-propylamine
▪ Nitrate and Nitrite	▪ Dibenzo(a,h)anthracene	▪ n-Nitrosodiphenylamine
▪ Selenium	▪ 3,3'-Dichlorobenzidine	▪ Pentachlorophenol
▪ Silver	▪ 1,2-Dichloroethane	▪ TCDD
▪ Thallium	▪ 1,3-Dichloropropene, cis-	▪ 1,1,2,2-Tetrachloroethane
▪ Vanadium	▪ 1,3-Dichloropropene, trans-	▪ 1,1,2-Trichloroethane
▪ Zinc	▪ Di(2-ethylhexyl)phthalate	▪ 2,4,6-Trichlorophenol
	▪ Dieldrin	▪ Toxaphene
	▪ 2,4-Dinitrophenol	▪ Trichloroethylene
	▪ 4,6-Dinitro-o-cresol	▪ Vinyl chloride

Biota

Fish

OREIS contains more than 16,000 records⁸ of chemicals sampled in fish (e.g., bass, carp, catfish, crayfish, and sunfish) from May 29, 1990, to August 14, 2002. A total of 147 different chemicals⁸ were analyzed—43 chemicals in fish collected from East Fork Poplar Creek (EFPC), 64 chemicals in fish collected from the Clinch River, 81 chemicals in fish collected from the Watts Bar Reservoir (WBR), and 124 chemicals in fish collected from on-site locations. See Figures D-7 through D-10 in Appendix D for the number of fish samples collected from and the number of chemicals sampled at each location.

Subsistence-level comparison values do not exist for chemicals detected in fish species. Therefore, as an initial screen, ATSDR calculated exposure doses for chemicals detected in fish samples (whole, filet, muscle, and unknown portions) using (1) the equation described in Section III.B, “Methodology”; (2) the subsistence exposure parameters listed in Table 3; and (3) the average of the maximum concentrations detected for each group/species.⁹ Exposure doses are most likely overestimated because the inclusion of whole fish and crayfish data—fillet and muscle (edible portions) typically have less contamination. ATSDR compared these exposure doses to noncancer and cancer screening guidelines. Estimated exposure doses for the following 12 chemicals exceeded the screening guidelines for at least one location.

Chemicals with Initial Screen Exposure Doses Above Screening Guidelines (12 Chemicals)

Inorganics

- Arsenic
- Cadmium
- Chromium
- Thallium

Organics

- Aldrin
- Benzo(a)pyrene
- Dibenzo(a,h)anthracene
- Dieldrin
- HCH, alpha-
- Heptachlor epoxide
- TCDD
- Toxaphene

As a second screen, ATSDR calculated recreational and subsistence-level exposure doses using the second-tier screening concentrations for the chemicals listed above. Then ATSDR compared these doses to noncancer and cancer screening guidelines (see Table 22 through Table 29). For this level of the evaluation, the fish were grouped by species and by location.¹⁰ Chemicals that exceeded noncancer or cancer screening guidelines in at least one fish species during this second

⁸ Records for mercury, uranium, and PCBs are not included in the total because ATSDR has evaluated or is evaluating them in separate, chemical-specific public health assessments.

⁹ ATSDR averaged the maximum concentrations for each group/species of fish (across multiple sampling locations and events) because individual species data were available for multiple chemicals and for multiple sampling locations. In addition, people may only eat certain fish species and/or different species may have different territorial and behavioral patterns (i.e., chemicals may accumulate differently in different species found at different locations).

level of screening are further evaluated in the Public Health Implications section (see Section IV). Figure 7 shows the results of ATSDR's chemical screening process. Chemicals without screening guidelines are discussed in Appendix B.

Chemicals with Second Screen Exposure Doses Above Screening Guidelines in EFPC Fish (6 Chemicals)

Inorganics

- Arsenic
- Cadmium
- Chromium

Organics

- Dibenzo(a,h)anthracene
- Dieldrin
- Heptachlor epoxide

Chemicals with Second Screen Exposure Doses Above Screening Guidelines in Clinch River Fish (6 Chemicals)

Inorganics

- Arsenic

Organics

- Aldrin
- Dieldrin
- HCH, alpha-
- Heptachlor epoxide
- Toxaphene

Chemicals with Second Screen Exposure Doses Above Screening Guidelines in WBR Fish (8 Chemicals)

Inorganics

- Arsenic
- Chromium

Organics

- Aldrin
- Dieldrin
- HCH, alpha-
- Heptachlor epoxide
- TCDD
- Toxaphene

Chemicals with Second Screen Exposure Doses Above Screening Guidelines in On-Site Fish (8 Chemicals)

Inorganics

- Arsenic
- Cadmium
- Thallium

Organics

- Aldrin
- Dieldrin
- HCH, alpha-
- Heptachlor epoxide
- Toxaphene

¹⁰ As a second screen, ATSDR believes, grouping the data by species and location provides a more comprehensive representation of potential exposure patterns and estimated exposure doses for people consuming fish from water bodies near the reservation.

Game

OREIS contains more than 2,200 records¹¹ of chemicals sampled in game species (e.g., turtles and wood ducks) from March 28, 1990, to May 23, 1996. A total of 118 different chemicals were analyzed—27 chemicals¹¹ in game collected from off-site locations and 118 chemicals¹¹ in game collected from on-site locations. See Figures D-11 through D-14 in Appendix D for the number of game samples collected from and the number of chemicals sampled at each location.

Comparison values do not exist for chemicals detected in game species. Therefore, as an initial screen, ATSDR calculated exposure doses using (1) the equation described in Section III.B, “Methodology”; (2) the exposure parameters listed in Table 3; and (3) the average of the maximum detected concentrations.¹² ATSDR compared these exposure doses to noncancer and cancer screening guidelines. No exposure doses for chemicals detected in game from *off-site* locations exceeded the screening guidelines. Calculated exposure doses exceeded the screening guidelines for the following eight chemicals detected in game from *on-site* locations.

Chemicals with Initial Screen Exposure Doses Above Screening Guidelines in On-Site Game (8 Chemicals)

Inorganics

- Aluminum
- Antimony
- Cadmium
- Iron
- Manganese
- Thallium

Organics

- 4,6-Dinitro-o-cresol
- 2,4-Dinitrophenol

As a second screen, ATSDR calculated exposure doses using the second-tier screening concentrations for the chemicals listed above and compared these doses to noncancer screening guidelines¹³ (see Table 30). For this part of the evaluation, the game samples collected on site were grouped by species. Exposure doses for seven of the eight chemicals exceeded noncancer screening guidelines during this second level of screening, and are further evaluated in the Public Health Implications section (see Section IV). Figure 7 shows the results of ATSDR’s chemical screening process. Chemicals without screening guidelines are discussed in Appendix B.

¹¹ Records for mercury and PCBs are not included in the total because ATSDR has evaluated or is evaluating them in separate, chemical-specific public health assessments.

¹² ATSDR averaged the maximum concentrations for each game species (across multiple sampling locations and events) because individual species data were available for multiple chemicals and for multiple sampling locations.

¹³ During the second level of screening, chemicals detected in game species were evaluated for noncarcinogenic effects only—cancer screening guidelines are not available for these chemicals.

Chemicals with Second Screen Exposure Doses Above Screening Guidelines in On-Site Game (7 Chemicals)

Inorganics

- Antimony
- Cadmium
- Iron
- Manganese
- Thallium

Organics

- 4,6-Dinitro-o-cresol
- 2,4-Dinitrophenol

Off-Site Vegetation

OREIS contains 236 records¹⁴ of chemicals sampled in vegetation (e.g., beets, kale, and tomatoes) from July 30, 1992, to September 8, 1992. These samples were analyzed for a total of six chemicals.¹⁴ See Figures D-15 and D-16 in Appendix D for the number of off-site vegetation samples collected from and the number of chemicals sampled at each location.

Comparison values do not exist for chemicals detected in vegetation. Therefore, as an initial screen, ATSDR calculated exposure doses for the six chemicals using (1) the equation described in Section III.B, “Methodology”; (2) the exposure parameters listed in Table 3; and (3) the average of the maximum concentrations.¹⁵ ATSDR compared these exposure doses to noncancer and cancer screening guidelines. Calculated exposure doses exceeded the screening guidelines for the following three chemicals detected in vegetation from off-site locations.

Chemicals with Initial Screen Exposure Doses Above Screening Guidelines in Off-Site Vegetation (3 Chemicals)

Inorganics

- Arsenic
- Cadmium
- Chromium

As a second screen, ATSDR calculated exposure doses using the second-tier screening concentrations for the chemicals listed above and compared these doses to noncancer and cancer screening guidelines (see Table 31 and Table 32). For this level of the evaluation, the vegetation samples were grouped by type (beets, kale, tomatoes, and unknown terrestrial plant). All three chemicals exceeded noncancer and/or cancer screening guidelines during this second level of screening, and are further evaluated in Section IV, “Public Health Implications.” Figure 7 shows the results of ATSDR’s chemical screening process.

¹⁴ Records for mercury and uranium are not included in the total because ATSDR has evaluated or is evaluating them in separate, chemical-specific public health assessments.

¹⁵ ATSDR averaged the maximum concentrations for each vegetation species (across multiple sampling locations and events) because individual species data were available for multiple chemicals and for multiple sampling locations.

**Chemicals with Second Screen Exposure Doses Above Screening Guidelines
in Off-Site Vegetation (3 Chemicals)**

Inorganics

- Arsenic
- Cadmium
- Chromium

Air

OREIS contains about 1,100 records¹⁶ of chemicals sampled in the air from July 31, 1997, to June 30, 2002, from air monitoring stations near the East Tennessee Technology Park. Five different chemicals¹⁶ were analyzed at these locations. See Figures D-17 and D-18 in Appendix D for the number of air samples collected from and the number of chemicals sampled at each location.

ATSDR compared the maximum detected concentration for each chemical to that chemical's conservative health-based comparison value. Based on this initial screen (see Table 33), ATSDR further evaluated the following three chemicals in Section IV, "Public Health Implications." (Beryllium and lead were not detected above comparison values.)

Chemicals Detected Above Comparison Values in Air (3 Chemicals)

Inorganics

- Arsenic
- Cadmium
- Chromium

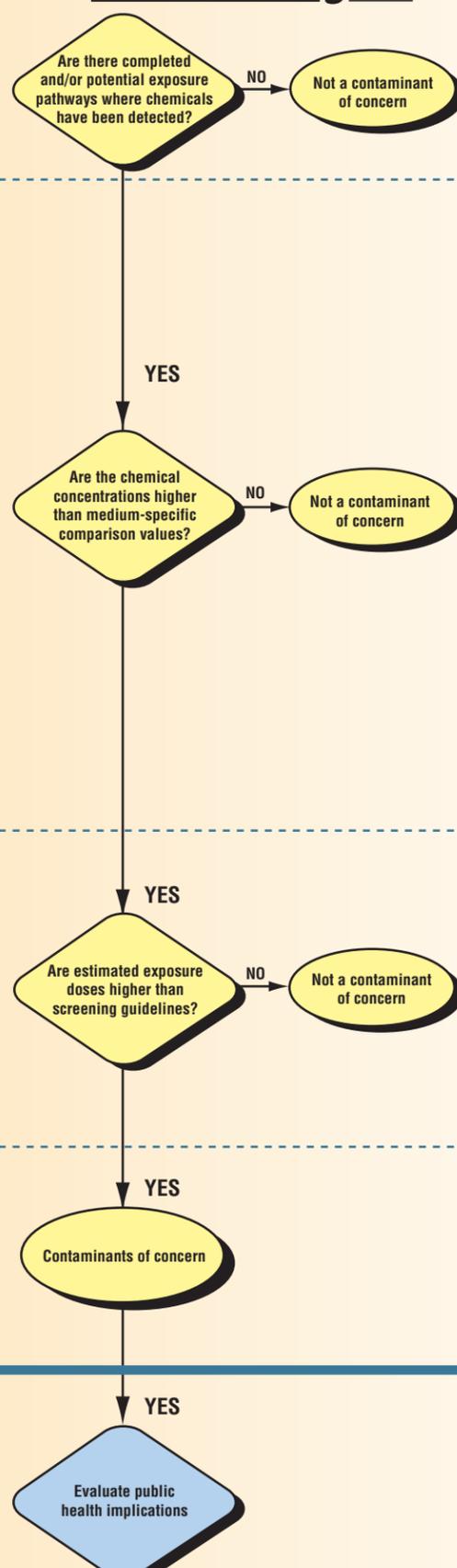
The list of chemicals evaluated for public health implications, as shown in Figure 7, is compiled from the list of chemicals exceeding screening guidelines. To eliminate duplication, the chemicals are combined across the different media.

¹⁶ Records for mercury and uranium are not included in the total because ATSDR has evaluated or is evaluating them in separate, chemical-specific public health assessments.

Figure 7. Results from ATSDR's Chemical Screening Process

Pathway Evaluation

Decision Diagram



Preliminary Screening

Results

Off-Site Soil	Off-Site Sediment	Off-Site Surface Water	Off-Site and On-Site Fish	Off-Site and On-Site Game	Off-Site Vegetation	Off-Site and On-site Air
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Criteria

- Based on the results of environmental investigations
- Can or are exposures occurring
- Identify potential or completed exposure pathways

Chemicals Detected Above Comparison Values

Soil	Sediment	Surface Water	Fish*	Game*	Vegetation*	Air			
22 chemicals Arsenic Benzidine Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene Cadmium Chlordane, trans bis(2-Chloroethyl) ether Chromium Chrysene Dibenzo(a,h)anthracene 3,3'-Dichlorobenzidine HCDD Heptachlor epoxide Hexachlorobenzene Indeno(1,2,3-cd)pyrene Iron Lead n-Nitroso-di-n-butylamine n-Nitrosodi-n-propylamine TCDD	33 chemicals Aldrin Arsenic Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene Cadmium Chlordane, cis Chlordane, trans bis(2-Chloroethyl) ether Copper DDD, p,p'- DDE, p,p'- DDT, p,p'- Dibenzo(a,h)anthracene 3,3'-Dichlorobenzidine Dieldrin di(2-Ethylhexyl)phthalate HCDD HCH, alpha HCH, beta HCH, delta HCH, gamma	Heptachlor Heptachlor epoxide Hexachlorobenzene Iron Lead Manganese n-Nitrosodi-n-propylamine Pentachlorophenol Toxaphene	75 chemicals Aldrin alpha-HCH Aluminum Ammonia Antimony Arsenic Barium Benzene Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene Beryllium beta-HCH Bis(2-chloroethyl) ether Boron Bromodichloromethane Bromoforn Cadmium Carbazole Carbon tetrachloride cis-Chlordane trans-Chlordane Chlorine	Chlorodibromomethane Chloroethane Chloromethane Chromium Chrysene Copper delta-HCH Di(2-ethylhexyl)phthalate Dibenzo(a,h)anthracene 1,2-Dichloroethane 1,3-Dichloropropene, cis- 2,4-Dinitrophenol 3,3'-Dichlorobenzidine Dieldrin 4,6-Dinitro-o-cresol HCDD Heptachlor Heptachlor epoxide Hexachlorobenzene Hexachlorobutadiene Hexachloroethane Indeno(1,2,3-cd)pyrene Iron Lead Lithium	Manganese Methoxychlor Methylene chloride Nickel Nitrate Nitrate and nitrite 2-Nitroaniline 3-Nitroaniline 4-Nitroaniline Nitrobenzene n-Nitrosodi-n-propylamine n-Nitrosodiphenylamine Pentachlorophenol Selenium Silver TCDD 1,1,2,2-Tetrachloroethane Thallium Toxaphene 1,1,2-Trichloroethane 2,4,6-Trichlorophenol Trichloroethylene Vanadium Vinyl chloride Zinc	12 chemicals Aldrin Benzo(a)pyrene Cadmium Chromium Dibenzo(a,h)anthracene Dieldrin HCH, alpha Heptachlor epoxide TCDD Thallium Toxaphene	8 chemicals Aluminum Antimony Cadmium 4,6-Dinitro-o-cresol 2,4-Dinitrophenol Iron Manganese Thallium	3 chemicals Arsenic Cadmium Chromium	3 chemicals Arsenic Cadmium Chromium

* Comparison values do not exist for chemicals detected in fish, game, and vegetation. Therefore, as an initial screen, ATSDR calculated exposure doses using the average of the maximum concentrations and compared these exposure doses to noncancer and cancer screening guidelines.

- Based on maximum exposure conditions
 - maximum concentration detected
 - maximum exposure duration
 - maximum exposure frequency
 - maximum exposure bioavailability

Exposure Dose Comparison

Chemicals with Exposure Doses Above Cancer/Noncancer Screening Guidelines

Soil	Sediment	Surface Water	Fish	Game	Vegetation	Air*
4 chemicals Arsenic (pica only) Benzidine Iron Lead (pica only)	0 chemicals	0 chemicals	11 chemicals Aldrin Arsenic Cadmium Chromium Dibenzo(a,h)anthracene Dieldrin HCH, alpha	7 chemicals Antimony Cadmium 4,6-Dinitro-o-cresol 2,4-Dinitrophenol Iron Manganese Thallium	3 chemicals Arsenic Cadmium Chromium	3 chemicals Arsenic Cadmium Chromium

* Chemicals in air were retained for further evaluation based on the initial screen against comparison values.

- Estimate doses based on site-specific exposure conditions
- Use more realistic exposure assumptions
 - realistic concentrations
 - realistic exposure duration
 - realistic exposure frequency
 - realistic exposure bioavailability

Contaminants of Concern

Chemicals Evaluated for Public Health Implications

Aldrin & Dieldrin	Antimony	Arsenic	Benzidine	Cadmium	Chromium	Dibenzo(a,h)anthracene	4,6-Dinitro-o-cresol	2,4-Dinitrophenol
	Dioxin (TCDD)	Heptachlor epoxide		HCH, alpha	Iron	Lead	Manganese	Toxaphene

- Evaluate the public health implications of contaminants of concern in greater detail

Public Health Implications

Conclusions

ATSDR concludes that current and future exposures to site-related chemicals (individually or in combination) in soil, sediment, surface water, biota, and air do not pose a public health hazard. Because there are very limited data, exposure to dioxins in fish poses an indeterminate public health hazard. Therefore, ATSDR recommends following the current State of Tennessee fish advisories.

- Review toxicologic, medical, epidemiologic, and other scientific data on the contaminants of concern
- Evaluate whether contaminants of concern can affect public health in the vicinity of the site