II.C. Remedial and Regulatory History

The Federal Facility Agreement was implemented at the ORR on January 1, 1992. This is a legally binding agreement used to establish schedules, procedures, and documentation for remedial activities at the ORR (EUWG 1998). The Federal Facility Agreement is available online at http://www.bechteljacobs.com/ettp_ffa.shtml.

On November 21, 1989, the U.S. Environmental Protection Agency (EPA) listed ORR on the final National Priorities List (NPL). This was a result of several on-site processes that produced nonradioactive and radioactive wastes (EUWG 1998; U.S. DOE 2002a). DOE is performing remediation activities at the reservation under a Federal Facilities Agreement (FFA), which is an interagency agreement between DOE, the EPA, and the Tennessee Department of Environment and Conservation (TDEC). EPA and TDEC, along with the public, help DOE select the details for remedial actions at the ORR (ATSDR and ORREHS 2000; U.S. DOE 2003b). These parties collaborate to ensure adequate remediation, and to ensure complete study of hazardous waste related to previous and current ORR activities (ATSDR and ORREHS 2000; U.S. DOE 1996, 2003b). DOE is conducting its investigations of the ORR under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), a program that requires that an FFA for all NPL sites owned by the federal government (EUWG 1998). In addition, DOE is incorporating response procedures designated by CERCLA, with mandatory actions from the Resource Conservation and Recovery Act (RCRA) (U.S. DOE 1995).

Many old disposal sites at the ORR contain waste material. These waste sites constitute 5 to 10 percent of the reservation. Leaching caused by abundant rainfall, high water tables, and the resulting floods have contributed to the PCB contamination of surface water, groundwater, soil, sediments, and fish at the ORR (EUWG 1998). In fact, the 1994 DOE Remedial Investigation for the Lower Watts Bar Reservoir and the 1995 DOE Remedial Investigation for the Clinch River/Poplar Creek found ingestion to be the most significant exposure pathway (Jacobs Engineering Group Inc 1996; U.S. DOE 1994).

The ORR's activities historically required electrical components to supply and satisfy a large energy appetite. From the mid-1950s through the 1970s, the fluids in these electrical components often contained high PCB concentrations. Lower concentrations were also contained in fluids for cooling during machining operations or for hydraulic lifting. Before the 1970s, toxicological information about PCBs and related regulatory requirements did not demand, or even suggest, a need for caution in management and disposal of these fluids. During these times, and to a diminishing extent over the next 10 to 20 years, PCBs were routinely released into the environment, where in nearby waterways they contaminated water and sediment.

In 1979, EPA issued final regulations banning the manufacture of PCBs and phasing out most PCB uses. The regulations prohibited the manufacture, processing, distribution in commerce, and "non-enclosed" (i.e., open to the environment) uses of PCBs unless specifically authorized or exempted by EPA (e.g., research and development samples). "Totally enclosed" uses (i.e., contained, therefore making exposure to PCBs unlikely) were allowed to continue for the life of the equipment. The regulations allowed under controlled conditions use and servicing of most existing large electrical equipment containing PCBs for the life of the equipment. The manufacture of new PCB electrical equipment (transformers and capacitors) was entirely prohibited. The regulations phased out or reduced PCB uses in mining machinery, in hydraulic and heat transfer systems, and in paints and pigments. The ban on the manufacturing, processing, distribution, and use of PCBs, as well as the PCB disposal and marking regulations, were issued under authority of the Toxic Substances Control Act (TSCA) (U.S. EPA 1979).

In 1986, DOE began remedial actions at the ORR under a RCRA permit. Since then, DOE started about 50 response activities under the FFA that address waste disposal and contamination issues at the ORR (U.S. DOE 2002a). These early response activities were made on single sites or projects (SAIC 2004). To facilitate the investigation and remediation of contamination related to the ORR, the contaminated areas on the ORR were separated into five large tracts of land that are typically associated with the major hydrologic watersheds (EUWG 1998; SAIC 2004). This watershed approach to remediation addresses the cumulative impact on environmental conditions within the watershed of all contamination sources and associated contaminated media.

The ETTP watershed encompasses 2,200 acres, including the former K-25 site. The ETTP watershed is bounded by the Black Oak Ridge on the north, West Pine Ridge on the southeast, and the Clinch River on the southwest. Contaminants are transported from the site via Poplar Creek, which bisects the main plant area and flows through the watershed to the Clinch River; the Clinch River joins the Tennessee River, which then flows into Lower Watts Bar Reservoir (ChemRisk 1999a; SAIC 2004).

The Upper East Fork Poplar Creek watershed encompasses all of theY-12 complex and drains about 1,170 acres (SAIC 2004). Y-12 contamination flows into the Upper East Fork Poplar Creek, which originates from a spring beneath the Y-12 plant and flows through the Y-12 plant along Bear Creek Valley. The creek flows north from the Y-12 complex off site into Lower East Fork Poplar Creek, which goes into the city of Oak Ridge through a gap in Pine Ridge. Lower East Fork Poplar Creek flows through residential and business sections of Oak Ridge to join Poplar Creek, which flows to the Clinch River (SAIC 2004).

The Bear Creek watershed extends from the west end of the Y-12 complex westward to Highway 95. Contaminants from waste areas within Bear Creek Valley are captured by Pine Ridge tributaries and Bear Creek, which confluence with the Lower East Fork Poplar Creek, and then to the Clinch River (SAIC 2004).

X-10 is located in the Bethel Valley Watershed and the Melton Valley Watershed (U.S. DOE 2001b). However, the major operations at X-10 take place within the Bethel Valley Watershed. Over the past 60 years, X-10 releases have contaminated the Bethel Valley Watershed. Mobile contaminants primarily leave the Bethel Valley Watershed via White Oak Creek. These contaminants travel from the Bethel Valley Watershed to the Melton Valley Watershed, where further contaminants enter White Oak Creek. Then, the contaminants that have been discharged to White Oak Creek are released over White Oak Dam and into the Clinch River (U.S. DOE 2001b).

X-10 disposed of its radioactive wastes (liquid and solid) in Melton Valley and also operated its experimental facilities within this watershed (U.S. DOE 2002a, 2002b). Discharges from Melton Valley's waste areas have produced secondary contamination sources that include sediment, groundwater, and soil contamination. Furthermore, contaminants that are discharged from Melton Valley travel off the reservation through surface water and flow into the Clinch River (SAIC 2002). As a result, the waste sites in the Melton Valley Watershed "…are the primary contributors to offsite spread of contaminants" from the ORR (U.S. DOE 2002b).

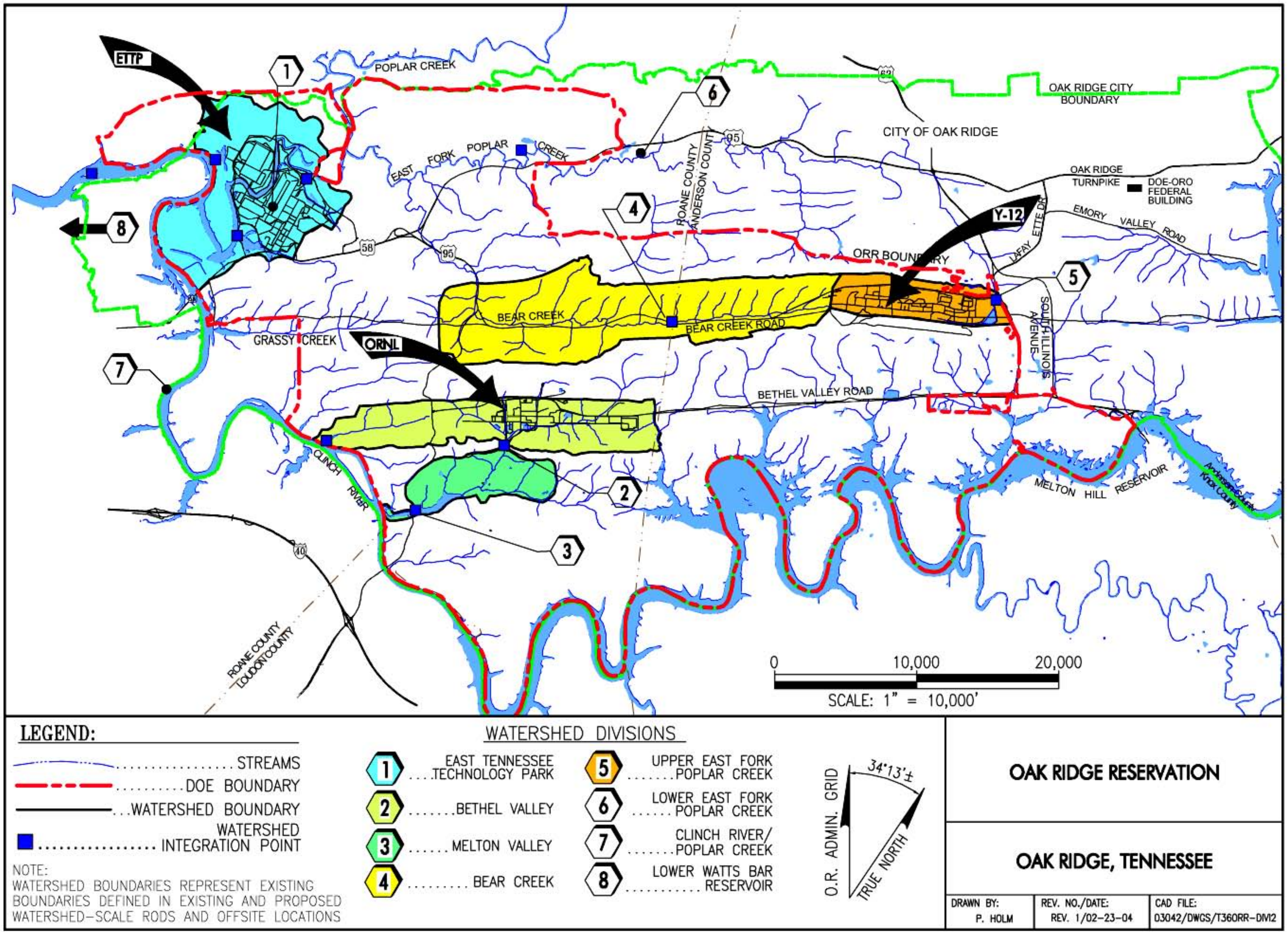
See Figure 8 and Figure 9 for the locations of these watersheds within the ORR and the surface water flow from these watersheds. The investigations and remedial actions described in the next sections pertain to three off-site locations that were affected by contaminant releases from these on-site watersheds located at K-25, Y-12, and X-10.

II.C.1. Lower East Fork Poplar Creek

Lower East Fork Poplar Creek flows north from the Y-12 plant off site into the city of Oak Ridge through a gap in Pine Ridge. The creek flows through residential and business sections of Oak Ridge to join Poplar Creek, which flows to the Clinch River. Starting in the early 1950s Lower East Fork Poplar Creek was contaminated by releases of mercury and other contaminants.

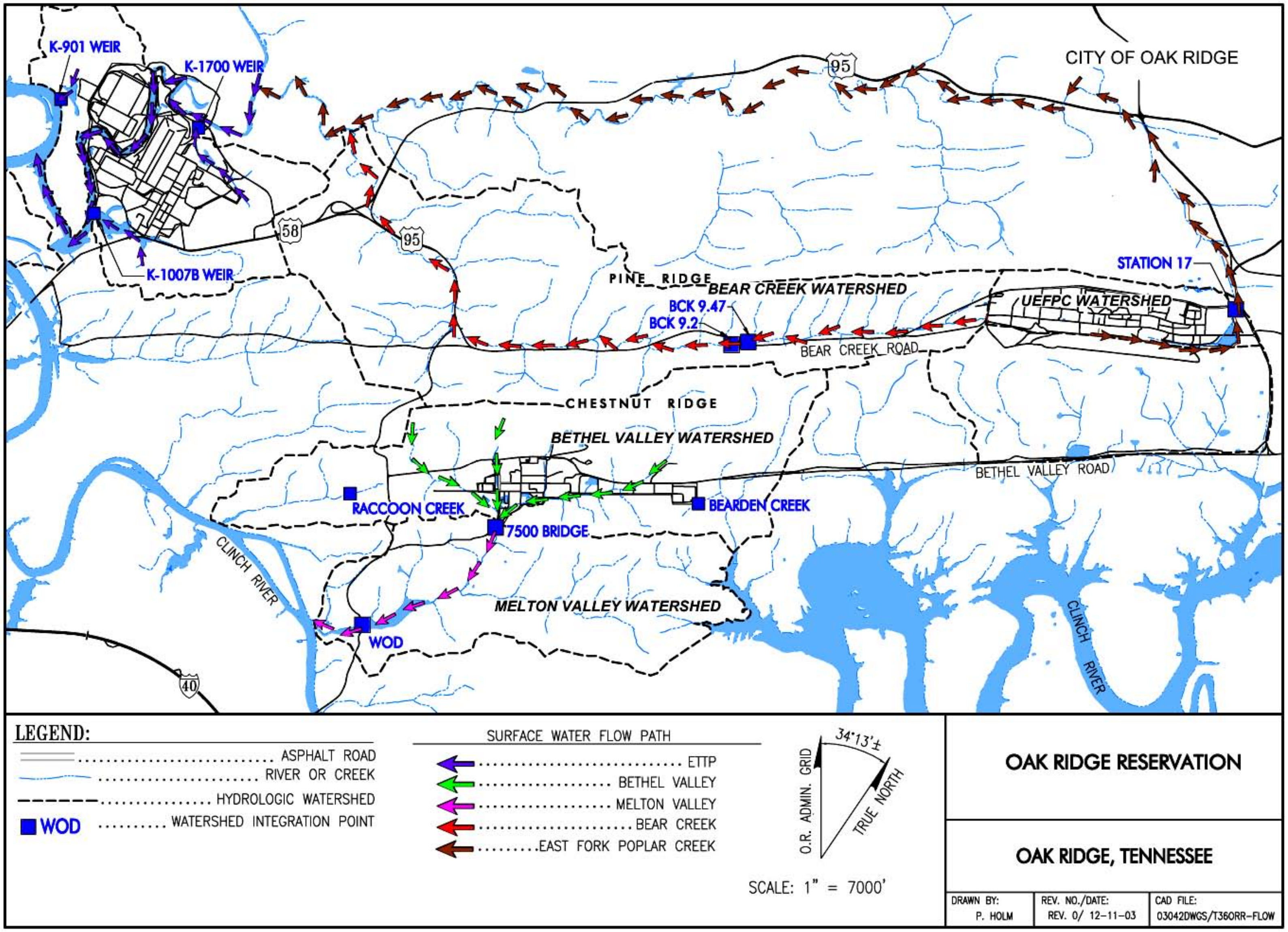
The remedial investigation/feasibility study for Lower East Fork Poplar Creek was completed in 1994. The Record of Decision was approved in September 1995, and remediation field activities began in June 1996 (ATSDR and ORRHES 2000). The remedial investigation and proposed plan ultimately led to the decision to excavate floodplain soils containing mercury levels higher than 400 parts per million (ppm), sampling to ensure that all mercury above this level had been removed, and conducting periodic monitoring (U.S. DOE 2001a). The Agency for Toxic Substances and Disease Registry (ATSDR) evaluated the public health impacts of the 400-ppm cleanup level and concluded that it was protective of public health (ATSDR 1996). During the remediation, several pockets of radiologically contaminated soils (>250 counts per minute gross beta-gamma) were located, excavated, placed in containers, and stored at the ETTP (U.S. DOE 2002a).

Figure 8. Watersheds within the Oak Ridge Reservation



Source: SAIC 2004

Figure 9. Surface Water Flow at the Oak Ridge Reservation



Source: SAIC 2004

II.C.2. Clinch River/Poplar Creek

The Clinch River/Poplar Creek operable unit consists of the biota and sediments in the Melton Hill Reservoir and the Watts Bar Reservoir from CRM 0.0 (where the Tennessee and Clinch Rivers join) to CRM 43.7, which is upstream of Melton Hill Dam. In addition, the operable unit contains the Poplar Creek embayment from the mouth of Poplar Creek along the Clinch River (at CRM 12.0) to its joining with East Fork Poplar Creek (at Poplar Creek mile [PCM] 5.5). All of the Poplar Creek sections of the operable unit are within the borders of the ORR (SAIC 2002; U.S. DOE 2001a).

In 1996 a remedial investigation/feasibility study examined the past and present releases to off-site surface water to determine whether remedial action was necessary (ATSDR and ORRHES 2000). The remedial investigation/feasibility study concluded that the Clinch River/Poplar Creek operable unit presented two main risks by exposure to 1) fish tissue that contained chlordane, mercury, PCBs, and arsenic; and to 2) deep sediments in the primary river channel that contained arsenic, mercury, cesium 137, and chromium (Jacobs EM Team 1997b; Jacobs Engineering Group Inc 1996; SAIC 2002; U.S. DOE 2001a). The largest concentrations of radionuclides that have been detected are buried between 8 and 32 inches into the deep sediments; radionuclide contamination has *not* been detected in the shoreline sediment (Jacobs EM Team 1997b).

A subsequent baseline risk assessment suggested that consumption of certain fish contaminated with PCBs posed the greatest risk to public health. In addition, fish contaminated with chlordane, mercury, and arsenic presented the possible chance of causing health effects. The assessment also determined that the consumption of any type of fish in Poplar Creek posed a health risk, as well as bass from the Clinch River below Melton Hill Dam. Furthermore, the risk assessment determined that contaminants in deep-water sediments would only present a health risk if they were dredged; no exposure pathway currently exists to the deep-water sediments (Jacobs EM Team 1997b).

In September 1997, DOE issued a Record of Decision for the Clinch River/Poplar Creek operable unit. EPA and TDEC—supportive agencies for this response action—agree with the remedial actions selected for this operable unit. The chosen actions, which comply with federal and state requirements, were undertaken to protect human health and the environment in the present and future. The following remedial actions were selected for the operable unit:

- Yearly monitoring to assess fluctuations in concentration levels and contaminant dispersion.
- Fish consumption advisories.
- Surveys to gauge the usefulness of the fish advisories.
- Institutional controls to restrict activities that could unsettle the sediment (Jacobs EM Team 1997b; SAIC 2002; U.S. DOE 2001a).

These institutional controls are developed under an interagency agreement established in February 1991 by DOE, EPA, TVA, TDEC, and the U.S. Army Corps of Engineers (USACE). The interagency agreement allows these agencies to work cooperatively through the Watts Bar

Interagency Agreement to review permitting and other activities that could result in disturbing the sediment (for example, building a dock or erecting a pier) (ATSDR 1996; Jacobs EM Team 1997b; U.S. DOE 2003a). For more details see pages 3 to 12 of the Clinch River/Poplar Creek Record of Decision at http://www.epa.gov/superfund/sites/rods/fulltext/r0497075.pdf. For additional information on institutional controls to prevent sediment-disturbing activities, see *Rules of the Tennessee Department of Environment and Conservation, Chapter 1200-4-7, Aquatic Resource Alteration Permit Process; Section 26A of the Tennessee Valley Authority Act of 1933; and Section 10 of the Rivers and Harbors Act of 1910 (U.S.A.C.E.)* (Jacobs EM Team 1997b).

In February 1998 a Remedial Action Report was approved. This report recommended that monitoring be conducted for surface water, fish, sediment, and turtles in the Clinch River/Poplar Creek operable unit (ATSDR and ORRHES 2000). Since this time, annual surface water sampling, sediment monitoring, and fish and turtle sampling have been conducted at the Clinch River/Poplar Creek operable unit (SAIC 2002; U.S. DOE 2001a). Institutional controls examine activities that could result in movement of the sediments, and the Tennessee Wildlife Resources Agency (TWRA) prints fish consumption advisories in its *Tennessee Fish Regulations* (SAIC 2002).

II.C.3. Lower Watts Bar Reservoir

The Lower Watts Bar Reservoir operable unit is downstream of the ORR, extending from the confluence of the Clinch and Tennessee Rivers to the Watts Bar Dam (ATSDR 1996). All surface water and sediment released from the ORR enters the Lower Watts Bar Reservoir operable unit (SAIC 2002; U.S. DOE 2001a, 2003c). In 1995, a remedial investigation/feasibility study was conducted to assess the level of contamination in the Watts Bar Reservoir, to create a baseline risk analysis based on the contaminant levels, and to determine whether remedial action was necessary (ATSDR and ORRHES 2000). The remedial investigation/feasibility study revealed that discharges of radioactive, inorganic, and organic pollutants from the ORR have contributed to biota, water, and sediment contamination in the Lower Watts Bar Reservoir (ATSDR and ORRHES 2000; SAIC 2002; U.S. DOE 2001a, 2003b). The baseline risk analysis indicated that standards for environmental and human health would not be reached if deep channel sediments with cesium 137 were dredged and placed in a residential area, and if people consumed moderate to high quantities of specific fish that contained increased levels of PCBs (ATSDR and ORRHES 2000; Environmental Sciences Division et al. 1995).

In September 1995, DOE issued a Record of Decision for the Lower Watts Bar Reservoir operable unit. EPA and TDEC, which are support agencies for this response action, agree with the remedial actions selected for this operable unit. The chosen actions were undertaken to protect human health and the environment in the present and future and comply with federal and state requirements. The following contaminants of concern were identified at the operable unit: 1) mercury, arsenic, PCBs, chlordane, and aldrin in fish; 2) mercury, chromium, zinc, and cadmium in dredged sediments and sediments used for growing food products; and 3) manganese through ingestion of surface water (ATSDR and ORRHES 2000; SAIC 2002; U.S. DOE 2001a, 2003b). The greatest threat to public health from the Lower Watts Bar Reservoir is related to the consumption of PCB-contaminated fish (SAIC 2002; U.S. DOE 2001a, 2003b).

The Record of Decision concluded that if the deep sediments were kept in place, then "…these sediments do not pose a risk to human health because no exposure pathway exists" (U.S. DOE 1995).

The remedial activities selected for the Lower Watts Bar Reservoir have included 1) preexisting institutional controls to decrease contact with contaminated sediment, 2) fish consumption advisories printed in the *Tennessee Fish Regulations*; and 3) yearly monitoring of biota, sediment, and surface water (ATSDR and ORRHES 2000; SAIC 2002; U.S. DOE 1995, 2001a, 2003b). The February 1991 interagency agreement established by DOE, EPA, TVA, TDEC, and USACE allows these agencies to work cooperatively through the Watts Bar Interagency Agreement to review permitting and all other activities that could result in disturbing the sediment, such as building a dock or erecting a pier (ATSDR 1996; Jacobs EM Team 1997b; U.S. DOE 2003a). According to the interagency agreement, DOE is required to take action if an institutional control is not effective or if a sediment-disturbing activity could cause harm (Jacobs EM Team 1997b; U.S. DOE 2003a). See pages 3 to 5 of the Lower Watts Bar Reservoir Record of Decision at http://www.epa.gov/superfund/sites/rods/fulltext/r0495249.pdf. For additional information on institutional controls to prevent sediment-disturbing activities, see *Rules of the Tennessee Department of Environment and Conservation, Chapter 1200-4-7, Aquatic Resource Alteration Permit Process; Section 26A of the Tennessee Valley Authority Act of 1933; and Section 10 of the Rivers and Harbors Act of 1910 (U.S.A.C.E.)* (Jacobs EM Team 1997b).

II.D. Land Use and Natural Resources

With its 1942 ORR acquisition, the government reserved a section (about 14,000 acres out of the total of approximately 58,575) for housing, businesses, and support services (ChemRisk 1993b; ORNL 2002). In 1959, that section became the independent city of Oak Ridge. This self-governing area has parks, homes, stores, schools, offices, and industrial areas (ChemRisk 1993b).

The majority of residences in Oak Ridge are located along the northern and eastern borders of the ORR (Bechtel Jacobs Company LLC et al. 1999). Since the 1950s, however, the urban population of Oak Ridge has grown toward the west. As a result of this expansion, the property lines of many homes in the city's western section border the ORR property (ChemRisk 1993b). Apart from these urban sections, areas close to the ORR continue their historically mostly rural character (Bechtel Jacobs Company LLC et al. 1999; ChemRisk 1993b). Indeed, the closest homes to X-10 are near Jones Island, about 2.5 to 3 miles southwest of the main facility (ChemRisk 1993b).

In 2002, the ORR comprised 34,235 acres, which include the three main DOE facilities: Y-12, X-10, and K-25 (ORNL 2002). The majority of the ORR is within the city limits of Oak Ridge. These DOE facilities constitute approximately 30 percent of the reservation. In 1980 the remaining 70 percent was turned into a National Environmental Research Park. This park was created to protect land for environmental education and research and to demonstrate the compatibility between energy technology development and a quality environment (EUWG 1998). Over several decades a large amount of land at the ORR has become fully forested. Sections of this land contain "deep forest" areas that include flora and fauna considered ecologically important, and portions of the reservation are regarded as biologically rich (SAIC 2002).

Today, the entire ORNL site comprises approximately 26,580 acres. The main operations at the ORNL take place on about 4,250 acres, in an area formerly known as the X-10 site. The remaining acreage is divided between the Oak Ridge National Environmental Research Park (21,980 acres) and the Solway Bend area, which is used for environmental monitoring (350 acres) (ORNL et al. 1999).

Historically, forestry and agriculture (beef and dairy cattle) have constituted the primary land use in the area around the reservation. These activities are currently in decline. For several years, milk produced in the area was bottled for local distribution, whereas beef cattle from the area were sold, slaughtered, and nationally distributed. In addition, tobacco, soybeans, corn, and wheat were the primary crops grown in the area. Small game and waterfowl were regularly hunted in the ORR area, and deer are today hunted annually during specific time periods (ChemRisk 1993b). During the annual deer hunts, radiological monitoring is conducted on all deer prior to their release to the hunters. Monitoring is conducted to ensure that none of the animals contain quantities of radionuclides that could cause “significant internal exposure” to the consumer (Teasley 1995).

The southern and western boundaries of the ORR are formed by the Clinch River; Poplar Creek and East Fork Poplar Creek drain the ORR to the north and west (Jacobs EM Team 1997b). White Oak Creek, which travels south along the eastern border of the X-10 site, flows into White Oak Lake, over White Oak Dam, and into the White Oak Creek Embayment before meeting the Clinch River at CRM 20.8 (ChemRisk 1993b, 1999a; TDOH 2000; U.S. DOE 2002a). Ultimately, every surface water system on the reservation drains into the Clinch River (ChemRisk 1993b). The Lower Watts Bar Reservoir is situated downstream of the ORR, extending from the confluence of the Clinch and Tennessee Rivers to the Watts Bar Dam (ATSDR 1996). As a result, the Clinch River and the Lower Watts Bar Reservoir have received contaminants associated with X-10 operations (Jacobs EM Team 1997b; U.S. DOE 1995, 2001a).

The majority of land around the Clinch River and the Lower Watts Bar Reservoir is undeveloped and wooded. Other than activities at the ORR, minimal industrial development has occurred in these surrounding areas, but residential growth has been fairly steady. The public has access to the Clinch River and to the Lower Watts Bar Reservoir, which it uses for recreational purposes such as boating, swimming, fishing, water skiing, and shoreline activities (U.S. DOE 1996d, 2001b, 2003b).

Kingston and Spring City both maintain public water supplies in the vicinity of the Oak Ridge Reservation. The Kingston water supply has two water intakes, but only one of the intakes—located upstream on the Tennessee River in Watts Bar Lake at Tennessee River Mile (TRM) 568.4—would potentially be affected by ORR contaminants (Hutson and Morris 1992; G. Mize, TDEC, Drinking Water Program, personal communication, 2004). Spring City obtains its water from an intake on the Piney River branch of Watts Bar Lake (Hutson and Morris 1992).

Under the authority of the Safe Drinking Water Act, since 1974 the EPA has set health-based standards for substances in drinking water and has specified treatments for providing safe drinking water (U.S. EPA 1999b). The public water supplies for Kingston and Spring City are continually monitored for these regulated substances, which include 15 inorganic contaminants, 51 synthetic and volatile organic contaminants, and four radionuclides. For EPA's monitoring schedules, see http://www.epa.gov/safewater/pws/pdfs/qrg_smonitoringframework.pdf (U.S. EPA 2004a).

According to EPA's Safe Drinking Water Information System, the Kingston and Spring City public water supply systems have not experienced any notable violations (U.S. EPA 2004b). (To access information related to these and other public water supplies, visit EPA's Local Drinking Water Information Web site at http://www.epa.gov/safewater/dwinfo.htm. In addition, in 1996 TDEC's DOE Oversight Division began participating in EPA's Environmental Radiation Ambient Monitoring System. Under this program, TDEC collects finished drinking water samples from the Kingston Water Treatment Plant on a quarterly basis and then submits the samples to EPA for radiological analyses (TDEC 2002, 2003a). TDEC has also conducted filter backwash sludge sampling at Spring City because contaminants from the reservation could potentially move downstream into community drinking water supplies (TDEC 2003b). Additional information on TDEC's participation in the Environmental Radiation Ambient Monitoring System program is provided in Section II.F.3. of this document. To find additional information related to either of these water supplies or additional water supplies in the area, call EPA's Safe Drinking Water Hotline at (800) 426-4791 or visit EPA's Safe Drinking Water Web site at http://www.epa.gov/safewater.

II.E. Demographics

The study area of the PCB PHA consists of the off-site area along Lower East Fork Poplar Creek, Poplar Creek, the Clinch River, and the Tennessee River from the Melton Hill Dam to the Watts Bar Dam (see Figure 10). Parts of four counties and five principal cities fall within this area. Figure 11 and Figure 12 show the population demographics and distribution for the entire PCB study area.

Figure 10. Map of the PCB Study Area

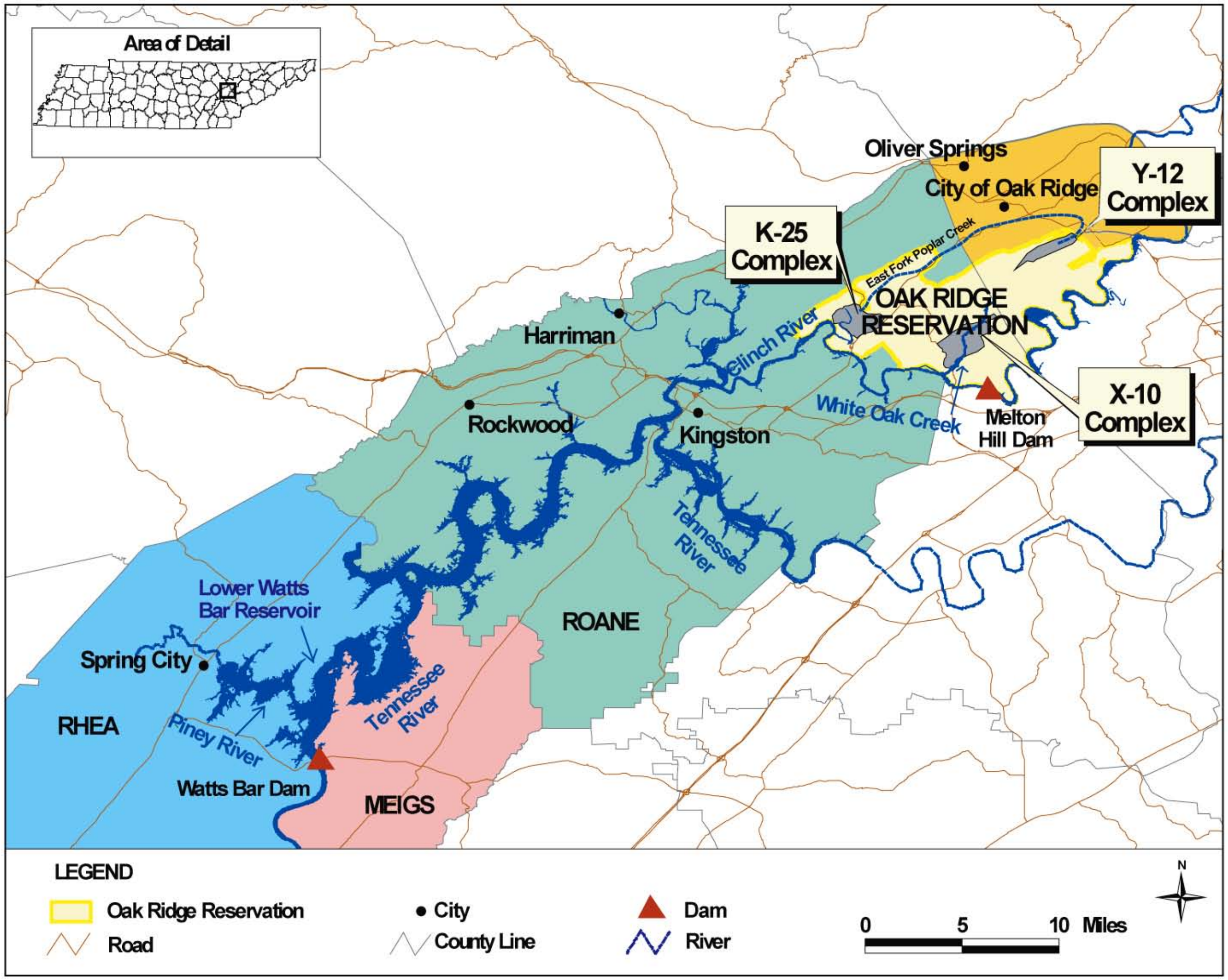
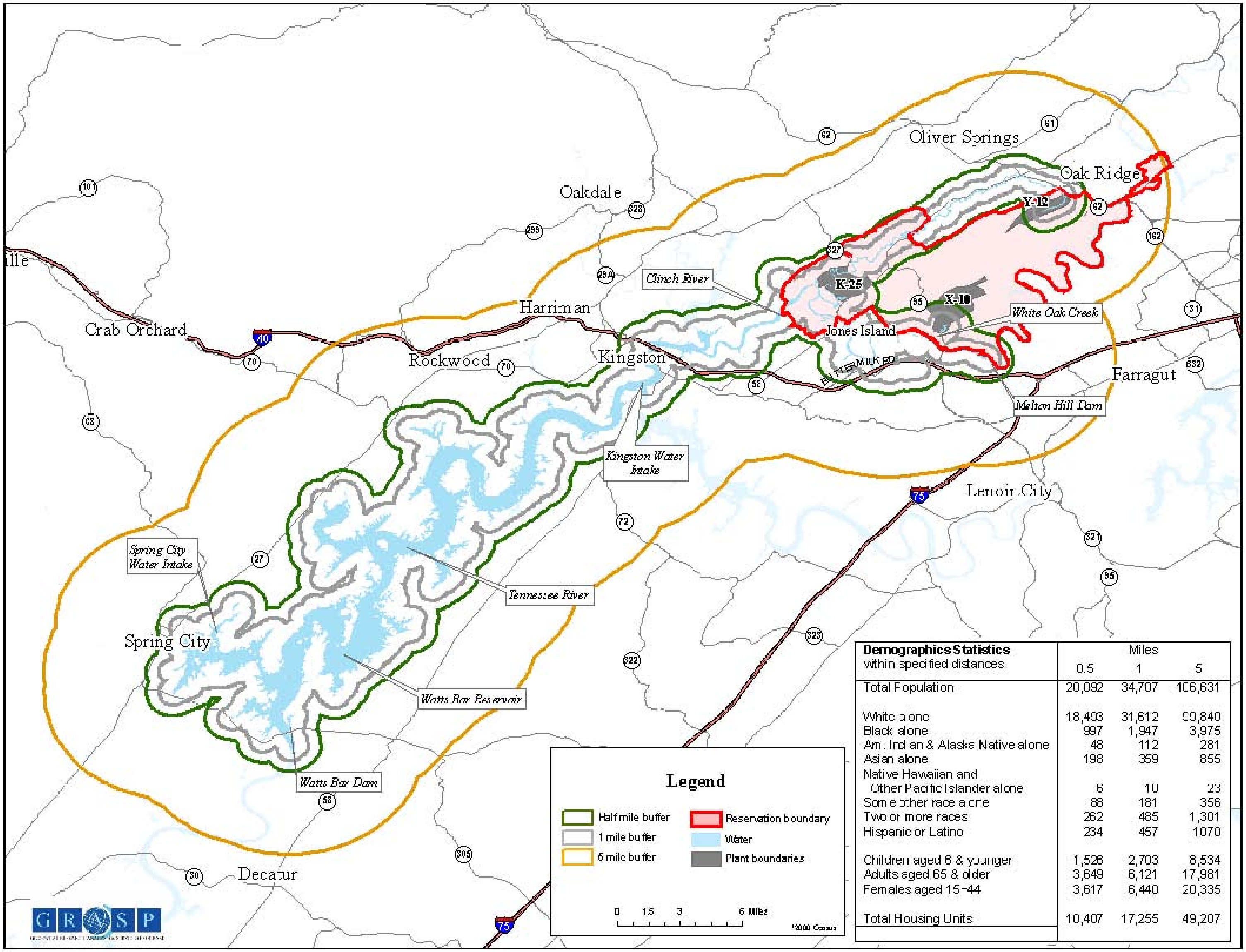
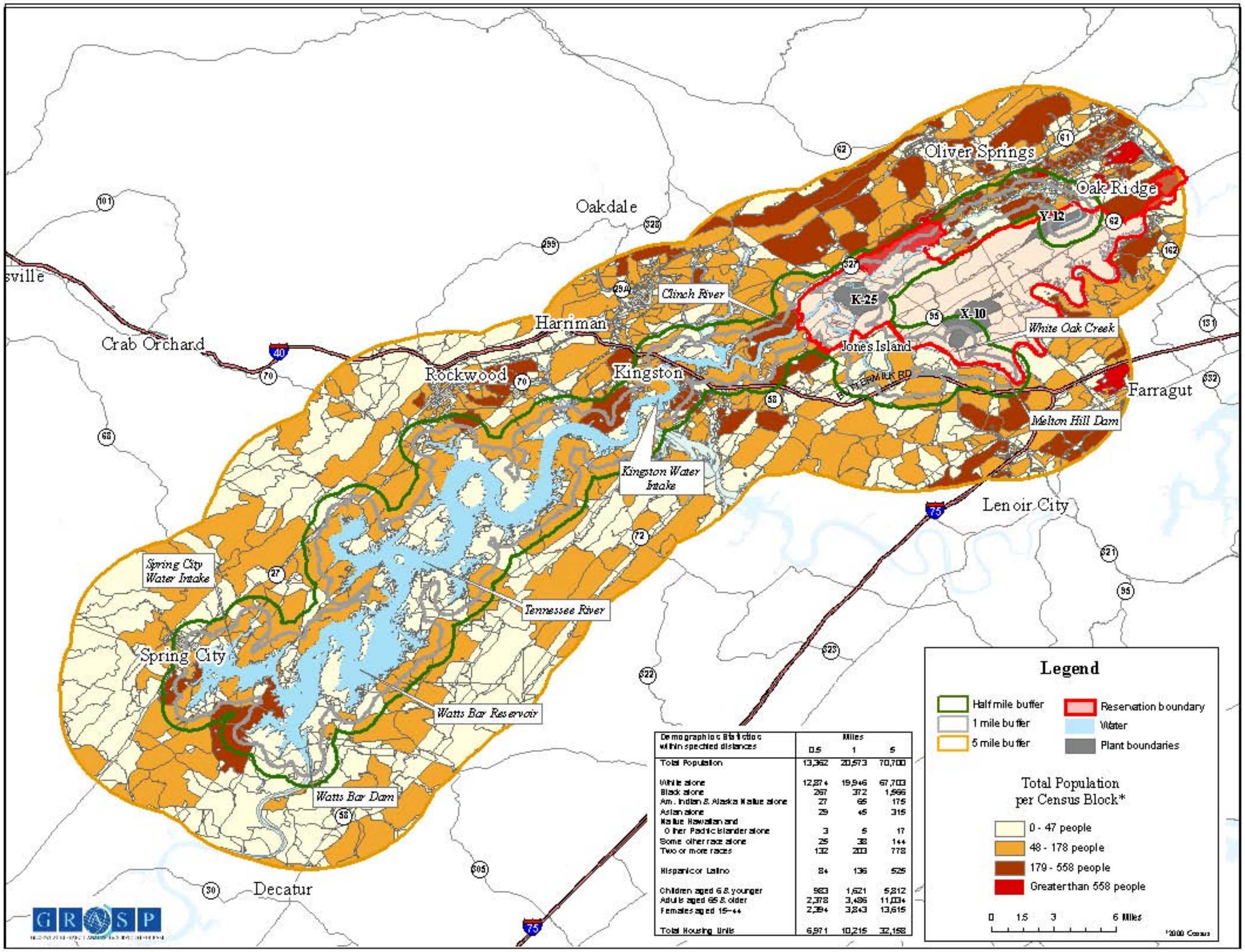


Figure 11. Population Demographics



Demographics Statistics within specified distances	Miles 0.5	1	5
Total Population	20,092	34,707	106,631
White alone	18,493	31,612	99,840
Black alone	997	1,947	3,975
Am. Indian & Alaska Native alone	48	112	281
Asian alone	198	359	855
Native Hawaiian and Other Pacific Islander alone	6	10	23
Some other race alone	88	181	356
Two or more races	262	485	1,301
Hispanic or Latino	234	457	1070
Children aged 6 & younger	1,526	2,703	8,534
Adults aged 65 & older	3,649	6,121	17,981
Females aged 15-44	3,617	6,440	20,335
Total Housing Units	10,407	17,255	49,207

1 **Figure 12. Population Distribution**



Demographic Statistics within specified distances	Miles 0.5	1	5
Total Population	13,362	20,573	70,700
White alone	12,874	19,946	67,703
Black alone	267	372	1,966
Am. Indian & Alaska Native alone	27	65	175
Asian alone	29	45	315
Native Hawaiian and Other Pacific Islander alone	3	5	17
Some other race alone	25	38	144
Two or more races	132	203	778
Hispanic or Latino	84	136	525
Children aged 6 & younger	983	1,621	5,812
Adults aged 65 & older	2,378	3,486	11,034
Females aged 15–44	2,394	3,843	13,615
Total Housing Units	6,971	10,215	32,158

2

II.E.1 Counties within the Study Area

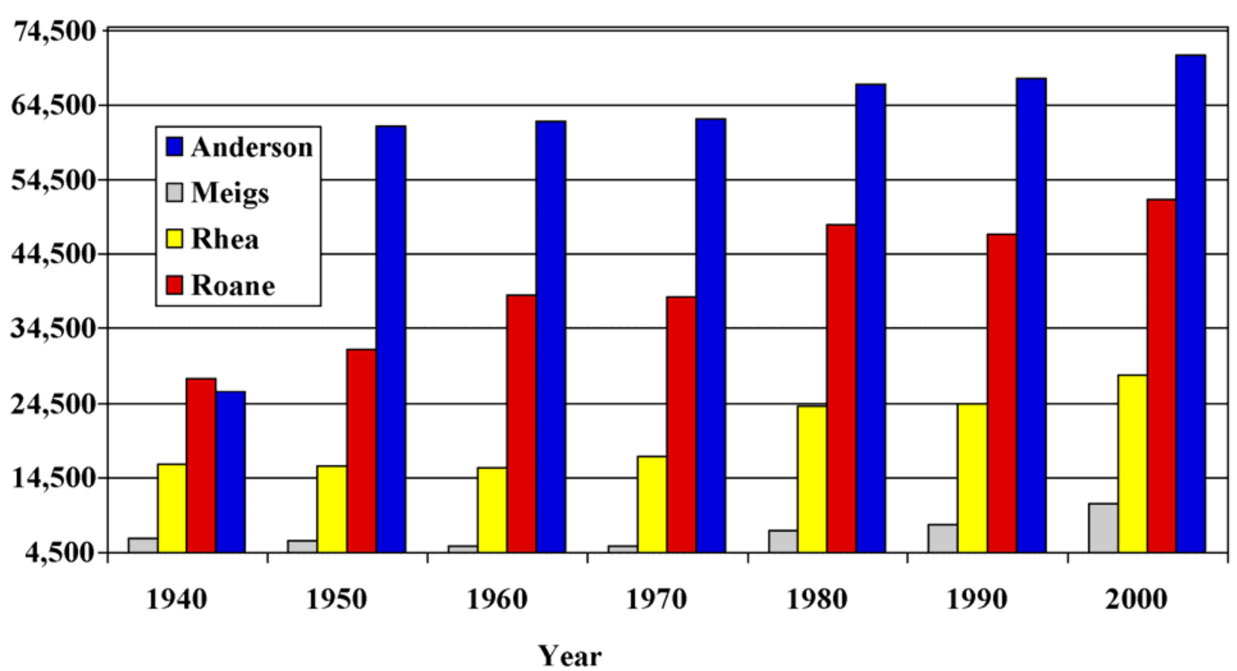
Since 1940, the populations of Anderson, Meigs, Rhea, and Roane Counties have all grown by more than 50 percent (U.S. Census Bureau 1993, 2000). Table 1 shows the population for these counties over 60 years, and Figure 13 shows the population distribution for the counties over time.

Table 1. Populations of Anderson, Meigs, Rhea, and Roane Counties from 1940 to 2000

County	*1940*	*1950*	*1960*	*1970*	*1980*	*1990*	*2000*
Anderson County	26,504	59,407	60,032	60,300	67,346	68,250	71,330
Meigs County	6,393	6,080	5,160	5,219	7,431	8,033	11,086
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

Source: U.S. Census Bureau 1993, 2000

Figure 13. Population Distribution of Anderson, Meigs, Rhea, and Roane Counties from 1940 to 2000



Source: U.S. Census Bureau 1993, 2000

Anderson County

From 1940 to 1950, the population of Anderson County more than doubled from 26,504 to 59,407 as families arrived to build and operate the new Y-12 facilities. After that initial increase, the county grew steadily at the more modest rate of 20 percent over the next 50 years to 71,330 in the year 2000 (U.S. Census Bureau 1993, 2000). Figure 13 shows the pattern of growth. As of 2000, most residents worked in management, professional, and related fields. Anderson County is home to 66,593 Caucasians, 2,766 African Americans, and 828 persons of other races. Most residents are between 40 and 44 years old, with a median age of 39.9 years (U.S. Census Bureau 2000).

Meigs County

Between 1940 and 1960, the population of Meigs County decreased. The population has, however, nearly doubled since then—from 5,160 to 11,086 (46.5 percent) (see Table 1 and Figure 13). The largest percentage increase in population occurred between 1970 and 1980, when the number of residents grew from 5,219 to 7,431 (42.4 percent). Since 1940, the population of Meigs County has grown by almost 60 percent (U.S. Census Bureau 1993, 2000). As of 2000, most residents worked in the manufacturing industry. The Meigs County population comprises 10,826 Caucasians, 138 African-Americans, and 122 persons of other races. Also, most residents are between the ages of 35 and 44 years, and the median age is 36.7 years (U.S. Census Bureau 2000).

Rhea County

Between 1940 and 1960 the population of Rhea County declined but has since the 1960s increased steadily (see Table 1 and Figure 13). The largest increase (40.9 percent) was between 1970 and 1980, when the number of residents went from 17,202 to 24,235. Over the past 60 years, the population of Rhea County has increased by nearly 75 percent (U.S. Census Bureau 1993, 2000). As of 2000, most residents worked in the manufacturing industry. Rhea County has 27,097 Caucasians, 580 African-Americans, and 723 persons of other races. Most residents are between the ages of 35 and 44 years, with a median age of 37.2 years (U.S. Census Bureau 2000).

Roane County

Over this 60-year period, the population of Roane County has grown by 86.8 percent, as shown in Table 1 (U.S. Census Bureau 1993, 2000). The population declined slightly from 1960 to 1970, and between 1980 and 1990 (East Tennessee Development District 1995; U.S. Census Bureau 1993, 2000). The county population grew during the remaining time and reached a population of 51,910 in 2000. Figure 13 shows the population distribution of the county over time (East Tennessee Development District 1995; U.S. Census Bureau 1993, 2000).

Most of Roane County's residents are Caucasian (49,440); the rest are African American (1,409) and other races (1,061) (U.S. Census Bureau 2000). Since the 1970s, the median age of Roane County residents has increased from 32.1 to 40.7 years, suggesting that the county population is aging (East Tennessee Development District 1995; U.S. Census Bureau 1993, 2000). The X-10 site and the K-25 site are both within Roane County (East Tennessee Development District 1995; Jacobs EM Team 1997a). Primarily because of these two facilities, between 1940 and 1990 manufacturing was the predominant occupation for Roane County residents (East Tennessee Development District 1995; U.S. Census Bureau 1993).

II.E.2. Cities within the Study Area

Five principal cities fall within the study areas—part of one city (Oak Ridge) and three other cities (Harriman, Kingston, and Rockwood) are in Roane County, the remainder of Oak Ridge is in Anderson County, and one city (Spring City) is in Rhea County. Table 2 shows the populations of these five cities between 1940 and 2000, and Figure 14 shows the population distribution during that time period.

Table 2. Populations of Spring City, Kingston, Rockwood, Harriman, and Oak Ridge from 1940 to 2000

City	1940	1950	1960	1970	1980	1990	2000
Spring City	1,569	1,725	1,800	1,756	1,951	2,199	2,025
Kingston	880	1,627	2,010	4,142	4,561	4,552	5,264
Rockwood	3,981	4,272	5,345	5,259	5,695	5,348	5,774
Harriman	5,620	6,389	5,931	8,734	8,303	7,119	6,744
Oak Ridge	3,000*	30,229	27,169	28,319	27,662	27,310	27,387

* Combined population on land that was established as Oak Ridge in 1942, with 13,000 initial residents (Convention and Visitors Bureau 2003).
Sources: ChemRisk 1993b; City of Oak Ridge 1989; Convention and Visitors Bureau 2003; U.S. Census Bureau 1940, 1950, 1960, 1970, 1980, 1993, 2000

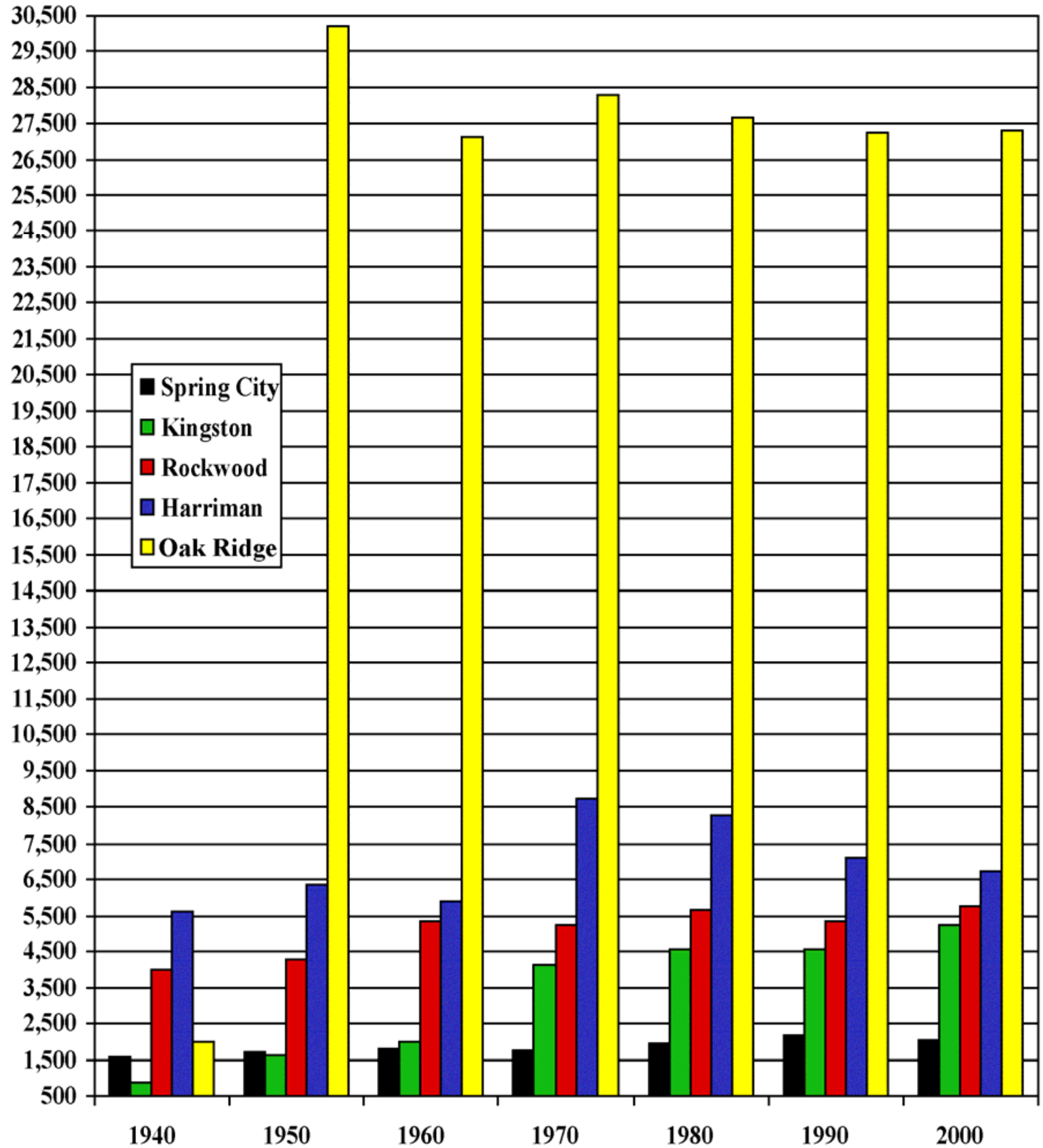
Oak Ridge

In 1942 Oak Ridge was established in Anderson County for the 13,000-strong labor force anticipated at the ORR (Friday and Turner 2001). To present decade-by-decade size comparison for the available census intervals, Table 2 and Figure 14 understate the city's dramatic population growth and its contrast with the growth of its neighbors. By July 1944, the population of Oak Ridge had in fact increased to 50,000. The population peaked at 75,000 in 1945, decreased to 30,229 by 1950, and to 27,169 by 1960, but remained relatively stable thereafter (see Table 2 and Figure 14) (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 the largest population center in eastern Tennessee (ChemRisk 1993b).

Spring City

Spring City is approximately 49 miles southwest of the X-10 site (see Figure 10) (MapQuest 2003). Between 1940 and 2000, the population of Spring City continually fluctuated, as shown in Table 2 and Figure 14. During this time, the number of residents increased between 1940 and 1960 and between 1970 and 1990. The population declined from 1960 to 1970, and from 1990 to 2000. The largest percentage increase in population was seen between 1980 and 1990, followed by the largest decrease between 1990 and 2000 (U.S. Census Bureau 1940, 1950, 1960, 1970, 1980, 1993, 2000). As of 2000, the largest percentage (31.6 percent) of residents worked in the manufacturing industry. The population consists of 1,914 Caucasians, 91 African Americans, and 20 persons of other races. The highest percentage of the population is between the ages of 35 and 44 years, and the city's median age is 44 years (U.S. Census Bureau 2000).

Figure 14. Population Distribution of Spring City, Kingston, Rockwood, Harriman, and Oak Ridge from 1940 to 2000



Population for Oak Ridge in 1940 is the combined population on land that was established as Oak Ridge in 1942 with 13,000 initial residents (Convention and Visitors Bureau 2003).
Sources: ChemRisk 1993b; City of Oak Ridge 1989; Convention and Visitors Bureau 2003; U.S. Census Bureau 1940, 1950, 1960, 1970, 1980, 1993, 2000

Kingston

The city of Kingston is located at the confluence of the Clinch River and the Tennessee River (see Figure 10), and is about 22 miles southwest of the X-10 site (MapQuest 2003). As shown in Table 2 and Figure 14, the population of Kingston has grown steadily from 1940 to 2000, except for a 0.2 percent decrease between 1980 and 1990 (East Tennessee Development District 1995, U.S. Census Bureau 1993, 2000). In 1969, the city of Kingston had one manufacturing plant; by 1990, 6 of the 35 manufacturing plants in Roane County were in Kingston (East Tennessee Development District 1995). Since 1990, the greater number of residents has been employed in the professional services field (East Tennessee Development District 1995; U.S. Census Bureau 2000). In 2000, the population consisted of 4,935 Caucasians, 187 African Americans, and 142 persons of other races. The majority of Kingston residents are between the ages of 45 and 54 years; the median age is 41.6 years (U.S. Census Bureau 2000).

Rockwood

The city of Rockwood is about 33 miles southwest of the X-10 site (see Figure 10) (MapQuest 2003). As Table 2 and Figure 14 show, the population of Rockwood fluctuated from 1940 to 2000. The city experienced steady growth between 1940 and 2000, except for slight declines that occurred between 1960 and 1970, and between 1980 and 1990 (East Tennessee Development District 1995; U.S. Census Bureau 1993, 2000). In 1969, 10 out of 29 manufacturing plants in Roane County were in Rockwood. By 1990, Rockwood had 13 out of the 35 manufacturing plants in the county (East Tennessee Development District 1995). The largest percentage of residents is employed in the manufacturing field. As of 2000, the Rockwood population consisted of 5,362 Caucasians, 314 African Americans, and 98 persons of other races. The median age is 42 years, and the greatest portion of individuals is between the ages of 45 and 54 years (U.S. Census Bureau 2000).

Harriman

The city of Harriman is about 24 miles west of the X-10 site (see Figure 10) (MapQuest 2003). As Table 2 and Figure 14 show, the population of Harriman peaked between 1970 and 1980 and has continued to decline since that time (East Tennessee Development District 1995; U.S. Census Bureau 1993, 2000). In 1969, 18 of the 29 manufacturing plants in Roane County were located in the city of Harriman. By 1990, Roane County had 35 manufacturing plants, but the number in Harriman had fallen to 15 (East Tennessee Development District 1995). Still, as of 2000, manufacturing remains the leading source of employment for Harriman residents. In 2000, the population consisted of 6,077 Caucasians, 501 African Americans, and 166 persons of other races. Most residents are between the ages of 45 and 54 years, with the median age of 40.5 years (U.S. Census Bureau 2000). As of 1990, Harriman had more minority residents than any other city in Roane County (East Tennessee Development District 1995).

II.F. Summary of Public Health Activities Pertaining to PCB Releases

This section describes the public health activities that pertain to PCB releases to the Clinch River, East Fork Poplar Creek, and White Oak Creek, and thence to the Watts Bar Reservoir from the Y-12, K-25, and X-10 sites. ATSDR, the Tennessee Department of Health (TDOH), and other agencies have conducted additional public health activities at the ORR, which are described in Appendix B. Summary of Other Public Health Activities.

II.F.1. ATSDR

Since 1992, ATSDR has worked extensively to determine whether levels of environmental contamination at and near the ORR present a public health hazard to nearby communities. During this time, ATSDR identified and evaluated several public health issues and has worked closely with community members, physicians, and several federal, state, and local health and environmental agencies. While TDOH conducted the Oak Ridge Health Studies to estimate whether off-site populations could have experienced exposures in the *past,* to avoid duplication of the state's efforts ATSDR's activities have focused on *current* public health issues. The following paragraphs highlight major public health activities conducted by ATSDR health scientists and health educators to address current public health issues that pertain to PCB releases into the East Fork Poplar Creek, Clinch River, and the Watt Bar Reservoir.

Public Health Consultation on the Y-12 Weapons Plant Chemical Releases Into East Fork Poplar Creek, Oak Ridge, Tennessee, April 1993. This health consultation provided DOE with advice on current public health issues related to past and present chemical releases into the creek from the Y-12 plant. Before finalizing its remedial investigation on East Fork Poplar Creek, DOE implemented many of ATSDR's recommendations. The East Fork Poplar Creek Phase I data evaluated for this health consultation indicate that the creek's soil, sediment, groundwater, surface water, air, and fish are contaminated with various chemicals. Consequently, ATSDR drew the following public health conclusions.

- Soil and sediments in certain locations along the East Fork Poplar Creek floodplain are contaminated with levels of mercury that might be sufficient to affect human health.
- Fish in the creek contain levels of mercury and PCBs that could pose a moderately increased risk of adverse health effects to people—if they eat fish frequently over long periods of time.
- Shallow groundwater in a few areas along the East Fork Poplar Creek floodplain contains metals at levels that might be sufficient to affect people's health if they drink the water; the groundwater in this area is, however, too shallow to support productive drinking water wells.

Other contaminants found in soil, sediment, surface water, and fish were not detected at levels that could make people ill. In summary, among other recommendations, ATSDR advised continuation of the East Fork Poplar Creek fish advisory with posting of signs, especially at the confluence of Poplar Creek. This public health consultation can be accessed at http://www.atsdr.cdc.gov/HAC/PHA/efork1/y12_toc.html. A brief summarizing the health consultation is provided in Appendix F. Summary Briefs and Fact Sheets.

Health Consultation on the Lower Watts Bar Reservoir, February 1996. In March 1995, DOE proposed a plan to address contaminants in the Lower Watts Bar Reservoir. Local residents requested that ATSDR assess the health hazards associated with contaminants in the Lower Watts Bar Reservoir. In response, ATSDR conducted a health consultation.

ATSDR reviewed environmental sampling data from the 1980s and 1990s compiled by DOE, TVA, their consultants, and TVA's 1993 and 1994 Annual Radiological Environmental Reports for the Watts Bar nuclear plant. ATSDR screened the data for contaminant levels that exceeded health-based comparison values.

During the public health assessment process, ATSDR uses comparison values as conservative screening tools.

ATSDR found that PCBs in the Lower Watts Bar Reservoir—if they accumulated in the body in large amounts—could present a risk of illness. Using conservative risk modeling, the agency estimated that frequent and long-term consumption of reservoir fish, if high levels entered and remained in the bodies of the consumers, could moderately increase a person's risk of cancer. In addition, ATSDR concluded that mothers who regularly consumed these fish while nursing or during pregnancy and acquired large quantities of the PCBs in their bodies might increase the risk of having a child with developmental anomalies (ATSDR and ORRHES 2000). For more specific details on the findings of ATSDR's health consultation, the document itself, located at http://www.atsdr.cdc.gov/HAC/PHA/efork3/hc_toc.html. A brief summarizing the health consultation is provided in Appendix F. Summary Briefs and Fact Sheets.

ATSDR determined that current contaminant levels in the reservoir sediment and in surface water were not a public health concern. The reservoir was safe for recreational activities such as skiing, swimming, and boating; the municipal water was also safe to drink. Further, ATSDR concluded that DOE's chosen remedial actions were protective of public health. These actions included

- ongoing environmental monitoring,
- continuing fish consumption advisories,
- offering community and physician education concerning PCB contamination, and
- applying institutional controls to prevent resuspension, removal, disruption, or disposal of contaminated sediment (ATSDR and ORRHES 2000).

Given these findings, and because the level of PCB contamination in the bodies of people who already had consumed large amounts of fish or turtles was not known, ATSDR made the following recommendations:

- To minimize PCB exposure, the Lower Watts Bar Reservoir fish advisory should remain in effect.
- ATSDR and the state of Tennessee should implement a community health education program regarding the Lower Watts Bar Reservoir fish advisory and the potential health effects of PCB exposure.

- Evaluate the likelihood of health effects from consumption of turtles in the Lower Watts Bar Reservoir. The evaluation should investigate turtle consumption patterns and PCB levels in edible portions of turtles.
- Do not disturb, remove, or dispose of surface and subsurface sediments.
- Continue sampling of municipal drinking water at regular intervals. In addition, if a significant release of contaminants from the ORR is discharged into the Clinch River at any time, DOE should notify the municipal water systems and should monitor surface water intakes.

Community and Physician Education on PCBs in Fish, September 1996. As a follow up to the recommendations in the Lower Watts Bar Reservoir Health Consultation, ATSDR created a program to educate the community and its physicians on PCBs in Watts Bar Reservoir fish. On September 11, 1996, Daniel Hryhorczuk, MD, MPH, ABMT, from the Great Lakes Center at the University of Illinois at Chicago, spoke on health risks related to the consumption of PCBs in fish. Dr. Hryhorczuk made his presentation to about 40 area residents at the community health education meeting in Spring City, Tennessee. In addition, on September 12, 1996, an educational meeting for health care providers in the Watts Bar Reservoir area was held at the Methodist Medical Center in Oak Ridge, Tennessee. Furthermore, ATSDR collaborated with local residents, associations, and state officials to create a brochure informing the public about TDEC's fish consumption advisories for the Watts Bar Reservoir (ATSDR and ORRHES 2000).

Watts Bar Reservoir Exposure Investigation, March 1998. Before this exposure investigation, studies on the Watts Bar Reservoir and on the Clinch River reviewed several contaminants, but the only one suspected to be capable of causing illness was PCBs in Watts Bar Reservoir fish. These studies include DOE's 1994 remedial investigation on the Lower Watts Bar Reservoir and on the Clinch River/Poplar Creek (Jacobs Engineering Group Inc 1996), as well as ATSDR's 1993 Public Health Consultation on the Y-12 Weapons Plant Chemical Releases into East Fork Poplar Creek (ATSDR 1993) and its 1996 Health Consultation on the Lower Watts Bar Reservoir (ATSDR 1996). The studies based their findings on estimated PCB exposure doses and conservatively modeled increases of cancer likelihood after consuming large amounts of fish over extended time periods, assuming all the fish contamination was taken up and remained in the bodies of the consumers. ATSDR conducted this exposure investigation because of the uncertainties associated with estimating exposure doses and with estimating increases in cancer likelihood from ingestion of reservoir fish and turtles. In addition, these past investigations did not confirm that people were actually being exposed or that sufficient amounts of the chemicals had accumulated in their bodies to result in elevated blood levels. Also, a TDOH contractor suggested conducting an extensive region-wide evaluation to assess the relevant exposures and health effects in counties surrounding the Watts Bar Reservoir. ATSDR believed, however, that before any agency conducted extensive investigations, it should determine whether mercury and PCBs were elevated in individuals who consumed large amounts of fish and turtles from the reservoir.

> Exposure investigations are one of the tools ATSDR uses to develop a better characterization of past, present, or possible future human exposure to hazardous substances in the environment. These investigations only evaluate exposure—they do not assess whether exposure levels result in adverse health effects.

The exposure investigation evaluated exposures at one time point. Historical exposures were estimated from these modern results by looking at changes in PCBs as they were deposited in river sediments over time. ATSDR focused its evaluation on those who consumed moderate to high amounts of fish and turtles from the Watts Bar Reservoir. Participants were recruited through newspaper, radio, and television announcements, as well as through posters and flyers placed at various fishing-related locations (e.g., bait shops). ATSDR interviewed more than 550 volunteers, 116 of whom ate enough fish or turtles for inclusion in the investigation. These 116 participants supplied a high-end estimate of exposure doses resulting from fish consumption.

The results of this investigation were released via a mailing and a public forum. Participants' serum PCB and blood mercury levels turned out to be similar to those in the general population. A brief summary of the exposure investigation is provided in Appendix F. Summary Briefs and Fact Sheets. The major findings are (ATSDR and ORREHS 2000; ORHASP 1999)

- The investigation participants' serum PCB levels and blood mercury levels were very close to levels seen in the general population.
- Of the 116 people tested, only five (4 percent) had serum PCB levels above 20 micrograms per liter (μg/L) or parts per billion (ppb)—the level regarded as elevated for total serum PCBs. Four of the five participants who exceeded 20 μg/L had levels between 20 and 30 μg/L. The remaining participant, who spent 2 months of each year in Tennessee and 10 months of each year in Florida, had a serum PCB level that measured 103.8 μg/L, which is above the distribution the agency observed in the population in the Tennessee Watts Bar Reservoir area or in the U.S. population in general. Follow-up counseling was given to study participants with elevated PCB blood levels. Through this counseling, researchers were able to investigate other potential past exposure routes and to recommend behaviors that could reduce future exposure. It should be noted that, although these five participants were 4 percent of the highest Watts Bar Reservoir fish consumers, they were less than 1 percent of those surveyed for fish consumption (i.e., 550 volunteers interviewed).
- One investigation participant (1 percent of the highest fish consumers and 0.2 percent of those surveyed for fish consumption) had a total blood mercury level above 10 μg/L, which is regarded as elevated. The other participants had mercury blood levels below 10 μg/L, which is likely in the general population. Follow-up counseling was also given to this person.

Coordination with Other Parties and Establishment of the ORR Public Health Working Group and the Oak Ridge Reservation Health Effects Subcommittee (ORRHES). Since 1992, ATSDR has consulted regularly with representatives of other parties involved with the ORR. In 1998, under a collaborative effort with the DOE Office of Health Studies, ATSDR and the Centers for Disease Control and Prevention (CDC) developed credible, coherent, and coordinated agendas for public health activities and health studies at each DOE site. ATSDR coordinated its efforts with TDOH, TDEC, the National Center for Environmental Health (NCEH), the National Institute for Occupational Safety and Health (NIOSH), the Health Resources Services Administration (HRSA), and DOE. In February 1999,ATSDR became the lead agency to improve communication between the group and ORR. In cooperation with other agencies and to gather input from local organizations and individuals about creation of a public health forum, in 1999 ATSDR established the ORR Public Health Working Group. After consideration of community input, ATSDR and CDC determined that establishing the ORRHES was the most effective way to meet the community's needs. Also, ATSDR provided some assistance to TDOH in its study of past public health issues (ATSDR and ORREHS 2000).

Oak Ridge Reservation Health Effects Subcommittee. In 1999, ATSDR and CDC, under authority of the Federal Advisory Committee Act (FACA), established the ORRHES 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 with diverse interests, expertise, backgrounds, and communities, as well as liaison members from federal and state agencies. It became a forum for communication and collaboration between the citizens and those agencies that evaluate public health issues and conduct public health activities at the ORR. To help ensure citizen participation, the meetings of the subcommittee's work groups were open to the public; everyone was invited to attend and present their ideas and opinions. The subcommittee

- Served as a citizen advisory group to CDC and ATSDR and made recommendations on matters related to public health activities and research at the ORR.
- Allowed citizens 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 evaluated by ATSDR.

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.

How to Obtain More Information on ATSDR's Activities at Oak Ridge

ATSDR has conducted several additional analyses that are not documented here or in Appendix B, as have other agencies involved with this site. Community members can find more information on ATSDR's past activities by 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 the DOE Information Center, Harriman Public Library, Kingston City Library, Oak Ridge Public Library, Roane State Community College, and the Rockwood Public Library.

2. *Visit the ATSDR Web site.* ATSDR's Oak Ridge Reservation Web site is at http://www.atsdr.cdc.gov/HAC/oakridge. This Web site includes our past publications, schedules of future events, and other materials. 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, 1-888-42ATSDR (1-888-422-8737).

II.F.2. Tennessee Department of Health (TDOH)

Oak Ridge Health Studies. In 1991, DOE and the state of Tennessee entered into the Tennessee Oversight Agreement, which allowed TDOH to undertake a two-phase independent state research project to determine whether past environmental releases from ORR operations could have harmed people who lived nearby (ORHASP 1999). All of the technical reports produced for the TDOH Oak Ridge Health Studies are accessible at http://cedr.lbl.gov.

Phase I. Phase I of the Oak Ridge Health Study is a dose reconstruction feasibility study. This feasibility study evaluated all past releases of hazardous substances and operations at the ORR. The objective was to determine the quantity, quality, and potential uses of the available information and data on these past releases and subsequent exposure pathways. Phase I of the health studies began in May 1992, and was completed in September 1993 (ATSDR and ORREHS 2000). A brief summarizing the Phase I Feasibility Study is provided in Appendix F. Summary Briefs and Fact Sheets.

During the health study process the state reviewed thousands of documents and interviewed knowledgeable parties to assess the possibility of creating a dose reconstruction, and to examine historical releases from the ORR that posed the greatest threat to public health. The state reviewed documents related to the three major facilities (X-10, Y-12, and K-25), the former S-50 site, and for several off-site areas associated with ORR contamination (ChemRisk 1993a, 1993b). In the feasibility study, the state

1. evaluated historical activities at each facility on the ORR,
2. compiled an inventory of environmental sampling and research data for use in dose reconstruction,
3. identified activities with the highest potential to release substantial quantities of contaminants to off-site populations,
4. determined the potential the released contaminants had to affect public health,
5. identified important environmental media and exposure pathways through which off-site populations could be exposed,
6. compiled a list of contaminants to evaluate those that needed further evaluation,
7. examined whether a completed exposure pathway existed, and
8. assessed which pathways contributed significantly to the potential health risks for off-site populations.

Through this extensive process ChemRisk, TDOH's contractor, attempted to identify the contaminants and pathways having greatest likelihood of causing adverse health effects. For information on other activities conducted during the feasibility study, see ChemRisk's 1993 *Oak Ridge Health Studies* (ChemRisk 1993a, 1993b).

The findings of the Phase I Dose Reconstruction Feasibility Study indicated that a significant amount of information was available to reconstruct the past releases and potential off-site exposure doses for four hazardous substances that might have been responsible for adverse health effects. These four substances include 1) radioactive iodine releases associated with radioactive lanthanum processing at X-10 from 1944 through 1956; 2) mercury releases associated with lithium separation and enrichment operations at the Y-12 plant from 1955 through 1963; 3) PCBs in fish from East Fork Poplar Creek, the Clinch River, and the Watts Bar Reservoir; and 4) radionuclides from White Oak Creek associated with various chemical separation activities at X-10 from 1943 through the 1960s (ATSDR and ORREHS 2000).

Phase II (also referred to as the Oak Ridge Dose Reconstruction). Phase II of the health studies conducted at Oak Ridge 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 also included additional detailed screening analyses for releases of uranium and several other toxic materials that had not been fully characterized in Phase I. The significant findings for each of the substances evaluated, as well as the significant findings of the additional screening analyses in the Task 7 report, are summarized here.

- Radioactive iodine releases were associated with radioactive lanthanum processing at X-10 from 1944 through 1956. Results indicate that children who were born in the area in the early 1950s and who drank milk produced by cows or goats living in their yards had the highest theoretical increased risk of developing thyroid cancer. The results suggest that a female born in 1952 at Bradbury, Tennessee, would have the highest risk of developing thyroid cancer from the radioactive iodine releases.
- The study evaluated mercury releases associated with lithium separation and enrichment operations at the Y-12 plant from 1955 through 1963. Results indicate that during the mid-1950s farm families living along East Fork Poplar Creek and children playing in the creek may have received annual average doses of mercury exceeding the EPA reference dose. The results also suggest that fetuses of pregnant women who ate significant quantities of fish from the Clinch River or Poplar Creek in the late 1950s and early 1960s, are at the highest risk from methylmercury exposure.

> EPA defines a reference dose as an "estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime."

- Additional studies were conducted on PCBs in fish from East Fork Poplar Creek, the Clinch River, and the Watts Bar Reservoir. TDOH concluded that persons who consumed large amounts of fish from the Clinch River and the Lower Watts Bar Reservoir were at risk from noncancer effects of PCBs. They also concluded that three or fewer cases of cancer could have resulted from eating Clinch River and Watts Bar Reservoir fish. Because, however, the estimates and modeling are conservative, "the actual risks and expected number of cases are likely to be smaller and could be zero" (ChemRisk 1999a). TDOH also made recommendations for further study to reduce uncertainty. A brief summarizing the PCB dose reconstruction (Task 3) is provided in Appendix F. Summary Briefs and Fact Sheets.
- Radionuclides associated with various chemical separation activities at the X-10 site from 1943 through the 1960s, were released into White Oak Creek. Eight radionuclides

(cesium 137, ruthenium 106, strontium 90, cobalt 60, cerium 144, zirconium 95, niobium 95, and iodine-131) deemed more likely to carry significant risks were studied. The results indicate that the releases caused small increases in the radiation dose over background for individuals who consumed fish from the Clinch River, near the mouth of White Oak Creek. The dose reconstruction scientists estimated that a man who ate up to 130 meals of fish from the mouth of White Oak Creek every year for 50 years (worst-case scenario) had the highest theoretical increase risk of developing cancer. The risk from eating fish declines proportionately for people who eat fewer fish and for people who eat fish caught farther downstream.

- Uranium was released from various large-scale uranium operations, primarily uranium processing and machining operations at the Y-12 plant and uranium enrichment operations at the K-25 and S-50 plants. Because uranium was not initially given high priority as a contaminant of concern, a Level II screening assessment for all uranium releases was performed. Preliminary screening indices for Y-12 and K-25 were below the Oak Ridge Health Agreement Steering Panel (ORHASP) decision guide.
- The *Screening-Level Evaluation of Additional Potential Materials of Concern* was conducted to determine whether contaminants other than those identified in the *Oak Ridge Dose Reconstruction Feasibility Study* warranted further evaluation to assess their potential to cause health effects to off-site populations. Three methods—a qualitative screening, a quantitative screening, and a threshold quantity approach—were used to evaluate the potential for 25 materials or groups of materials to cause off-site health effects. A review of the screening results disclosed that five materials used at the K-25 plant and 14 materials used at the Y-12 plant warranted no further study. Three materials used at the K-25 plant (copper powder, nickel, and technetium 99), three materials used at the Y-12 plant (beryllium compounds, lithium compounds, and technetium 99), and one material used at the ORR (chromium VI) were determined to be potential candidates for further study. High-priority candidates for further study included one material used at the K-25 plant (arsenic) and two materials used at the Y-12 plant (arsenic and lead).
- *The Oak Ridge Health Agreement Steering Panel (ORHASP).* A panel consisting of experts and local citizens was appointed to direct and oversee the Oak Ridge Health Studies and provide liaison with the community. Using the findings of the Oak Ridge Health Studies and what is generally known about the health risks posed by exposures to various toxic chemicals and radioactive substances, ORHASP concluded that "past releases from the Oak Ridge Reservation were likely to have harmed some people." Two groups most likely to have been harmed were 1) local children who drank milk produced by a backyard cow or goat in the early 1950s and 2) fetuses of women who routinely ate fish from contaminated creeks and rivers downstream of the ORR in the 1950s and early 1960s. For additional information on the ORHASP findings, please see the final report of the ORHASP titled *Releases of Contaminants from Oak Ridge Facilities and Risks to Public Health* (ORHASP 1999).

II.F.3. Tennessee Department of Environment and Conservation (TDEC)

Watts Bar Reservoir and Clinch River Turtle Sampling Survey, May 1997. TDEC conducted this survey to assess PCB body burdens in snapping turtles in the Clinch River and in the Watts Bar Reservoir. Fish advisories had been in effect for several years because of PCB contamination, and TDEC was concerned that people who consumed turtles from these water sources might also be exposed to PCBs. TDEC concluded that PCBs and additional contaminants accumulate in turtles from the Clinch River and the Watts Bar Reservoir. Reviewing data used to formulate the fish advisories, TDEC found that the PCB concentrations in turtle tissue were detected at levels such that, if the tissue were consumed by people and the PCBs accumulated in their bodies, it might make them ill. Most PCB contamination was, however, in the fat tissue of the turtles, as is the case in fish. Thus food preparation techniques, particularly tissue selection and draining away fat, can significantly influence the quantities of PCBs consumed with turtle meat (ATSDR and ORREHS 2000). A brief summarizing the turtle sampling is provided in Appendix F. Summary Briefs and Fact Sheets.

Fish Advisories. The fish advisory for East Fork Poplar Creek was originally issued in 1982. The fish advisories for the Tennessee River and the Clinch River were issued a decade later, in 1992 (G. Denton, TDEC, personal communication, February 2005.). In February 2004, the following fish advisories were in place for waterways near the ORR (TDEC 2004). For the advisory, go to http://www.state.tn.us/environment/wpc/publications/advisories.pdf.

- Given the levels of mercury and PCBs for the East Fork of Poplar Creek, including Poplar Creek Embayment, fish taken from these waters should not be eaten and water contact should be avoided.
- For the Tennessee River portion of the Watts Bar Reservoir, a review of PCB levels shows that catfish, striped bass, and hybrid bass (striped bass-white bass) should not be eaten. Children, pregnant women, and nursing mothers should not consume white bass, sauger, carp, smallmouth buffalo, or largemouth bass, but other people can consume one meal per month of these fish.
- For the Clinch River, detected PCB levels indicate that striped bass should not be eaten. Children, pregnant women, and nursing mothers should not consume sauger, carp, smallmouth buffalo, or largemouth bass, but other people can consume one meal per month of these fish.

Sampling of Public Drinking Water Systems in Tennessee. For 30 years, under the Safe Drinking Water Act of 1974 (http://www.epa.gov/OGWDW/sdwa/30th/factsheets/understand.html), EPA has set health-based standards and specified treatments for substances in public drinking water systems. In 1977, EPA gave the state of Tennessee authority to operate its own Public Water System Supervision Program under the Tennessee Safe Drinking Water Act. Through this program, TDEC's Division of Water Supply regulates drinking water at all public water systems. As a program requirement all public water systems in Tennessee individually monitor their water supply for EPA-regulated contaminants and report monitoring results to TDEC. The public water supplies for Kingston, Spring City, and other supplies in Tennessee are monitored for 15 inorganic contaminants, 51 synthetic and volatile organic contaminants, and four radionuclides (EPA 2004a). According to EPA's Safe Drinking Water Information System, the Kingston and Spring City public water supply systems have not had any notable violations (U.S. EPA 2004b). For EPA's monitoring schedules for each contaminant, go to http://www.epa.gov/safewater/pws/pdfs/qrg_smonitoringframework.pdf.

> EPA's Environmental Radiation Ambient Monitoring System program was established to provide radiological monitoring for public water supplies located close to U.S. nuclear facilities.

TDEC submits quarterly the individual water supply data to EPA's Safe Drinking Water Information System (TDEC 2003c). To look up information and sampling results for public water supplies in Tennessee, visit EPA's Local Drinking Water Information Web Site at http://www.epa.gov/safewater/dwinfo/tn.htm.

In addition, in 1996 TDEC's DOE Oversight Division began participation in EPA's Environmental Radiation Ambient Monitoring System. As part of this Oak Ridge program, TDEC collects samples from five facilities on the ORR and in its vicinity. These public water suppliers include the Kingston Water Treatment Plant (TRM 568.4), DOE Water Treatment Plant at K-25 (CRM 14.5), West Knox Utility (CRM 36.6), DOE Water Treatment Plant at Y-12 (CRM 41.6), and Anderson County Utility District (CRM 52.5) (TDEC 2003b). Under the Oak Ridge Environmental Radiation Ambient Monitoring System, TDEC collects finished drinking water samples from the Kingston Water Treatment Plant on a quarterly basis and then submits the samples to EPA for radiological analyses. Please see the TDEC–DOE Oversight Division's annual report to the public at http://www.state.tn.us/environment/doeo/active.shtml for a summary of drinking water sampling results. TDEC has also conducted filter backwash sludge sampling at Spring City—radioactive contaminants from the reservation could potentially move downstream into community drinking water supplies. TDEC analyzed Spring City samples for gross alpha, gross beta, and gross gamma emissions (TDEC 2002, 2003a, 2003b). To find additional information related to either of these water supplies or additional water supplies in the area, please call EPA's Safe Drinking Water Hotline at 800-426-4791 or visit EPA's Safe Drinking Water Web site at http://www.epa.gov/safewater.

II.F.4. U.S. Department of Energy (DOE)

Watts Bar Interagency Agreement, February 1991. DOE, EPA, TVA, TDEC, and USACE comprise the Watts Bar Reservoir Interagency Working Group. This group works collaboratively through the Watts Bar Interagency Agreement, which established guidelines related to any dredging in Watts Bar Reservoir. Through this agreement, these agencies review permitting and all other activities that could possibly disturb the sediment of Watts Bar Reservoir, such as erecting a pier or building a dock (ATSDR 1996; Jacobs EM Team 1997b; U.S. DOE 2003a). The agreement also establishes guidelines for reviewing potential sediment-disturbing activities in the Clinch River below Melton Hill Dam, including Poplar Creek (Jacobs EM Team 1997b). According to the interagency agreement, DOE is required to take action if an institutional control is ineffective or if a sediment-disturbing activity could cause harm (U.S. DOE 2003a).

Permit coordination under the Watts Bar Interagency Agreement was established to allow TVA, USACE, and TDEC (the agencies with permit authority over actions taken in Watts Bar Reservoir) to discuss proposed sediment-disturbing activities with DOE and EPA before conducting the normal permit review process to determine the presence of any DOE contaminants in the sediments. The coordination follows a series of defined processes as outlined in the agreement.

The basic process of obtaining a permit is the same for any organization or individual (Jacobs EM Team 1997b). If dredging is necessary in an area with contaminated sediments, DOE will assume any financial and waste management responsibility over and above the costs that would normally be incurred (Jacobs EM Team 1997b). For more details, please see the Clinch River/Poplar Creek Operable Unit Record of Decision at http://www.epa.gov/superfund/sites/rods/fulltext/r0497075.pdf and the Lower Watts Bar Reservoir Record of Decision at http://www.epa.gov/superfund/sites/rods/fulltext/r0495249.pdf (Jacobs EM Team 1997b; U.S. DOE 1995).

Oak Ridge Environmental Information System (OREIS), April 1999. Over the years an abundance of ORR-related environmental data has accumulated. To process this data DOE created an electronic management system to integrate all of the data into one database. This database now facilitates public and governmental access to ORR environmental operations data, while at the same time maintaining data quality. DOE’s objective was to ensure that the database had long-term retention of the environmental data and provided useful ways 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. Such information includes, but is not limited to, studies of the Clinch River embayment and the Lower Watts Bar Reservoir, as well as annual site summary reports. As new studies are completed, the environmental data are entered as well (ATSDR and ORREHS 2000).

Comprehensive Epidemiologic Data Resource (CEDR). CEDR is a public-use database that contains information pertinent to health-related studies performed at the ORR and other DOE sites. DOE provides this easily accessible, public-use repository of data (without personal identifiers) collected during occupational and environmental health studies of workers at DOE facilities and nearby community residents. This large resource organizes the electronic files of data and documentation collected during these studies and makes them accessible on the Internet at http://cedr.lbl.gov. Most of CEDR’s large data collection pertains to about 50 epidemiological studies of workers at various DOE sites. Of particular interest to Tennessee residents is an additional feature of CEDR (available at http://cedr.lbl.gov/DR/ordr.html) that provides searchable text for about 1,800 original government documents (now declassified) used by the TDOH scientists for the Oak Ridge Dose Reconstruction. Also available through CEDR at http://cedr.lbl.gov are all of the technical and summary reports produced by this study. For the first time, this complex information is easily accessible in a concise, uncluttered, and easily understood manner. In addition, CEDR now provides images in slideshow format that give estimated concentrations, doses, and risk values for three contaminants (iodine, mercury, and uranium) in air at locations studied in TDOH’s Dose Reconstruction.