3.0 DESCRIPTION OF AFFECTED ENVIRONMENT OF THE PROPOSED FRC ALTERNATIVES

This section describes the affected environment of the three alternatives for the proposed action—the ORNL/Y-12 Site, the PNNL/Hanford 100-H Area, and No Action. Each description includes the site location and a summary of the existing environmental conditions on and in the vicinity of the site. Included in this section are descriptions of the existing earth resources; climate and air quality; water resources; ecological resources; archaeological, cultural and historical resources; land use; recreation and visual/aesthetic resources; socioeconomic conditions; waste control; human health; and environmental justice.

3.1 Oak Ridge National Laboratory/Y-12 Site

A proposed host site for the FRC would be the DOE Oak Ridge Reservation (ORR) in East Tennessee. The ORR consists of approximately 34,516 acres (13,968 hectare [ha]) of land and is the site for three major DOE facilities—the Oak Ridge National Laboratory (ORNL), the Y-12 Plant, and the East Tennessee Technology Park (ETTP), formerly known as the K-25 Site. Figure 3-1 shows the general location of the ORR, surrounding counties, and the location of the three major DOE facilities within the Oak Ridge and Knoxville region.

The majority of the ORR falls within the corporate limits of the city of Oak Ridge in Anderson and Roane counties. The Clinch River borders the ORR to the east, south and west, while the residential and commercial portions of the city of Oak Ridge are located to the north of the ORR.

The ORR was placed on the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) National Priorities List in 1989. Remediation efforts at ORR, including individual sites in Bear Creek Valley, are governed by the Federal Facility Agreement (FFA) among DOE, Region IV of the U.S. EPA, and the Tennessee Department of Environment and Conservation (TDEC). Subsequently, the Remedial Investigation/Feasibility Study (RI/FS) for the Bear Creek Watershed has been completed to address contamination associated with former waste disposal activities in Bear Creek Valley. The Record of Decision (ROD) is scheduled to be signed in calendar year 2000. Several CERCLA remedial actions have been identified for implementation in the Bear Creek Valley Watershed. Proposed CERCLA actions that could impact levels of groundwater and soil contamination within the proposed FRC boundaries include but are not limited to the following: hot spot removal and capping of the BY/BY, S-3 Ponds plume tributary interception, and removal of soil and sediment hot spots of contamination within the Bear Creek floodplain.

The proposed FRC contaminated area and background area lie within the Y-12 Plant area of responsibility on the ORR. The Y-12 area of responsibility, including the area located outside the Y-12 perimeter security fence, includes 4,468 acres (1,808 ha). The Y-12 Plant is located in Bear Creek Valley (BCV) adjacent to the city of Oak Ridge. The developed portion of the plant covers an area of 811 acres (328 ha), with some 250 buildings that house about 7 million square feet of laboratory, machining, dismantlement, and research and development areas. The Y-12 Plant is operated by Lockheed Martin Energy Systems, the Management and Operations contractor. Bechtel Jacobs Company, Limited Liability Corporation (BJC) is the Management and Integration contractor responsible for environmental management activities.

The proposed FRC would include a 243-acre (98-ha) previously disturbed contaminated area and a 404-acre (163-ha) background area (Figure 3-1). The contaminated area would be used for conducting experiments on contaminated groundwater and subsurface sediments. The background area would provide for comparison studies in an uncontaminated area.

Initially, test plots of approximately one-half acre, situated in proximity to the S-3 Ponds Site parking lot (Figure 3-2 and Figure 3-3) would be used. As the course of NABIR investigations proceed, other test plots might be used farther down BCV.

The proposed contaminated area and background area would be located in BCV (Figure 3-2 and Figure 3-3). BCV is approximately 10 miles (16 kilometers [km]) long and extends from the eastern end of the Oak Ridge Y-12 Plant to the Clinch River on the west (Figure 3-1). Bear Creek is a tributary to East Fork Poplar Creek, which drains into the Clinch River at ETTP. Except for the extreme eastern end of the contaminated part of the proposed FRC, the area is outside of any security fences, adjacent to public use roads, but protected from unwarranted passersby.

3.1.1 Earth Resources

3.1.1.1 Topography

The ORR lies within the Valley and Ridge Physiographic Province, which is characterized by steep-sided parallel ridges with broad intervening valleys, generally oriented in a northeast-southwest direction. The valleys are generally underlain by softer rocks that are not as resistant to erosion as the rocks beneath the ridges. BCV is bordered by Pine Ridge on the northwest and by Chestnut Ridge on the southeast. Topographic relief from the crest of Pine Ridge to the floor of BCV ranges from 260 to 300 feet (79 to 91 meters [m]); relief from the crest of Chestnut Ridge to the floor of BCV ranges from 280 to 400 feet (85 to 122 m). The average elevation of the ridges is approximately 1,100 feet (335 m) above mean sea level (amsl), with elevation of the floor of BCV ranging from 800 feet (244 m) to 1,000 feet (305 m) amsl.

3.1.1.2 Geology

The western Appalachian Valley and Ridge Province is characterized by northwestward-moving, southeast-dipping imbricate thrust sheets. The Copper Creek and White Oak Mountain fault thrust sheets are traceable through the ORR. Bear Creek Valley is part of the White Oak Mountain fault thrust sheet.

The geological units in the ORR (Hatcher et al. 1992) can be grouped into low permeability shales and higher permeability carbonates (Solomon et al. 1992). On a regional scale, the geology of Bear Creek Valley is limestone- and dolomite-dominated (carbonate) rock groups interbedded with predominantly clastic shale groups. On an outcrop scale, clastic shale beds are interlayered with carbonate beds. The geologic units are parallel to the valleys and ridges.

Bear Creek Valley is underlain by the Rome Formation, the Conasauga Group, and the Knox Group (Figure 3-4). All of these rocks were formed over 500 million years ago. The Rome Formation and the Conasauga Group crop out in BCV on Pine Ridge and dip to the southeast beneath BCV.

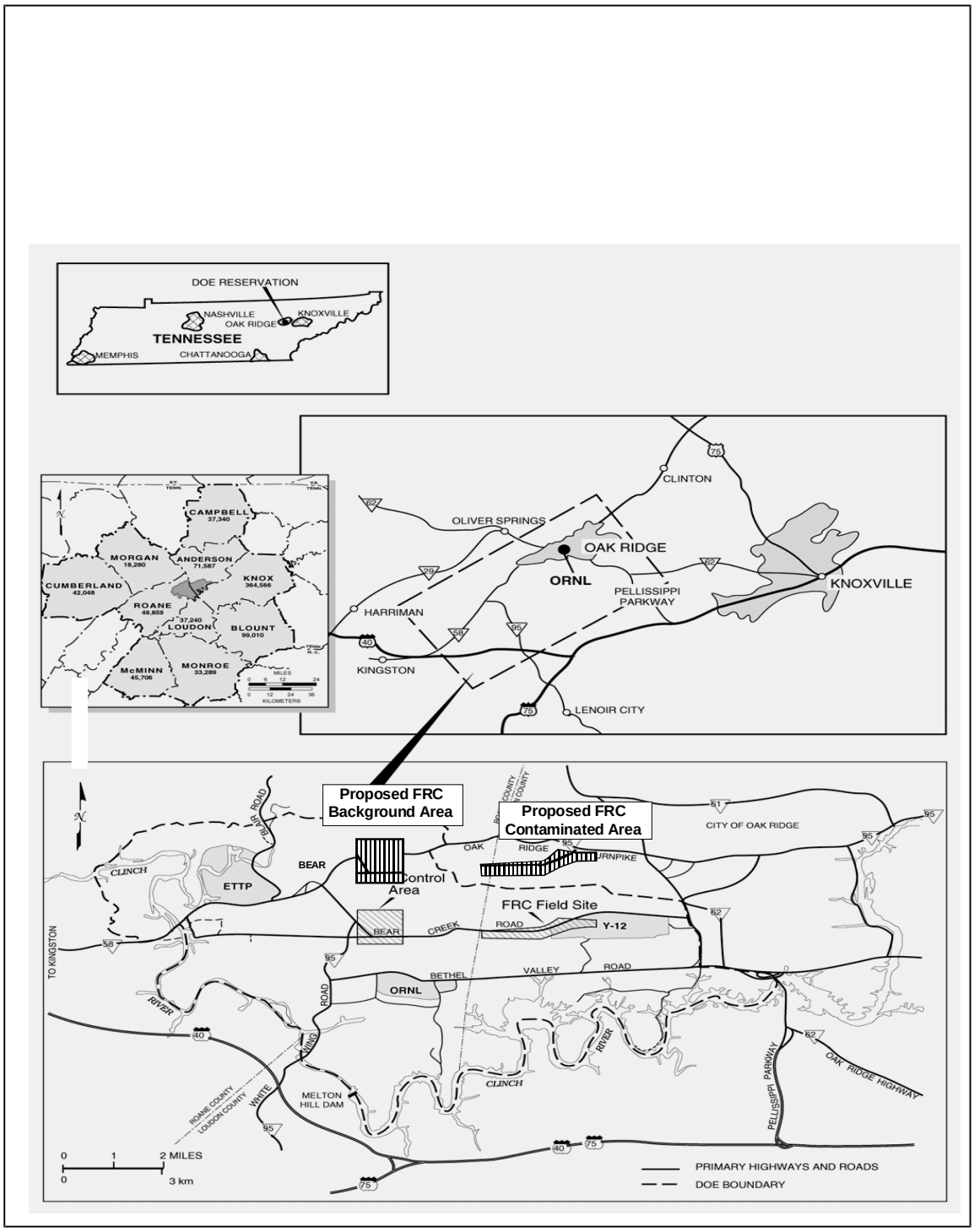


Figure 3-1 Location of Proposed FRC in Oak Ridge, Tennessee

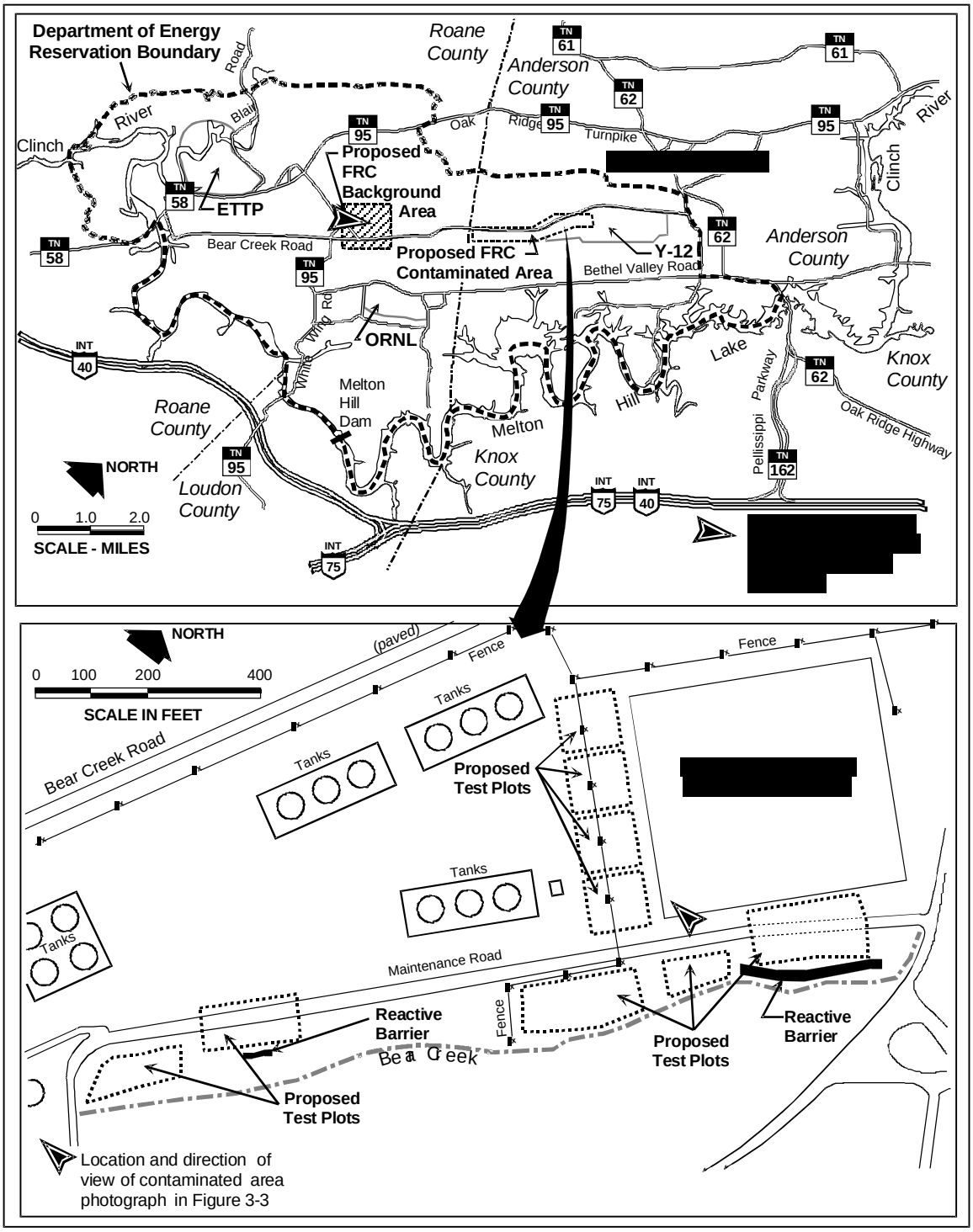


Figure 3-2 Locations of the Background Area, and the initial test plots within the Proposed FRC Contaminated Area

A portion of the Proposed FRC Contaminated Area located adjacent the S-3 Ponds at ORNL/Y-12 Site

A portion of the Proposed FRC Background Area at ORNL/Y-12 Site

Figure 3-3 Photographs of the Proposed FRC Contaminated and Background Areas at ORNL/Y-12 Site

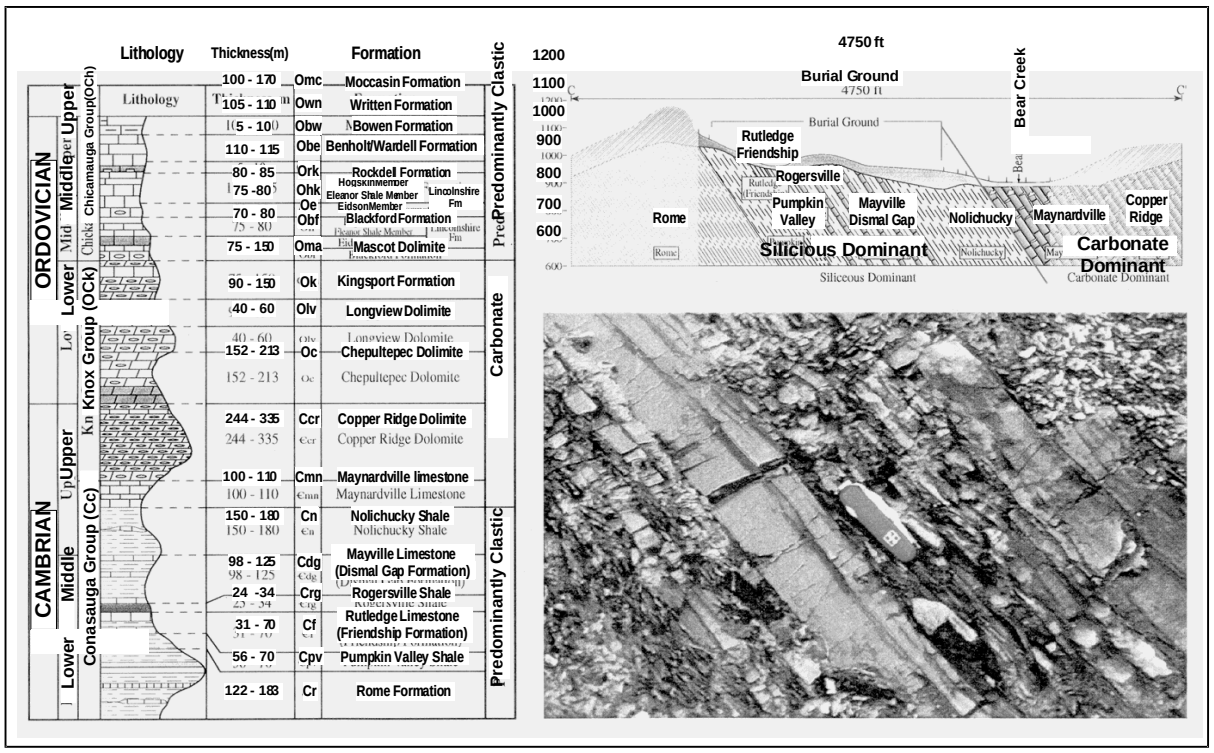


Figure 3-4 Geology of the proposed FRC

With the exception of the Maynardville Limestone, the Conasauga Group is a sequence of fractured shale, siltstone, and thin-bedded limestone. Some formations include laterally continuous limestone beds. High permeability zones parallel to bedding planes may exist, especially where karstification has enlarged fractures.

The Knox Group (i.e., Copper Ridge Dolomite) underlies and forms Chestnut Ridge, the southern boundary of BCV. It is composed of a series of medium- to thick-bedded, massive dolomite. Fracturing and karst formation in the Knox Group have resulted in locally high permeability (Shevenell and Beauchamp 1994). Sinkholes are common, and springs and seeps are common features at the upper and lower geologic contacts.

The primary geologic units that underlie the proposed contaminated area and background area are the Maynardville Limestone (carbonate) and Nolichucky Shale. The Maynardville Limestone, which forms the BCV floor, is a massively bedded limestone and dolomite (carbonate) with fracturing and karstification. The Nolichucky Shale is located just up slope and stratigraphically lower than the Maynardville Limestone.

There may be some geologic hazard associated with rare occurrence of sinkhole development in carbonate rock units in BCV. Hazards related to seismic activity along the faults located in the East Tennessee Valley and Ridge geologic province are relatively minor. There has been no known recent fault activity, although numerous small earthquakes (Richter magnitude of less than 4) occur yearly.

3.1.1.3 Soils and Waste Areas

Overlying the bedrock on the ORR is unconsolidated material that consists of weathered bedrock (referred to as residuum), man-made fill, alluvium, and colluvium. Silty and clayey residuum comprises a majority of the unconsolidated material in this area. The depths to unweathered bedrock differ throughout the ORR because of the different thicknesses of fill and alluvium and the particular weathering characteristics of the bedrock units. The total thickness of these materials typically ranges from 10 to 50 feet (3 to 15 m) (Hoos and Bailey 1986).

The principal waste areas and contaminant sources in BCV— the S-3 Ponds Site, the Oil Landfarm and Boneyard/Burnyard (BY/BY) area, and the Bear Creek Burial Grounds (BCBG)—are located in the upper 2.2 miles (3.5 km) of the valley on the outcrop of the Nolichucky Shale. Solid and liquid waste disposal has caused shallow soil and groundwater contamination. Where dense liquids were disposed of at the S-3 Ponds Site and BCBG, contamination of shallow and deep groundwater in the Nolichucky Shale has occurred.

The following volumes of waste and contaminated soils are estimated to be present in BCV (note that volume estimates for soils and wastes do not include the volumes of the caps themselves):

Location	**Volumes of Waste, Contaminated Soils**
S-3 Ponds Site—capped under RCRA in 1988	1.3 acre feet (1,600 m^3) waste and contaminated soils
Oil Landfarm—capped under RCRA in 1988	20 acre feet (25,000 m^3) waste and contaminated soils
BY/BY—This area has not been capped	73 acre feet (90,000 m^3) waste and contaminated soils
Sanitary Landfill 1—Capped under TDEC requirements in 1983	89 acre feet (110,000 m^3) waste and contaminated soils
BCBG—Capped under RCRA in 1989	150 acre feet (190,000 m^3) waste and contaminated soils

In addition, it is estimated that less than 0.82 acre feet (1,000 cubic meters [m^3]) of soils and waste materials on the BCV floodplain contain low levels of contamination. Contaminants of the soil include uranium, technetium-99 (Tc^{99}), strontium, nitrate, barium, cadmium, boron, volatile organic contaminants (VOCs), and other inorganics and radionuclides. Although the proposed contaminated area is adjacent to most of these waste areas, it actually includes the former S-3 Ponds Site disposal area and portions of the BCV floodplain.

What is a RCRA Cap?

A RCRA Cap is a multi-layered barrier placed on top of a disposal site to control deep percolation of soil moisture in accordance with the requirements of the Resources Conservation and Recovery Act.

However, proposed FRC activities would not include drilling through the S-3 Ponds Site.

3.1.2 Climate and Air Quality

The climate of the region surrounding the Oak Ridge area is broadly classified as humid continental. The Cumberland Mountains to the northwest have a moderating influence on the climate of the area by shielding the region from cold air masses that frequently extend far south over the plains and prairies of the central United States during the winter months. In the summer months, tropical air masses from the south provide warm and humid conditions that often produce thunderstorms; however, anticyclonic circulation around high-pressure systems centered in the western Gulf of Mexico can bring dry air from the southwestern United States into the region, which causes occasional periods of drought.

The annual mean air temperature for the Oak Ridge area is 57.1°F (13.9°C) (1963 through 1992 base period). The coldest month is usually January, with temperatures averaging about 35.6°F (2.0°C), but occasionally falling as low as -17°F (-27°C). July is typically the hottest month of the year, with average temperatures of 76.5°F (24.7°C), but occasionally rising to 105°F (41°C). Diurnal temperature changes are relatively consistent from month to month having a range of 18 to 27°F (10 to 15°C).

Average precipitation in the Oak Ridge area varies from place to place by as much as 30 percent depending on the location relative to local terrain. The 40-year annual average precipitation is 53.75 inches (137 centimeters [cm]), including about 10.4 inches (26 cm) of snowfall. Precipitation in the region is greatest in the winter and spring months (January through April) and least during the fall months (September through November), when high-pressure systems are most frequent.

The Oak Ridge area has relatively light winds compared to other parts of the United States. The Cumberland Mountains and Plateau to the northwest and west, and the local valley-and-ridge topography divert severe storms and minimize air movement and local wind impact. Ridge-top and valley sites in the Oak Ridge area (excluding the Cumberland Plateau) experience wind speeds less than 11.2 miles per hour (5 meters per second [m/s]) over 90 percent of the time, and many valley-bottom sites experience winds less than 4.5 miles per hour (2 m/s) over 70 percent of the time. Prevailing wind directions in the Oak Ridge area are primarily oriented parallel to the direction of the local ridge and valley terrain. Prevailing winds are either up-valley (northeasterly) day-time winds, or down-valley (southwesterly) night-time winds.

Existing air quality at ORR is in attainment with National Ambient Air Quality Standards (NAAQS) for all criteria pollutants (i.e., sulfur dioxide, nitrogen dioxide, inhalable particulate matter, carbon monoxide, ozone, and lead).

The Y-12 Site has permits for radiological and non-radiological air emissions. Radioactive emissions are registered by EPA under NESHAP regulations (40 *CFR* 61, Subpart H). Non-radiological emissions are regulated under the rules of Tennessee Department of Air Pollution Control (ORNL 1998).

3.1.3 Water Resources

3.1.3.1 Surface Water

Bear Creek is the predominant surface water feature of the proposed FRC in BCV. The creek is one of the surface water features of the ORR, which is characterized by a network of small streams that are tributary to the Clinch River. Water levels in the Clinch River are regulated by the Tennessee Valley Authority (TVA), and fluctuations in the river have a localized effect on tributary creeks and streams draining the ORR. Drainage from Y-12 enters both Bear Creek and East Fork Poplar Creek (EFPC); the headwaters of both originate within the Y-12 Area. Bear Creek and EFPC have total drainage areas of 7.4 and 30 square miles (1,900 and 7,700 ha), respectively.

Bear Creek is a relatively small (third-order) spring-fed stream that flows out of the Y-12 Plant and ultimately into the EFPC. Its watershed divide with EFPC crosses the western portion of the plant site near the S-3 Ponds Site, and most of the drainage from the Y-12 facilities flows to the EFPC. In addition to EFPC and Bear Creek, there are numerous streams, springs, and quarries/ponds within the Y-12 Area.

Bear Creek flows west down BCV and then flows north where it empties into EFPC. Little high-density development has occurred within the Bear Creek watershed, but a great deal of clearing and waste control activity has taken place. The drainage pattern of Bear Creek is a good example of trellis (i.e., lattice-like) drainage patterns typical of the Valley and Ridge Province. About 65 percent of the drainage basin is wooded. Although Bear Creek does not drain the main Y-12 site, it does drain the areas used for waste storage and closed waste disposal areas. As mentioned in Section 3.1.1.3, contaminants originating from the waste disposal units, and potentially present in surface water to some extent, include uranium, Tc^{99}, strontium, nitrate, barium, cadmium, boron, VOCs, and other inorganics and radionuclides.

Surface water and spring samples collected during 1997 show that spring discharges and water in upper reaches of Bear Creek contain many of the contaminants found in the groundwater; however, the concentrations in the creek and spring discharges decrease rapidly with distance downstream of the waste disposal sites (ORNL 1998).

3.1.3.2 Floodplain and Wetlands

Bear Creek completely traverses the length of both the proposed contaminated area and the background area, and thus includes the associated section of 100-year floodplain. Neither the FRC field office nor laboratory structures would be located in the floodplain.

Numerous wetlands have been identified in BCV. Most of these are small—from a few square yards up to about 2 acres (0.8 ha)—and are classified as palustrine forested, scrub-shrub, and emergent wetlands (Cowardin et al. 1979). Within the proposed contaminated area, wetlands have been identified at three separate surface springs. These are south of Bear Creek Road and outside the floodplain. Wetlands have also been identified on the seven tributaries that join Bear Creek along its reach within the proposed FRC. Five of these are outside the floodplain, and two of the wetlands lie both within and beyond the Bear Creek floodplain. Downstream of the proposed FRC, including the section of Bear Creek through the background area, wetlands occur within numerous floodplain locations and at higher elevations in several tributaries. Species normally found in these wetlands are

described in the ecological risk assessment in Appendix G of the BCV Remedial Investigation Report (DOE 1997a).

3.1.3.3 Groundwater

The proposed FRC contaminated and background areas are located in the BCV watershed. However, the eastern edge of the FRC boundary is located near a groundwater divide. Groundwater to the east of this divide flows to the east and into the Upper East Fork Poplar Creek (UEFPC) watershed; groundwater to the west of this divide flows to the west and into the BCV watershed. All FRC activities will be conducted west of this divide in the BCV watershed.

Groundwater flow through rocks underlying the proposed FRC in BCV is primarily through fractures and dissolution features (i.e., karst features) in the bedrock. The orientations of well-connected fractures or solution conduits are predominantly parallel to bedding planes (i.e., geological strike.) This results in dominance of strike-parallel groundwater flow paths. Fracture aperture width generally decreases with depth in all formations; thus, active groundwater circulation decreases with depth. Active (or open) fractures occur at greater depths in the carbonate members of the Knox Group and the Maynardville Limestone than in the shale members of the Conasauga Group. Therefore, active groundwater circulation is deeper in these carbonate formations.

Figure 3-5 shows a conceptual model for the movement of groundwater, surface water and

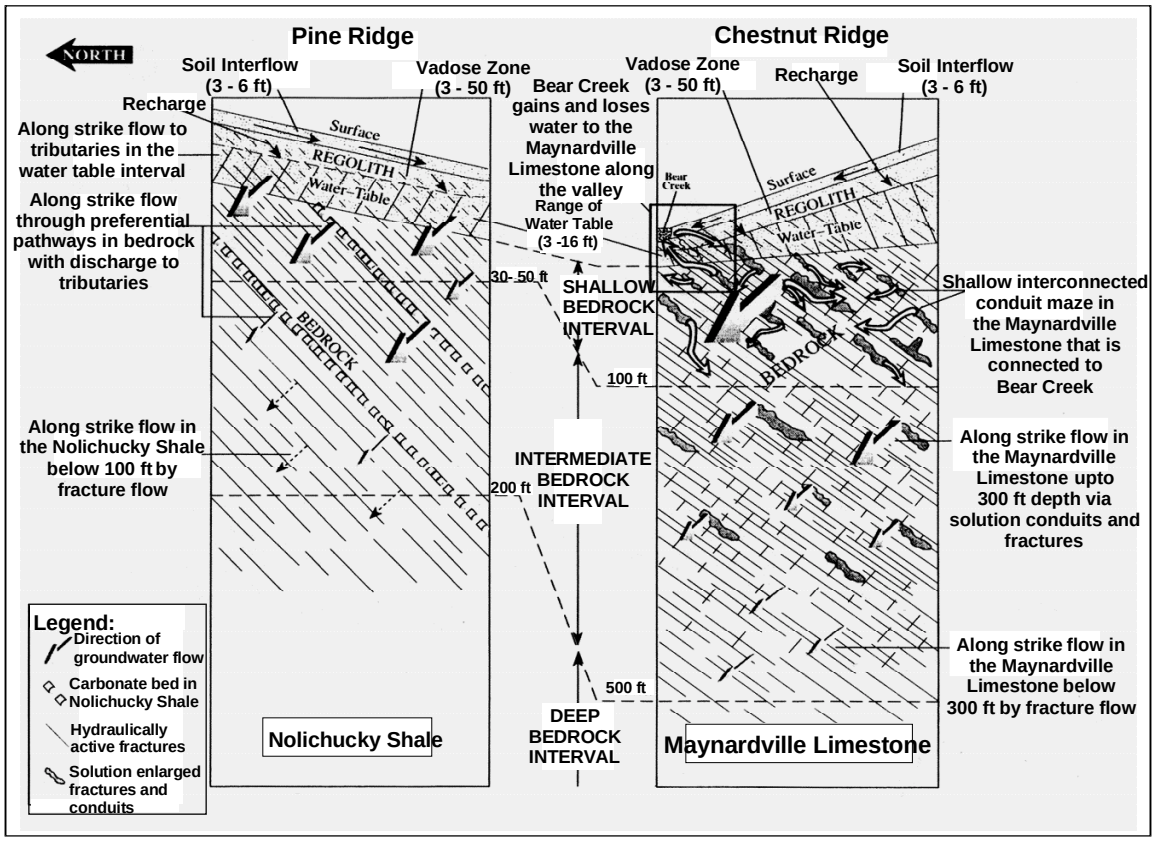


Figure 3-5 Conceptual model for movement of groundwater, surface water, and contaminants

contaminants in BCV (DOE 1997a). The hydrogeology differs significantly between the shale formations (e.g., Nolichucky Shale) and the carbonate formations (e.g., Maynardville Limestone). In BCV, the contact between the Maynardville Limestone and the Nolichucky Shale roughly corresponds to the axis of the valley and marks a major transition from predominantly low hydraulic conductivity shale formations to higher conductivity carbonate formations. Groundwater in the shale formations generally migrates in the direction of the geologic strike (generally from northeast to southeast) until eventually discharging to a tributary of Bear Creek. This surface water can enter the Maynardville groundwater system through losing sections of Bear Creek.

Key features of the shale and carbonate formations are discussed in the following paragraphs, followed by a discussion of groundwater quality in the area of the proposed FRC.

Flow in Predominantly Shale Formations (e.g., Nolichucky Shale)

Although there are no clearly defined abrupt hydrologic and geologic changes in the shale formations with depth, a general hydrologic and geologic stratigraphy can be defined that separates these formations into shallow, intermediate, and deep flow regimes (Figure 3-4). The boundary between shallow and intermediate intervals is defined by a consistent change in groundwater geochemistry at approximately 100-foot (30-m) depth that indicates flow is considerably slower below this depth (Haase 1991; Dreier, Early, and King 1993). The boundary between intermediate and deep intervals is poorly defined and is indicated by a change in groundwater geochemistry that has been observed between about 328- and 492-foot (100 and 150 m) depth (Solomon et al. 1992; Haase 1991; Dreier, Early, and King 1993).

Most flow in the shale formations occurs in the shallow interval. This interval includes the water table interval that usually occurs close to the soil-bedrock interface. Most flow in the shallow interval is probably through higher conductivity zones that may exist at the soil-bedrock interface (Solomon et al. 1992) or through other preferential flow pathways in the bedrock. Flow in the shallow interval is oriented predominantly along geological strike, with discharge occurring at the tributaries to Bear Creek.

In the intermediate interval, geochemistry data indicate greater groundwater residence times; thus, generally slower flow below 100 feet (30 m). However, the distribution of contaminant plumes in BCV indicates that more rapid flow than predicted by major ion geochemistry may in preferential pathways in this interval and may occur up to 200 feet (61 m) in depth. (Nitrate from the S-3 Site has migrated approximately 0.62 miles [1 km] or more since 1950.)

An upward hydraulic gradient occurs almost everywhere in the shale formations that crop out on the southern flank of Pine Ridge. Groundwater in deep formations is hydraulically connected along the bedding planes to recharge areas located up-dip at higher elevations on Pine Ridge. As a result, deeper formations tend to have recharge zones farther up-slope than shallow formations, creating the upward hydraulic gradient.

Flow in Carbonate Formations (e.g., Maynardville Limestone)

The Maynardville Limestone crops out along the southern side of the BCV floor. This formation and Copper Ridge Dolomite act as a hydraulic drain for the valley. Flow in these formations is predominantly along geologic strike and parallel to the maximum hydraulic gradient.

The hydrostratigraphy in the carbonate formations is less well defined than that in the shale formations (Solomon et al. 1992). The shallow interval includes groundwater to approximately 100-

foot (30-m) depth. Flow in this interval occurs through a system of interconnected fractures and solution conduits and cavities and is closely associated with flow in Bear Creek. The channel of Bear Creek is one of the main hydraulic conduits in this system. In this interval, groundwater flow is relatively rapid.

The intermediate interval occurs between approximately 100-foot and 328-foot (30-m and 100-m) depth. Solution cavities and solution-enlarged fractures exist in the Maynardville Limestone in this interval and are probably well connected by other fractures. Because of its depth, this zone is isolated from dilution effects seen in shallower zones. Thus, flow rates are probably slower than those in the shallow interval, but contaminant plumes are more persistent and extend farther along the valley. This zone constitutes an important contaminant transport pathway.

In the deep interval (greater than 328-foot [100-m] depth), flow through fractures dominates groundwater movement, and flow zones become less frequent as fracture density decreases with depth.

Groundwater Quality

The proposed contaminated site includes portions of the commingled plume of groundwater contamination in the Nolichucky Shale and Maynardville Limestone (490 acre feet [600,000 cubic meters] of contaminated groundwater) that originated predominantly from the S-3 Disposal Ponds and the BY/BY. The BCBG is also a source of groundwater contamination and dense nonaqueous phase liquid (DNAPL) in BCV, but the BCBG is not included in the FRC boundary. Contaminants in the commingled S-3 Disposal Ponds and BY/BY plume include uranium, Tc^{99}, strontium, nitrate, barium, cadmium, boron, mercury, chromium, VOCs and other inorganics and radionuclides. The S-3 Disposal Ponds site is a source of all of these contaminants. The BY/BY site has contributed primarily uranium and VOCs. There are 570 acre feet (700,000 m^3) of contaminated groundwater from the S-3 site and 57 acre feet (70,000 m^3) of contaminated groundwater from the BY/BY.

The S-3 Ponds Site and BY/BY are located on top of the Nolichucky Shale, and historical waste discharges have contaminated groundwater beneath the waste sites. Due to the high dissolved solids contents of the liquid wastes disposed at the S-3 Ponds Site, contamination has migrated to depths as great as 200 feet (60 m) in the Nolichucky Shale. The S-3 Ponds Site is located on a groundwater divide so contamination has migrated both to the west and east.

Contaminants migrate away from the waste disposal units through a number of pathways. Contaminated shallow groundwater at sources above the Nolichucky Shale migrates through fractures along geological strike and discharges to tributaries or directly to Bear Creek, causing the tributaries and Bear Creek to become contaminated. Contaminants in deep groundwater in the Nolichucky Shale also migrate through fractures along geologic strike and discharge to tributaries. However, contaminant pathways in the deep groundwater can underflow proximal tributaries and/or springs and be a source of contamination in neighboring tributary subwatersheds.

After entering tributaries, contaminants migrate in surface water directly to Bear Creek. Bear Creek intermittently loses and gains water from groundwater in the Maynardville Limestone throughout the length of the valley. Losing reaches of Bear Creek cause groundwater contamination in the Maynardville Limestone. Gaining reaches of Bear Creek are associated with large springs at the base of Chestnut Ridge, some of which have contaminated discharge.

Surface water in Bear Creek and shallow groundwater in the Maynardville Limestone constitute 96 percent of water flowing along the valley. Contaminants in these media pathways are quickly diluted by rapid recharge of rainwater and inputs from noncontaminated tributaries.

Deep groundwater in the Maynardville Limestone (100- to 300-foot [30 to 90 m] depth) constitutes less than 4 percent of water flowing along the valley. Concentrations of contaminants in this and in the deep groundwater pathway are not attenuated as rapidly as those in shallow groundwater. This pathway is an important source of long distance groundwater transport along the valley.

Contaminant concentrations in shallow groundwater in the Nolichucky Shale and the Maynardville Limestone and in surface water are diluted by recharge during storm events, and show seasonal trends of lower concentrations during periods of high rainfall.

3.1.4 Ecological Resources

The following section identifies and describes the terrestrial, and aquatic resources that occur in BCV and near the proposed contaminated area and background area.

3.1.4.1 Terrestrial Resources

The vegetation of the ORR is primarily second-growth hardwood oak-hickory forest that is mostly distributed on ridges and dry slopes. Virginia and shortleaf pines are also common, particularly in areas that were cleared and farmed before 1942. The ORR provides habitat for a large number of animal species, including about 60 reptilian and amphibian species, more than 152 species of birds (including 32 species of waterfowl, wading birds, and shorebirds), and about 40 mammalian species. Habitats supporting the greatest number of species are those dominated by hardwood forests and wetlands. Wetland areas within the ORR consist mostly of small swampy areas, generally less than 30 feet (9 m) wide, within and around major drainage basins (DOE 1997a).

Bear Creek Valley, the location of the proposed FRC, lies outside the main Y-12 Plant complex close to areas of potential ecological sensitivity. Before 1940, most of BCV was cleared and used for agriculture (Southworth et al. 1992). Currently, about 65 percent of the BCV watershed is wooded, with common vegetation being predominantly oak and oak-hickory associations on the upper slopes and ridgetops and planted pine along the creek and floodplain area (McMaster 1967). Old field and grassland habitat zones are also present. Thus elements of the majority of wildlife habitat types and the expected terrestrial fauna found on the ORR occur in BCV (Welch 1989). Hardwood and mixed hardwood/conifer habitats are the most abundant of the habitat types in the Bear Creek watershed, followed by pine plantation and grassland habitats, with considerable riparian habitat along the length of Bear Creek. Species commonly found in these habitats are described in the ecological risk assessment in Appendix G of the BCV Remedial Investigation Report (DOE 1997a).

According to the U.S. Fish and Wildlife Service, the gray bat (*Myotis grisescens*) and the Indiana bat (*Myotis sodalis*), which are on the federal endangered species list, may inhabit areas near the proposed FRC (Appendix E). Avian species that have been observed on the ORR and may be present in the BCV are the Cooper's hawk (*Accipter cooperii*) and the sharp-shinned hawk (*A. striatus*), both listed by the State of Tennessee as threatened; and the red-shouldered hawk (*Buteo lineatus*), listed by the state as in need of management (Kroodsma 1987, Mitchell et al. 1996). The southeastern shrew (*Sorex longirostris*), which the state lists as in need of management, and the pine snake (*Pituophis melanoleuas*), which the state lists as threatened, have been documented in BCV (Mitchell et al.

1996). The Tennessee dace is listed by the State of Tennessee as in need of management, and occurs throughout most of Bear Creek. Its habitat is protected by the State of Tennessee (Starnes and Etnier 1980).

Rare plant species that occur in BCV include the Canada lily (*Lilium canadense*), which the state lists as threatened, and the southern rein orchid (*Platanthera flava*), which the state lists as a species of special concern. An uncommon aquatic plant, *Orontium aquaticum*, also occurs in BCV. In addition, the Chestnut Ridge Whorled Horse-Balm Forest, which overlaps the southeast border of the experimental project area, contains ginseng (*Panax quinquifolius*), which is listed as special concern in Tennessee due to commercial exploitation, and whorled horsebalm (*Collinsonia verticillata*), which is considered to be globally rare by the Nature Conservancy. Natural communities of concern within this tract include mesic hardwoods. Landscape elements of concern include mature forest, steep slopes, and moist ravines.

The Oak Ridge National Environmental Research Park (NERP) serves as an outdoor laboratory and encompasses approximately 22,500 acres (9100 ha) of the 34,516-acre (13,968-ha) ORR. It is one of seven DOE NERPs across the country. A portion of the Oak Ridge NERP overlays the Y-12 area of responsibility, and overlaps with the western and southern portions of the proposed contaminated area and all of the background area. The DOE NERP provide opportunities for environmental studies on protected lands that act as buffers around DOE facilities. They are used to evaluate the environmental consequences of energy use and development as well as the strategies to mitigate these effects. The research parks are also used to demonstrate possible environmental and land-use options.

DOE has made a commitment to preserve biological diversity through protection of special habitats on the ORR such as habitat of rare plants or animals, vegetational communities representative of the Southern Appalachians, and vegetational communities uncommon in the area. Special habitats on the ORR are protected through National Environmental Research Natural Area or Reference Area designations. The entire length of Bear Creek, from its beginning in the proposed FRC through the background area, is a designated Aquatic Natural Area. The Chestnut Ridge Whorled Horse-Balm Forest, described in the previous section, is also a designated National Environmental Research Natural Area, as is the Bear Creek Spring Area, which is just south of the western end of the proposed FRC.

Species of concern in the Bear Creek Spring Area include tuberculed rein-orchid (*Platanthera flava* var. *herbiola*) listed as threatened in Tennessee, golden seal (*Hydrastis canadensis*) listed as special concern in Tennessee due to commercial exploitation, ginseng (*Panax quinqauifolius*) listed as special concern in Tennessee due to commercial exploitation, and whorled horsebalm (*Collinsonia verticillata*) considered to be globally rare by the Nature Conservancy. Natural communities include mesic hardwoods, mixed pine and hardwoods, and meadows. Landscape elements of concern include wetlands, springs, seeps, ponds, mature forests, and forested rock outcrops.

The entire ORR, including the Y-12 Area, is designated as a Wildlife Management Area through a cooperative agreement between DOE Oak Ridge Operations and the Tennessee Wildlife Resources Agency. This agreement provides for management of game and non-game wildlife on the ORR.

Wildlife management includes game species management (particularly reduction of the white-tail deer herd); species richness management (ensuring reservation wildlife residents are maintained in viable numbers); featured species management (introduction/restoration of native species); threatened and endangered species management (identifying and protecting individuals, habitat, and factors that

create and maintain particular habitats); and pest management (evaluating current land uses and those under consideration for potential wildlife problems).

A portion of the Y-12 Area, including the western portion of the proposed contaminated area and all of the background area, is open to deer hunting for six days each year. The hunt is conducted to control the deer population and to help minimize the number of deer/vehicle collisions. Turkey hunting began on the ORR in April 1996. The hunt consists of one scouting Saturday followed by two hunting weekends. The turkey hunting area is the same as the deer hunting area on the ORR.

3.1.4.2 Aquatic Resources

Nineteen species of fish have been found in quantitative monitoring efforts conducted at seven sites along almost the entire length of Bear Creek; some fish communities have shown evidence of degraded conditions (Southworth et al. 1992; Hinzman et al. 1995). Minnows are the predominant fish found in the upstream reaches of the creek. Downstream of the location of the proposed background area, northern hogsucker (*Hypentelium nigricans*), white sucker (*Catastomus commersoni*), and rock bass (*Ambloplites rupestris*) are more common. The Tennessee dace (*Phoxinus tennesseensis*), listed by Tennessee Wildlife Resources Agency as in need of management, was found at all sites except near the confluence of Bear Creek and EFPC. Studies have shown that, not only did the number of fish species increase from 1988 to 1993, but the frequency of occurrence also increased between 1984 and 1987. Recent studies conclude that, while much of Bear Creek still has limited fish fauna (low species richness), it is characterized by robust population parameters (high densities and biomass).

The benthic invertebrate fauna, which is rich and diverse at the downstream sections of Bear Creek, shows considerable impact near the headwaters. Quantitative sampling of benthic invertebrates showed a pattern of increasing density, biomass, and taxonomic diversity and richness with increasing distance downstream from the uppermost sampling site (Southworth et al. 1992).

3.1.5 Archaeological, Cultural, and Historic Resources

Under the National Historic Preservation Act, the National Register of Historic Places (NRHP) was established to protect important cultural resources. A listing in the NRHP provides recognition that a property is of significance to the national, state, or community, and requires consideration in the planning of federal or federally assisted projects.

Cultural resources within the Y-12 area of responsibility include seven cemeteries; one prehistoric site, which is not eligible for inclusion in the NRHP and which has an undetermined cultural affiliation; and 22 pre-World War II structures, four of which are eligible for inclusion in the NRHP. A cultural resources evaluation of previously recorded and inventoried sites within portions of the Y-12 area of responsibility has been prepared but has not been published.

One of the seven cemeteries, the Currier Cemetery, is located near the western boundary of the proposed background area in BCV. The Cox-Copeland Cemetery and the Douglas Chapel Cemetery are near but outside of the western and northern boundaries of the proposed FRC, respectively. These cemeteries are protected by law, managed by the Y-12 Environmental Management Department, and open to related families.

One pre-World War II structure site (852A) is close to the northwestern edge of the proposed contaminated area. No details are available for this site, but it is designated as not being eligible for inclusion in the NRHP.

According to the Tennessee Historical Commission, there are no NRHP-listed or NRHP-eligible properties affected by the proposed FRC (Appendix E).

3.1.6 Land Use, Recreation, and Aesthetic Resources

As discussed in Section 3.1.1, the proposed contaminated area and background area lie within the BCV, which is located on the DOE ORR in Anderson and Roane counties. The residential section of Oak Ridge forms the northern boundary of the ORR. The TVA's Melton Hill and Watts Bar reservoirs on the Clinch and Tennessee rivers form the eastern, southern, and western boundaries. Oak Ridge and the ORR are about 23 miles (37 km) west of the center of Knoxville, 12 miles (19 km) southwest of Clinton, and 7 miles (11 km) northeast of Kingston.

The area is linked by Interstates 40 and 75, which intersect in Knoxville.

BCV, bordered by Pine Ridge on the northwest and by Chestnut Ridge on the southeast, is approximately 10 miles (16 km) long, spanning the distance from the eastern end of the Y-12 Plant to the Clinch River on the west. The eastern portion of the valley is on ORR land and the western portion (i.e., the Grassy Creek watershed) includes TVA and private land. The proposed contaminated area and background area lie solely within the Bear Creek watershed.

Recreational uses of the surrounding area include fishing, boating, hunting, and camping. Melton Hill Lake, which delineates the southern boundary of the ORR, is the closest major water body for recreational uses. Major lake recreational areas within a 5-mile (8-km) radius of BCV include Clark Center Park, Melton Hill Park, Solway Public Use Area, Haw Ridge Park, Oak Ridge Marina, and Guinn Road Park. Additional recreational areas include neighborhood parks and civic centers managed by the city of Oak Ridge. Controlled deer and turkey hunts are held annually on the ORR but are not allowed in areas immediately adjacent to the Y-12 Plant or its disposal areas in BCV. Within the footprint of the proposed FRC, there are no recreational uses of Bear Creek.

Much of the region in which the proposed contaminated area and background area are located, between the west end of the Y-12 plant and the junction of Bear Creek Road and State Route 95, has second-growth hardwood forest. Near the Y-12 plant, developed areas associated with the S-3 Ponds Site and waste control areas are open and highly visible. Mowed grassy areas surround these more developed portions. Thus, visual resources range from relatively closed forests to developed areas that include waste control areas and storage yards for scrap metal and other materials.

3.1.7 Socioeconomic Conditions

Over 80 percent of ORR employees live in five counties surrounding the ORR; i.e., Anderson, Knox, Loudon, Morgan, and Roane counties). The total population of this five-county area was 517,158 in 1992.

The total 1997 labor force in the four-county area, excluding Morgan County, evaluated by DOE in 1998 was 280,190. In 1995, the average per capita income for the four-county area was $20,771, while the Tennessee state average was $21,060. Per capita income in the area ranged from $23,107 in

Knox County to $18,749 in Roane County. Per capita income in Knox County and Anderson County ($21,621) were higher than the state average, while both Roane County and Loudon County ($19,606) fell below the average income for the state. Per capita income is typically higher in the city of Oak Ridge than in surrounding counties, reflecting the higher level of education in Oak Ridge and the concentration of residents employed by DOE and its contractors (DOE 1992). Recent downsizing at the DOE facilities in Oak Ridge is a concern of local communities, and significant efforts are underway to attract new industries and businesses. (DOE 1999a, DOE 1997b).

3.1.8 Human Health

A baseline human health risk assessment has been conducted as part of the BCV Remedial Investigation (DOE 1997a). The data for the entire valley were divided into four functional areas (FAs) for analysis based on location and/or contaminant source. The proposed FRC lies within the Maynardville Limestone and Bear Creek FA and S-3 Ponds Site FA. The contaminants in these FAs are those to which workers at the proposed contaminated area could be exposed.

The primary contaminants in the Maynardville Limestone and Bear Creek FA are: nitrate, boron, uranium, strontium, barium, cadmium, manganese, PCE, TCE, 1,2-DCE, and Tc^{99}.

The primary contaminants in the S-3 Ponds Site FA are: uranium, TC^{99}, strontium, cadmium, barium, boron, mercury, chromium, VOCs and nitrates, copper, lead, mercury, nickel, vanadium, and zinc.

Persons currently visiting or working in BCV include maintenance or sampling workers. They have limited contact with these contaminants, and are protected from exposure to contamination via adherence to Health and Safety Plans, the use of personal protective equipment when necessary, and Occupational Safety and Health Administration (OSHA)/Superfund Amendments and Reauthorization Act (SARA) training. Administrative controls are in place to limit exposure to radionuclides. These include Radiological Control Organization (RADCON) policies, standards, and procedures.

Noise

Background data on noise levels at the proposed contaminated area and background area are not available. Noise levels 200 feet (60 m) from main thoroughfares such as State Route 95 have been estimated from traffic counts during rush hour to be between 55 and 60 decibels (dB/A). Noise levels at relatively isolated sites within the plant area may be lower than 55 dB/A (DOE 1997b).Potential activities at the proposed contaminated area and background area are listed in Section 2.2.3. Noise associated with potential FRC activities would be produced by well-drilling equipment, compressors, trucks, and generators. Typical noise levels of familiar noise sources are provided in Figure 3-6.

3.1.9 Waste Control

Wastes generated at the proposed contaminated area and background area could include small quantities of contaminated groundwater from drilling wells and sampling in contaminated zones; small quantities of excess soil from coring; field laboratory wastes, some of which would be considered RCRA waste; biological wastes; domestic wastes from the offices and laboratories; and sanitary wastes.

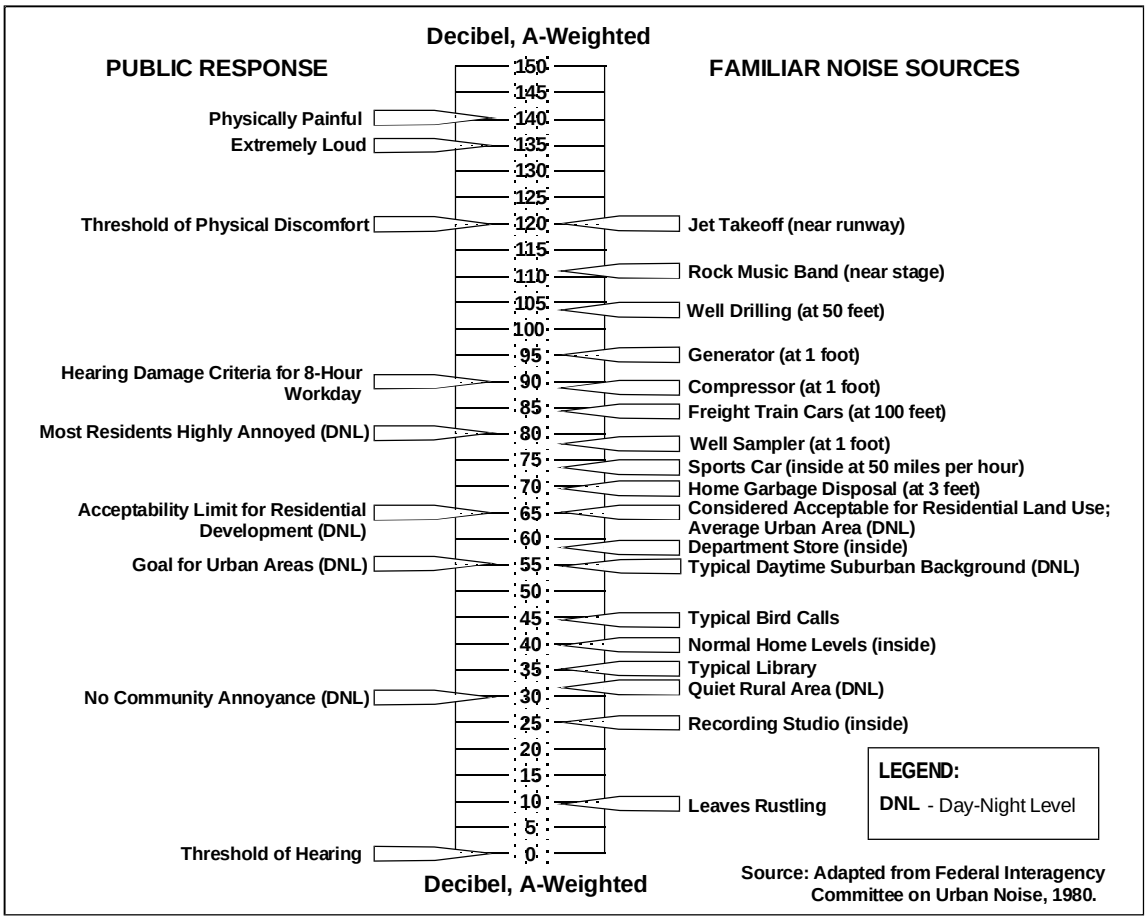


Figure 3-6 Typical noise level of familiar noise sources and public responses

There are existing waste disposal facilities at both ORNL and at Y-12 for the disposal of radioactive, hazardous, chemical, biological, and domestic wastes.

The waste generator (e.g., FRC Manager), would work with the ORNL "generator interface" to prepare and submit data packages to BJC to classify the waste stream under the BJC Master Waste Stream Profile. The data package would be reviewed by BJC to ensure that waste acceptance criteria were met. Once the waste certification became official, the waste would be accepted by BJC for final disposition. Waste accepted by BJC would be owned by BJC; they would decide how the waste would be handled, stored, treated and disposed of. Based on current practices, liquid wastes would be treated at the Y-12 West End Treatment Facility (WETF) but ORNL treatment facilities could also be used. Treated water from the WETF is generally discharged to Upper East Fork Poplar Creek. Low level solid wastes are generally disposed of at an appropriate waste disposal facility, such as Envirocare in Clive, Utah. Nonhazardous waste is disposed of at onsite landfills. Any RCRA waste generated by the proposed FRC would be stored in an onsite satellite accumulation area or taken to a 90-day area.

3.1.10 Transportation

Much of the proposed contaminated area and parts of the background area are adjacent to Bear Creek Road, which has considerable employee traffic during shift changes at the plant and intermittent

traffic during most of the workday. The western boundary of the background area is adjacent to State Route 95, which had existing peak travel volumes of 970 vehicles per hour in 1997 (Table 3.7-2 in DOE 1997b).

The Environmental Sciences Division at ORNL currently conducts research at a variety of field sites on the ORR, including groundwater sampling in BCV. Therefore, collection and transport of samples for the proposed FRC would follow existing procedures and meet all environmental, safety, and health (ES&H) requirements. For each new research project that would be conducted at the FRC, the principal investigator would be required to fill out an Environmental, Safety, Health, and Quality Evaluation and complete a Transportation Checklist. Among the items that are detailed in the ES&H evaluation are the movement of soil samples and the transport of samples on public roads. The Transportation Checklist includes questions about the specific activity of the material, its flashpoint, whether or not it is preserved, if samples contain hazardous materials, if the sample is a RCRA waste, and whether there is any question about the hazardous nature or radioactivity of the shipment. Completion of the checklist gives the researcher guidance on the need to contact ES&H specialists in transportation to assist with compliance with appropriate shipping requirements. Transport of samples off the ORR must meet all applicable Department of Transportation requirements for packaging and shipping.

3.1.11 Utilities and Services

Electricity for the ORR is provided by the Tennessee Valley Authority. Power is brought onsite via transmission lines currently owned by DOE.

DOE withdraws water from the Clinch River at a point south of the eastern end of the Y-12 Plant. The water is filtered and chlorinated at a water treatment plant located north of the Y-12 Plant and distributed to the City of Oak Ridge, the Y-12 Plant and ORNL. This treatment facility provides potable water through two storage reservoirs with a combined capacity of 7 million gallons (26.5 million liters [L]).

ORNL operates and maintains an individual sanitary waste treatment plant (SWTP), while the Y-12 Plant uses sewage treatment services at the City of Oak Ridge. The SWTP at ORNL has a current capacity of 300,000 gallons per day (1.1 million liters per day [Lpd]), while the average daily flow to the to the SWTP is less than 200,000 gallons per day (757,080 Lpd). Ancillary facilities would be used to support the proposed FRC. FRC staff and researchers would use existing facilities at ORNL, including offices and research laboratories in Building 1505, drilling and field equipment storage and shop in Building 0855, core barn sample storage in Building 7042, and field equipment storage in Building 7874. At Y-12, there is an existing office trailer near the S-3 Ponds Site that could be used for some FRC purposes. (See Figure 3-7 for locations.)

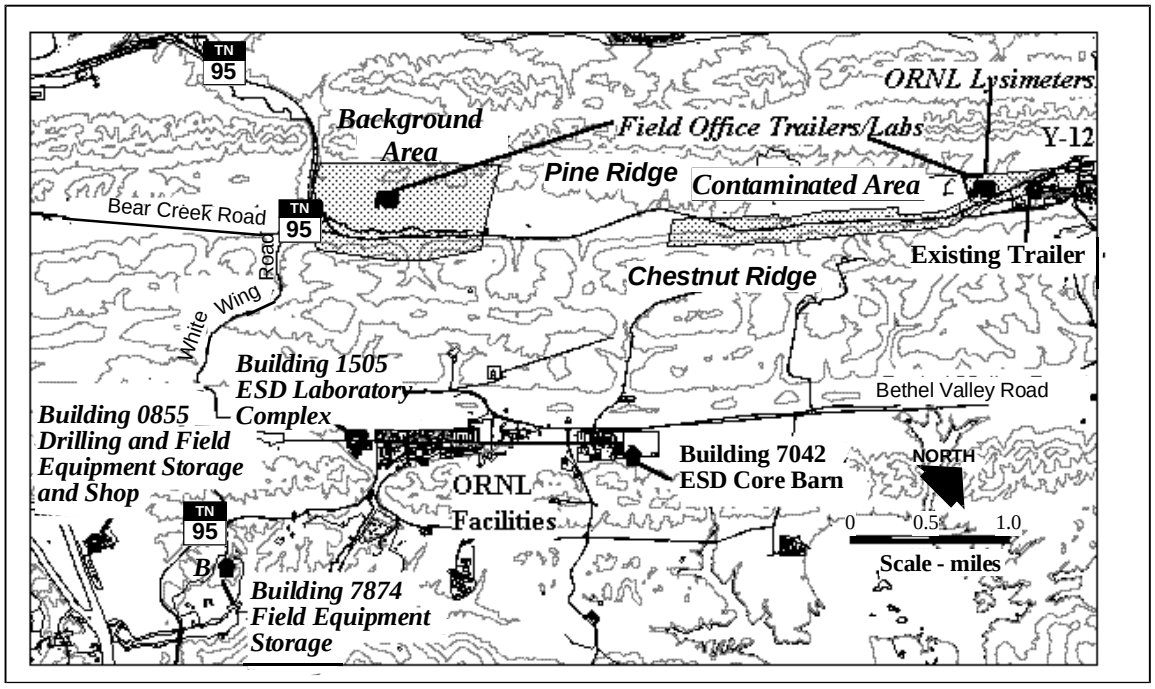


Figure 3-7 Proposed FRC ancillary facilities

3.1.12 Environmental Justice

On February 11, 1994, the President of the United States issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*. The Executive Order mandates that each federal agency make environmental justice part of the agency mission and to address, as appropriate, disproportionately high and adverse human health or environmental effects of the programs and policies on minority and low-income populations.

Approximately 880,000 people live within a 50-mile (80-km) radius of the ORR. Based on 1990 census data, minorities compose about 6 percent of this population, compared to about 24 percent for the nation and 17 percent for the State of Tennessee. No federally recognized Native American groups are present within the 50-mile (80-km) radius (DOE 1999a).

The distribution of minority populations and low-income housing data surrounding the ORR is summarized in Table 3-1. The data are provided by census tract in the City of Oak Ridge, the nearest population center to the ORR and the proposed FRC. The minority population data is composed of any census tract within the 50-mile radius with a minority population proportion greater then the national average of 24.4 percent. The low-income household data is composed of any census tract within the 50-mile radius with a low-income population proportion greater than the national average of 13.1 percent.

Table 3-1. Description of the Populations Surrounding ORNL (1990)

Environmental Justice Parameter	ORNL
Population and Minority Population Statistics	
Population within 50 mi (80 km) of center of Site	880,000
Minority population within 50 mi (80 km) of center of Site	6%
Native American, Eskimo, or Aluet populations	0
Asian or Pacific Islander population and other race categories	733
African American population	2,148
Hispanic origin population	437
Low-Income Households surrounding the site*	
Households surrounding the Site	7,092
Low-income households surrounding the Site	568
Percent of low-income households surrounding the Site	8%

*Data calculated by City of Oak Ridge census tracts

3.2 Pacific Northwest National Laboratory/Hanford Site 100-H Area

The Hanford Site lies within the semiarid Pasco Basin of the Columbia Plateau in southeastern Washington State. The Hanford Site occupies an area of about 560 square miles (1,450 km^2) north of the confluence of the Yakima River with the Columbia River. The Columbia River flows through the northern part of the site and turning south, forms part of the Hanford Site's eastern boundary. Rattlesnake Mountain forms the southwestern boundary and the Saddle Mountains form the northern boundary. Adjoining lands to the west, north, and east are principally agricultural and range land. The cities of Richland, Kennewick, and Pasco (also referred to as the Tri-Cities) constitute the nearest population center and are located immediately to the southeast of the Hanford Site (Figure 3-8).

In the late 1980s, portions of the Hanford Site were listed on the National Priorities List because of extensive contamination from past activities. In 1989, the DOE entered into an enforceable agreement with the U.S. Environmental Protection Agency and the State of Washington Department of Ecology for achieving environmental compliance. The *Hanford Federal Facility Agreement and Consent Order*, or Tri-Party Agreement, establishes enforceable milestones for achieving remediation and regulatory compliance.

The Hanford Site encompasses more than 1,500 waste control units and four groundwater contamination plumes that have been grouped into 79 operable units. Each unit has complementary

characteristics of such parameters as geography, waste content, type of facility, and relationship of contaminant plumes. The 79 operable units have been aggregated into four areas: 22 in the 100 Area, 43 in the 200 Area, five in the 300 Area, and four in the 1100 Area.

The proposed FRC would be located in the 100-H Area. The 100-H Area was the site of one of nine plutonium production reactors, the H Reactor, which operated from 1949 to 1965. Following shutdown of reactor operations in the mid-1960s, most of the facility was demolished.

The 100-H Area contains several CERCLA operable units that fall under the Tri-Party Agreement. The R-3 Operable Unit in the 100-H Area contains the contaminated groundwater underlying the 100-H Area. This designation is beneficial because although remediation-related activities within the operable unit must meet all of the substantive requirements of applicable permits, they do not need to obtain the permit itself. This operable unit is currently undergoing an interim remedial action (pump and treat system) for chromium contamination in accordance with a CERCLA Interim Record of Decision (ROD).

The irregular boundaries of the proposed FRC site were chosen to avoid other construction and waste-remediation activities there, planned or ongoing. The contaminated area would encompass an area approximately 2,950 feet long by 2,300 feet wide (900 m by 700 m) (Figures 3-9 and 3-10). Two smaller background areas would be located just southeast and southwest of the contaminated area. As with the proposed ORNL background and contaminated areas, the proposed background and contaminated areas at the 100-H Area would have test plots of several areas (Figure 3-9). Groundwater extraction wells would be placed at the border of each test plot to capture groundwater that flows through the test plot area. In addition, monitoring wells would be placed outside the boundary of the FRC, particularly along the Columbia River, so that groundwater chemistry could be monitored.

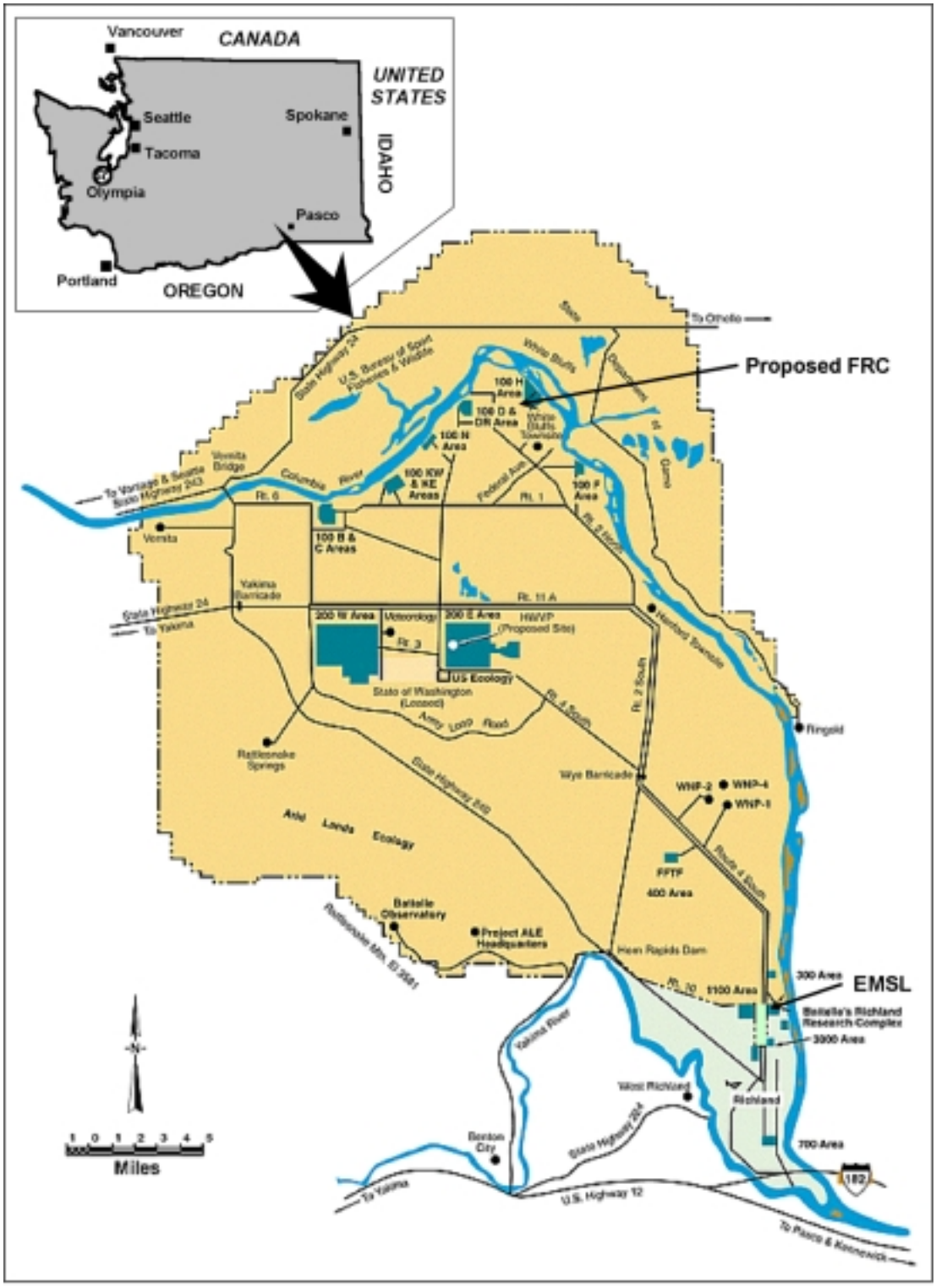


Figure 3-8 Location of proposed FRC in Hanford, Washington

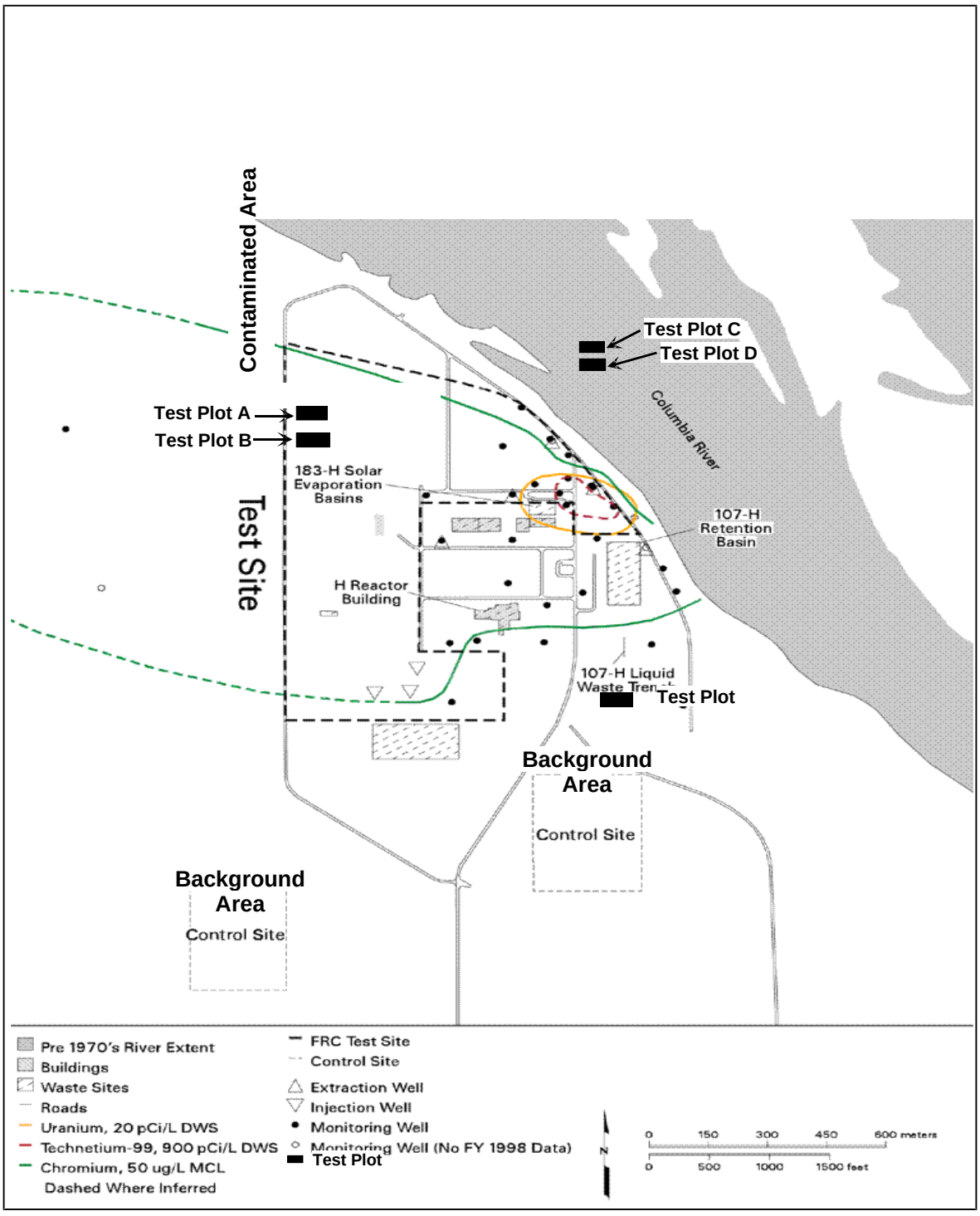
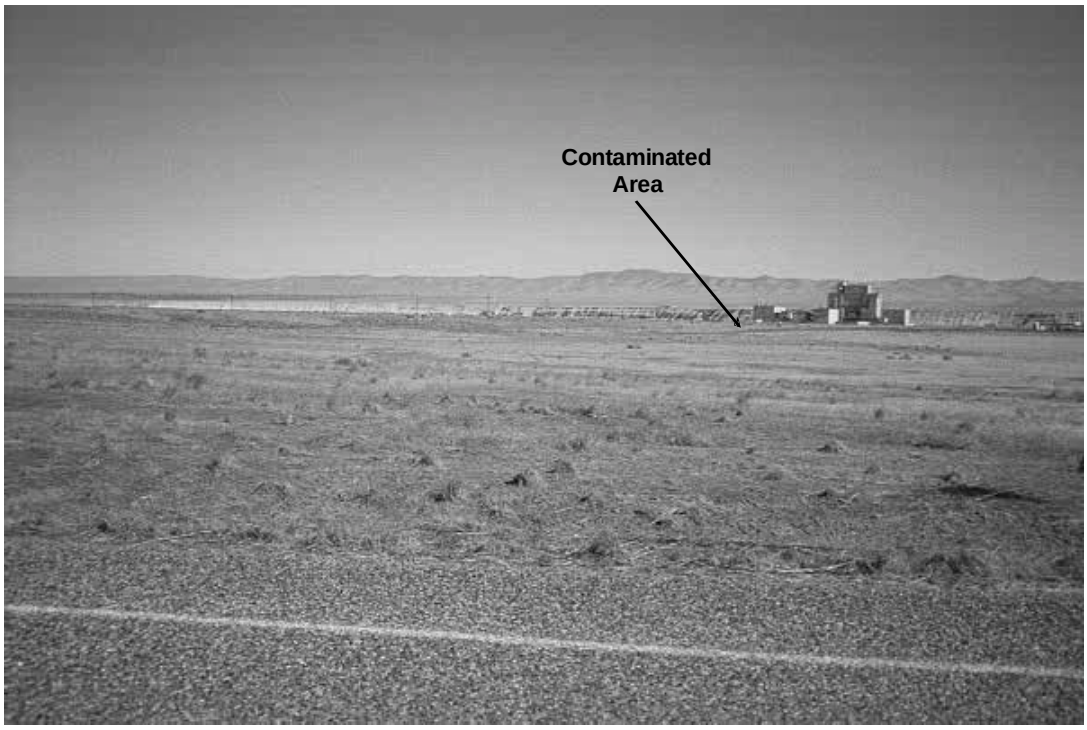


Figure 3-9 Proposed FRC in the 100-H Area of the Hanford site



A portion of the Proposed FRC Contaminated Area at PNNL/Hanford

A portion of the Proposed FRC Background Area at PNNL/Hanford

Figure 3-10 Photographs of the Proposed FRC Contaminated and Background Areas at PNNL/Hanford

3.2.1 Earth Resources

3.2.1.1 Topography

The 100-H Area lies on an essentially low-relief, semiarid bench south of the Columbia River. The elevation of the area ranges from river level (~380 feet) to 425 feet above mean sea level. The land surface slopes gradually toward the river, with a bank up to 30 feet at the edge of the river. The surface topography of the 100-H Area reflects the impacts of river erosion (i.e., channeling) of the area during unregulated floods prior to construction of Priest Rapids Dam up-river. To the east, beyond the 100-H Area, lie the high-relief cliffs of eroded Ringold Formation, referred to as the White Bluffs.

3.2.1.2 Geology

The Hanford Site is located near the junction of the Yakima Fold Belt and the Palouse structural subprovinces (DOE 1988a). The Palouse subprovince is primarily a regional paleoslope that dips gently toward the central Columbia Basin and exhibits only relatively mild structural deformation. The principal characteristics of the Yakima Fold Belt are a series of segmented, narrow, asymmetric anticlines. These anticlinal ridges are separated by broad synclines or basins that, in many cases, contain thick accumulations of sediments (i.e., Ringold and Hanford formations). Thrust or high-angle reverse faults are principally found along the limbs of the anticlines.

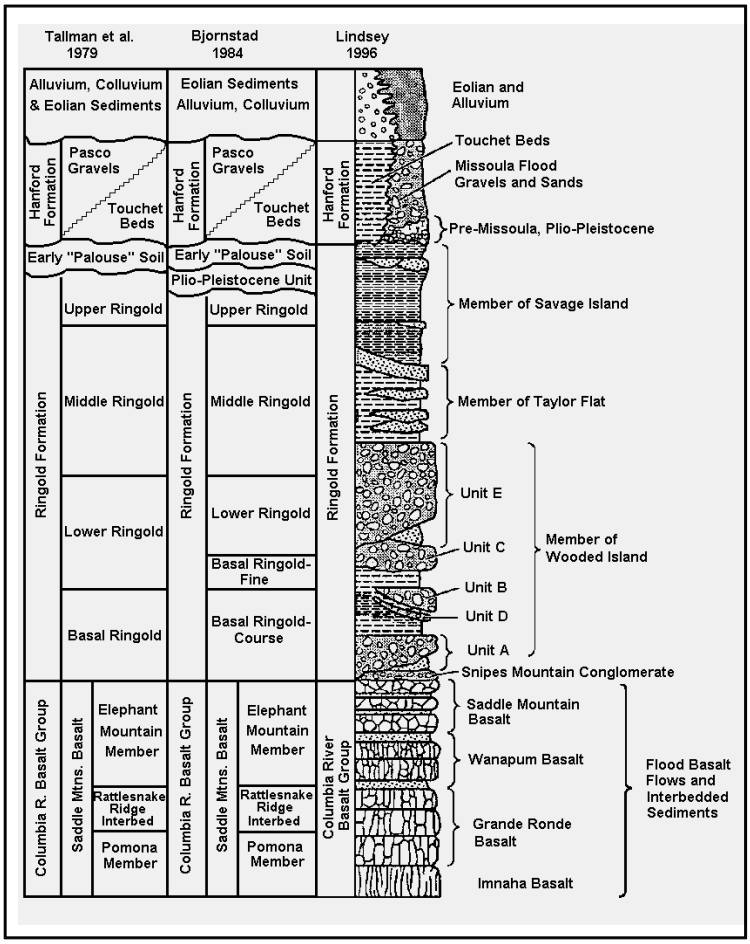


Figure 3-11 Stratigraphic column for the Hanford site showing correlations among various authors

The 100-H Area lies within the Wahluke syncline, the east-west trending structural depression lying between Saddle Mountains to the north and the Umtanum Ridge-Gable Mountain uplift to the south. The Wahluke syncline is asymmetric and relatively flat-bottomed. The Umtanum Ridge-Gable Mountain uplift is a segmented, asymmetrical anticlinal ridge that extends onto the Hanford Site from the west. Gable Mountain and Gable Butte consist of two topographically isolated, anticlinal ridges

composed of a series of northwest-trending, doubly plunging, en echelon anticlines, synclines, and associated faults. The potential for present-day faulting has been identified on Gable Mountain.

Bedrock beneath the Hanford Site consists of the Miocene Columbia River Basalt Group (volcanic origin) interbedded with sedimentary deposits of the Ellensburg Formation. Overlying bedrock are suprabasalt sediments belonging to the Miocene-Pliocene Ringold Formation and Pleistocene Hanford formation. Other stratigraphic units of local extent include the early "Palouse" soil, the Plio-Pleistocene unit, and pre-Missoula gravels. The Hanford Site stratigraphy (Figure 3-11) is described in more detail in Neitzel et al. 1999.

The Columbia River Basalt Group consists of continental flood basalts that erupted from linear vents within northeastern Oregon, eastern Washington, and western Idaho between 6 to 17 million years ago. The Saddle Mountains Basalt forms the uppermost basalt unit in the Pasco Basin, except along some of the bounding ridges where Wanapum and Grande Ronde Basalt flows are exposed.

The fluvial-lacustrine Ringold Formation was deposited in generally east-west trending valleys by the ancestral Columbia River and its tributaries in response to development of the Yakima Fold Belt.

Cataclysmic flooding, originating in western Montana and northern Idaho, spilled across eastern and central Washington, forming the channeled scablands and depositing sediments in the Pasco Basin. The last major flood occurred about 13,000 years ago. Cataclysmic floods inundated the Pasco Basin a number of times during the last ice age. The flood deposits, informally called the Hanford formation, blanket low-lying areas over most of the central Pasco Basin.

Alluvium is present as a surficial deposit along the Columbia and Yakima Rivers; and in the subsurface, interbedded with cataclysmic flood deposits. Colluvium (talus and slopewash) is a common Holocene deposit in moderate- to-high-relief areas. Varying thicknesses of loess or sand mantle much of the Columbia Plateau. Active and stabilized sand dunes are widespread over the Pasco Basin. Landslide deposits in the Pasco Basin occur within the basalt outcrops along the ridges or steep river embankments (e.g., the north side of Rattlesnake Mountain and White Bluffs, respectively).

Approximately 300 feet (91.5 m) of suprabasalt sediments overlie the proposed FRC and the 100-H Area. Sediments overlying Columbia River basalt include the Ringold Formation, the Hanford formation, as well as localized Holocene alluvium and backfill (Lindsey and Jaeger 1993). The Ringold Formation and Hanford formation are continuous across the 100-H Area.

The Hanford formation consists primarily of gravel-dominated facies, with local occurrences of sand-dominated or silt-dominated facies. The Hanford formation generally thickens from north to south, ranging from 30 to 65 feet (9 to 20 m), and overlies fine-grained facies of the Ringold Formation.

Ringold Formation sediments—with total thickness of 250 to 270 feet (76 to 82 m) near the proposed FRC —are dominated by lacustrine, overbank deposits and associated paleosols. All are represented within the 100-H Area. Fine-grained, overbank-paleosol facies (Ringold upper mud) (Auten and Myers 1996), comprises the upper 100 to 125 feet (30 to 38 m) of the Ringold Formation. The upper mud unit is described as a moderately consolidated, light brownish gray to light yellowish brown to reddish brown, sandy clayey silt to clayey silt (Fruchter et al. 1996). This unit averages 19.7 percent sand, 54.7 percent silt, and 25.5 percent clay.

Two other Ringold units are present within the 100-H Area. A sandier facies (Unit B/D [Auten and Myers 1996]) separates the upper mud sequence from the Ringold lower mud unit. Unit B/D is

composed of a fluvial sand facies. The Ringold lower mud unit (90- to100-foot total thickness) is interpreted to be lacustrine (Lindsey and Jaeger 1993).

In the 100-H Area, an erosional unconformity exists between the Ringold and Hanford formations, which slopes gently toward the east. The upper contact with the Ringold Formation was scoured out during Pleistocene cataclysmic flooding, and subsequently deposited the Hanford formation during the waning stages of flooding (Baker et al. 1991).

Seismicity of the Columbia Plateau is relatively low when compared with other regions of the Pacific Northwest, the Puget Sound area, and western Montana/eastern Idaho. The largest known earthquake in the Columbia Plateau occurred in 1936 near Milton-Freewater, Oregon. This earthquake had a Richter magnitude of 5.75. In the central portion of the Columbia Plateau, the largest recorded earthquake near the Hanford Site occurred in 1973. This event registered a magnitude of 4.4 and was located north of the Hanford Site near Othello.

Earthquakes commonly occur in spatial and temporal clusters in the central Columbia Plateau and are termed "earthquake swarms." The region north and east of the Hanford Site is a region of concentrated earthquake swarm activity, but earthquake swarms have also occurred in several locations within the Hanford Site. The frequency of earthquakes in a swarm tends to gradually increase and decline without a large event in the sequence. Roughly 90 percent of the earthquakes in swarms have Richter magnitudes of 2 or less. These earthquake swarms generally occur at shallow depths, with 75 percent of the events located at depths of less than 2.5 miles (<4 km).

3.2.1.3 Soils

Hajek 1966 describes 15 different soil types on the Hanford Site, varying from sand to silty and sandy loam. In the 100-H Area, soils are classified as either Burbank loamy sand or Riverwash, with Riverwash occurring closer to the river. Burbank loamy soil is a course-textured soil underlain by gravel. The surface soil is usually about 16 inches (40 cm) thick, but can be 30 inches (75 cm) thick. This soil type is highly permeable. Soils beneath 100-H Area waste disposal sites have been found to contain uranium, technetium-99 (Tc^{99}), strontium, and chromium, among other constituents.

3.2.2 Climate and Air Quality

Climate at the Hanford Site is classified as mid-latitude semiarid or mid-latitude desert, depending on the climatological classification scheme used. Summers are warm and dry with abundant sunshine. Large diurnal temperature variations result from intense solar heating during the day and radiational cooling at night. Daytime temperatures in June, July, and August periodically exceed 100°F (38C). Winters are cool with occasional precipitation. Outbreaks of cold air associated with modified arctic air masses can reach the area and cause temperatures to drop below 0°F (-18C). Overcast skies and fog occur periodically.

Air quality in the Hanford region is well within the state and federal standards for criteria pollutants, except that short-term particulate concentrations occasionally exceed the 24-hour "particulate matter nominally 10 microns or less" (PM_{10}) standard. Benton County is in an "unclassified" area for PM_{10} (Neitzel et al. 1999).

3.2.3 Water Resources

3.2.3.1 Surface Water

The primary surface water feature in the vicinity of the proposed FRC is the Columbia River. The primary uses of the Columbia River include the production of hydroelectric power and extensive irrigation in the Mid-Columbia Basin. Several communities located on the Columbia River rely on the river as their source of drinking water. The river is also used as a source of drinking water at several Hanford facilities and for onsite industrial uses (Neitzel et al. 1999).

The Comprehensive Land Use Plan designates 43.1 miles (111.6 km) of the Columbia River adjacent to the Hanford Site as the Columbia River Corridor. Along the southern shoreline of the corridor, the 100 Areas occupy approximately 26 miles (68 km). RCRA closure permit restrictions have been placed in the vicinity of the 100-H Area, which is associated with the 183-H Solar Evaporation Basins. Additional deed restrictions or covenants for activities that potentially extend more than 15 feet (4.6 m) below ground surface are expected for CERCLA remediation areas.

The Columbia River borders the 100-H Area on the northeast. The Hanford Reach is the only stretch of the Columbia River within the United States that is not impounded by a dam, though the flow is controlled by the Priest Rapids Dam located several miles upstream of the Hanford Site.

The existence of the Hanford Site has precluded development of this section of the river for irrigation and power and the Hanford Reach is now currently under consideration for Wild and Scenic River status by the National Park Service. In 1988, Congress passed Public Law 100-605. The law requires the Secretary of Interior to prepare a study in consultation with the Secretary of Energy to evaluate the outstanding features of the Hanford Reach and its immediate environment and to institute interim protection measures. An Environmental Impact Statement (EIS) was prepared to evaluate the unique natural features of the Hanford Reach. Based on the evaluation in the EIS, the Secretary of Interior signed a Record of Decision on July 16, 1996 (DOI 1996), recommending Congress designate the Hanford Reach and public land within one-quarter mile of the river on the south shore (as well as a larger area on the north shore) as a Wild and Scenic River. To date, despite the introduction of bills concerning this issue, Congress has not acted to designate the Hanford Reach as a Wild and Scenic River.

Water samples are collected quarterly from the Columbia River along established points on the Hanford Site as well as immediately upstream and downstream. The current major source of heat to the Hanford Reach is solar radiation. The average pH values ranged from 7.7 to 8.1. Mean specific conductance values ranged from 128 to 165 microSiemens/cm. Radionuclides consistently detected in the river during 1998 included tritium, Sr-90, I-129, U-234,238, and Pu-239,240. Total alpha and beta measurements (useful indicators of the general radiological quality that provide an early indication of changes in radioactive contamination levels) were approximately 5 percent or less of the applicable drinking water standards of 15 and 50 pCi/L, respectively (Neitzel et al. 1999, PNNL 1998).

3.2.3.2 Floodplain and Wetlands

There are no Federal Emergency Management Agency (FEMA) floodplain maps of the Hanford Reach of the Columbia River. Prior to 1933, when the Columbia River was free-flowing, periodic

large floods occurred that affected the 100-H Area. This is indicated by a series of fluvial channels that dissect older cataclysmic-flood and older fluvial deposits in the vicinity of 100-H Area. These channels were probably last occupied during the largest known unregulated historical flood, which occurred in 1894 and is estimated to have a discharge of 742,000 cubic feet per second (21,000 cubic meters per second [m^3/s]) (Neitzel et al. 1999). The Columbia River flow is now controlled by a series of dams located both upstream and downstream of the Hanford Area.

The largest recent flood at the Hanford Area took place in 1948 with an observed peak discharge of 700,000 cubic feet per second (20,000 m^3/s). The 1948 flood did not inundate the 100-H Area. An estimate of the 100-year dam-regulated flood is 440,000 cubic feet per second (12,400 m^3/s) (Neitzel et al. 1999). The 100-year regulated flood would not affect the 100-H Area.

The 100-H Area does not include any wetlands other than the narrow ribbon of wetlands along the shoreline of the Columbia River; these wetlands are not located within the proposed FRC (Neitzel et al. 1999).

3.2.3.3 Groundwater

Groundwater beneath the Hanford Site is found in both an upper unconfined aquifer system and deeper basalt-confined aquifers (Neitzel et al. 1999). Portions of the upper aquifer system are in locally confined or semiconfined. Confined aquifers within the Columbia River Basalt Group are formed by relatively permeable sedimentary interbeds and the more porous tops and bottoms of basalt flows. The horizontal hydraulic conductivities of most of these aquifers fall in the range of 3×10^{-10} to 3×10^{-4} feet per second (10^{-10} to 10^{-4} m/s). The dense interior sections of the basalt flows have horizontal hydraulic conductivities ranging from 3×10^{-15} to 3×10^{-9} feet per second (10^{-15} to 10^{-9} m/s), about five orders of magnitude lower than those of the confined aquifers. Groundwater in the basalt confined aquifers generally flows toward the Columbia River and, in some places, toward areas of enhanced vertical communication with the unconfined aquifer system.

Groundwater in the unconfined aquifer at Hanford generally flows from recharge areas in the elevated region near the western boundary of the Hanford Site toward the Columbia River on the eastern and northern boundaries (the 100-H Area). The Columbia River is the primary discharge area for the unconfined aquifer. Along the Columbia River shoreline, daily river level fluctuations may result in water table elevation changes of up to 10 feet (3 m). During the high river stage periods of 1996 and 1997 some wells near the Columbia River showed water level changes of more than 10 feet). As the river stage rises, a pressure wave is transmitted inland through the groundwater. The longer the duration of the higher river stage, the farther inland the effect is propagated. The pressure wave is observed farther inland than the water actually moves. For the river water to flow inland, the river level must be higher than the groundwater surface and must remain high long enough for the water to flow through the sediments. Typically, this inland flow of river water is restricted to within several hundred feet of the shoreline.

Groundwater recharge from precipitation across the entire Hanford Site is thought to range from approximately 0 to 4 inches per year (0 to 10 cm/yr) but is probably less than 1 inch per year (<2.5 cm/yr) over most of the Site. Since 1944, the artificial recharge from Hanford wastewater disposal in the 200 Areas has been significantly greater than the natural recharge. An estimated 4.44×10^{11} gallons (1.68×10^{12} L) of liquid was discharged to disposal ponds, trenches, and cribs from 1944 to the present. Horizontal hydraulic conductivities of sand and gravel facies within the Ringold Formation generally range from about 0.9 to 9 feet per day (0.3 to 3 meters per day [m/d]) compared to 1,000 to 10,000 feet per day (300 to 3,000 m/d) for the Hanford formation. Because the Ringold

sediments are more consolidated and partially cemented, they are approximately 10 to 100 times less permeable than the sediments of the overlying Hanford formation. Before wastewater disposal operations at the Hanford Site, the uppermost aquifer was mainly within the Ringold Formation and the water table extended into the Hanford formation at only a few locations. However, wastewater discharges raised the water table elevation across the Site, especially within the 200 Areas. Because of the general increase in groundwater elevation, the unconfined aquifer now extends upward into the Hanford formation. This change has resulted in an increase in groundwater velocity not only because of the greater volume of groundwater but also because the newly saturated Hanford sediments are highly permeable. More recently, water levels have declined over most of the Hanford Site because of decreased wastewater discharges (Neitzel 1999).

The hydrology of the 100 Areas is notable because of the location adjacent to the Columbia River. A map showing the water table elevations in the vicinity of the 100-H Area is shown in Figure 3-12. The water table ranges in depth from near 0 feet at the river edge to 107 feet (30 m). The groundwater flow direction is generally toward the river. During high-river stage, however, the flow direction may reverse immediately adjacent to the river.

The groundwater gradient varies depending on the distance from the river and the time of year. Groundwater flow near the river is strongly influenced by fluctuations in Columbia River stage, which is controlled by dams. River stage can vary 6 to 8 feet daily and 8 to 10 feet seasonally. The hydraulic gradient is greatly increased near the river during periods of low flow. As the river stage increases the gradient flattens, as the groundwater responds to a higher discharge elevation. Normal peak discharge occurs during June while normal low flow occurs in October and November. River stage can influence wells up to 2,000 feet (600 m) inland from the river. Confined aquifer layers have potentiometric surfaces that are generally above those of the unconfined aquifer.

Groundwater Quality

Groundwater quality has been negatively impacted by past practices at the 100-H Area, and because of its proximity to the Columbia River, the 100-H Area has received high priority for the remediation of hazardous and radioactive wastes at Hanford. Contaminants of concern include chromium, nitrate, Tc^{99}, and uranium, all of which occur above drinking water standards within the 100-H Area. A pump and treat system is presently in operation to contain these contaminants and prevent them from entering the river. The proposed FRC is located hydraulically upgradient of the pump and treat system. The system is presently pumping contaminated groundwater from five wells immediately adjacent to the river, passing the water through an ion-exchange filter and injecting the treated water into several wells located 1,970 to 2,300 feet (600 to 700 m) upgradient of the river. Through the CERCLA Interim Record of Decision, the EPA and DOE are scheduled to review the status and success of this pump and treat effort in 2002. At that time, changes might be made to the pump and treat system.

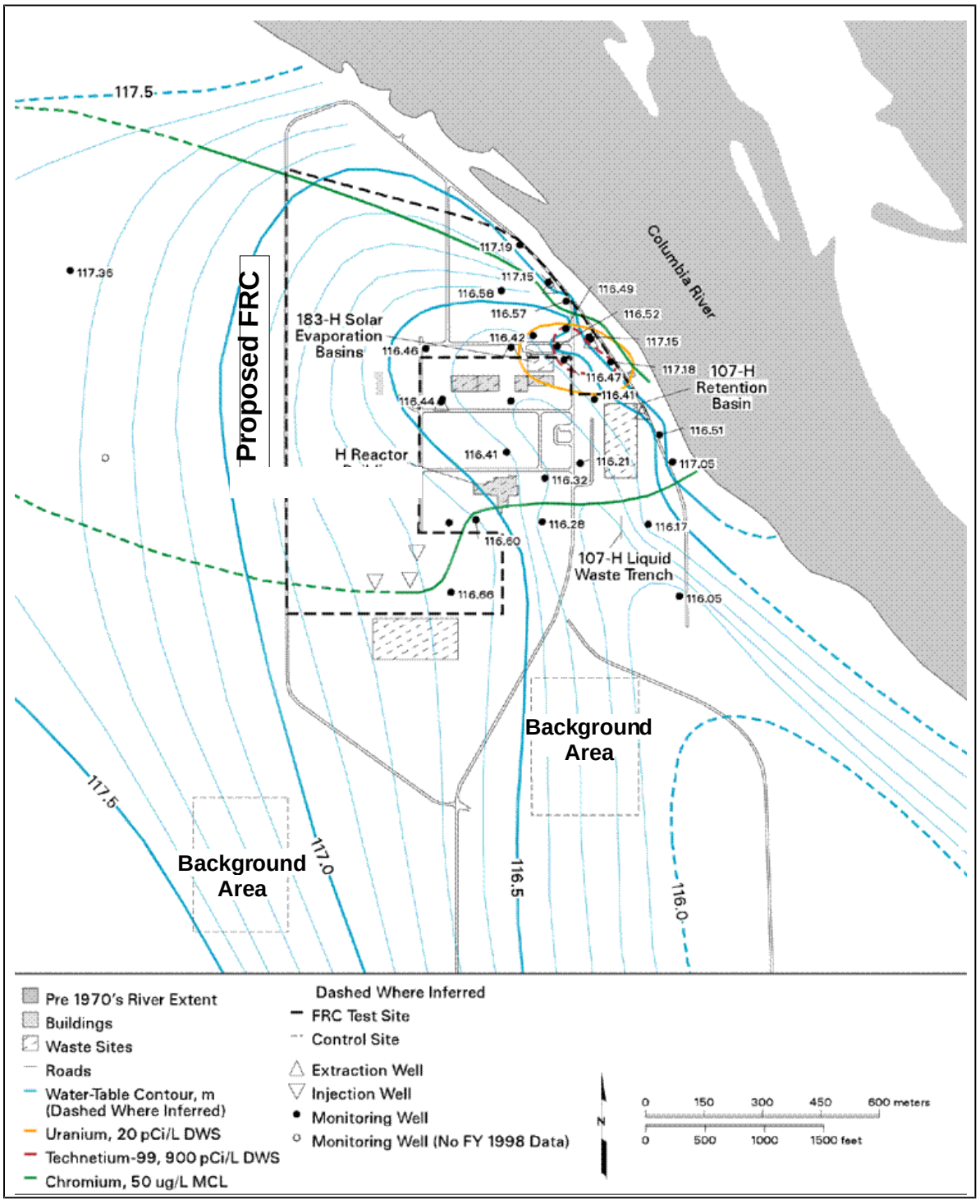


Figure 3-12 Groundwater table in the vicinity of the 100-H Area

3.2.4 Ecological Resources

The following section identifies and describes the terrestrial, and aquatic resources that occur on the Hanford Site and in the 100-H Area

3.2.4.1 Terrestrial Resources

The Hanford Site is located within what has been botanically characterized as a shrub-steppe ecosystem, with various shrub and bunchgrass associations playing dominant roles. The region is often referred to as high desert, northern desert shrub, or desert scrub (Franklin and Dyrness 1973). The Hanford Site is a relatively large, undisturbed area of shrub-steppe habitat that contains numerous plant and animal species adapted to the semi-arid environment in the region. The major DOE facilities and infrastructure occupy only a small part of the site and their impact on the surrounding ecosystems is minimal. Most of the Hanford Site has not experienced tillage or livestock grazing since the early 1940s.

A pedestrian and visual reconnaissance of the proposed contaminated area and the background area near the southeast corner of 100-H Area was performed by staff from the Hanford Biological Resources Laboratory on April 23, 1998. An additional background area, which is proposed to be to the south/ southwest of the original 100-H perimeter, has not been recently surveyed. However, information on the habitat of the region was obtained from the habitat classification database of the Ecosystems Monitoring Project (Neitzel et al. 1999). The Braun-Blanquet cover-abundance scale (Bonham 1989) was used to determine percent cover of dominant vegetation.

The northern portion of the proposed contaminated area is characterized as a Rabbitbrush (*Crysothamnus nauseosus*)/cheatgrass (*Bromus tectorum*) community, with a significant amount of bulbous bluegrass (*Poa bulbosa*). Other portions of the proposed contaminated area are primarily characterized as cheatgrass communities. All proposed contaminated areas have been previously disturbed. The proposed background area in the southeast corner of 100-H Area is characterized as a cheatgrass community.

In 1999, the U.S. Fish and Wildlife Service provided a list of threatened and endangered species, candidate species and species of concern, which may be present in the Benton County portion of the Hanford Area (Appendix E). However, no plant or animal species protected under the Endangered Species Act, candidates for such protection, or species listed by the Washington State government as threatened or endangered were observed within the proposed FRC boundaries. Bald eagles use the river area adjacent to the proposed area during the winter. Bald eagles are currently on the Federal Endangered Species list; however, a proposal to delist the bald eagle was published in the Federal Register, July 6, 1999. A final decision is expected in July 2000.

3.2.4.2 Aquatic Resources

The Columbia River is the dominant aquatic ecosystem on the Hanford Area and flows to the northeast of the 100-H area. The river supports a large and diverse community of fish, benthic invertebrates, and other communities.

Neitzel 1999 lists 43 species of fish in the Hanford Reach of the Columbia River. The brown bullhead (*Ictalurus nebulosus*) has been collected since 1977, bringing the total number of fish

species identified in the Hanford Reach to 44. Of these species, chinook salmon, sockeye salmon coho salmon, and steelhead trout use the river as a migration route to and from upstream spawning areas and are of the greatest economic importance. The Upper Columbia River steelhead, Upper Columbia River spring-run chinook salmon, and the bull trout are known to occur in the Columbia River immediately adjacent to the proposed project areas. All three species are federally listed as endangered

Benthic organisms are found either attached to or closely associated with the substratum. All major freshwater benthic taxa are represented in the Columbia River. Insect larvae such as caddisflies (*Trichoptera*), midge flies (*Chironomidae*), and black flies (*Simuliidae*) are dominant. Other benthic organisms include limpets, snails, sponges, and crayfish. Peak larval insect densities are found in late fall and winter, and the major emergence is in spring and summer (Neitzel 1999).

3.2.5 Archaeological, Cultural, and Historic Resources

Management of the Hanford Area cultural resources follows the *Hanford Cultural Resources Management Plan* (PNL 1989), which was approved by the State Historic Preservation Office in 1989. The Management Plan was developed to establish guidance for the identification, evaluation, recordation, curation, and management of archaeological, historic, and traditional cultural resources as individual entities or as contributing properties within a district. The plan specifies methods of consultation with affected tribes, government agencies, and interested parties, and includes strategies for the preservation and/or curation of representative properties, archives, and objects.

The proposed contaminated area was reviewed by staff from the Hanford Cultural Resources Laboratory (Appendix E). There are no known historic properties within the proposed contaminated area. A records review indicated that approximately half of the proposed contaminated area has been intensively surveyed for cultural resources. No archaeological sites or isolated artifacts were identified in the survey area. The proposed contaminated area is primarily within areas where the ground surface has been disturbed by prior Hanford Site construction activities. All but a very small part of the remainder of the proposed contaminated area not intensively surveyed is identified as original ground surface. Part of the proposed contaminated area is within 1,310 feet (400 m) of the Columbia River, which is considered culturally sensitive. A cultural resource expert is required to be present during excavation in this area.

The proposed southwest and southeast background areas have also been previously surveyed for cultural resources. No archaeological sites or isolated artifacts were located within the background areas. Review of 1941 aerial photographs indicates that, prior to Hanford Site development, the southwest background area was undeveloped range land, while the southeast background area was a combination of undeveloped and agricultural land. There are no known historic properties within either of the background areas.

3.2.6 Land Use, Recreation, and Aesthetic Resources

The Hanford Site encompasses 560 square miles (1,450 km^2) and includes several DOE operational areas. Land use categories at the Hanford Site include reactor operations, waste operations, administrative support, operations support, sensitive areas, and undeveloped areas. Remedial activities are currently focused within or near the disturbed areas, such as the 100 Areas. Much of the Hanford Site is undeveloped, providing a safety and security buffer for the smaller areas used for

operations. The entire Hanford Site has been designated a National Environmental Research Park. Public access to most facility areas is restricted.

DOE, in partnership with several cooperating agencies, has issued a Record of Decision based on the Hanford Comprehensive Land-Use Plan Environmental Impact Statement (EIS) (DOE/RL 1999b) to address proposed land uses at the Hanford Site over the next 50 years. The comprehensive land use plan provides a comprehensive and long-term approach to planning and development for the Hanford Site and recognizes the multiple uses that must be coordinated, including research and development activities. The 100 Areas are the site of eight retired plutonium production reactors and the N Reactor. The facilities in the 100 Areas are being placed in a stabilized state for ultimate decommissioning. Remedial activities are currently focused within or near the disturbed areas.

Access to the Hanford Site is restricted, so recreation does not occur on the site. However, access to the Hanford Reach of the Columbia River, which flows adjacent to the 100-H Area, is unrestricted. The river is used extensively for fishing, hunting, boating, windsurfing, water-skiing, diving, and swimming.

The Hanford Reach of the Columbia River is designated as Class A, Excellent. Class A waters are suitable for all uses, including raw drinking water, recreation, and wildlife habitat. Water quality is routinely monitored from locations upstream and downstream of the Hanford Site. State and federal drinking water standards apply to the Columbia River and are currently being met.

The land in the vicinity of the Hanford Site is generally flat with little relief. Rattlesnake Mountain, rising to 3,480 feet (1,060 m) above mean sea level, forms the southeastern boundary of the Hanford Site. Gable Mountain and Gable Butte are the highest landforms within the Hanford Site. Large rolling hills are located to the west and north of the Site. The Columbia River, flowing across the northern part of the Site and forming the eastern boundary, is generally considered scenic, with its contrasting blue against a background of dark basaltic rocks and desert sagebrush. The White Bluffs' steep, whitish-brown bluffs adjacent to the Columbia River (located across the river from the 100-H Area) are a striking natural feature of the landscape.

3.2.7 Socioeconomic Conditions

The Tri-Cities constitute the nearest population center and are located southeast of the Hanford Site. The 1997 estimates distributed the Tri-Cities population as follows: Richland 36,860, Pasco 26,000, and Kennewick 50,390. Activity on the Hanford Site plays a dominant role in the socioeconomics of the Tri-Cities and surrounding counties. In addition to providing direct employment, the Hanford payroll has a widespread impact on the Tri-Cities and state economies (Neitzel et al. 1999).

Three major employment sectors have been the principal driving forces of the economy of the Tri-Cities since the early 1970s: 1) DOE and its contractors operating the Hanford Site; 2) Energy Northwest and its operation of a commercial nuclear power plant located on the Hanford Site; and 3) the agricultural community, including a substantial food processing component. In 1997, nearly 20 percent of the nonagricultural jobs in Benton and Franklin counties were composed of DOE and its contractors at the Hanford Site (Neitzel et al. 1999).

Land in the surrounding environs is used for urban and industrial development, irrigated and dry-land farming, and grazing. Major industrial facilities within a 50-mile (80-km) radius include a meat-packing plant, food-processing facilities, fertilizer plants, a pulp and paper mill, chemical plant, hydroelectric dams, and small manufacturing firms. Within a 50-mile radius of the 100-H Area, but

outside the Hanford boundary, agriculture is the predominant land use. Government facilities located on the Hanford Site include retired chemical processing plants, radioactive waste control units, decontamination facilities, nuclear materials storage facilities, research laboratories, and a retired reactor at the 100-H Area. Commercial use of the Hanford Site includes a nuclear power plant (Energy Northwest Nuclear Plant 2) and a low-level radioactive waste burial area administered by Washington State and operated by U.S. Ecology Inc.

3.2.8 Human Health

Radioactive emissions from many onsite facilities are approaching levels practically indistinguishable from the naturally occurring radioactivity present everywhere. (PNNL 1998). This translates to a very small offsite radiation dose attributable to site activities. Using thermoluminescent dosimeters, radiological dose rates were measured at both onsite and offsite locations during 1997. Radioactive substances contributing to the measured dose rates were of either natural or man-made origin. The dose rates did not change significantly from the dose rates measured in previous years. The 1997 annual average background dose rate measured in communities distant from the Hanford Site was 67 ± 1 millirem per year (mrem/yr). The 1997 annual average perimeter dose rate was 89 ± 10 mrem/yr. All onsite thermoluminescent dosimeters averaged 85 ± 5 mrem/year (PNNL 1998).

The Hanford Environmental Health Foundation (HEHF) provides occupational health services to Hanford personnel through health risk management and occupational health monitoring. The HEHF's health risk management program identifies and analyzes the hazards Hanford personnel face in the work environment and brings an awareness to worker heath and safety issues at Hanford. HEHF's occupational health services provide occupational medicine and nursing, including medical monitoring and surveillance; ergonomics assessment; psychology and counseling; fitness for duty evaluation; infection control; immediate health care; industrial hygiene; and health, safety, and risk assessments.

Noise

Background noise levels were evaluated in the 1980s at five Hanford Site locations. Noise levels were expressed as equivalent sound levels for 24 hours (Leq-24). The average noise level for these five sites was 38.8 dB/A on the dates tested. The wind was identified as the primary contributor to background noise levels, with winds exceeding 12 miles per hour (19 km/hr) significantly affecting noise levels. This study concluded that background noise levels in undeveloped areas at the Hanford Site are generally in the range of 24 to 36 dB/A. Periods of high wind, which normally occur in the spring, would elevate background noise levels (Neitzel et al. 1999).

Noise levels at the 100-H Area are expected to be similar to the levels identified in the Hanford study. There might occasionally be higher noise levels associated with ongoing remediation work at 100-H. Potential activities at the contaminated area and background area are listed in Section 2.2.3. Noise associated with potential FRC activities would be produced by well-drilling equipment, compressors, trucks, and generators. Noise from FRC activities would be temporary and likely to disturb wildlife or other sensitive receptors for only short periods during daylight hours.

3.2.9 Waste Control

Wastes generated at the proposed contaminated area and background area could include small quantities of contaminated groundwater from drilling wells and sampling in contaminated zones;

small quantities of excess soil from coring; field laboratory wastes, some of which would be considered RCRA waste; biological wastes; domestic wastes from the offices and laboratories; and sanitary wastes.

There are existing waste disposal facilities on the Hanford Site for the disposal of radioactive, hazardous, chemical, biological, and domestic wastes.

3.2.10 Transportation

U.S. Department of Transportation (DOT) Hazardous Materials Regulations (Title 49, *CFR*, Parts 171-180) establishes requirements governing packaging and shipping hazardous materials on public highways. The standards are applicable to any necessary shipments of hazardous materials to or from the proposed FRC. The PNNL Shipping and Transportation Program ensures compliance with the DOT Hazardous Materials Regulations and DOE requirements specific to packaging and transportation safety. The PNNL Hazardous Materials Transportation Officer would be consulted to assure safe packaging and transportation of regulated samples, hazardous materials, or wastes.

The 100-H Area is restricted to use only by DOE and its contractors. In the vicinity of the proposed FRC, the majority of roads are being used for the decommissioning of the H Reactor Building, and for remediation activities at the 183-H Solar Evaporation Basins and 107-H Liquid Waste Trench. Large trucks are frequently on the roads.

3.2.11 Utilities and Infrastructure

The Hanford Site has a potable and raw water system, supplying the developed areas of the Site, including the 100-H Area. Electrical power is provided to the 100 Areas from the Bonneville Power Administration. Additional support services include sewers, fire protection, waste disposal, and safeguards, and security.

Key elements of site infrastructure include facilities and roads (DOE/RL 1994a). Onsite programmatic and general purpose facilities provide 6.5 million square feet (600,000 m^2) of space. General purpose facilities include offices, laboratories, shops, warehouses, and other facilities. Programmatic space supports a liquid waste evaporator, waste recovery, treatment, storage facilities, and research and development laboratories. The road network is well developed at Hanford with approximately 290 miles (460 km) of roads. Upgrades are planned or underway to support remediation efforts including in the 100 Areas, as hauling wastes and waste site cover material is integral to many of the remediation efforts. Ancillary facilities would be used to support the proposed FRC.

FRC staff and researchers would use existing facilities at PNNL, including offices/laboratories in the Life Science Building (331 Building), the Environmental Molecular Sciences Laboratory, Sigma V Building, the Research Technology Laboratory, the Chemical Engineering Laboratory, and the Plant Growth Facilities.

3.2.12 Environmental Justice

On February 11, 1994, the President of the United States issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*.

The Executive Order mandates that each federal agency make environmental justice part of the agency mission and to address, as appropriate, disproportionately high and adverse human health or environmental effects of the programs and policies on minority and low-income populations.

Approximately 383,934 people live within a 50-mile (80-km) radius of the Hanford Site. Based on 1990 census data, minorities compose nearly 25 percent of the population.

The distribution of minority populations residing in areas surrounding the Hanford Site is shown in Table 3-2. The table shows minority populations and the racial and ethnic compositions within a 50-mi (80-km) radius of the Site. At the time of 1990 census, Hispanics composed nearly 81 percent of the minority population surrounding the Hanford Site. The Site is also surrounded by a relatively large percentage (about 8 percent) of Native Americans because of the presence of the Yakama Indian Reservation in the vicinity (Neitzel et al. 1999).

Table 3-2. Description of the Populations Surrounding the Hanford Site (1990)

Environmental Justice Parameter	PNNL
Population and Minority Population Statistics	
Population within 50 mi (80 km) of center of Site	383,934
Minority population within 50 mi (80 km) of center of Site	25%
Native American and other race categories	7,913
Asian or Pacific Islander population	5,864
African American population	4,331
Hispanic origin population	76,933
Distribution of Low-Income Households in 50 mi Radius of Site	
Households in counties surrounding the Site	204,501
Low-income households in counties surrounding the Site	86,693
Percent of low-income households in counties surrounding the Site	42%

3.3 No Action

There would be no affected environment under the No Action alternative. No DOE sites would be used for operation of an FRC to conduct basic fundamental bioremediation research.