CHAPTER 4 ENVIRONMENTAL IMPACTS OF CONSTRUCTION

Chapter 4 presents the potential environmental impacts of construction and preconstruction activities for the Clinch River (CR) Small Modular Reactor (SMR) Project, which will include the construction and operation of two or more SMRs at the Clinch River Nuclear (CRN) Site.

As defined in Title 10 of the Code of Federal Regulations (10 CFR) 50.10, "construction" includes activities related to installation of structures, systems, and components related to safety, security, fire protection, or onsite emergency facilities. "Preconstruction" activities include site exploration, preparation for construction (including clearing, grading, and establishment of temporary roads), excavation, and erection of temporary construction support buildings.

As discussed in Section 3.9, the project schedule indicates that completion of preconstruction and construction activities for two or more SMRs would require approximately 6 years (yr). Preconstruction activities will occur over a period of approximately 1 yr and construction activities will continue for an additional approximately 4 to 5 yr.

In accordance with 10 CFR Part 51, impacts are analyzed, and a significance level of potential impact to each resource (i.e., SMALL, MODERATE, or LARGE) is assigned consistent with the criteria that U.S. Nuclear Regulatory Commission (NRC) established in 10 CFR Part 51, Appendix B, Table B-1, Footnote 3. Unless the impact is identified as beneficial, the impact is adverse. In the case of “SMALL,” the impact may be negligible. The definitions of significance are as follows:

SMALL — Environmental effects are not detectable or are so minor that they neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the NRC has concluded that those impacts that do not exceed permissible levels in the NRC’s regulations are considered SMALL.

MODERATE — Environmental effects are sufficient to alter noticeably, but not to destabilize important attributes of the resource.

LARGE — Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

This chapter is divided into seven sections:

- Land Use Impacts (Section 4.1)
- Water-Related Impacts (Section 4.2)
- Ecological Impacts (Section 4.3)
- Socioeconomic Impacts (Section 4.4)
- Radiation Exposure to Construction Workers (Section 4.5)

- Measures and Controls to Limit Adverse Impacts During Construction (Section 4.6)
- Cumulative Impacts Related to Construction Activities (Section 4.7)

These sections present the potential environmental impacts of construction of the CR SMR Project. Impacts are analyzed and a significance level of potential impact to each resource is assigned. In addition, this section presents ways to avoid, minimize, or mitigate adverse impacts of CR SMR Project construction to the maximum extent practical. For the purposes of this Environmental Report, the site, vicinity, and region are defined in Chapter 2.

4.1 LAND USE IMPACTS

The following subsections describe the impacts on land use and historic and cultural resources at the Clinch River Nuclear (CRN) Site and within the 6-mile (mi) vicinity associated with the Clinch River (CR) Small Modular Reactor (SMR) Project. Subsection 4.1.1 describes the effects on the CRN Site and the 6-mi vicinity. Subsection 4.1.3 describes the effects of construction on historic properties and cultural resources.

4.1.1 The Site and Vicinity

The following subsections describe the effects of preconstruction and construction activities on land use at the CRN Site and in the 6-mi vicinity. As described in Section 2.2, the CRN Site is approximately 935 acres (ac). As described in Section 3.1, approximately 30 ac of land off the CRN Site will be permanently impacted by roadway improvements and refurbishment of a barge terminal. Approximately 15 ac of land will be temporarily impacted by construction in the Barge/Traffic Area, which is off the CRN Site. An additional approximately 210 ac of land off the CRN Site will be temporarily impacted by construction of a 69-kilovolt (kV) underground transmission line within the existing Bull Run – Watts Bar 500-kV transmission line right-of-way (ROW). These improvements will occur within the 6-mi site vicinity.

4.1.1.1 The Site

The majority of the CRN Site currently consists of undeveloped areas as described in Subsection 2.2.1.1 and Table 2.2-1. Subsection 2.2.1.1 describes the current conditions at the CRN Site and past land uses and disturbances at the CRN Site, primarily associated with the Clinch River Breeder Reactor Project (CRBRP). Approximately 240 ac of the CRN Site were disturbed during site preparation for the CRBRP (Reference 4.1-1).

The surrogate plant for the Clinch River SMR project is described in Chapter 3. Figure 4.1-1 depicts the CRN Site layout during the construction process and shows the land cover of the areas that will be permanently and temporarily cleared during construction. Section 3.9 describes the construction activities that will occur on and in the vicinity of the CRN Site. The surrogate plant will permanently disturb approximately 327 ac of the CRN Site. An additional 167 ac will be temporarily disturbed during construction for use as laydown areas for staging materials, assembling project components, and installation of the onsite portion of the 69 kV underground transmission line. Table 4.1-1 lists the numbers of acres of each land use type which will be temporarily disturbed and permanently converted. Subsection 4.3.1.2 provides discussion regarding the impacts to wetlands.

Prime farmland at the CRN Site is discussed in Subsection 2.2.1.1. A Farmland Conversion Impact Rating (Form AD-1006) was completed by TVA in consultation with the USDA's Natural Resources Conservation Service to quantify the potential impacts to prime farmland. The impact rating considers the acreage of prime farmland to be converted, the relative abundance of prime farmland in the surrounding county, and other criteria such as distance from urban support

services and built-up areas, potential effects of conversion on the local agricultural economy, and compatibility with existing agricultural use. Sites with a total score of at least 160 have the potential to adversely affect prime farmland. The impact rating score for the CRN Site was 102 points (Environmental Report Appendix A). Therefore, the impact of the CR SMR Project on the relative value of farmland would be SMALL.

As stated in Subsection 2.2.1.1, there are no known mineral resources within or adjacent to the CRN Site that are being exploited or are of any known value. The only known mineral resource located within the CRN Site is limestone, which is not currently being exploited. There would be no adverse impacts on mineral resources from preconstruction and construction activities at the CRN Site.

Site preconstruction and construction activities that affect land use on the CRN Site and the associated areas off the CRN Site (i.e., Barge/Traffic Area and underground transmission line ROW) include clearing, grubbing, grading and excavating, stockpiling soils, and onsite disposal of construction-related debris. Materials excavated on the CRN Site would be stockpiled and/or used as fill onsite. Tennessee Valley Authority (TVA) expects to construct and operate an onsite landfill for construction, site clearing, and grading debris. The construction/demolition landfill would be sized to accommodate the anticipated materials and would be located in the permanently cleared laydown area north of the main plant area. The landfill would be constructed in accordance with relevant permits and licenses. No hazardous or municipal waste would be disposed of in this landfill. The landfill would be closed at the end of the construction period. Therefore, land use impacts associated with the onsite landfill would be SMALL.

Prior to commencement of earth-moving activities, appropriate permits and authorizations including coverage under the Tennessee Individual National Pollution Discharge Elimination System (NPDES) Permit for Construction Stormwater Discharges will be obtained and appropriate environmental control measures will be implemented. A site-specific Stormwater Pollution Prevention Plan (SWPPP) will be developed as a part of the permit application to prevent erosion, minimize the discharge of sediments with stormwater, prevent spills and address operation, maintenance, sampling, and reporting using site-specific details and best management practices (BMPs). The BMPs will be implemented in accordance with existing TVA best management practices and may include one or more of the methods described in the State of Tennessee Erosion and Sediment Control Handbook (Reference 4.1-2). Approval under the Construction Stormwater Permit will be in place before site preparation and preconstruction activities commence. Therefore, impacts associated with stormwater are considered to be SMALL.

Construction materials will be shipped to the CRN Site and construction debris and associated waste not placed in the onsite disposal pit will be removed from the Site via road, rail, and/or barge. Bear Creek Road and the U.S. Department of Energy (DOE) road near the Rail Offload Area will be modified to handle heavy haul traffic. The CRN Site Access Road will also be modified to handle heavy haul traffic into the CRN Site. River Road will be improved to handle regular patrol traffic. The DOE former K-25 Power House Area rail siding near the CRN Site, the

Rail Offload Area will be refurbished and stabilized for deliveries. The DOE former K-25 Barge Loading Area between Tennessee State Highway (TN) 58 and the CRN Site entrance will also be refurbished for deliveries. Alternatively, a new barge slip may be constructed. No dredging is anticipated to be required for the barge terminal. These road and barge improvements will occur within the CRN Site vicinity and are discussed in Subsection 4.1.1.2. Impacts to land use associated with roadway modifications on the CRN Site would be SMALL.

Transmission lines are discussed in Subsection 2.2.3 and Section 3.7. The 161 kV transmission line on the CRN Site will be relocated, as shown in Figure 3.7-1. The new location will be within the area designated as permanently disturbed on Figure 4.1-1. Changes to land use due to construction along the transmission corridor will include the removal of trees in the new ROW and the re-clearing of the existing transmission line ROWs. Additional information on transmission corridors is discussed in Section 5.6. Impacts to land use associated with construction of the new onsite 161 kV transmission line corridor would be SMALL.

Areas that are temporarily disturbed during preconstruction and construction activities will be rehabilitated and restored to a condition similar to their present land cover. Permanently disturbed locations will either be part of the plant itself or will be stabilized and contoured in accordance with plant design specifications and in compliance with applicable safety and permit requirements, regulations, and standard practices. As described previously, stormwater will be managed and controlled in accordance with a site-specific SWPPP. The impact on erosion and sedimentation on surface waters at the CRN Site and in the vicinity would be SMALL.

The Clinch River arm of the Watts Bar Reservoir surrounds the CRN Site on three sides. The Clinch River arm of the Watts Bar Reservoir in this area is not designated as a national wild or scenic river (Reference 4.1-3). As described in Subsection 2.5.2, currently limited hunting has been allowed on the CRN Site under a revised agreement between DOE and the Tennessee Wildlife Resources Agency (TWRA) that incorporated the CRN Site into the Oak Ridge Wildlife Management Area managed-hunt program for deer and wild turkey. After the commencement of construction activities on the CRN Site, hunting will no longer be allowed on the CRN Site. Additional information discussing recreational opportunities is provided in Subsection 2.5.2.5.

Zoning ordinances in Roane County and the City of Oak Ridge, Tennessee, are discussed in Subsections 2.2.1.2 and 2.5.2.4. The majority of the CRN Site is designated as Zone 2 – Project Operations. A strip along the reservoir shoreline is designated Zone 3 – Sensitive Resource Management. The Grassy Creek HPA (adjacent to the CRN Site) is also designated Zone 3 – Sensitive Resource Management/Natural Area. (Reference 4.1-4) The CR SMR project will attempt to follow all zone designations in its site planning. Should implementation of the CR SMR Project at the CRN Site conflict with existing zone allocations, TVA will follow its reservoir land management process to request modification of the CRN Site zones as appropriate. Impacts on land use associated with zoning would be SMALL.

There are no national wild and scenic rivers or recreational opportunities located on the CRN Site, and there are no zoning conflicts that affect the Site. Impacts on recreational types of land use would be SMALL.

Contacted tribes and tribal lands are discussed in Subsection 2.5.3.2. No concerns regarding the construction on the CRN Site have been received from the contacted tribes. As a result, the effects on tribal lands would be SMALL.

As discussed in Section 2.9, there are no related federal project activities within the CRN Site which will affect construction or operation. Therefore, effects on land within the CRN Site due to related projects would be SMALL.

4.1.1.2 The Vicinity

The vicinity of the CRN Site is defined as the area within a 6-mi radius of the center point of the surrogate plant. Land use in the vicinity of the CRN Site is described in detail in Subsection 2.2.1.2, summarized in Table 2.2-1, and shown in Figure 2.2-4. Land use outside the CRN Site but within the 6-mi radius is discussed in this subsection.

As part of the preconstruction and construction activities for the CR SMR Project, land off the CRN Site will be impacted by roadway improvements and refurbishment of a barge terminal in the Barge/Traffic Area, which extends from the CRN Site entrance northwest to encompass the ramp on the west side of TN 58 at Bear Creek Road (Figure 4.1-1). Approximately 30 ac of land in the Barge/Traffic Area will be permanently impacted, and approximately 15 ac of land will be temporarily impacted by the improvements in this area. Table 4.1-1 provides the numbers of acres of each land use type which will be temporarily disturbed and permanently converted by construction activities in the Barge/Traffic Area. Subsection 4.3.1.2 provides additional discussion regarding the impacts to wetlands.

As discussed in Subsection 4.1.1.1, there are no first-class or prime farmland soils within the Barge/Traffic Area and underground transmission line ROW. Therefore, the impact of the CR SMR Project on the relative value of farmland in the CRN Site vicinity will be SMALL.

As discussed in Subsection 4.1.1.1, the only known mineral resource within or adjacent to the CRN Site vicinity is limestone, which is not currently being exploited. Impacts of construction on mineral resources in the CRN Site vicinity would therefore be SMALL.

The road and highway system in Roane, Loudon, Anderson, and Knox counties is shown in Figure 2.5.2-1 and discussed in Subsection 2.5.2.2. Information pertaining to the effects of construction workers on the local road and highway system is presented in Subsections 4.4.2.3. Modifications to the existing ramp from TN 58 to Bear Creek road and construction of a new ramp connecting TN 58 to Bear Creek Road on the east side of TN 58 as part of the CR SMR Project is anticipated. This road and the ramps are shown in Figure 3.1-1. No bridge work will be anticipated as part of the CR SMR Project. Refurbishment of a barge terminal on the Clinch

River arm of the Watts Bar Reservoir is anticipated to allow the transport of heavy equipment and reactor components to the CRN Site. The impact on local roadways and waterborne transportation facilities would be MODERATE.

Figure 2.1-1 shows railways within the CRN Site region and Figure 2.1-2 shows railways within the 6 mi vicinity. Norfolk Southern rail lines are located approximately 7.5 mi northwest and 9 mi southeast of the CRN Site. The line to the southeast runs through Knoxville, Tennessee, connecting Chattanooga, Tennessee, with Johnson City and Kingsport, Tennessee. The nearest rail spur (Energy Solutions Heritage Railroad) is located 2.5 mi north-northwest of the CRN Site center point. This rail line will be utilized to transport materials in support of construction. The impact of construction on the rail line would be SMALL.

Transmission lines are discussed in Subsection 2.2.3 and Section 3.7. Service lines provide electrical power to the CRN Site for construction. A new 69 kV underground transmission line will be constructed from the CRN Site to the Bethel Valley substation within the existing 500 kV transmission line ROW as shown in Figure 3.7-2. Changes to land use due to construction along the transmission corridors could include the re-clearing of existing transmission line ROWs. Additional information on transmission corridors is discussed in Section 5.6. Impacts to land use associated with construction of the transmission line corridor would be SMALL.

Numerous locations within the CRN Site vicinity provide recreational opportunities; these facilities are discussed in Subsection 2.5.2.5.2. Offsite construction areas are limited in extent and do not intersect with any of these recreational areas or facilities. Therefore, impacts of construction on these recreational areas and facilities would be SMALL.

The Clinch River arm of the Watts Bar Reservoir is not designated a national wild and scenic river in the CRN Site vicinity, nor are any of the other rivers in the CRN Site vicinity (Reference 4.1-3). Thus, there will be no effects from construction on any national wild and scenic rivers in the vicinity of the CRN Site. Additional information about the Clinch River arm of the Watts Bar Reservoir can be found in Section 2.3.

Section 2.9 discusses the related federal project activities within the CRN Site vicinity which will affect preconstruction and construction activities. Impacts on other federal project activities from construction are considered to be SMALL.

4.1.2 Transmission Corridors and Offsite Areas

Transmission lines are discussed in Subsection 2.2.3 and Section 3.7. Impacts associated with onsite transmission line changes and the new underground 69 kV transmission line are described in Subsections 4.1.1.1 and 4.1.1.2 respectively. As described in Section 3.7, several offsite transmission lines in the region will be uprated. Changes to offsite land use due to construction along the transmission corridors will include the re-clearing of the existing transmission line ROWs. Additional information on transmission corridors is discussed in

Section 5.6. Impacts to offsite land use associated with uprating transmission lines would be SMALL.

As discussed in Subsection 2.2.3, fill material will be required for the CRN Site. In addition to potentially using borrow material from the CRN Site, offsite borrow sources may be used. The volume of fill material and selection of the source for fill material will be dependent on the backfill plan and the required material properties identified by analyses performed in support of the combined license application (COLA). Material excavated from portions of the CRN Site will be evaluated in accordance with the backfill plan to determine whether the material provides characteristics and quantities needed for use as fill on the site. If additional fill material is needed from offsite, the borrow source(s) will be selected based on the properties and quantities of fill material available at the potential source locations. The soil quality at each potential borrow site will be required to meet the criteria for acceptability for use as fill material at the CRN Site. Nine possible offsite borrow areas have been identified and are shown in Figure 2.2-8. The total acreage of these nine potential borrow sites is 227 ac. The combined volume of fill material present in the disturbed and fully permitted offsite borrow areas is anticipated to meet the volume of fill that would be needed for the CR SMR Project. Therefore, it is unlikely that any existing borrow areas would need to be expanded beyond currently permitted boundaries or that any new borrow areas would need to be opened to accommodate the CR SMR Project.

If material excavated on the CRN Site is not suitable for fill, it will be disposed of in accordance with TVA's waste management program and regulatory requirements or, if appropriate, in the onsite landfill. In Tennessee, borrow areas are subject to permitting under the State Stormwater Pollution Prevention regulations, Aquatic Resource Alteration Regulations depending upon proximity to aquatic resources, and state mining regulations, if applicable, depending upon the material to be excavated. Each of these state permitting programs includes environmental protection requirements that must be met during operation of the borrow area facilities. Based on compliance with these permitting programs and the expected availability of sufficient borrow material from existing borrow sites, land use impacts associated with the potential use of borrow areas would be SMALL.

4.1.3 Historic Properties

This subsection focuses on the potential for the CR SMR Project construction to affect historic properties within the CRN Site, within 0.5-mi of the CRN Site (including the Barge/Traffic Area), at the Melton Hill Dam, and within 0.5 mi of the Melton Hill Dam. Archaeological sites and aboveground historic properties are among the properties that can be considered for listing on the National Register of Historic Places (NRHP). They are the principal historic properties of concern with regard to effects from CRN Site construction, along with traditional cultural properties. (Subsection 2.5.3, Tables 2.5.3-1 and 2.5.3-2, and Figures 2.5.3-1 and 2.5.3-2 present the site numbers, locations, and NRHP status of relevant historic properties within the 10-mi radius of the CRN Site center point, which includes the Melton Hill Dam.) Direct effects from CR SMR Project construction to historic properties are possible within the CR SMR Project

area of potential effect (CR SMR Project APE). The CR SMR Project APE is described in Subsection 2.5.3.

As described in Subsection 2.5.3, no NRHP-listed properties are located on or immediately adjacent to the CRN Site or the Barge/Traffic Area. One NRHP eligible National Register Historic District (NRHD) is located within the CR SMR Project APE. Fifty-nine recorded archaeological sites, four isolated finds, one non-site locality, and one cemetery have been identified within or immediately adjacent to the CR SMR Project APE. Of these sites, one is considered eligible for listing on the NRHP; 16 are considered potentially eligible for the NRHP; and 42 are considered not eligible for the NRHP. Ten of the eligible and potentially eligible sites are avoidable. Within the CRN Site, sites 40RE0107, 40RE0595, 40RE0549, 40RE0104, and 40RE0105 will potentially be impacted by CR SMR Project preconstruction and construction activities. In the Barge/Traffic Area, sites 40RE138 and 40RE233, may be affected by CR SMR Project preconstruction and construction activities. Within the CR SMR Project APE, the Melton Hill Dam will potentially be impacted by CR SMR Project preconstruction and construction activities.

To avoid, minimize, and mitigate potential effects to historic properties, TVA has executed a Programmatic Agreement (PA) pursuant to 36 CFR 800.14(b)(3), the signatories are: TVA and the Tennessee State Historic Preservation Officer (SHPO). Invited concurring parties are the Eastern Band of the Cherokee Indians and the United Keetoowah Band of the Cherokee Indians in Oklahoma. The PA records the terms and conditions agreed upon to resolve potential adverse effects of the undertaking. It provides for modifications to the CR SMR Project APE, evaluating the NRHP eligibility of unevaluated resources (archaeological sites and historic architectural resources), evaluating project effects to resources, and resolution of adverse effects. The current PA is in effect until construction of the SMR project is complete or the undertaking is otherwise terminated (Reference 4.1-5). The following paragraphs describe the stipulations in the PA to avoid, minimize, and mitigate potential effects to historic properties within the CR SMR Project APE.

As stipulated in the PA, the CR SMR Project APE will remain as defined unless TVA determines, in consultation with the Tennessee SHPO, that final project plans warrant revisions to better delineate the area in which there is a potential for effects on historic properties. If project plans result in activities that would disturb soils or sediments to depths greater than the maximum depth investigated previously during the archaeological surveys of the CR SMR Project APE (approximately 80 centimeters/31 inches), in areas with potential for deeply buried cultural deposits, the CR SMR Project APE would be enlarged in the vertical dimension in those areas to include deposits not previously investigated that could be affected by the undertaking. Should the CR SMR Project APE be revised in either the vertical and/or horizontal direction, TVA would undertake any additional steps necessary to identify historic properties within the revised CR SMR Project APE. Such steps could include additional Phase I surveys. (Reference 4.1-5)

TVA, in consultation with the Signatories of the PA, shall seek ways to avoid adverse effects to properties determined eligible for inclusion in the NRHP whenever economically prudent and technically feasible. To the extent practical, TVA will:

- Avoid locating any project elements within the identified boundaries of NRHP-eligible historic properties
- Mark or delineate sensitive archaeological areas and define any special conditions placed on such areas located within the CR SMR Project APE on the plans to be used during construction
- Avoid locating any transmission line structure, substation, building, or infrastructure within the viewshed of any NRHP-eligible historic architectural resource (Reference 4.1-5)

After the SMR technology is selected and the facility layout is finalized, Phase II (site evaluation) consultations with the Tennessee SHPO, and federally recognized Native American tribes that attach religious and cultural significance to the historic property affected by the undertaking, will be conducted for any undetermined potentially eligible or eligible sites that cannot be avoided. After the investigation, if the TVA and the Tennessee SHPO agree that the property meets NRHP criteria, the property shall be considered eligible for inclusion in the NRHP. TVA would, then, continue to seek ways to avoid adverse effects to the property. If the property is found not eligible for the NRHP, TVA shall notify the Signatories of the PA and make the documentation available for public inspection pursuant to 36 CFR 800.4(d)(1). Provisions for resolving disagreements on eligibility are provided in the PA. (Reference 4.1-5) A final assessment of effects on such properties identified as “potentially eligible” or of “undertermined” eligibility for the NRHP, and any required mitigation, are dependent on the outcome of the Phase II testing, in consultation with the Tennessee SHPO and federally recognized Native American tribes that attach religious and cultural significance to the historic property.

If TVA, in consultation with the Signatories of the PA, determines that avoidance of NRHP-eligible properties is not possible, TVA shall notify and invite the Advisory Council on Historic Preservation to participate with the Signatories of the PA in establishing a course of action for minimization and mitigation of effects on such properties. TVA will consult with the Signatories of the PA to minimize effects to the extent realistically possible. If both avoidance and minimization are not possible, TVA will develop treatment measures for mitigation of adverse effects. TVA shall consult with the Signatories to reach agreement on appropriate mitigation measures. For NRHP-eligible archaeological sites, mitigation shall consist of data recovery. TVA will develop a Data Recovery Plan, written by a qualified professional archaeologist, that meets Secretary of the Interior standards. The Data Recovery Plan shall be developed consistent with the applicable provisions in 36 CFR 800.5 and 800.16, the standards set forth in Archeology and Historic Preservation: Secretary of Interior’s Standards and Guidelines, and the standards set forth in the Tenness SHPO Standards and Guidelines for Archaeological Resource Management Studies (March 2009 revision). TVA will distribute the Data Recovery Plan to the Signatories for concurrence. The Data Recovery Plan shall specify, at a minimum:

- The property, properties, or portions of properties where data recovery is to be carried out
- Any property, properties, or portions of properties that will be destroyed without data recovery
- The research questions to be addressed through data recovery, with an explanation of their relevance and importance
- The field and laboratory methods to be used, with an explanation of their relevance to the research questions
- The methods to be used in analysis, data management, and dissemination of data
- A schedule for implementation of the above parts of the Plan
- The curation facility selected by TVA, in consultation with the Tennessee SHPO, and the procedures for curation of the recovered materials and records consistent with the curation standards prescribed in 36 CFR Part 79 (except for human remains)
- Procedures for the treatment of any human remains discovered within the CR SMR Project APE as a consequence of implementation of the Data Recovery Plan
- Proposed methods for involving the interested public in data recovery and for disseminating results of the work to the interested public
- A proposed schedule for the submission of progress reports to the Tennessee SHPO (Reference 4.1-5)

In the event of potential impacts to historic architectural properties (historic district, site, building, structure, or object), mitigation would be developed in consultation with the Signatories of the PA. Mitigation measures could include, but are not limited to:

- Vegetation screening
- Historic American Building Survey (HABS) or Historic American Engineering Record (HAER) equivalent documentation
- Preparation of a Tennessee Historical and Architectural Resource form
- National Register of Historic Places nomination
- Interpretative panels presenting summary historical information about the resource in a location accessible for public viewing
- Presentation of historical research paper at a public meeting or professional conference (Reference 4.1-5)

TVA will adhere to and comply with the stipulations of the PA. Because there is the potential for undiscovered resources and human remains and because the extent of effects to those undiscovered resources is unknown, impacts to historic properties as a result of preconstruction and construction activites associated with the CR SMR Project would be SMALL to

MODERATE. Implementation of the mitigation measures as stipulated in the PA would minimize the potential for LARGE impacts to historic properties.

4.1.3.1 Prehistoric and Historic Archaeological Sites

Archaeological sites may be adversely affected by the construction of the CR SMR Project. As described previously, final assessment of effects to archaeological sites within the CR SMR Project APE and any required mitigation are dependent on the outcome of the Phase II testing/reporting conducted in consultation with the SHPO and federally recognized Native American tribes that attach religious and cultural significance to the historic property. Project effects to archaeological sites determined in consultation to be eligible for listing in the NRHP would be treated pursuant to mitigation measures developed in consultation with the consulting parties. As described previously, because there are the potential for undiscovered resources and human remains and because the extent of effects to those undiscovered resources is unknown, impacts to archaeological sites as a result of preconstruction and construction activites associated with the CR SMR Project would be SMALL to MODERATE. Implementation of the mitigation measures as stiupated in the PA would minimize the potential for LARGE impacts to archaeological sites.

With preconstruction and construction activities, there is the possibility for the inadvertent discovery of previously unknown archaeological resources or human remains. The PA describes the measures that will be implemented in the event of such discoveries. Should previously unknown archaeological resources be discovered, sites will be protected and stabilized to prevent any further disturbance. Ground-disturbing work will stop within a 50-foot (ft) radius of the discovery. TVA, in consultation with the SHPO and federally recognized Native American tribes that attach religious and cultural significance to the property affected by the undertaking, would develop and implement a discovery plan to make an informed NRHP eligibility determination. TVA would continue to fulfill all stipulations of the PA and its obligations under Section 106. Ground-disturbing work would not resume at the previously unknown site until completion of the NRHP determination and PA signatory consultation. (Reference 4.1-5)

In the event of discovery of human remains as a result of preconstruction and/or construction activities, TVA will implement the following measures. TVA will:

- Ensure that the treatment of any human remains complies with all state and federal laws concerning archaeological sites and treatment of human remains
- Immediately cease all-ground disturbing activities within a 10-ft radius of the burial
- Notify the Roane County Coroner and the Tennessee SHPO within 24 hours (hr)
- Notify the Signatories of the PA and potentially culturally affiliated federally-recognized tribal governments within 72 hr and invite them to comment on any plans developed to treat the human remains

- Ensure that the remains are treated in a manner consistent with the Advisory Council on Historic Preservation's *Policy Statement Regarding Treatment of Burial Sites, Human Remains, and Funerary Objects* (2007) and will be conducted in accordance with the applicable provisions of Tennessee Code Annotated (T.C.A.) 46-4-101 et seq. (*Termination of Use of Land as a Cemetery*); T.C.A. 11-6-116 (*Excavation of Areas Containing Native American Indian Remains*); T.C.A. 11-6-119 (*Reburial of Human Remains or Native American Burial Objects Following Discovery or Confiscation*); and Tennessee Rules and Regulations Chapter 0400-9-1 (*Native American Indian Cemetery Removal and Reburial*) (Reference 4.1-5)

4.1.3.2 Historic Structures

As discussed in Subsection 2.5.3.7.2, one eligible nominated NRHD, the Melton Hill Hydroelectric Project/Melton Hill Dam was identified within the CR SMR Project APE. As described in Subsection 3.4.2.5, TVA has identified the potential need for a future minor modification to the flow of the Clinch River in the CR SMR Project vicinity. An increase in flow of up to 400 cubic feet per second (cfs) may be needed to regulate water temperatures in the Clinch River arm of the Watts Bar Reservoir during times of low water levels, depending on the reactor design ultimately selected for the site. The magnitude of the change would be small compared to the average unregulated flow of 4520 cfs at Melton Hill Dam, approximately 3.5 river miles upstream of the intake location. TVA is considering a number of alternatives for providing this additional flow. Some of the alternatives could require changes at Melton Hill Dam. Project designs would not be proposed until a reactor design is selected. The Melton Hill Dam (including the spillway) is a contributing structure to the Melton Hill Hydroelectric Project nominated NRHD. TVA will adhere to and comply with the stipulations of the PA with respect to modifications of the Melton Hill Dam. Therefore, impacts to historic structures as a result of preconstruction and construction activities associated with the CR SMR Project would be SMALL to MODERATE. Implementation of the mitigation measures as stipulated in the PA would minimize the potential for LARGE impacts to historic structures.

4.1.3.3 Cemeteries

One cemetery, the Hensley Cemetery, exists on the CRN Site. As discussed in Subsection 2.5.3.9, this cemetery is not eligible for the NRHP. TVA has determined that this cemetery will remain in place onsite and that families will be able access the cemetery (Reference 4.1-6). Therefore, impacts to the Hensley Cemetery would be SMALL.

4.1.3.4 Traditional Cultural Properties

As discussed in Subsection 2.5.3.10, no traditional cultural properties have been identified in consultation with federally recognized Native American tribes that attach religious and cultural significance to an archaeological historic property, or any other interested parties on the CRN Site, or within a 0.5-mi radius from the CRN Site.

4.1.4 References

Reference 4.1-1. U.S. Department of Energy, "Clinch River Breeder Reactor Plant Project Site Redress Plan," March, 1984.

Reference 4.1-2. Tennessee Department of Environment and Conservation, "Tennessee Erosion & Sediment Control Handbook - Fourth Edition," August, 2012.

Reference 4.1-3. National Park Service, Tennessee Segments of the National River Inventory, Website: http://www.nps.gov/ncrc/programs/rtca/nri/states/tn.html, January 18, 2007.

Reference 4.1-4. Tennessee Valley Authority, "Final Environmental Impact Statement Watts Bar Reservoir Land Management Plan Loudon, Meigs, Rhea, and Roane Counties, Tennessee," February, 2009.

Reference 4.1-5. Tennessee Valley Authority and Tennessee State Historic Preservation Officer, "Programmatic Agreement between the Tennessee Valley Authority and the Tennessee State Historic Preservation Office regarding the management of historic properties affected by the Clinch River SMR Project," July 20, 2016.

Reference 4.1-6. AECOM, "Final Clinch River Site Land Use and Recreation Technical Report - Revision 2," Greenville, SC, Tennessee Valley Authority, October, 2014.

Table 4.1-1 (Sheet 1 of 2)
Land Cover Types to be Disturbed by Development on the CRN Site

Land Cover Type	Approximate Acreage Affected	Percentage of Disturbed Areas	Total Acreage on the CRN Site	Percent of Land Cover Type Distrubed on the CRN Site
CRN Site - Temporarily Disturbed Areas				
Barren Land (Rock/Sand/Clay)	6	4	20	30
Cultivated Crops	0	0	8	0
Deciduous Forest	55	33	320	17
Developed, High Intensity	0	0	1	0
Developed, Medium Intensity	0	0	6	0
Developed, Low Intensity	0	0	19	0
Developed, Open Space	0	0	42	0
Emergent Herbaceous Wetlands	0	0	0	0
Evergreen Forest	13	8	67	19
Grassland/Herbaceous	7	4	26	27
Mixed Forest	6	4	62	10
Open Water	0	0	16	0
Pasture/Hay	64	38	245	26
Shrub/Scrub	11	6	20	55
Woody Wetlands	5	3	83	6
Total:	167	100	935	NA
CRN Site - Permanently Disturbed Areas				
Barren Land (Rock/Sand/Clay)	14	4	20	70
Cultivated Crops	7	2	8	88
Deciduous Forest	78	24	320	24
Developed, High Intensity	0	0	1	0
Developed, Medium Intensity	4	1	6	67
Developed, Low Intensity	14	4	19	74
Developed, Open Space	17	5	42	40
Emergent Herbaceous Wetlands	0	0	0	0
Evergreen Forest	14	4	67	21
Grassland/Herbaceous	16	5	26	62
Mixed Forest	14	4	62	23
Open Water	1	1	16	6
Pasture/Hay	122	37	245	50
Shrub/Scrub	4	2	20	20
Woody Wetlands	22	7	83	27
Total:	327	100	935	NA

Table 4.1-1 (Sheet 2 of 2)
Land Cover Types to be Affected by Development on the CRN Site

Land Cover Type	Approximate Acreage Affected	Percentage of Affected Areas	Total Acreage in the Barge/Traffic Area	Percent of Land Cover Type Affected in the Barge/Traffic Area
Barge/Traffic Area - Temporarily Disturbed Areas				
Barren Land (Rock/Sand/Clay)	0	0	1	0
Cultivated Crops	1	7	4	25
Deciduous Forest	10	66	102	10
Developed, High Intensity	0	0	2	0
Developed, Medium Intensity	4	27	16	25
Developed, Low Intensity	0	0	21	0
Developed, Open Space	0	0	4	0
Emergent Herbaceous Wetlands	0	0	2	0
Evergreen Forest	0	0	7	0
Grassland/Herbaceous	0	0	1	0
Mixed Forest	0	0	0	0
Open Water	0	0	9	0
Pasture/Hay	0	0	28	0
Shrub/Scrub	0	0	0	0
Woody Wetlands	0	0	9	0
Total:	15	100	203	NA
Barge/Traffic Area - Permanently Disturbed Areas				
Barren Land (Rock/Sand/Clay)	0	0	1	0
Cultivated Crops	2	7	4	50
Deciduous Forest	7	24	102	7
Developed, High Intensity	0	0	2	0
Developed, Medium Intensity	6	20	16	38
Developed, Low Intensity	7	24	21	33
Developed, Open Space	3	10	4	75
Emergent Herbaceous Wetlands	0	0	2	0
Evergreen Forest	1	2	7	14
Grassland/Herbaceous	0	0	1	0
Mixed Forest	0	0	0	0
Open Water	0	0	9	0
Pasture/Hay	3	11	28	11
Shrub/Scrub	0	0	0	0
Woody Wetlands	1	2	9	11
Total	30	100	203	NA

Note: NA = Not applicable

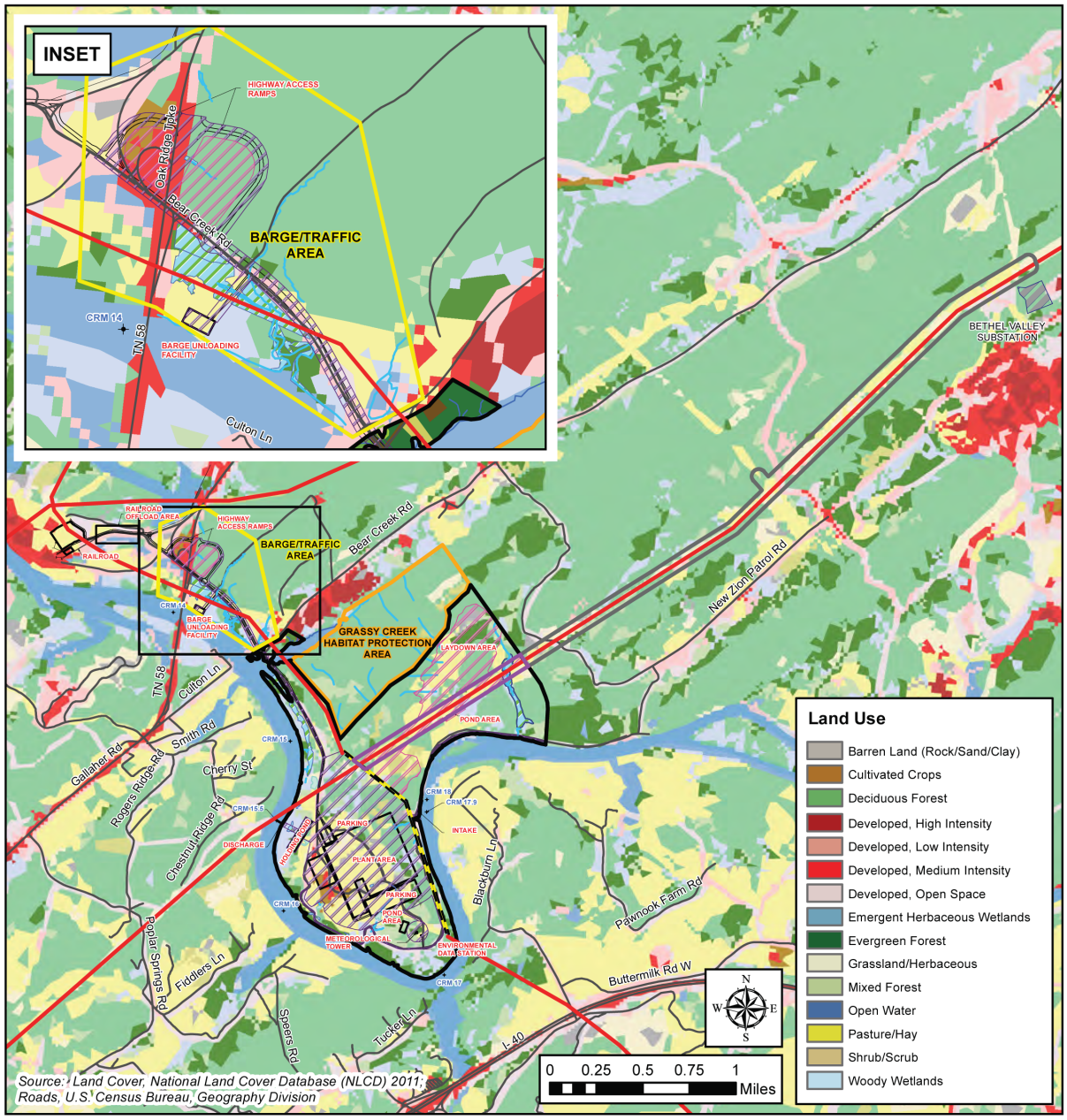

Figure 4.1-1. Areas to be Cleared and Land Cover Disturbed on the CRN Site Vicinity

4.2 WATER-RELATED IMPACTS

This section describes water-related impacts that could result from construction and preconstruction activities for the Clinch River (CR) Small Modular Reactor (SMR) Project. Subsection 4.2.1 addresses hydrologic alterations, Subsections 4.2.2 and 4.2.3 address water use impacts and water quality impacts, respectively.

Potential water-related impacts from construction of a nuclear power plant could include:

- Direct physical alteration of local streams and wetlands
- Indirect physical alteration of receiving surface water bodies, especially streams, due to increased runoff volumes and rates during construction or diversions of runoff
- Alteration of surface water quality as a result of erosion and sedimentation
- Discharges of pollutants associated with construction activities
- Changes in groundwater flow patterns from dewatering and soil retention management practices
- Downgradient groundwater quality changes from spills of fuels and lubricants used in construction equipment
- Increased groundwater use during construction

The following subsections describe the anticipated construction-related impacts to both surface water and groundwater resources.

4.2.1 Hydrological Alterations

This subsection identifies and describes the hydrological alterations that could result from construction of SMRs at the Clinch River Nuclear (CRN) Site. The following preconstruction and construction activities have the potential to impact the hydrology at the CRN Site:

- Clearing land and installing infrastructure such as roads and stormwater conveyance and retention systems
- Raising the surface grade
- Constructing new buildings and structures (reactor containment structure, turbine building, cooling towers, electrical substation, sub-grade piping and systems), roads, rails, parking lots
- Constructing transmission towers
- Constructing cooling water intake and discharge structures on the shoreline and into the reservoir
- Placing the diffuser in the reservoir

- Disturbing currently vegetated areas and wetlands for construction laydown areas, concrete batch plants, sands/gravel stockpiles and construction-phase parking areas
- Dewatering foundation excavations during construction
- Improving rail siding and barge terminal

4.2.1.1 Surface Water

Surface water could potentially be impacted by land-based construction activities such as building and infrastructure construction or water-based construction activities such as barge terminal improvements and excavations along the shoreline in the intake and discharge areas. The potential surface water hydrological impacts of these activities would be SMALL as described below.

4.2.1.1.1 Land-Based Construction

Land-based preconstruction and construction activities for Tennessee Valley Authority (TVA) projects, including site grading, access road improvements, transmission line installation, power block excavation, and building construction, are conducted in accordance with all applicable federal, state and local regulations, and TVA procedures.

As discussed in Subsection 4.1.1.1, anticipated construction and preconstruction activities on the CRN Site include clearing, grubbing, grading and excavating, and stockpiling soils. Materials excavated on the CRN Site are to be stockpiled and/or used as fill onsite. Prior to commencement of earth-moving activities, TVA obtains all appropriate permits and authorizations and appropriate environmental control measures are implemented. As part of the application for a National Pollutant Discharge Elimination System (NPDES) permit, TVA will submit a Notice of Intent (NOI) for Construction Activity Stormwater Discharges and an associated Stormwater Pollution Prevention Plan (SWPPP) to the Tennessee Department of Environment and Conservation (TDEC). SWPPPs are implemented to minimize the discharge of sediments and other pollutants with stormwater. The NPDES permit will be obtained before any construction activities take place.

In addition to the Clinch River arm of the Watts Bar Reservoir, there are four perennial streams, one intermittent stream, and 19 ephemeral streams/wet-weather conveyances (WWCs) on the CRN Site (Figure 2.4.1-2; (Reference 4.2-1)). The current footprint of the land-based construction likely would directly impact one small perennial stream (S01) and 11 WWCs. Stream S01 and six of these WWCs are within the footprint of the areas to be permanently developed and would be removed. Portions of five WWCs are within the area in the northeast portion of the CRN Site to be temporarily developed then revegetated and restored following completion of construction.

In order to minimize the potential surface water impacts, soil stockpiles and disturbed areas are stabilized using best management practices (BMPs) in accordance with design specifications.

Revegetation activities required by applicable soil erosion and sediment control permits would be conducted in accordance with site maintenance and safety requirements. As stated in Subsection 3.9.2.1, drainage control measures for the spoils piles may include berms, riprap, sedimentation filters, and detention ponds. Land-based construction-related discharges would be managed in accordance with the CRN Site's SWPPP and NPDES permit for discharges of stormwater associated with construction activities. BMPs and engineered site drainage structures are used to control run-off. Existing and additional stormwater retention ponds would moderate the increased runoff from impervious structures and surfaces and allow infiltration to reduce runoff directly into the reservoir. This would limit stormwater flow rates into the reservoir and associated increases in stormwater discharges during high intensity precipitation events. Assuming the implementation of effective stormwater controls and given the small size of the single perennial stream that would be lost, effects on hydrology are expected to be so minor that they neither destabilize nor noticeably alter any important attribute of the surface water resources of the area. Therefore, the hydrological impacts on surface water from land-based construction would be SMALL.

4.2.1.1.2 Water-Based Construction

As discussed in Subsection 3.9.2.11, no dredging would be required for the project. However, there would be underwater excavation required along the shoreline, for construction of the intake structure. In addition, underwater excavation would be required to bury the diffuser pipe at the discharge. The Lower Clinch River sediments are listed as impaired for mercury, polychlorinated biphenyl (PCBs), and chlordane. Additional legacy contamination present in the portion of the Clinch River arm of the Watts Bar Reservoir adjacent to the CRN Site includes radionuclides from U.S. Department of Energy (DOE) activities.

As shown in Table 1.2-2, a Clean Water Act Section 404 permit for disturbance of wetlands and navigable waters, and a Rivers and Harbors Act Section 10 permit for construction within navigable waters, are among the authorizations and permits that will be obtained, if applicable. In addition to obtaining and complying with the conditions of these permits, TVA is party to an Interagency Agreement, along with the U.S. Army Corps of Engineers (USACE), DOE, TDEC, and the U. S. Environmental Protection Agency (EPA), to coordinate review of permitting and other use authorization activities which could result in the disturbance, re-suspension, removal, and/or disposal of contaminated sediments in the reservoir. The agreement, signed in 1991, defines how each agency coordinates with the others to review proposed activities to determine their potential to disturb contaminated sediments. (Reference 4.2-5) TDEC requires monitoring of sediment in the area(s) where disturbance of sediment is proposed. In addition, Section 404 and Section 10 permit conditions intended to ensure that activities which disturb sediments do not further degrade surface water quality will be followed. Any sediment removed may also contain manmade radionuclides; therefore coordination of the disposition of the sediment with DOE is also anticipated.

Burial of diffusers and construction of intake and discharge structures may cause localized changes in surface water flow patterns. However, water-based construction of the intake

structure is expected to be limited to an area along the shoreline, and burial of the diffuser pipe would involve only temporary modification of the river bottom. These activities would not be expected to destabilize the surface water resource. Therefore, the overall hydrological impacts on surface water from water-based construction would be SMALL.

4.2.1.2 Groundwater

Potential hydraulic alterations to groundwater that may result from preconstruction and construction activities include those associated with dewatering.

As discussed in Subsection 2.3.2.2.4, temporary dewatering would be required to maintain a dry excavation for the construction of the foundations for the CR SMR Project structures. It is anticipated that dewatering would be accomplished using similar techniques as were used during the Clinch River Breeder Reactor Project (CRBRP), including installation of horizontal gravity drains in the excavated rock faces and pumping from sumps located around the perimeter of the excavation and at the base of the excavation. These dewatering methods are localized to the power block area excavation and to the areas immediately in the vicinity of the power block excavations. All de-watering flows would be routed to one of the stormwater retention ponds (either existing or planned to be installed as part of initial construction). Once dewatering is no longer needed, the water table is expected to return to static conditions.

During the CRBRP, results of the test grouting program and bedrock verification program investigated the depth of weathering in bedrock. These investigations concluded that the foundations would be anchored in solid, unweathered bedrock and there would be no risk of subsidence. (Reference 4.2-2) Therefore, dewatering is not anticipated to create subsidence in adjoining areas and impacts from the dewatering of the excavation would be SMALL.

4.2.2 Water-Use Impacts

This subsection describes the potential impacts of water use during preconstruction and construction activities.

4.2.2.1 Surface Water

Surface water may be used during the preconstruction and construction phases of the project for activities such as dust suppression. A conservative estimate of the volume of surface water to be used for dust suppression is 5000 gallons per day (gpd). The minimum daily flow rate of the Clinch River arm of the Watts Bar Reservoir past the CRN Site (release rate from the Melton Hill Dam) is more than 179,000 gallons per minute (gpm). Withdrawal and consumption of 5000 gpd (or 3.5 gpm) of surface water for dust suppression would be less than 0.002 percent of the daily flow rate. The City of Oak Ridge would provide potable water during construction activities. The City of Oak Ridge obtains potable water from the Melton Hill Reservoir (Reference 4.2-3). Therefore, the impacts from surface water use during preconstruction and construction would be SMALL.

4.2.2.2 Groundwater

There are no planned uses of groundwater during construction activities; therefore the hydrologic impacts from groundwater use would be SMALL.

4.2.3 Water Quality Impacts

Various impacts to water quality may occur as a result of preconstruction and construction activities. These potential impacts include: increased soil erosion and/or sediment transport, changes in stormwater flow, and changes in water quality parameters such as pH and temperature. The following subsections discuss the potential effects of construction activities on surface water and groundwater quality.

4.2.3.1 Surface Water

Impacts to surface water quality can occur as the result of chemical spills, dewatering, and soil erosion due to ground disturbance during construction. Additionally, accidental discharges of construction-related chemicals such as fuel, oil or grease can occur. As stated in Subsection 2.3.1.1 and shown on Figure 2.3.1-1, water bodies near the CRN Site that discharge to the Clinch River arm of the Watts Bar Reservoir include Caney Creek, Poplar Springs Creek, and Grassy Creek. Caney Creek and Poplar Springs Creek enter the Clinch River arm of the Watts Bar Reservoir on the shore opposite the CRN Site; Grassy Creek enters from the northwestern corner of the CRN Site. As discussed in Subsection 4.1.1.1, the CR SMR Project would permanently disturb 327 acres (ac) on the CRN Site and 30 ac offsite for road, rail, and barge terminal improvements. An additional 167 ac on the CRN Site would be temporarily disturbed during construction for use as laydown areas for staging materials and assembling project components, as well as installation of the onsite portion of the 69-kV underground transmission line within the existing ROW of the 500-kV transmission line. Approximately 15 ac offsite would be temporarily disturbed during construction of road and rail improvements and barge terminal refurbishment. Up to an additional 210 ac offsite would be temporarily disturbed for installation of the offsite portion of the 69-kV underground transmission line. Table 4.1-1 lists separately the acreage of each land cover type which would be temporarily disturbed and permanently converted within the CRN Site and the Barge/Traffic Area.

As discussed in Subsection 4.2.1.1.1, compliance with federal, state, and local requirements minimizes potential impacts, construction and preconstruction activities. Surface water monitoring requirements for the preconstruction and construction phases are developed as part of the permit application for a NPDES permit for stormwater discharges issued by the TDEC. Prior to initiation of construction, a completed and signed NOI for Construction Activity - Stormwater Discharges will be submitted to TDEC, and the NPDES permit will be obtained. A site-specific SWPPP will be developed and submitted with the NOI. In addition, compliance with the terms of applicable Section 404 and Section 10 permits, and coordination with the USACE, DOE, TDEC, and EPA on these permits, is expected to minimize the amount of disturbance of contaminated sediments.

Given that construction-related discharges would be managed in accordance with the CRN Site's SWPPP and NPDES permit for stormwater discharges, BMPs would be followed during construction, and permit and coordination requirements for disturbance of contaminated sediments would be followed, the impacts of construction on surface water quality would be SMALL.

4.2.3.2 Groundwater

Dewatering of the power block area usually occurs within a limited area during the duration of the construction of the below grade nuclear island structures and foundations. Drainage sumps installed at the bottom of the excavation pump surface drainage and/or accumulated groundwater to an established and, if necessary, permitted release point. However, these activities will not have any permanent effect at the CRN Site because of the following:

- The extent of the dewatering effects on groundwater levels is expected to be limited to about 150 ft from the edge of the excavation, based on the pumping test data, and is not expected to impact existing or future offsite groundwater users; and

- Streams, pond, and wetlands present on the CRN Site are not expected to be impacted by excavation dewatering. The closest such feature, excluding wetlands planned for removal, is approximately 500 ft away from the limits of the power block area, whereas excavation dewatering within the power block area is expected to have a radius of influence of approximately 150 ft. Therefore, no impact on groundwater levels and on groundwater discharge to springs, streams, ponds, and wetlands is expected.

Also during construction, gasoline, diesel fuel, hydraulic lubricants, and other similar products are used for construction equipment. Controls are described in Integrated Pollution Prevention Plans. BMPs are also employed during construction to minimize potential discharges to the environment. Construction dewatering is managed in accordance with TVA BMP procedures and Construction Stormwater Permits which may include design considerations described in Practice 7.21 of the State of Tennessee Erosion and Sediment Control Handbook, depending upon the volume of water involved (Reference 4.2-4).

In the unlikely event small amounts of contaminants are released into the environment, they would have only a small, localized, temporary impact on the water table aquifer. In conclusion, because engineering controls which prevent or minimize the release of harmful effluents would be used, and effluent concentrations would be maintained at levels below permitted limits established to be protective of water quality and aquatic life, any impacts to groundwater quality would be SMALL and would not warrant mitigation beyond those described in this subsection or required by a permit.

4.2.4 References

Reference 4.2-1. Howard, Charles S., Henderson, Andrew R., and Phillips, Craig L., "Clinch River Small Modular Reactor and Barge/Traffic Site Evaluation of Aquatic Habitats and Protected Aquatic Animals Technical Report - Revision 4," Tennessee Valley Authority, November 20, 2015.

Reference 4.2-2. Project Management Corporation, "Clinch River Breeder Reactor Plant Environmental Report Volume V," 1982.

Reference 4.2-3. City of Oak Ridge, Tennessee, "Annual Water Quality Report 2014," TN0000522, 2014.

Reference 4.2-4. Tennessee Department of Environment and Conservation, "Tennessee Erosion & Sediment Control Handbook - Fourth Edition," August, 2012.

Reference 4.2-5. Tennessee Valley Authority, "Interagency Agreement (Memoranda of Agreement [MOA]) Watts Bar Reservoir Permit Coordination," February 1991.

4.3 ECOLOGICAL IMPACTS

This section describes the potential effects on terrestrial and aquatic ecological resources from preconstruction and construction activities for the Clinch River (CR) Small Modular Reactor (SMR) Project, which includes the construction and operation of two or more SMRs at the Clinch River Nuclear (CRN) Site. For the purposes of this assessment, the plant parameter envelope was used as the source of bounding values for the new plant.

As discussed in Section 3.9, the anticipated project schedule indicates that completion of preconstruction and construction activities for two or more SMRs would require approximately 5 years (yr). Preconstruction activities would occur over a period of approximately 1 yr and construction activities would continue for an additional approximately 4 to 5 yr. Ecological impacts from construction are likely to occur principally during preconstruction, when existing habitats would be removed in many areas of the CRN Site to prepare for the installation of both temporary and permanent facilities.

Preconstruction and construction activities associated with the CR SMR Project have the potential to affect terrestrial and aquatic ecosystems occurring on and adjacent to the CRN Site. These resources include upland and wetland habitats, streams and ponds, and the ecological communities they support. Preconstruction activities such as land clearing, grading, excavation, and filling have the greatest potential to result in substantial effects on ecosystems.

The extent of the areas on the CRN Site that would be affected by these activities was estimated conservatively such that it would encompass the range of possible requirements associated with the various SMR design options under consideration. Therefore, the potentially affected areas evaluated represent an upper bound estimate, and the actual areas disturbed may be somewhat smaller. Figure 4.3-1 shows the general layout of facility, laydown and storage areas, with the proposed cleared areas superimposed on the land cover types currently present on the CRN Site. It is estimated that up to approximately 494 acres (ac) of the CRN Site would be affected by preconstruction and construction activities, including approximately 327 ac that would be permanently covered by the facility or otherwise developed and 167 ac that would be affected temporarily during construction.

In addition to the areas on the CRN Site that would be affected by preconstruction and construction, additional areas that would be affected are located off the CRN Site within an existing transmission line right-of-way (ROW) and the Barge/Traffic Area. The Barge/Traffic Area extends northwest from the CRN Site entrance to Tennessee State Highway (TN) 58. The Barge/Traffic Area encompasses locations that would be affected by the development of the barge facility and its haul road, the construction of road/intersection improvements to facilitate the flow of traffic, and the hauling of heavy loads into and out of the CRN Site. Development plans for the CRN Site and adjacent areas are shown in Figure 3.1-2. The only new transmission line proposed to be built off the CRN Site is a 69-kilovolt (kV) underground line to be installed within the existing 500-kV ROW from the CRN Site to the Bethel Valley substation, located approximately 5 miles (mi) northeast of the CRN Site. The preconstruction activities

involved in installing the 69-kV underground line are expected to occur principally within the ROW. Modifications to other segments of the existing transmission system also are planned, but new ROWs would not be developed.

4.3.1 Impacts to Terrestrial Ecosystems

The terrestrial ecosystem of the CRN Site is described in detail in Subsection 2.4.1, including both upland and wetland habitats and the ecological communities and important species they support. Subsection 2.4.1 also briefly describes these features for areas off the CRN Site, including the Barge/Traffic Area. Subsection 4.3.1 evaluates the potential effects of preconstruction and construction activities on the terrestrial ecosystems that occur on the CRN Site, the Barge/Traffic Area, and in the proposed 69-kV underground line installation area.

4.3.1.1 Upland Habitats

Dominant vegetation communities and other land cover types on the CRN Site are described in Subsection 2.4.1. Figure 4.3-1 depicts the areas to be temporarily or permanently disturbed by proposed preconstruction and construction activities on the CRN Site and the Barge/Traffic Area overlaid on the current vegetation communities and land cover types. The communities on the CRN Site most affected by construction-related activities would be, in order of decreasing acreage affected, herbaceous/grassland, mixed evergreen/deciduous forest, deciduous forest, and evergreen forest. Table 4.3-1 shows the estimated acreage of each type of vegetation community or land use potentially disturbed by development on the approximately 935-ac CRN Site, the approximate percentage of each type that would be disturbed temporarily and permanently, and the percentage of each type that would be disturbed on the CRN Site overall. Table 4.1-1 shows the estimated acreage of each land cover type in the Barge/Traffic Area. More than 90 percent of the Barge/Traffic Area is covered by deciduous forest, and the remainder is covered by herbaceous vegetation (Reference 4.3-1).

Preconstruction and construction activities would comply with federal and state regulations, permit requirements, established best management practices (BMPs), and Tennessee Valley Authority (TVA) procedures and guidelines. An initial preconstruction activity, land clearing, would involve the cutting and removal of trees and other vegetation. Clearing operations would be conducted in accordance with TVA BMPs and in a manner that will prevent any unnecessary damage to the remaining natural vegetation, will protect wetlands and streams, and will prevent soil erosion (Reference 4.3-12). If clearing of trees is required, TVA would evaluate the potential for the trees to provide roosting habitat for listed bat species. Depending on the amount and type of clearing to be done and the potential for the trees to provide bat habitat, bat surveys may be conducted and the timing of clearing activities may be scheduled to avoid seasons when bats are present. In areas such as transmission line ROWs that need to be kept cleared of vegetation, mechanical (mowing, hand trimming) and chemical clearing (herbicides) may be used. As described in Section 4.2, BMPs for erosion control and stormwater management would be employed during preconstruction and construction to minimize the potential for erosion, sediment deposition, and dust. These BMPs would substantially reduce the potential for such

processes to directly disturb or indirectly impact nearby plant communities outside the footprint of development.

The upland plant communities that would be permanently disturbed by the construction of facilities on the CRN Site comprise predominantly mixed evergreen-deciduous, deciduous, and evergreen forest (162 ac) and herbaceous/grassland (152 ac) habitats (Table 4.3-1), which are common in the vicinity. The total acreages of these forest and herbaceous communities that would be permanently lost to development would be 54 percent and 75 percent, respectively, of the areas these communities now cover on the CRN Site (Table 4.3-1). These acreages are a minor component of the expanse of such communities within the vicinity and the region. (The Oak Ridge Reservation (ORR), which adjoins the CRN Site to the east, north, and west, encompasses more than 33,100 acres of federally owned land. Most of the ORR is a relatively undisturbed ecosystem of nearly continuous forest within a surrounding region that is more fragmented by agriculture and development. The ORR is a large area of relatively unfragmented eastern deciduous and mixed forest communities, as well as semi-natural grasslands and forest edges, which provide a diversity of habitats for a great variety of wildlife. (Reference 4.3-2)

Riparian habitats on the CRN Site and the Barge/Traffic Area, consisting principally of forest in the floodplain of the Clinch River arm of the Watts Bar Reservoir and immediately adjacent to streams and wetlands, would be mostly avoided by development. Construction of the intake and discharge structures would require the removal of vegetation from the narrow riparian zone on the shoreline of the reservoir within the footprint of each structure, along the small stream and wetland where the intake pipeline would be installed, and around the margin of the wetland (W001) within the discharge pipeline corridor. Relatively small areas would be affected by the installation of these structures across these narrow riparian zones. The plants potentially affected, described in Subsection 2.4.1.1.1, and are not rare or unusual in the region. Natural riparian vegetation previously was removed during historical development of the barge facility, and improvements to that existing facility would not require substantial additional clearing of shoreline vegetation.

Some of the areas disturbed on the CRN Site (approximately 167 ac or 34 percent of the total disturbed area) would be for temporary, construction-related facilities, material laydown areas, and installation of the onsite portion of the 69-kV underground transmission line (Table 4.3-1). Installation of the offsite portion of the 69-kV underground line within the existing ROW from the CRN Site to the Bethel Valley substation also may temporarily disturb up to 210 ac of mainly herbaceous/grassland community. The areas cleared for temporary uses may be revegetated or otherwise restored after construction completion using native or non-invasive species. Over time, some of these areas likely would undergo succession and gradually transition from herbaceous/grassland to forest habitat. Other areas may be replanted in trees, and some areas where open spaces need to be maintained may be permanently converted from forest to herbaceous/grassland vegetation. Thus, the functional value of the former forest communities would not be restored in these converted areas.

Terrestrial vegetation communities and other land cover types on the Barge/Traffic Area east of TN 58 are described in Subsection 2.4.1. Deciduous forest is the upland plant community that predominantly would be affected by construction in the Barge/Traffic Area. As shown in Table 4.1-1, approximately 45 ac in the Barge/Traffic Area would be temporarily or permanently disturbed by the planned improvements. Of that 45 ac, approximately 20 ac (44 percent) are currently developed and 25 ac (56 percent) are undeveloped and potentially could be impacted. A 17-ac area of predominantly deciduous forest is a minor component of the expanse of this common community within the vicinity and the region. Furthermore, some of the undeveloped areas that could be disturbed (approximately 15 ac, or 33 percent, of the total cleared area) would be disturbed temporarily and may be revegetated or otherwise restored after completion of the Barge/Traffic Area improvements. Temporarily disturbed areas adjacent to the planned traffic improvements may be permanently converted from forest to herbaceous/grassland vegetation to maintain open space near roadways.

Thus, effects from preconstruction and construction activities on terrestrial plant communities and upland habitats at the CRN Site and in the adjacent Barge/Traffic Area would be SMALL in both the short and long-term.

4.3.1.2 Wetland Habitats

Wetland communities on the CRN Site are described in Subsection 2.4.1.2 and mapped in Figure 2.4.1-2 based on field surveys and wetland identifications performed by TVA. Figure 4.3-1 shows the wetlands that would be affected by construction and preconstruction activities. Facilities are planned and sited to avoid impacts and minimize effects on wetlands to the extent practicable. TVA's BMP manual includes a requirement that site construction plans include a 50-ft wetland buffer, and project managers integrate these buffers into construction plans (1242 Muncy 2012). Most wetlands would be avoided and unaffected. Of the 12 wetlands on the CRN Site, only four small wetlands would need to be removed because they are within the footprint of facilities: Wetland 001 (0.67 ac) is in the planned ROW for the discharge pipeline from the holding pond to the reservoir, Wetland 002 (0.13 ac) is in the planned power block area, Wetland 012 (0.13 ac) is in the planned power block and parking areas, and Wetland 008 (0.23 ac) is in the planned ROW for the makeup water pipeline from the cooling water intake structure. Thus, only 1.2 ac of the 15.54 ac of wetlands on the CRN Site (Table 2.4.1-3) are expected to be lost due to filling for construction. The functions of wetland areas impacted by filling would be lost. Other wetlands not directly affected would be protected from the indirect effects of preconstruction and construction activities by the use of BMPs to prevent erosion and the transport of sediment to wetlands via stormwater. Preconstruction and construction activities would comply with federal and state BMPs for erosion control and stormwater management, thereby largely eliminating the potential for those processes to directly disturb or indirectly impact nearby wetland communities outside the footprint of development.

As discussed in Subsection 4.2.3.2, dewatering of groundwater within a limited area in the power block area is likely during construction of the below-grade nuclear island structures and foundations. Drainage sumps installed at the bottom of the excavation would pump surface

drainage and/or accumulated groundwater to an established and, if necessary, permitted release point. These activities could have an effect on the surrounding water table. Wetlands W003 (0.18 ac), W004 (0.24 ac), and W007 (0.17 ac) are the only wetlands not otherwise affected by construction that are sufficiently close to the power block area that they potentially could be affected by alterations in groundwater flow. All three of these small wetlands are located immediately adjacent to the reservoir, and assessments of these wetlands did not identify groundwater as a source of their hydrology. The hydrology of two wetlands (W005 and W008) located near the power block area is affected by groundwater discharge. (Reference 4.3-3) Wetland 008 would be removed due to intake pipeline construction. The hydrology of W005 is affected by the Clinch River arm of the Watts Bar Reservoir and an intermittent stream and is unlikely to be noticeably affected by temporary groundwater dewatering in the power block construction area more than 800 feet (ft) away (Reference 4.3-3). As indicated by the wetland descriptions in Subsections 2.3.1.1.1.6 and 2.4.1.2, these three wetlands and the other wetlands on the CRN Site and in the Barge/Traffic Area are predominantly associated with surface water (streams or the reservoir); thus, they would not be substantially affected by alterations in groundwater levels.

Wetlands located off the CRN Site in the Barge/Traffic Area are discussed in Subsection 2.4.1.2 and mapped in Figure 2.4.1-2. The wetland survey identified four wetlands totaling 10.06 ac along the south side of Bear Creek Road between TN 58 and the CRN Site entrance: W013 (3.73 ac), W014 (3.05 ac), W015 (1.95 ac), and W017 (1.33 ac). Wetlands W013 and W014 are on each side of the haul road connecting the barge facility to Bear Creek Road. Based on the proximity of these wetlands to Bear Creek Road and the haul road and the planned widening of these roads, there is a potential that the margins of these wetlands would be impacted by road improvements, which may require forest removal and filling in marginal areas. It is estimated that the total 10-ac area of these four wetlands approximately 5 percent (0.5 ac) would be impacted by road construction. In addition, a small, 0.11-ac wetland (Wetland W016) is located immediately adjacent to the planned intersection of a new CRN Site access road to be constructed on the east side of TN 58. This wetland likely would be impacted by preconstruction activities, which may require filling. The extent to which these five wetlands are affected will be determined by the roadway design finalized during the combined license application (COLA) stage and specific plans developed for these areas. Wetlands are not present in the underground transmission line ROW located off the CRN Site.

The U.S. Army Corps of Engineers (USACE) determines whether individual wetlands are within its jurisdiction and provides guidance regarding permitting of wetland impacts and compensatory mitigation. If impacts to wetlands are unavoidable, mitigation likely would be required in accordance with USACE guidelines. During a September 2013 site visit, USACE personnel determined that all but two of the 12 wetlands on the CRN Site are under federal jurisdiction. Of the two wetlands that are not under federal jurisdiction, one is an isolated wetland under state jurisdiction (W002), and one may be non-jurisdictional and associated with historic site grading activities (W012). The jurisdictional status of W012 and the wetlands in the Barge/Traffic Area have not yet been determined by the USACE. The total area of wetlands

impacted by preconstruction activities on and off the CRN Site potentially would be approximately 2 ac, so impacts on wetlands would be SMALL and would likely be further reduced by mitigation.

4.3.1.3 Important Terrestrial Habitats

As discussed in Subsection 2.4.1.3, important terrestrial habitats comprise natural areas as well as habitats that have been identified by government agencies as unique, rare, or a priority for protection, including managed areas and ecologically significant sites. Such habitats adjoining the CRN Site include the Grassy Creek Habitat Protection Area (HPA) as well as natural areas, managed areas, and other designated areas on the ORR. Preconstruction and construction activities on the CRN Site would be separated from these habitats by undeveloped buffers resulting in SMALL impacts. The implementation of BMPs would further minimize the potential for effects on habitats beyond the areas directly disturbed.

Development off the CRN Site in the Barge/Traffic Area would occur within the ORR. Two small natural areas have been designated in the vicinity of the Barge/Traffic Area: the 7-ac East Tennessee Technology Park (ETTP) Filtration Plant Wetland, located across Bear Creek Road from the CRN Site entrance, and the 17-ac K-25 Beaver Pond Complex, located west of the TN 58 intersection and south of the ETTP (Reference 4.3-4). Neither these areas nor other ORR natural areas, managed areas, or other designated areas would be within the footprint of preconstruction or construction activities or otherwise adversely affected by these activities.

4.3.1.4 Wildlife

Terrestrial wildlife species identified on the CRN Site, other areas of the CR Property, and the Barge/Traffic Area are described in Subsection 2.4.1.4. The native species observed are characteristic of the region and the habitats described in Subsection 2.4.1. Preconstruction and construction activities on the CRN Site and the Barge/Traffic Area would have both short-term and long-term effects on these wildlife species. The removal of upland plant communities described in Subsection 4.3.1.1 would eliminate wildlife habitat permanently in the areas where permanent facilities are constructed and temporarily in some areas to be used only during the construction period and later revegetated, such as the areas in the eastern part of the CRN Site to be used for construction material laydown and storage of equipment and supplies.

As discussed in Subsection 4.3.1.1 and shown in Figure 4.3-1, the areas of the CRN Site and the Barge/Traffic Area to be directly affected by preconstruction disturbance currently are covered by forest and herbaceous/grassland habitats. None of these habitats are unique in the region, and the permanent loss of approximately 357 ac (327 ac on the CRN Site plus 30 ac on the Barge/Traffic Area) to the building of facilities would not noticeably reduce the local abundance and diversity of wildlife in the surrounding vicinity. Much of the approximately 182 ac to be cleared for temporary use (167 ac on the CRN Site plus 15 ac on the Barge/Traffic Area) is expected to be restored and returned to habitat after the construction phase. Removal of forest from the peninsula would not affect forest fragmentation any further than it already has

been affected by previous work on the CRBRP. The CR SMR Project would result in removing the forested areas described in Subsection 4.3.1.1 from use by species currently occupying those areas, but all of these species would have access to adjacent suitable habitat. Proposed clearing on the Barge/Traffic Area would be small and would not permanently preclude species access and movement to suitable adjacent habitat.

A forested riparian zone would be retained along most of the shoreline of the reservoir, and the clearing that would occur in the interior portions of the peninsula would not result in forest fragmentation or impede the movements of terrestrial wildlife. Similar riparian habitat for wildlife is extensively available along reservoirs and other water bodies in the region, and the loss of small segments at the intake and discharge structures would not affect populations of wildlife that utilize riparian habitats.

During the preconstruction activities for the CR SMR Project, disturbance, displacement, and mortality of individual animals likely would occur as heavy equipment is used for clearing, grading, and excavation. Mobile animals, including birds, larger mammals, and some reptiles, can avoid such disturbances and move to safer areas. However, small, less-mobile animals, such as amphibians, turtles, and small mammals, are likely to be at much greater risk of mortality. Although wildlife displaced by clearing activities can find refuge in undisturbed habitats in the vicinity, temporary reductions in population could occur as a result of increased predation and competition in these habitats. These effects from clearing, grading, excavation, and building of facilities also would occur on a smaller scale in localized portions of areas located off the CRN Site, including the Barge/Traffic Area and the Watts Bar NP – Bull Run FP 500-kV transmission line ROW. Effects within the ROW would be particularly limited because burial of the transmission line would be a temporary disturbance within an existing ROW in which vegetation is maintained and habitat is disturbed.

Birds can be affected by collisions with transmission towers or other tall structures, such as towers and construction cranes. However, the CRN Site is not within a major migratory flyway and is surrounded by higher terrain with tall trees. Evaluation of avian impacts by the U. S. Nuclear Regulatory Commission (NRC), summarized in NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, determined that the effects of avian collisions with existing structures at nuclear power plants have been small. The mechanical draft cooling towers to be constructed for the cooling system for the CR SMR Project would not be as tall as natural draft cooling towers, which have been found by NRC to cause only low levels of bird mortality due to collisions, and would pose little risk to migrating birds (Reference 4.3-5). Based on the findings at other facilities and the lack of concentrated numbers of birds at the CRN Site, avian collisions with man-made structures during preconstruction and construction are predicted to have a negligible effect on avian mortality and populations.

Subsection 4.4.1.1, describes noise that can result from preconstruction and construction activities and factors that influence noise effects, such as frequency, intensity, duration, location, and timing. As discussed in that section, construction-related noise is attenuated by natural factors such as vegetation, topography, and temperature, and it quickly decreases over

relatively short distances. The majority of the preconstruction and construction activities occurring on the CRN Site would generate noise levels below 65 A-weighted decibels (dBA) at the Site Boundary. Some infrequent or night-time construction activities could generate temporary noise levels at or above 60 to 90 dB at a distance of 100 ft from the equipment; however, the noise level should be attenuated to below 65 dBA at the Site Boundary. The threshold noise level at which birds and small mammals are frightened or startled is 80 to 85 dBA (Reference 4.3-6). This noise level is not expected to occur beyond the Site Boundary.

Prediction of the effects of noise on wildlife is limited by the paucity of information linking sound levels to effects on species. A study by the Federal Highway Administration that summarized information from the available literature on the effects of noise on wildlife populations indicated that birds have been studied more than other wildlife. The review found that some studies indicated that bird numbers and breeding were adversely affected by proximity to roads and their associated noise, while other studies found the opposite effect, with reports of many bird species using roadside habitats despite the noise. The sensitivity of birds seems to vary by species, with some species being affected, some being not affected, and others being more common even near noisy interstate highways. For mammals, the review found that studies indicate large mammals may avoid noise, but the effect seems to be small to moderate, and small mammals occur in significant numbers in highway ROWs and do not seem to be adversely affected by road noise. (Reference 4.3-7) Thus, more sensitive species may be temporarily displaced to more distant habitats during periods of elevated construction noise, while more tolerant species likely would remain nearby.

Based on the predicted lack of noise exceeding 80 to 85 dB in habitat areas beyond the Site Boundary, the similarity of construction and highway noise levels, the rapid attenuation of noise expected to occur beyond the construction areas, and the habituation and limited sensitivity of many wildlife species to the noise levels likely to occur in habitat areas, impacts of noise from preconstruction and construction activities on wildlife are expected to be negligible. The loss of approximately 494 ac of habitat at the CRN Site (327 ac permanently disturbed plus 167 ac temporarily disturbed) and 45 ac in the Barge/Traffic Area (30 ac permanently disturbed plus 15 ac temporarily disturbed) would result in mortality or temporary displacement of wildlife in those areas; however, this acreage would be a small component of the accessible, undeveloped habitat in the vicinity to which animals can disperse with minimal effects on populations. In addition, noise avoidance and collisions with structures also would have a negligible impact on wildlife populations in the vicinity. Overall, impacts on terrestrial wildlife from preconstruction and construction would be SMALL.

4.3.1.5 Important Terrestrial Species

Subsection 2.4.1.5 describes the important terrestrial species that potentially can be affected by preconstruction and construction activities, including federally or state-listed species and commercially or recreationally valuable species. Table 2.4.1-5 identifies terrestrial and wetland species with federal or state status and recorded occurrences in Roane County, Tennessee. As discussed in Subsection 2.4.1.5.1, no federally listed or candidate species of plants were found

on the Clinch River Property, which includes the CRN Site and the adjoining Grassy Creek Habitat Protection Area, or in the Barge/Traffic Area during TVA botanical surveys, and habitats suitable for such species were not found to be present. However, three federally listed bat species were found by TVA surveys to forage on the Clinch River Property and the Barge/Traffic Area: the gray bat (endangered), Indiana bat (endangered), and northern long-eared bat (threatened). All three of these bats hibernate in caves during the winter. During the rest of the year, including the period when young are born, the gray bat roosts in caves and the Indiana bat and northern long-eared bat roost in trees. Given the absence of caves on the CRN Site and the Barge/Traffic Area, gray bat roosts would not be affected by preconstruction or construction activities. TVA performed surveys to identify suitable summer roosting habitat for the Indiana bat and northern long-eared bat within forested areas of the Clinch River Property and found potential roosting habitat of moderate to high quality on the northern half of the property. However, no occupied roost trees were documented, which made difficult any estimate of the numbers of individual bats that may roost or forage on the Clinch River Property or the CRN Site.

Preconstruction clearing of forest and herbaceous/grassland habitats would reduce foraging habitat available to all three listed bat species on the CRN Site and the Barge/Traffic Area, including forest, edge, and riparian foraging habitats. However, the habitat types that would be affected are common in the vicinity, and bats are highly mobile and capable of utilizing other, similar foraging habitats nearby. Clearing of forested areas of the CRN Site and the Barge/Traffic Area potentially could result in the removal of roost trees for the Indiana bat and northern long-eared bat. The extensive forests on the ORR and elsewhere in the vicinity provide numerous potential roost trees that could be used as alternatives to any roost trees removed from the CRN Site. There is a potential for bat injury or mortality if an occupied roost tree were inadvertently removed during the warmer months. However, surveys of specific areas to be cleared could identify roost trees if present and allow them to be avoided, and removal of trees during the winter would preclude the possibility of direct effects on roosting bats. As part of TVA's consultation with the U.S Fish and Wildlife Service (USFWS) under Section 7 of the Endangered Species Act, the USFWS may identify measures such as these to be employed in minimizing potential take of these listed bat species. Based on the limited dependence of these bats on the CRN Site and the Barge/Traffic Area for foraging habitat, the low likelihood of occupied roosting trees on the CRN Site and the Barge/Traffic Area, and the ability to avoid direct effects on bats in occupied roosting trees if present, the potential for construction and preconstruction impacts on the gray bat, Indiana bat, or northern long-eared bat would be SMALL.

The description of state-listed species in Subsection 2.4.1.5.2 identified two state-status species that have been observed on the Clinch River Property (in addition to the federally listed gray bat and Indiana bat discussed above): the sharp-shinned hawk and bald eagle. A bald eagle also was observed flying over the Barge/Traffic Area. Both of these raptors have a state status of "in need of management." Marginally suitable habitat is available for the sharp-shinned hawk within the upland habitat in the northern half of the Clinch River Property, principally the Grassy Creek

HPA. The closest documented bald eagle nest is approximately 8 mi from the CRN Site on Watts Bar Reservoir. Both the hawk and the eagle are highly mobile and neither is known to nest on the Clinch River Property. The preconstruction clearing of forest habitat on the CRN Site and the Barge/Traffic Area would have a minor effect on the amount of potential habitat available to both species in the area, and the potential for preconstruction and construction impacts on the sharp-shinned hawk or bald eagle would be SMALL.

As discussed in Subsection 2.4.1.5.3, commercially or recreationally valuable terrestrial species on the CRN Site and the Barge/Traffic Area are game species such as deer, turkey, and waterfowl. Impacts to these species would be SMALL as described above for other wildlife.

Invasive terrestrial species, such as those discussed in Subsection 2.4.1.5.4, already are present at the CRN Site, on the Barge/Traffic Area, and in transmission line ROWs. With use of established TVA BMPs, preconstruction and construction activities associated with the CR SMR Project would not contribute to the spread of exotic or invasive species or increase their impacts on native species. Thus, impacts related to invasive species from the CR SMR project would be SMALL.

4.3.1.6 Transmission Corridors

As discussed in Subsections 2.4.1.6 and 3.7.3, two transmission corridors cross the CRN Site (Figure 2.2-1). The Kingston – Fort Loudoun #1 line is a 161-kV transmission line that crosses the CRN Site from the southeastern tip of the peninsula to the northwestern corner of the CRN Site near the entrance gate. The Watts Bar NP– Bull Run FP line is a 500-kV transmission line that crosses the reservoir and the western boundary of the CRN Site, extends northeast across the widest part of the CRN Site, and continues past the Bethel Valley substation, which is located approximately 5 mi northeast of the Site.

An approximately 1.2-mi segment of the 161-kV line within the CRN Site would be re-routed from its current alignment to make room for construction of the power island. The new 161-kV ROW likely would extend north from the reservoir parallel to the shoreline before turning northwest and connecting to the existing ROW slightly northwest of where it crosses the 500-kV ROW. The re-located segment from near the reservoir to where the ROW turns northwest near the cooling water intake would require clearing of deciduous and mixed evergreen/deciduous forest within the ROW. In addition, relocation of this segment of the 161-kV transmission line is likely to displace an osprey nest that has been built on a tower in this area.

The only new transmission line proposed for construction off the CRN Site is a 69-kV underground line to be installed within the 500-kV ROW between the CRN Site and the Bethel Valley substation. The preconstruction activities involved in installing the 69-kV underground line are expected to occur principally within the ROW. However, there is the possibility that some trees may need to be removed. Therefore, the terrestrial ecological resources affected predominantly would be communities previously impacted by clearing for the existing 500-kV ROW, construction of the aboveground transmission lines, and ongoing vegetation maintenance

practices within the ROW that maintain a herbaceous community within the ROW. Terrestrial resources within the segment of the ROW in which the 69-kV underground line would be installed have been documented by the U.S. Department of Energy (DOE). Subsection 2.4.1 summarizes existing information from previous DOE surveys of this 5-mi segment of the 500-kV ROW where installation of the 69-kV underground line is planned. The data indicate that no recorded occurrences of federally or state-listed terrestrial species are known from within this ROW. However, if any clearing of trees is required, TVA would evaluate the potential for the trees to provide bat habitat. Depending on the amount and type of clearing to be done and the potential for the trees to provide bat habitat, bat surveys may be conducted.

Subsection 3.7.3.8 describes planned modifications to the existing transmission system outside the CRN Site, and Subsection 2.4.1.6 describes the ecological resources in the segments of the ROWs for those transmission lines that would potentially be affected. The uprating, reconductoring, and rebuilding activities would involve existing lines within existing ROWs, and additional ROWs would not be established, cleared, or developed. The resources within these ROWs (identified in Table 2.4.1-7) would not be noticeably affected by the temporary activities required for the planned upgrades. BMPs would be employed as described in Subsection 3.7.3.8 to prevent or minimize impacts to terrestrial habitats as a result of temporarily accessing and working on these line modifications.

As discussed above for the CRN Site, collisions of birds with transmission towers or other tall structures are possible; however, collisions of birds with structures are unlikely to be a major source of mortality for local bird populations. Based on NRC findings at other facilities, the lack of concentrated numbers of birds at the CRN Site, and the fact that new transmission towers would not be constructed off the CRN Site and some of those on the CRN Site would simply be relocated, increases in avian collisions with man-made structures is not expected. TVA would comply with federal and state regulations regarding the siting of transmission lines, use construction BMPs, and install the lines under state oversight. Therefore, avian collisions with man-made structures during preconstruction and construction activities in transmission corridors on or off the CRN Site are predicted to have a negligible effect on avian mortality and populations.

Terrestrial resources would be minimally affected by the relocation of lines on the CRN Site, installation of an underground line in an existing ROW off the CRN Site, or modifications to existing line segments of the transmission system. Therefore, impacts associated with preconstruction activities in transmission corridors are expected to be SMALL.

4.3.1.7 Summary of Impacts to Terrestrial Ecosystems during Preconstruction and Construction

The environmental effects from preconstruction and construction activities on the CRN Site and in adjacent offsite areas would not disrupt or alter important terrestrial ecosystems. Impacts on upland habitats would be minor based on the lack of high quality or unique habitats in the areas to be developed and the expanse of quality, undeveloped habitats in the vicinity and the region.

Impacts on wetlands would be minor and would be further reduced by mitigation. Important terrestrial habitats (e.g., ORR natural areas, managed areas, or other designated areas) would not be within the footprint of preconstruction and construction activities or otherwise adversely affected by these activities, and the impact of these activities on terrestrial wildlife and important terrestrial species would be minimal. Impacts on these components of the terrestrial ecosystem within transmission corridors similarly would be minimal. Accordingly, the overall impact of preconstruction and construction activities on terrestrial ecosystems on the CRN Site and affected offsite areas (Barge/Traffic Area and 500-kV transmission line ROW) would be SMALL for all resources.

4.3.2 Impacts to Aquatic Ecosystems

The aquatic ecosystems of the CRN Site are described in detail in Subsection 2.4.2. Subsection 2.4.2 also briefly describes aquatic resources in potentially affected areas off the CRN Site, including the Barge/Traffic Area and the Watts Bar NP – Bull Run FP 500-kV transmission line ROW from the CRN Site to the Bethel Valley substation. The principal aquatic ecosystem in the vicinity of the CRN Site is the Clinch River arm of the Watts Bar Reservoir. Preconstruction and construction activities that can affect aquatic ecosystems include: development of the intake structure and barge facility on the reservoir shoreline; installation of the discharge structure in the reservoir channel; and clearing and grading for temporary or permanent facilities, which can directly or indirectly affect streams and ponds on the CRN Site as well as in offsite areas where transmission lines or roads would be built. Adverse effects on aquatic ecosystems from the CR SMR Project would result predominantly from preconstruction activities. Such activities may directly cause physical alteration of aquatic habitats from activities such as underwater excavation, in-filling of streams and ponds, and placement of cofferdams, or they may indirectly cause degradation of habitat quality such as from sedimentation and accidental spills that reduce water quality.

Any alteration to a stream, river, lake, or wetland in Tennessee requires a water quality permit from the Tennessee Department of Environment and Conservation (TDEC) Division of Water Resources. Physical alterations to properties of waters of the state require an Aquatic Resource Alteration Permit (ARAP) or a Clean Water Act (CWA) Section 401 Water Quality Certification. A federal CWA Section 404 permit may also be required from the USACE for projects that include the discharge of dredged or fill material into waters of the United States. When a Section 404 permit is required, a Section 401 certification must first be obtained from TDEC to affirm that the discharge would not violate Tennessee water quality standards. TDEC has established General Permits that are developed and maintained by the Division of Water Resources to provide a streamlined, expedited means of authorizing projects that singularity or cumulatively propose minor impacts to water resources. Each of the General Permits contains conditions and mitigation measures required to be implemented as a part of the activity authorized by the permit. (Reference 4.3-14)

When the impacts of development on water resources (i.e., loss or degradation) cannot be avoided and/or minimized, the Division of Water Resources may require permittees to offset

their activities through compensatory mitigation. Compensatory mitigation is used to replace lost or impacted habitat with habitat that has similar functions of equal or greater ecological value. Compensatory mitigation may be accomplished by taking a degraded water resource such as a stream or wetland and returning the resource to a reference condition and/or improving the value of the resource. This may be accomplished through activities such as the replacement restoration, and/or enhancement of degraded streams. Treatments that may be employed in stream mitigation include riparian buffer restoration, bank stabilization, and hydrologic buffering (e.g., stormwater detention basins). In addition to the regulatory preference for avoidance of impacts, there is a strong preference for mitigation of unavoidable impacts onsite where practicable. If necessary, offsite mitigation may be used in accordance with TDEC guidance. (Reference 4.3-14)

4.3.2.1 Streams on the CRN Site and the Barge/Traffic Area

In addition to the Clinch River arm of the Watts Bar Reservoir, there are four perennial streams, one intermittent stream, and 19 ephemeral streams/wet-weather conveyances (WWCs) on the CRN Site (Figure 2.4.1-2; (Reference 4.3-8)). The current footprint of the planned permanent facilities and temporary materials laydown and storage areas likely would directly impact one small perennial stream (S01) and 11 WWCs (Figure 2.4.1-2 and Figure 4.3-1). In planning and siting facilities, structures are located to avoid impacts to streams and other water bodies to the extent practicable. Nevertheless, stream S01 and six of these WWCs are within the footprint of the areas to be permanently developed. Portions of five WWCs are within the area in the northeast portion of the CRN Site to be temporarily developed then revegetated and restored following the completion of construction.

Of the perennial and intermittent streams on the CRN Site (described in Subsection 2.4.2.1.3), only perennial stream S01 would be substantially affected by construction activities. This small stream is within the area to be affected by construction of the cooling water intake and the pipeline from the intake to the CR SMR Project. Impacts from intake and pipeline installation potentially would result in the loss of the entire length of stream S01, approximately 925 ft of stream. Stream S01 is a small tributary to the Clinch River arm of the Watts Bar Reservoir. It is fed by a spring and small pond (P04) and flows through a small wetland (W008). A biological survey of S01 in 2015 sampled the stream's entire length and found no fish and only a few small crayfish. (Reference 4.3-9) The 19 WWCs located on the CRN Site and the 15 WWCs located in the Barge/Traffic Area are ephemeral streams that flow only in response to precipitation runoff and do not support communities of aquatic organisms. Stream S01 is expected to be subject to USACE jurisdiction. USACE jurisdiction concerning the WWCs has not been determined.

There are two perennial streams, four intermittent streams, and 15 WWCs (Figure 2.4.1-2) in the Barge/Traffic Area. Of these, two intermittent streams (S09 and S10) and six WWCs are likely to be impacted by preconstruction activities associated with the development of a new intersection and access ramps at TN 58 and improvements to Bear Creek Road to the CRN Site entrance (Figure 4.3-1). Intermittent stream S09 is crossed by Bear Creek Road. Impacts to that

short stream segment would be possible in conjunction with widening and other improvements to the road at the existing stream crossing, but any such effects on the stream are expected to be temporary and minor. Impacts to the small, intermittent stream S10 and the six WWCs are expected to result from grading and filling for road development, and these impacts are likely to be permanent. Streams S09 and S10 are expected to be subject to USACE jurisdiction. USACE jurisdiction concerning the WWCs has not been determined.

Although sedimentation from erosion and stormwater runoff has the potential to impact nearby streams during and immediately following preconstruction activities, BMPs (described in Section 4.2) would be used to prevent or minimize erosion and sediment transport to streams and wet-weather conveyances on and off the CRN Site. A stormwater pollution prevention plan (SWPPP) would prescribe methods for collection and control of runoff from preconstruction and construction areas in accordance with state and federal regulations and permit requirements.

In summary, one small perennial stream and six short WWCs on the CRN Site and one small intermittent stream and six short WWCs in the Barge/Traffic Area are likely to be permanently impacted by the proposed development in these areas. Given the small size of these features, the minimal aquatic communities in the streams, and the lack of aquatic communities in the WWCs, preconstruction and construction activities on the CRN Site and in the Barge/Traffic Area would not result in substantial ecological impacts and would not notably affect aquatic species populations or communities in the vicinity; therefore the ecological impact to the streams would be SMALL. The SMALL impacts to streams would be further reduced by mitigation that would likely be required in accordance with TDEC and USACE guidelines.

4.3.2.2 Ponds on the CRN Site and the Barge/Traffic Area

Six small, constructed, freshwater ponds are present on the CRN Site (Figure 2.4.1-2 and Table 2.4.2-5). Five of these ponds were constructed as stormwater retention basins in conjunction with site preparation for the Clinch River Breeder Reactor Project (CRBRP), and one is a very small dug out pond. These ponds are generally shallow and have only intermittent connections to the Clinch River arm of the Watts Bar Reservoir during heavy rainfall events. Two of these small ponds (P04 and P06) are within the currently planned footprint of the switchyard and the parking lot, respectively, (Figure 4.3-1) and are expected to be filled and graded. The four onsite ponds not directly impacted would likely continue to be used as stormwater retention ponds during preconstruction and construction. Two ponds are present in the Barge/Traffic Area near the CRN Site entrance. Based on the proposed footprint of development in that area (Figure 4.3-1), neither pond is expected to be directly impacted by preconstruction or construction, and implementation of stormwater BMPs would prevent or minimize erosion and sediment transport to these ponds.

Construction activities for the CR SMR Project would result in the removal of two of the small, man-made ponds on the CRN Site and conversion of those areas to permanent facilities. Given the small size of these man-made ponds and the abundance of other pond and reservoir

habitats both on the CRN Site and in the vicinity, the impact from the loss of the habitat provided by these ponds on aquatic resources on the CRN Site or in the vicinity would be SMALL.

4.3.2.3 The Clinch River Arm of the Watts Bar Reservoir

Preconstruction and construction activities that potentially would affect the aquatic community in the Clinch River arm of Watts Bar Reservoir include the installation of the intake and discharge structures, improvements to the barge facility, and installation of a new culvert under the access road at the Grassy Creek embayment of the reservoir. Section 3.9 describes in detail the construction activities. The proposed intake structure is located on the east side of the CRN Site at Clinch River Mile (CRM) 17.9, and the proposed discharge is located on the west side at approximately CRM 15.5. The culvert would be installed in conjunction with improvements to the access road where the road crosses the Grassy Creek embayment. The installation of these facilities may involve excavation near the shoreline in the immediate area of construction. These activities would affect only small areas of the reservoir and would be conducted in accordance with USACE permit and TDEC Aquatic Resource Alteration Permit and NPDES Construction Stormwater Permit requirements. Such requirements are expected to include the use of BMPs in on-shore areas (described in Section 4.2) to prevent or minimize erosion and sediment transport to the reservoir or its tributaries, as well as silt curtains and cofferdams where structures are to be built in the water or on the shoreline. A cofferdam is expected to be used for construction of the intake. The size and exact location that would be excavated will not be known until COLA. The cofferdam would serve as the principal BMP to prevent sedimentation from the excavation process.

The aquatic and benthic habitats within the footprints of the intake and discharge structures would be lost. However, these areas would be very small in comparison to the extensive area of such habitats present within the Clinch River arm of the Watts Bar Reservoir adjacent to the CRN Site. As indicated by the results of the biological surveys and evaluations discussed in Subsection 2.4.2, the benthic community in these areas is relatively limited in abundance and diversity and does not include rare species, and the fish community is not dependent on these areas for spawning or other critical needs. In the immediate vicinity of the intake and discharge, increases in turbidity and sediment deposition may occur during development of these structures. These temporary and localized impacts would affect relatively small areas of the reservoir and would be minimized through the use of BMPs. Adverse effects on aquatic organisms from sedimentation are possible adjacent to and downstream of the activities if disturbed sediment escapes the immediate area. Potential impacts to aquatic organisms also may be possible as a result of spills of fuel, lubricants, solvents, or other liquids. Such impacts are unlikely due to the use of BMPs to prevent spills in accordance with an SWPPP.

The barge facility would be located just east of the TN 58 bridge. Re-development of the barge facility is not expected to involve dredging, and the area of reservoir bottom to be disturbed in conjunction with improvements to this facility would be negligible. If piles need to be driven into the reservoir bottom in conjunction with barge facility improvements, the aquatic and benthic habitats within the footprints of the pilings would be lost. The area potentially affected at the

barge facility would be very small in comparison to the extensive area of such reservoir habitats in the vicinity. As discussed in Subsections 2.4.2.1.1 and 2.4.2.3, the benthic community in the vicinity of the barge terminal area is ecologically healthy, but the mussel component is in poor condition, and the community does not include rare species; the fish community is limited in abundance, does not include rare species, and is not dependent on the area for spawning or other critical needs. Increases in turbidity and sediment deposition may occur in the immediate vicinity during pile driving activity. However, these impacts would be temporary and localized, and they would be minimized through the use of BMPs. The underwater noise produced by pile driving would be expected to cause fish to avoid the area of the barge facility during the relatively brief duration of this activity, thereby preventing the possibility of injury from noise or physical contact.

A culvert currently is present at the location where a new culvert would be installed in conjunction with improvements to the access road across the Grassy Creek embayment of the Watts Bar Reservoir. Therefore, this installation would not result in more than a negligible loss of additional reservoir bottom habitat.

As discussed in Subsection 3.4.2.5, a bypass would be installed at Melton Hill Dam to provide a continuous flow of approximately 400 cubic feet per second (cfs) around the hydropower generating units in the dam. Because this conduit would be installed within the existing dam, the Melton Hill bypass would not substantially disturb sediment or affect aquatic life in the Clinch River arm of the Watts Bar Reservoir or the Melton Hill Reservoir.

Preconstruction and construction activities on the CRN Site likely would result in the permanent loss of small areas of aquatic habitat and the temporary alteration of additional habitat nearby. However, as indicated by the results of the biological surveys and evaluations discussed in Subsection 2.4.2, no aquatic habitats in the Clinch River arm of the Watts Bar Reservoir adjacent to the CRN Site are known to be unique or essential to rare aquatic species or other important species. Fish and other mobile organisms would likely avoid these areas during construction activities, and impacts predominantly would be limited to temporary avoidance of the area. The more immobile benthic organisms would be displaced but likely would recolonize available habitats in the affected areas over time. For example, a study of the rate of colonization by macroinvertebrates of artificial substrate samplers in a Michigan stream found that multiple samplers placed on the substrate were colonized within 60 days by a diverse assemblage of taxa. The numbers of individuals colonizing the substrates reached a maximum after 39 days, and the number of taxa increased throughout the study period. (Reference 4.3-10) In addition, a study by the U.S. Environmental Protection Agency of the effects of suction dredging for commercial mining on freshwater benthic communities in several streams in Alaska found that the effects were local and short-lived even in such a relatively cold climate. In a river and a creek, impacts from small-scale dredging activity were contained primarily within the mined areas, and macroinvertebrates returned to pre-dredging densities within approximately 1 month. (Reference 4.3-11)

BMPs would contribute to minimizing impacts associated with the excavation that may be required to construct the intake and discharge structures, replace the Grassy Creek culvert, and other improvements on the Clinch River arm of the Watts Bar Reservoir. Accordingly, preconstruction and construction activities on the CRN Site and in the Barge/Traffic Area would not notably affect aquatic communities in the reservoir and the ecological impacts would be SMALL.

4.3.2.4 Important Aquatic Species and Habitats

Subsection 2.4.2.3.1 describes federally listed aquatic species that have recorded occurrences in Roane County, Subsection 2.4.2.3.2 describes species with state status and recorded occurrences in the county, and Table 2.4.2-6 summarizes these species and their status. The five aquatic species with a federal listing status that potentially occur in Roane County and are extant in the region (recorded occurrences within less than or equal to 25 yr) include three mussels, a fish, and a salamander. No live or relic specimens of these three mussel species were found during the 2011 mussel survey in the Clinch River arm of the Watts Bar Reservoir adjacent to the CRN Site, and suitable habitats for the fish and salamander are not present on the CRN Site. Thus, federally listed species with the potential for occurrence in the vicinity are not present on the CRN Site or in the Clinch River arm of the Watts Bar Reservoir adjacent to the CRN Site and would not be affected by preconstruction and construction activities for the CR SMR Project.

Subsection 2.4.2.3.2 discusses the aquatic species that have recorded occurrences in Roane County and a state listing or other protected status but no federal listing status. These species include one amphibian, four fish, and one plant. The amphibian, the hellbender, has been found in the tail waters below Melton Hill Dam, and the Clinch River arm of the Watts Bar Reservoir potentially provides habitat suitable for this large salamander. The four fish species with state status are unlikely to occur on or adjacent to the CRN Site due to unsuitable habitat conditions. The plant, a waterweed, potentially could occur in quiet waters of streams or ponds but has not been observed in botanical surveys of the CRN Site. The single small stream (S01) on the CRN Site that would be lost due to construction of the cooling water intake structure and pipeline does not provide suitable habitat for any of these species, and none were found in a survey of this stream. On the Barge/Traffic Area, surveys of streams S08, S09, and S12 also found no listed species. (Reference 4.3-9) Thus, aquatic species with state status and the potential for occurrence on the CRN Site, on the Barge/Traffic Area, or in the Clinch River arm of the Watts Bar Reservoir adjacent to the CRN Site would not be affected by preconstruction and construction activities for the CR SMR Project.

Other important species in the project area that potentially could be affected by preconstruction and construction activities in or adjacent to the Clinch River arm of the Watts Bar Reservoir are commercially or recreationally important fish species that inhabit the reservoir. As discussed in Subsection 2.4.2.3.3, commercially or recreationally valuable fish species have been documented in the reservoir both upstream and downstream of the CRN Site. (These species are identified in Table 2.4.2-1). All of these fish are highly mobile and are able and expected to

avoid the areas where excavation and other preconstruction and construction activities would be performed. These activities would create short-term disturbances and noise that would be likely to cause fish to avoid the immediate area. However, these activities would be temporary and very localized, and fish could readily avoid the source of disturbance. The number of individuals affected would likely be very limited, and populations would be essentially unaffected because individuals of these species could move away from the area of disturbance to suitable habitat elsewhere in the reservoir. Also, the limited water withdrawals associated with preconstruction and construction activities would not affect aquatic communities in the reservoir, including recreational fisheries. Thus, potential impacts to commercially or recreationally important aquatic species would be SMALL and temporary.

Invasive aquatic species, such as the zebra mussel and Asiatic clam, already are present the Clinch River arm of the Watts Bar Reservoir. With use of established TVA BMPs, preconstruction and construction activities associated with the CR SMR Project would not contribute to the spread of these or other exotic or invasive species or increase their impacts on native species. Thus, impacts from this project related to invasive species would be SMALL.

4.3.2.5 Transmission Corridors

Minor sedimentation or erosion due to runoff may occur during construction activities within the new segment of 161-kV ROW on the CRN Site and the installation of the underground 69-kV line within a 5-mi segment of the 500-kV ROW on the CRN Site and between the CRN Site and the Bethel Valley substation. If new access roads are needed for construction and maintenance of these lines, they would also have the potential to contribute to erosion and sedimentation at stream crossings. Three streams that cross the ROW are designated as aquatically sensitive areas (Figure 2.4.1-3). Ish Creek is an aquatic natural area (ANA1) that crosses the ROW approximately 0.5 mi from the CRN Site. Northwest Tributary is an aquatic reference area (ARA3) consisting of three small streams, two of which cross the ROW approximately 2 to 2.5 mi from the CRN Site. There are no recorded occurrences of federally or state-listed aquatic species within this ROW. The Tennessee dace, a fish designated by the state as in need of management, has been recorded in Ish Creek approximately 0.25 mi downstream of this ROW. Up to three additional streams also would be crossed: Streams S03 and/or S06 on the CRN Site near the northeastern boundary, and a small stream that crosses the ROW slightly southwest of the Bethel Valley substation.

Impacts on streams from installation of the underground line would be prevented or minimized through the use of BMPs such as hand clearing in sensitive areas, silt fencing, and other erosion control methods. BMPs for spill prevention would be employed to prevent chemical contamination of surface water within ROWs during preconstruction activities. The TVA procedural documents *Right-Of-Way Vegetation Management Guidelines* and *A Guide for Environmental Protection and Best Management Practices for Tennessee Valley Authority Transmission Construction and Maintenance Activities* provide guidance to TVA personnel conducting maintenance activities in transmission line ROWs (Reference 4.3-12; Reference 4.3-13). The guidelines address operations such as re-clearing of vegetation, maintenance of

access roads, and erosion control. BMPs include methods for re-clearing, such as cutting of trees and herbicide application, and for protection of sensitive resources. Also, structural controls, standards, and specifications are identified for maintaining physical components such as riprap and culverts within ROWs.

Where streams are crossed during installation of the underground 69-kV line, it is expected that BMPs would be employed to minimize impacts from sedimentation and the short segment of stream directly affected by the installation would be restored immediately afterward. Preliminary plans are to tunnel under streams whenever practicable. Consequently, potential impacts on aquatic habitats due to the installation of transmission lines either on the CRN Site or within the offsite 500-kV ROW would be SMALL.

Subsection 3.7.3.8 describes planned modifications to the existing transmission system outside the CRN Site, and Subsection 2.4.2.1.4 describes the aquatic ecological resources in the segments of the ROWs for those transmission lines that potentially would be affected. The uprating, reconductoring, and rebuilding activities would involve existing lines within existing ROWs, and additional ROWs would not be established, cleared, or developed. BMPs would be employed to prevent impacts from temporarily accessing and working on these line modifications. The aquatic resources within these ROWs are identified in Table 2.4.1-7. These resources, including designated critical habitats for two endangered mussel species, would not be noticeably affected by the temporary activities required for the planned upgrades. BMPs would be employed as described in Subsection 3.7.3.8 to prevent or minimize impacts to aquatic habitats as a result of temporarily accessing and working on these line modifications in the vicinity of aquatic habitats. Therefore, potential impacts are expected to be SMALL.

4.3.2.6 Summary of Impacts to Aquatic Ecosystems during Preconstruction and Construction

The environmental effects from preconstruction and construction activities on the CRN Site and in adjacent offsite areas would not disrupt or alter important aquatic ecosystems. Impacts on aquatic habitats would be minor based on the lack of high quality or unique habitats in the areas to be developed or the adjacent reservoir and the presence of extensive reservoir, pond, and stream habitats in the vicinity and the region. Impacts on most streams or other aquatic ecosystems would be minor and would be further reduced by compliance with permitting requirements and compensatory mitigation.

Important aquatic habitats (e.g., natural areas, managed areas, or other designated areas) would not be within the footprint of preconstruction or construction activities or otherwise adversely affected by these activities, and the impact of these activities on important aquatic species would be minimal. Impacts on components of the aquatic ecosystem within transmission corridors similarly would be minimal. Accordingly, the overall impact of preconstruction and construction activities on aquatic ecosystems on or adjacent to the CRN Site and affected offsite areas (Barge/Traffic Area and 500-kV transmission line ROW) would be SMALL for all resources.

4.3.3 References

Reference 4.3-1. Dattilo, Adam J., "Clinch River Barge/Traffic Area - Terrestrial Plant Communities and Botanical Resources Survey Report," Tennessee Valley Authority, June 18, 2015.

Reference 4.3-2. Parr, Patricia D. and Hughes, Joan F., "Oak Ridge Reservation Physical Characteristics and Natural Resources," ORNL/TM-2006/110, Oak Ridge National Laboratory, U.S. Department of Energy, October, 2006.

Reference 4.3-3. Pilarski-Hall, Kim and Lees, Britta P., "Clinch River Small Modular Reactor Site - Wetland Survey Report - Revision 4," November 19, 2015.

Reference 4.3-4. Baranski, Michael J., "Natural Areas Analysis and Evaluation, Oak Ridge Reservation," ORNL/TM-2009/201, Oak Ridge National Laboratory, U.S. Department of Energy, November, 2009.

Reference 4.3-5. Nuclear Regulatory Commission, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," NUREG-1437, 2013.

Reference 4.3-6. U.S. Nuclear Regulatory Commission, "Final Environmental Impact Statement for Combined Licenses for Virgil C. Summer Nuclear Station Units 2 and 3," NUREG-1939, Vol. 1, Washington, DC, April, 2011.

Reference 4.3-7. Federal Highway Administration, "Synthesis of Noise Effects on Wildlife Populations," FHWA-HEP-06-016, September, 2004.

Reference 4.3-8. Howard, Charles S., Henderson, Andrew R., and Phillips, Craig L., "Clinch River Small Modular Reactor and Barge/Traffic Site Evaluation of Aquatic Habitats and Protected Aquatic Animals Technical Report - Revision 5," Tennessee Valley Authority, December 22, 2015.

Reference 4.3-9. Henderson, Andrew R. and Phillips, Craig L., "Clinch River Small Modular Reactor and Barge/Traffic Site Stream Survey Report - Revision 3," Tennessee Valley Authority, December 22, 2015.

Reference 4.3-10. Meier, Peter G., Penrose, David L., and Polak, Loren, "The rate of colonization of macro-invertebrates on artificial substrate samplers, Freshwater Biology 9: 381-392, 1979.

Reference 4.3-11. Prussian, Aaron M., Royer, Todd V., and Minshall, G. W., "Impact of suction dredging on water quality, benthic habitat, and biota in the Forty mile River, Resurrection Creek, and Chatanika River, Alaska," U.S. Environmental Protection Agency, Region 10, Seattle, Washington, June, 1999.

Reference 4.3-12. Muncy, J. A., "A Guide for Environmental Protection and Best Management Practices," 2012.

Reference 4.3-13. Tennessee Valley Authority, "Right-Of-Way Vegetation Management Guidelines; Energy Delivery Environmental Protection Procedures," Revision 3, September 23, 2013.

Reference 4.3-14. Tennessee Department of Environment and Conservation, “Stream Mitigation Guidelines for the State of Tennessee,” Division of Water Pollution Control, Natural Resources Section, July 1, 2014.

Table 4.3-1
Land Cover Types to be Disturbed by Development on the CRN Site

Land Cover Types	Approximate Acreage Affected	Approximate Percentage of Affected Areas	Percent of cover type affected on the CRN Site[1]
CRN Site			
Permanently Disturbed Areas			
Herbaceous/grassland	152	47	75
Mixed evergreen-deciduous forest	106	32	27
Deciduous forest	53	16	18
Roads/developed areas	13	4	93
Evergreen forest	3	1	9
Total	327	100	
Temporarily Disturbed Areas			
Mixed evergreen-deciduous forest	90	54	23
Deciduous forest	19	11	7
Evergreen forest	17	10	53
Herbaceous/grassland	41	25	20
Total	167	100	
Total of Permanently and Temporarily Affected Areas	494		
Barge/Traffic Area			
Permanently Disturbed Areas			
Herbaceous/grassland	1	3	N/A
Deciduous forest	9	30	N/A
Roads/developed areas	20	67	N/A
Total	30	100	
Temporarily Disturbed Areas			
Herbaceous/grassland	1	7	N/A
Deciduous forest	14	93	N/A
Total	15	100	
Total of Permanently and Temporarily Affected Areas	45		

[1] Approximate acreages used in the denominator of these percent calculations are from Table 2.4.1-1.
Source: Figure 4.3-1.

Note:
N/A – Not Applicable

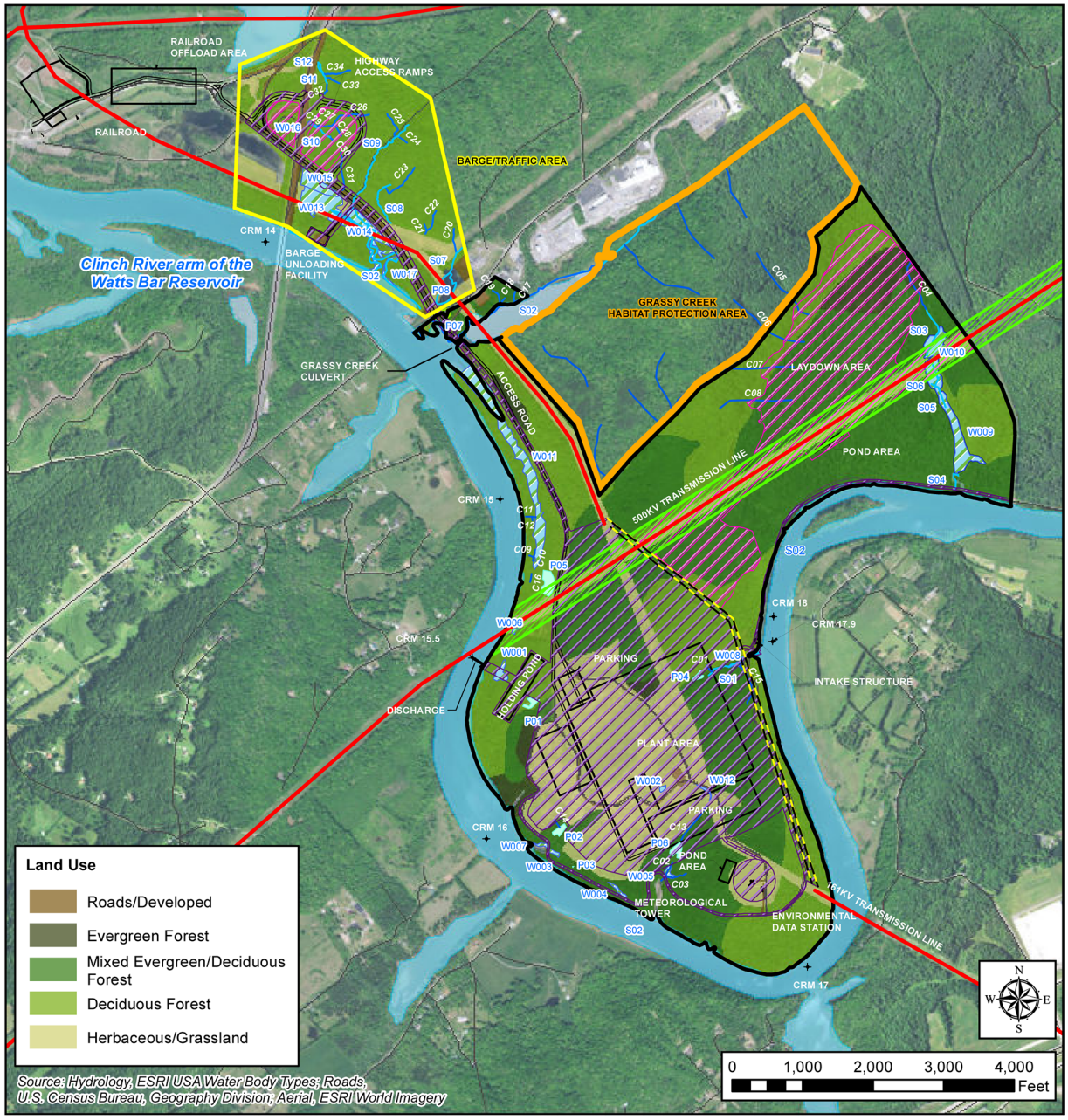

Figure 4.3-1. Areas to be Cleared and Land Cover Disturbed on the CRN Site and Barge/Traffic Area

4.4 SOCIOECONOMIC IMPACTS

This section describes the potential socioeconomic impacts associated with preconstruction and construction activities for the Clinch River (CR) Small Modular Reactor (SMR) Project, which includes the construction and operation of two or more SMRs at the Clinch River Nuclear (CRN) Site. The discussion is divided into three subsections. Subsection 4.4.1 describes physical impacts of preconstruction and construction activities on the community. Subsection 4.4.2 describes the social and economic impacts of the preconstruction and construction activities on the geographic area of interest and surrounding region. Subsection 4.4.3 describes environmental justice impacts within the region as a result of preconstruction and construction activities.

4.4.1 Physical Impacts

Preconstruction and construction activities can cause temporary and localized physical impacts such as noise, vibration, shock from blasting, odors, vehicle exhaust, and dust. This subsection addresses such potential construction impacts associated with the CRN Site that may affect noise, vibrations, and air quality.

4.4.1.1 Noise and Vibration

Preconstruction and construction related activities at the CRN Site and in the associated offsite areas (within the existing 500-kilovolt (kV) right-of-way (ROW) from the CRN Site to the Bethel Valley substation, the Barge/Traffic Area, potential rail modifications, and the borrow areas) have the potential to create elevated noise and vibrations beyond the baseline levels. The potential impacts of noise from the CRN Site preconstruction and construction have been analyzed by projecting construction-related noise levels at the CRN Site and within 5 miles (mi) of the CRN Site in comparison to ambient measurements described in Section 2.8, as well as to federal noise level guidelines. The results of these comparisons were then used to determine the magnitude of noise impacts at the various receptors identified in Section 2.8. Some activities which generate noise are also vibration-inducing activities; therefore, vibration impacts were analyzed in conjunction with the noise impacts.

The U.S. Department of Housing and Urban Development has established noise impact guidelines for residential areas based on day-night average sound levels (DNL) (Title 24 Code of Federal Regulations [24 CFR] 51.103). The CRN Site lies within the Oak Ridge city limits and the City of Oak Ridge has established noise ordinances based on the adjacent property uses. Adjacent property consists of the Clinch River Industrial Park on the north side of the CRN Site and the Oak Ridge Reservation (ORR) on the east side of the CRN Site. The Clinch River arm of the Watts Bar Reservoir is adjacent to the remainder of the CRN Site with residential areas on the opposite bank. The City of Oak Ridge sets a maximum limit of 80 A-weighted decibels (dBA) during the hours of 7:00 AM to 10:00 PM and a maximum of 75 dBA between 10:00 PM and 7:00 AM when the adjacent property use is residential. Additionally, the sound level should not exceed 65 dBA for more than half an hour during a one hour survey or 70 dBA for more than

10 minutes during a one hour survey. (Reference 4.4-1) Neither the State of Tennessee nor Roane County has developed noise regulations that specify acceptable community noise levels. When feasible, Tennessee Valley Authority (TVA) uses the U.S. Environmental Protection Agency (EPA) guideline of 55 dBA DNL as a design goal if the nearest receptor is residential. For industrial and commercial areas, TVA uses a 60 dBA equivalent noise level as a design goal at the property line. As described in Section 2.8, the DNL is the sound level average over a 24-hour (hr) period used to define the level of average noise exposure to a community during that 24-hr period. As part of the DNL sound level calculation, an additional 10 decibel (dB is added to nighttime (2200 to 0700) sound levels to account for the increased sensitivity of the community to nighttime noise. (Reference 4.4-2) When the background DNL is 60 dBA or less, TVA uses the Federal Interagency Committee on Noise recommendation that a 3 dB increase in DNL indicates a possible impact and necessitates further analysis (Reference 4.4-3).

Because the nearest adjacent property is the Clinch River Industrial Park, a commercial/industrial area, for the purpose of this Environmental Report, noise impacts are assessed using the DNL of 60 dBA at the property line as the level below which noise levels would be considered acceptable. As stated in NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants,* Rev. 1, in general, noise levels below a DNL of 65 dBA outside a residence are considered to be acceptable. Therefore, DNLs up to 65 dBA are considered to be SMALL impacts.

The amount of impact preconstruction or construction noise and vibrations have on the surrounding environment depends on factors including sound intensity, frequency, duration, location on site, the number and type of noise and vibration sources, time of day, weather conditions, wind direction, time of year, etc. Typical preconstruction and construction noise and vibration are generated by the operation of machinery and vehicles, including internal combustion engines (e.g., front end loaders, tractors, scrapers/graders, heavy trucks, cranes, concrete pumps, and generators), impact equipment (e.g., pneumatic equipment, jack hammers, and pile drivers), other equipment (e.g., vibrators, saws, and hydro excavation equipment), and machine backup-alarms. Equipment noise and vibration associated with preconstruction and construction activities can be categorized as either continuous (ongoing) or impulse (periodic) in nature and can be either stationary or mobile in location. Equipment that operates in one location for one or more days at a time is considered stationary (e.g., pumps, generators, compressors, and screens). Pile drivers and pavement breakers may also be categorized as stationary equipment depending on the nature of their use. Mobile equipment includes machinery such as bulldozers, scrapers, loaders, and haul trucks that perform cyclic processes. The equipment type, age of equipment, specific model, equipment condition and the operation performed influence equipment noise and vibrations. Because of design improvements and technological advances, new machines are typically quieter than older models due primarily to better engine mufflers, refinements in fan design, and improved hydraulic systems.(Reference 4.4-4)

Noise levels as generated by typical equipment are shown in Table 4.4-1. This information is being utilized to illustrate a worst case scenario. Attenuated noise levels calculated in Table

4.4-1 are considered to be maximum noise levels. Construction equipment and vehicles generally do not operate at maximum levels continuously; therefore actual noise (and the associated vibration) levels are expected to be lower than those levels shown on Table 4.4-1 and may also be further reduced by the use of modern equipment, mufflers, and hydraulic systems.

The majority of the preconstruction and construction activities occurring at the CRN Site and in the offsite areas would generate noise levels below 65 dBA at each of the receptors. Those construction activities that could generate noise above 65 dBA at the CRN Site border or in the offsite areas would be temporary. Most preconstruction and construction activities would occur during normal daylight hours between 0700 and 1700. There are occasions when preconstruction and construction activities must be scheduled during night time hours. Typical instances requiring overnight activities include continuous concrete pours to ensure homogeneity and strength of the structures. At these times the noise level would remain as high as or higher than 60 to 90 dB at a distance of 100 feet (ft) from the equipment; however, the noise level should be attenuated to below 65 dBA at the CRN Site border.

The nearest residences are located across the Clinch River arm of the Watts Bar Reservoir on three sides of the peninsula. Because water is between the CRN Site and the residences, construction noise would not be attenuated with distance as it would by natural insulators (e.g., ground cover, earthen berms, grass, or trees with foliage). If construction activities occur within 500 ft of the CRN Site border or of the offsite areas (distance at which estimated dBA for equipment [other than pile driver] is less than 65 dBA), or noise levels become excessive, the nearby residences could be temporarily impacted by construction noise above the acceptable levels. Altering terrain during construction activities at the CRN Site could increase or decrease impact noise levels across the Clinch River arm of the Watts Bar Reservoir. Common practices to mitigate noise include, but are not limited to:

- Using noise reduction devices on heavy equipment (i.e., mufflers)
- Limiting driving speeds, use of “Jake brakes,” and tail-gate slamming
- Constructing earthen berms
- Placing foliage or ground cover between the noise sources and receptors

The industrial facilities located north of the CRN Site along West Bear Creek Road in the Clinch River Industrial Park could be adversely affected by construction noise. However, noise levels are expected to be lower than at the residences across the reservoir because of the elevated topography separating the industrial park from the CRN Site. Other receptors (i.e., recreation areas, hospitals, and schools) are located at distances at which noise levels during construction activities would be comparable to background levels.

Unusual noise and vibrations due to construction activities such as blasting, demolition and testing of the emergency warning siren may periodically be necessary. These activities could result in temporarily excessive noise levels. These noise and vibration generating activities are

expected to fluctuate throughout the construction period. Blasting and demolition would occur early in the preconstruction and construction activities at intermittent frequencies and only occur during the daylight hours (between 0700 and 1700). If the construction activities occur in close proximity to the CRN Site border, then the residences closest to the CRN Site border (specifically those located across the Clinch River arm of the Watts Bar Reservoir) could temporarily experience noise and vibration impacts from the construction equipment. Mitigation measures as described previously would minimize noise and vibration.

Offsite preconstruction or construction activities include the installation of the 69-kV underground transmission line, roadway modifications, refurbishment of a rail siding, and improvements to the barge loading area, all located within property owned by the federal government and managed by the U.S. Department of Energy (DOE) or TVA and not in proximity to any residences. These offsite activities would, therefore, also be unlikely to cause direct impacts to the general public. However, workers at the Clinch River Industrial Park and ORR facilities could experience noise from construction activities, in particular the 5-mi long underground transmission line.

The identified potential offsite borrow areas for the CR SMR Project are located in areas in closer proximity to residences and communities than the CRN Site. Additionally, trucks transporting the borrow materials would travel near or through various communities in route to the CRN Site. These borrow areas are currently being used for the extraction of borrow material. Therefore preconstruction or construction activities at these borrow areas would be unlikely to create new impacts beyond those already occurring. Trucks hauling borrow materials would travel along roadways that are already used by a variety of vehicles, including similar trucks. Therefore, the transportation of borrow materials would also be unlikely to cause direct noise- or vibration-related impacts to the general public.

An increase in daily traffic (up to 3300 construction worker vehicles and 90 construction/transport vehicles per day) would be expected along Tennessee State Highway (TN) 58 and Bear Creek Road during peak construction. The composition of this traffic would include passenger cars and light-duty trucks of the construction workforce, as well as trucks for delivery of construction materials and heavy equipment used to support facility construction (e.g., excavators, bulldozers, heavy haul trucks, and cranes). This traffic would have the potential to increase noise along TN 58 and Bear Creek Road. Potential effects of this daily traffic are considered to be indirect impacts associated with onsite preconstruction and construction activities. Construction worker traffic would have a SMALL to MODERATE effect on noise levels along local roadways surrounding the CRN Site. Noise levels would vary over the course of construction based on the number of workers commuting to the CRN Site, with higher noise levels generated during the peak construction period. Because the construction workforce would be divided into three shifts (although approximately two-thirds of the construction workforce would work the day shift), the increased traffic would be concentrated at shift changes, including during the night and early morning. Therefore, the indirect noise and vibration impacts to the public from construction-related traffic on local roads associated with preconstruction and construction activities at the CRN Site would be SMALL to MODERATE.

Based upon the projected noise and vibration levels at various CRN Site and surrounding area receptors and the duration of preconstruction and construction activities, direct noise and vibration impacts from CRN Site construction are expected to be SMALL for the surrounding communities and the nearest residents.

4.4.1.2 Air Quality

Preconstruction and construction activities at the CRN Site and in the offsite areas would generate temporary air emissions of both gaseous and particulate pollutants. Potential air emission activities would likely include:

- Land clearing and material removal
- Material processing and handling
- Construction and preconstruction machinery operation and maintenance
- Material replacement (including subsurface preparation and concrete pouring and paving)
- Driving piles and erection of structures
- Truck deliveries of supplies and materials to the CRN Site and offsite areas
- Soil excavation and grading
- Soil transport and temporary stockpiling
- The workforce commute

In general, as stated in NUREG-1555, Subsection 4.4.1, “physical impacts to a community from construction of a nuclear plant are not markedly different from any other large heavy construction project.”

Preconstruction and construction-related emissions, typically from fugitive dust and construction equipment engine exhaust, tend to be limited and localized to the immediate project area because they are generated from groundlevel or near groundlevel. Therefore, the project’s preconstruction and construction phase geographic area of interest for air quality is estimated to extend no more than 5 mi from the CRN Site. Additionally, these emissions are intermittent, temporary and transient (e.g. the construction activities would not encompass the entire CRN Site at all times).

National ambient air quality standards (NAAQS) have been established by the EPA in 40 CFR 50 (Subsections 50.4 - 50.13 and 50.15 -50.18) for defined criteria compounds: sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter with a diameter less than 10 microns (PM_{10}), particulate matter with a diameter less than 2.5 microns ($PM_{2.5}$), lead (Pb), and ozone (O_3). In addition, the EPA has classified areas of the country where the NAAQS are met (attainment areas), locations that sufficient data are not available for setting a classification (unclassifiable or undesignated), and locations in the country that do not meet the NAAQS (nonattainment areas). These areas are designated on a pollutant-by-pollutant basis.

The portion of Roane County in which the CRN Site is located is in attainment for all air pollutants. Census Block Group 47-145-0307-2 in Roane County, located approximately 6 mi to the west of the CRN Site, is designated nonattainment for $PM_{2.5}$ (location shown in Section 2.7, Figure 2.7.2-1).

Preconstruction and construction activities associated with the operation of motor vehicles and engines would produce temporary emissions of both gaseous pollutants and particulate matter. These emissions are temporary in that equipment is only used for the preconstruction and construction phases of the project and this equipment is not used continuously during preconstruction and construction. An SMR technology has not yet been selected for the CR SMR Project; therefore, associated preconstruction and construction activities, including the numbers and types of equipment onsite and phasing, have not been determined. Preliminary estimates of emission factors for equipment typically used during preconstruction and construction phases are provided in Tables 4.4-2 and 4.4-3. Further evaluation of construction related emissions will be conducted at the combined license application stage once the SMR technology has been selected.

Because emissions from onsite preconstruction and construction activities are generally from near ground level, impacts are potentially greatest at sensitive receptors nearest to construction activities. Figure 2.7.6-1 shows the location of sensitive receptors in the area surrounding the CRN Site. The figure indicates the closest sensitive receptors are across the Clinch River arm of the Watts Bar Reservoir, at approximately 0.5 mi, to the northeast clockwise through the west-northwest. Emissions from preconstruction and construction activities would be temporary and are expected to be minor. Air permitting for the CR SMR under Tennessee and federal air laws are expected to address these emissions.

To minimize these temporary emissions, the CR SMR Project will utilize a preconstruction and construction-related mitigation plan. Mitigation measures may include:

- Scheduling preconstruction and construction activities to minimize running, inactive vehicles
- Phasing activities and equipment use
- Ensuring the use of heavy equipment that is in good condition, is properly maintained, and is compliant with applicable federal regulations for off-road diesel engines
- Ensuring all machinery is maintained and operated in accordance with the manufacturer's specifications
- Minimizing idling time of vehicles delivering materials to the CRN Site
- Maintaining low vehicle speeds on dirt covered roads and exposed areas to minimize dust generation
- Watering down roadways and exposed areas
- Minimizing storage piles of soils

- Minimizing dust generating activities during high wind conditions
- Locating stationary equipment (e.g., generators and compressors) as far away from sensitive receptors as practical
- Implementing specific contractor's procedures to minimize the generation of dust via materials handling, vehicle movement, and wind erosion

On-road indirect source emissions would also be generated from motor vehicles used for truck deliveries to the CRN Site and from the preconstruction and construction workforce's commute. Measures to mitigate on-road emissions may include staggered shift times, requiring delivery vehicles to shut down engines during off-loading, and supporting/encouraging van/carpooling and other commuting alternatives. Motor vehicle emissions are not expected to create significant impacts but will also be addressed, along with mitigation measures, as required under federal and state regulations during the air permitting process.

Preconstruction and construction activities at the CRN Site and in the offsite areas would generate temporary air emissions of both gaseous and particulate pollutants. The effects on air quality from these temporary emissions are expected to be minor and would be minimized through use of a mitigation plan, which will be prepared when the design of the facility is complete and provided to the air reviewing agencies. Further, the transportation analysis in Subsection 5.8.2.3 indicates that measures to offset impacts from construction related activity on local roads would be sufficient to offset impacts to roadway levels-of-service (LOS). This would also mitigate the potential for addition emissions from vehicles due to roadway congestion. Accordingly, air quality impacts from CRN Site construction are expected to be SMALL for the surrounding communities and the nearest residents.

4.4.2 Social and Economic Impacts

This subsection evaluates the potential demographic, economic, infrastructure, and community impacts associated with preconstruction and construction activities for the CR SMR Project, which includes the construction and operation of two or more SMRs at the CRN Site. The geographic area of interest identified for social and economic impacts, which is defined by the areas where the construction workforce and their families would reside, spend their income, and use their benefits, is the four-county area including Anderson, Knox, Loudon, and Roane counties. The evaluation assesses potential impacts associated with construction-related activities and the size of the construction workforce. The analysis is based on the plant parameter envelope, which is discussed in Section 3.1 and provided in Tables 3.1-1 and 3.1-2, a peak construction and operations overlap workforce of 3666 workers, which is discussed in Section 3.10.

4.4.2.1 Population and Housing

This analysis of population and housing is based on the estimated peak overlap workforce expected to be onsite at any point during the construction and operations period. As described

in Subsection 3.10.4, the CR SMR Project includes construction of multiple SMRs that would be brought into operation sequentially. Therefore, there would be a period of time when one or more SMR(s) is operating while other SMR(s) are being constructed, resulting in an overlap of construction and operations workers. The peak overlap workforce is defined in Subsection 3.10.4 as 3666, which is the peak construction workforce (3300) plus the peak operation workforce occurring during the same months as the peak construction workforce (366).

Based on the information presented in Section 3.10, it is anticipated that approximately 2185 construction workers already reside within the 50-mi region. The remaining 1115 workers would migrate into the region. It is conservatively assumed that 100 percent of this in-migrating workforce would relocate within the geographic area of interest. It is also estimated that 50 percent of the total operations workforce (250 workers) is recruited and trained from the Oak Ridge/Knoxville area, and 50 percent (250 workers) relocate to the Oak Ridge/Knoxville area from outside a 50-mi radius. This results in a total in-migrating workforce of 1365.

Population

In 2010, the permanent population within the 50-mi radius of the CRN Site was 1,158,026 and is projected to grow to 1,305,189 by 2021 (Tables 2.5.1-2 and 2.5.1-5). The four-county geographic area of interest, including Anderson, Knox, Loudon, and Roane Counties, had a population of 610,092 in 2010 and a projected population of 682,278 in 2020 and 807,594 in 2040 (Table 2.5.1-6).

It is assumed that each worker that relocates into the geographic area of interest would bring a family. The average household size in Tennessee is 2.48 (Reference 4.4-5). Therefore, an in-migrating workforce of 1365 would increase the population in the geographic area of interest by 3385 people, or 0.6 percent of the geographic area of interest population in 2010. Of the 11,433 employees at the DOE Oak Ridge facilities that reside within the geographic area of interest, 27 percent reside in Anderson County, 50 percent in Knox County, 6 percent in Loudon County, and 17 percent in Roane County (Reference 4.4-6). It is assumed that the residential distribution of the in-migrating workforce would resemble the residential distribution of the DOE workforce. Of the total population increase due to the in-migrating workforce, 914 people (27 percent of 3385) are expected to settle in Anderson County, 1693 people in Knox County, 203 people in Loudon County, and 575 people in Roane County. These numbers constitute 1.2 percent, 0.4 percent, 0.4 percent, and 1.1 percent of the 2010 populations of Anderson, Knox, Loudon, and Roane Counties, respectively.

The in-migrating workers and their families would represent a small increase to the populations of the four counties within the geographic area of interest and an even smaller increase to the total population in the geographic area of interest. Therefore, the potential impacts on population would be SMALL.

Housing

Subsection 2.5.2.6 and Table 2.5.2-12 review and show availability of housing in the year 2010 in the geographic area of interest and are used as a basis for estimating the number of housing units that may be available during the construction phase. Generally, the counties with larger populations (in particular Knox County) have more available vacant housing.

During the overlap between preconstruction/construction and operation, 3385 people would potentially seek permanent and temporary housing within the geographic area of interest.

There is currently enough housing to accommodate all the expected in-migrating families in Knox County alone. Knox County, with the greatest number of housing units in the geographic area of interest, had 17,700 vacant units in 2010, with 6777 for rent and 3747 for sale. In the geographic area of interest as a whole, there were a total of 26,403 vacant housing units, with 8984 for rent and 5120 for sale. It is likely adequate housing would be available within the geographic area of interest at the time the in-migrating peak overlap workforce would move into the area. It is also probable that workers on short-term assignments would utilize temporary housing in the form of hotels, seasonal homes (for long-term rentals), and recreational vehicle parks and campgrounds. As described in Subsection 2.5.2.6, there are over 8100 hotel rooms in the Knoxville area and another 1185 rooms in Anderson, Loudon, and Roane Counties. According to the 2010 Census, the geographic area of interest has 2329 seasonal housing units. Also, there are approximately 1302 temporary housing sites at recreational facilities in the geographic area of interest (Table 2.5.2-12).

The potential impacts on housing would be SMALL due to the large number of available vacant housing units in the geographic area of interest and the relatively small requirements for the in-migrating construction workforce.

4.4.2.2 Employment and Income

The in-migration of construction workers would be likely to create new indirect service jobs in the area and increase the amount of money used to purchase goods and services. The influx of new workers would spend a portion of their income on housing, food, entertainment, and other goods and services in the region, and additional jobs would be created through the multiplier effect. The number of times the final increase in consumption exceeds the initial dollar spent is called the multiplier. The U.S. Department of Commerce Bureau of Economic Analysis, Economics and Statistics Division, calculates multipliers for industry jobs and earnings within a specific region. The economic model they use is called the Regional Input-Output Modeling System (RIMS II).

RIMS II multipliers were obtained for the region consisting of Anderson, Knox, Loudon, and Roane counties. The RIMS II direct effect employment multiplier for construction jobs is 1.7415. Thus, for every newly created construction job, an estimated additional 0.742 jobs are created in the region. (Reference 4.4-7) Based on the Bureau of Economic Analysis multiplier and a

maximum overlap workforce of 3666 during the peak overlap period, CRN Site construction would create approximately 2720 indirect jobs within the geographic area of interest, which would be expected to occur during the fourth year of a projected six-year construction schedule. The combined total of 6386 direct construction jobs plus indirect jobs represents approximately 1.6 percent of the geographic area of interest workforce.

Most indirect jobs are assumed to be service-related and not highly specialized. Therefore, it is expected that those jobs would be filled by the existing workforce within the geographic area of interest. Some of the indirect jobs could benefit unemployed or underemployed workers in the geographic area of interest. The total number of indirect jobs that would be generated by construction is approximately 11 percent of the 24,000 unemployed persons in the geographic area of interest.

For every dollar earned by a construction worker, an additional 0.6998 dollars is added to the regional economy based on the Bureau of Economic Analysis direct-effect earnings multiplier for the geographic area of interest (Reference 4.4-7).

The employment of the overlap workforce over a period of several years would have positive economic effects on the geographic area of interest and surrounding region. It would introduce millions of dollars into the regional economy, creating indirect jobs that could help reduce unemployment and business opportunities for housing and service-related industries. Much of this positive effect would be expected to occur within the geographic area of interest. Therefore the impact of construction on the economy of the geographic area of interest would be beneficial and MODERATE.

4.4.2.3 Transportation

Roadways

As shown on Figure 2.5.2-1, several federal highways and state roads provide access to the geographic area of interest. Construction traffic would typically access the CRN Site via Oak Ridge Turnpike (TN 58) and Bear Creek Road. Driveway access to and from the CRN Site is from one roadway, Bear Creek Road. TN 58 and TN 95 provide access to Bear Creek Road. For workers commuting from the north and south, there are interchanges on Interstate (I-) 40 for both TN 58 and TN 95. For workers commuting from the west, TN 61 and TN 62 provide access to Bear Creek Road via TN 327. From the east, US 321/TN95 intersects with Bear Creek Road. The roadway configuration results in a concentration, or funneling, of facility-related traffic from I-40 and various highways onto Bear Creek Road.

Capacity analyses were performed for the four existing intersections most likely to be affected by construction and operation of the two or more SMRs at the CRN Site, as described in Subsection 2.5.2.2.3. These intersections are TN 58 at Bear Creek Road ramp (Intersection 1), TN 58 at TN 327 (Intersection 2), TN 95 at Bear Creek Road (Intersection 3), and Bear Creek Road at Bear Creek Road ramp/US Government Property Road (Intersection 4). The capacity

analyses evaluated existing (2013) conditions. The locations of Intersections 1 through 4 are shown on Figures 2.5.2-1 and 4.4-1. These figures illustrate the same roadways and intersections. Figure 2.5.2-1 shows the four existing intersections that were evaluated in the capacity analysis, and Figure 4.4-1 shows a schematic rendering of the proposed improvements to those intersections as well as the addition of two proposed new intersections.

A traffic assessment was completed for the four existing intersections (Intersections 1 through 4) as well as the two proposed new intersections (Intersections 5 and 6). This assessment included an analysis of traffic conditions on the roads adjacent to the CRN Site for the existing (2013) situation and for three future (2024) scenarios. The year 2024 is the expected peak traffic year, with an estimated construction workforce of 3300 (maximum number onsite during a 24-hr period) and an operation workforce of 366 for a peak overlap workforce of 3666. (Reference 4.4-8) The three future scenarios evaluated are:

- Background = future conditions *without construction*: Incorporates any historic background growth rates, any approved development traffic, and any planned roadway improvements independent of the project Site to estimate the future traffic volumes
- Background + Site = future conditions *with construction*: Estimates the future traffic volumes with the addition of proposed CRN Site traffic, based on existing roadway conditions
- Future + Site = future conditions *with construction and traffic improvements*: Estimates the future traffic volumes with the addition of proposed CRN Site traffic, assuming recommended roadway improvements are in place (Reference 4.4-8).

Traffic distribution and assignment were based on land uses and population densities in the area, as well as the surrounding roadway network. The majority of the workers (either construction or operation) were expected to commute from within a 50-mi radius, which includes the greater Oak Ridge and Knoxville, Tennessee metropolitan population areas. Approximately 40 percent of the proposed CRN Site traffic was expected to travel from the north (Oak Ridge and Oliver Springs, Tennessee) along TN 58, TN 95, and TN 327. The remaining 60 percent were expected to travel from the south (Kingston, Lenoir City, Farragut, and Knoxville, Tennessee) along TN 58 and TN 95 from I-40. (Reference 4.4-8)

The results of the traffic assessment, including level of service (LOS) and delay for each study intersection, are summarized in Table 4.4-4 for all periods analyzed. The LOS designations for *2024 Background + Site Scenario* represent traffic conditions at the intersections with the addition of proposed CRN Site construction based on existing roadways (without mitigation). The LOS for four of the intersections is F, the lowest level, which represents poor progression and extreme delay. This includes Intersection 3, TN 95 at Bear Creek Road, which would adversely affect access to the Clinch River Industrial Park on West Bear Creek Road. This represents a LARGE impact to traffic flow during construction.

As shown on Table 4.4-4, the LOS levels for *2024 Future + Site Scenario* represent project-related traffic conditions with the addition of roadway improvements (with mitigation).

Based on the future construction-related traffic analysis, the roadway improvements for the *2024 Future + Site Scenario* are expected to provide an acceptable operation for the peak year 2024. These improvements are summarized in Figure 4.4-1. The proposed additional northbound loop ramp between TN 58 and Bear Creek Road (Intersection 1) would provide the added capacity for the 2024 peak traffic year surrounding construction and operation. Rather than having all traffic entering/exiting the CRN Site from one ramp, the traffic would be distributed between two ramps. With this new distribution, Bear Creek Road at Bear Creek Road southbound ramp (Intersection 4) is expected to operate with an acceptable LOS. Another advantage of the ramp is that in the event of emergency, the ramp provides free flow movements to/from TN 58 for evacuation purposes. (Reference 4.4-8)

The addition of the proposed new Bear Creek Road northbound ramp is expected to provide added capacity to/from TN 58; however, the connection onto Bear Creek Road would also need to be improved (Intersection 6). Due to the large volume of traffic shifting to the proposed northbound ramp in morning peak hour, dual left-turn lanes would be needed (with a roundabout or a signal), requiring at least two receiving lanes onto Bear Creek Road. A roundabout instead of a signal (Intersection 6) is identified as a mitigation measure for efficiency and safety. (Reference 4.4-8)

During 2024 peak year of construction, the existing two-lane Bear Creek Road is projected to be over capacity during the morning (entering) and afternoon (exiting) peaks. An additional lane (reversible) is identified as a mitigation measure to accommodate the morning and afternoon peaks. The Bear Creek Road at Site Driveway (Intersection 5) should be realigned to a “T” intersection, eliminating the existing curve. A temporary traffic signal is recommended. It is encouraged that construction and operation workers enter the Site from TN 58 for traffic and safety reasons. TN 95, with the high speeds in conjunction with the horizontal (corners/bends) and vertical (hills/valleys) curvature, creates sight distance challenges along this route. (Reference 4.4-8)

Construction worker traffic would have a LARGE impact on local roadways surrounding the CRN Site. In order to avoid disruptions to local traffic during construction for the CR SMR Project, road modifications are proposed as mitigation for the potential adverse impacts. Although some intersections would still be operating at a LOS of D or worse, this would only be for less than 2 hr a day during shift changes. Deliveries would not be scheduled during these times in order to minimize potential adverse impacts. Additional measures such as traffic officers during peak hours could also be implemented in the event that traffic conditions are worse than anticipated. Once construction is complete, the smaller operations workforce would not create adverse impacts to local traffic conditions. With the recommended modifications, impacts to traffic flow during construction would be MODERATE and temporary.

Traffic Accidents

During development of representative commuter and construction traffic impacts, crash data on the primary roadways in the vicinity of the CRN Site for the years 2008 through 2012 were

obtained from the Tennessee Department of Transportation. Peak overlap workforce traffic increases are anticipated to occur on TN 58, TN 95, and TN 327 when the first SMR unit is operational while the second SMR unit is under construction. Using the peak construction year of 2024 with 3666 total workers (3300 construction and 366 operational), an estimate of the new vehicles trips and additional traffic accidents including injuries and fatalities was conducted.

The estimated impacts of the peak overlap workforce associated with the CRN Site are shown in Table 4.4-8. Total annual traffic accidents on the three affected roadways in the vicinity of the CRN Site are anticipated to increase by 3.37 accidents, injuries from traffic accidents to increase by 1.17 injuries, and traffic fatalities to increase by 0.08 fatalities per year as a result of combined construction and operation activities at the CRN Site. The projected peak overlap workforce is expected to increase traffic on TN 58 by nearly 50 percent. While TN 58 has the lowest crash, injury, and fatality rates of the three primary roadways used to access the site, a substantial increase in vehicles is likely to result in additional crashes per year. The number of traffic accidents would noticeably increase, but this increase would not destabilize the traffic flow or safety along TN 58, thus having a moderate impact.

TN 95 carries half the traffic of TN 58, but has the highest crash and fatality rate. The increase in traffic would noticeably alter (increase) the number of accidents, injuries, and fatalities on this road; however, this increase in number of traffic accidents on TN 95 would not be sufficient to destabilize traffic flow or safety along TN 95, thus having a small impact.

TN 327 is expected to carry the fewest number of vehicles but is shown to have the highest injury rate. The increase in traffic from the peak overlap workforce would result in an increase of accidents, injuries, and fatalities on this road. The increase in accidents on TN 327 would be minor and would not noticeably destabilize traffic flow or safety along TN 327, thus having a small impact.

The addition of vehicles associated with concurrent construction and operation activities at the CRN Site is expected to result in a minor increase relative to the current traffic accident injury risk in the vicinity of the site. This minor increase would be minimized through implementation of roadway modifications as shown in Figure 4.4-1, and through the use of best management practices (BMPs), such as posting signs near construction entrances and exits to make the public aware of areas with high construction traffic; development of a traffic control mitigation plan; use of staggered shift start and end times; use of carpooling; and scheduling of deliveries to avoid peak traffic periods. Therefore, overall impacts to traffic accidents as a result of construction and operation at the CRN Site would be SMALL to MODERATE and temporary.

Railroads

As described in Section 3.9, some items such as heavy modules and large components would be delivered by rail. They could potentially enter the CRN Site via the Site Access Road from the rail spur (EnergySolutions Heritage Railroad), located approximately 2.5 mi north-northwest of the center point of the CRN Site. The use of this rail spur would not impact other

transportation systems used by the local communities and the impact to railroads would be SMALL.

Waterways

As described in Section 3.9, very large components would be delivered by barge. The shipments would be offloaded at the refurbished DOE former K-1251 Barge Loading Area near Bear Creek Road between TN 58 and the CRN Site entrance, and brought to the CRN Site via Bear Creek Road and the Site Access Road. Because the majority of module and component deliveries would be over road and rail, and the barge shipments would be scheduled and arrangements made for the increased barge traffic as necessary, the impact to barge traffic on the Clinch River arm of the Watts Bar Reservoir would be SMALL.

Public Transportation

Public transportation services in the geographic area of interest are provided by the East Tennessee Human Resource Agency (including Oak Ridge Transit), Knoxville Area Transit, and Knox County Community Action Committee Transit (Reference 4.4-9). As discussed in Subsection 4.4.2.1, the estimated geographic area of interest population increase associated with construction of two or more SMRs at the CRN Site would be approximately 3385 people (2765 associated with construction and 620 associated with operation) for the overlap period between construction/preconstruction and operation or 0.6 percent of the geographic area of interest population in 2010). These numbers constitute approximately 1.2 percent, 0.4 percent, 0.4 percent, and 1.1 percent of the 2010 populations of Anderson, Knox, Loudon, and Roane counties, respectively. The construction workers and their families would represent a small increase to the populations of the four counties within the geographic area of interest and an even smaller increase to the total population in the geographic area of interest. This increase in the geographic area of interest population could increase public transportation usage, which would have a SMALL impact on public transportation facilities in the geographic area of interest.

4.4.2.4 Tax Revenues to Local Jurisdictions

Several types of taxes would be generated by construction activities and purchases and by workforce expenditures. These include sales and use taxes on corporate and employee purchases and personal property tax associated with employees. Anderson, Knox, Loudon, and Roane counties are the tax districts that are assumed to be most directly affected by the CR SMR Project.

As discussed in Subsection 2.5.2.3, TVA makes tax-equivalent payments to eight states under Section 13 of the TVA Act of 1933, including the State of Tennessee. TVA pays 5 percent of its gross proceeds from the sale of power (with certain exclusions) to states and counties where its power operations are carried out (the State of Tennessee and Roane County for the CR SMR Project). Payments to each state are determined based upon the proportion of TVA power

property and power sales, in each state, compared to TVA's total power property and power sales, respectively.

Tennessee sets aside a percentage of the tax equivalent payments received from TVA each year to redistribute to counties designated by TVA as affected by construction of major facilities used by TVA to produce electric power. These Impact Payments are received by Tennessee counties directly from the State of Tennessee. The payments to impacted counties are made during the period of significant construction activity and for one full fiscal year after completion of such activity, with reduced Impact Payments made during the following three years. Impact Payment allotments are in addition to the TVA tax-equivalent funds distributed by the state to local governments. TVA's designation of counties eligible to receive Impact Payments related to a project is based on anticipated effects such as an increase in local traffic, larger numbers of school-age children entering the county school systems, and a greater demand for the county's health and social services. (Reference 4.4-10) A quantitative estimate of the Impact Payments associated with the CM SMR Project is not available at this time. The additional state allocation of TVA tax equivalent payments as Impact Payments to the eligible local governments during construction could be used to address some of the impacts on public services discussed in Subsections 4.4.2.7 and 4.4.2.8.

Sales and use taxes would be generated in the geographic area of interest and region through retail expenditures of the construction workforce. The purchase of construction materials and supplies for the CR SMR Project also would generate sales and use taxes. However, estimates of regional expenditures expected during the duration of construction are not available.

Property tax revenues would be generated by the increased economic activity involving the construction workforce. Revenues such as residential property taxes, real estate transfer fees, and motor vehicle taxes are collected by or on behalf of the state government. These funds are then distributed to the jurisdictions, including schools and public services.

Given the structure by which the TVA makes payments in lieu of taxes, the general distribution structure of funding by the State of Tennessee, as well as the increase in income, sales, and property taxes, the potential impact of taxes within the geographic area of interest and region would be small and beneficial. Although the amount of income, sales, and property taxes as well as TVA tax-equivalent payments would be large in absolute terms, it would be SMALL when compared to the total amount of taxes collected within the geographic area of interest.

4.4.2.5 Land Use

In NUREG-1437, Rev. 1, the U.S. Nuclear Regulatory Commission (NRC) defines levels of significance for identifying impacts to offsite land use related to refurbishment of an existing nuclear facility. The analysis is based on population changes caused by refurbishment activities. These significance levels are applicable to the analysis of the impacts associated with constructing a new nuclear power plant. NRC concluded that the impacts to offsite land use during refurbishment at nuclear plants are considered:

- SMALL: if population growth results in very little new residential or commercial development compared with existing conditions and if the limited development results only in minimal changes in an area's basic land use pattern
- MODERATE: if plant-related population growth results in considerable new residential or commercial development and the development results in some changes to an area's basic land-use pattern
- LARGE: if population growth results in large-scale new residential or commercial development and the development results in major changes in an area's basic land-use pattern

NRC identified key predictors of population-induced land use changes as:

- SMALL: if plant-related population growth is less than 5 percent of the study area's total population, especially if the study area has established patterns of residential and commercial development, a population density of at least 60 persons per square mile, and at least one urban area with a population of 100,000 or more within 50 mi
- MODERATE: if plant-related growth is between 5 and 20 percent of the study area's total population, especially if the study area has established patterns of residential and commercial development, a population density of 30 to 60 persons per square mile, and one urban area within 50 mi
- LARGE: if plant-related population growth is greater than 20 percent of the study area's total population and population density is less than 30 persons per square mile

During the overlap period between preconstruction/construction and operation, the population in the geographic area of interest would increase by 3385 people (2765 associated with construction and 620 associated with operation) as described in Subsection 4.4.2.1. In 2010, the four counties within the geographic area of interest had a population of 610,092 and covered a land area of 1435 square mi, for an overall population density of 425 persons per square mi. A temporary population growth of 3385 persons represents a 0.6 percent increase in the population of the geographic area of interest. According to NRC guidelines, population-induced land use changes would be SMALL because the construction-related population increase would be 0.6 percent of the geographic area of interest population, the area has an established pattern of residential and commercial development, a population density of greater than 60 people per square mi, and at least one urban area with a population of 100,000 or more within 50 mi (178,874 in Knoxville, Tennessee) (Reference 4.4-11). Additionally, land use changes would be SMALL because the population growth would result in very little new residential or commercial development compared with existing conditions and would be expected to result in minimal changes to the basic land use patterns in the vicinity of the CRN Site.

Population-induced land use changes would also be SMALL if the counties within the geographic area of interest are considered individually. As discussed in Subsection 4.4.2.1, population increases due to the peak overlap workforce constitute 1.2 percent, 0.4 percent, 0.4

percent, and 1.1 percent of the 2010 populations of Anderson, Knox, Loudon, and Roane counties, respectively. The population density is greater than 60 people per square mi for each county: 222.8 in Anderson County, 850.5 in Knox County, 211.8 in Loudon County, and 150.2 in Roane County.

4.4.2.6 Aesthetics and Recreation

Visual and aesthetic effects associated with a project occur as a result of the introduction of a structure or facility that is not consistent with the existing viewshed. Consequently, the character of an existing site is an important factor in evaluating potential effects of construction on the visual resource. Visual resources of the CRN Site and surrounding areas are described in Subsection 2.5.2.5.1. Because the areas immediately surrounding the CRN Site are bound by water features, forests, and ridge lines, direct visual access to facility construction is limited primarily to construction workers, residents living along the Clinch River arm of the Watts Bar Reservoir across from the CRN Site, and recreators using the reservoir.

Although most of the construction activities are not expected to be visible to the general public, construction of the facility would entail the use of large cranes. The largest is expected to be a heavy lift crane with a height of 638 ft, which would be visible from local public roads. The tallest power block structure would be 160 ft above plant grade (Table 3.1-2, Item 1.1.1) and its construction would be visible above the tree line. Additional activities such as use of large earth-moving equipment, relocation of a portion of the Kingston FP – Fort Loudon HP 161-kilovolt transmission line on the CRN Site, and the transportation of large materials onto the CRN Site could be visible to members of the public from the surrounding area. Night time lighting could be used during construction if work is to proceed at night and for security purposes, and would be visible from the surrounding area. Construction of the two or more SMRs would be visible to recreational users of the Clinch River arm of the Watts Bar Reservoir, the Melton Hill Reservoir and Melton Hill Dam Reservation, and the Gallaher Recreation Area. Construction activities would be most noticeable to these groups while the intake and discharge structures were being built. Because the impacts of construction activities on visual resources would be localized and the construction timeframe is limited, the aesthetic impacts to the general public would be small. For nearby residents and recreational users of the Clinch River arm of the Watts Bar Reservoir, the aesthetic impacts would be MODERATE.

A number of public and private recreational facilities and a range of outdoor activities are located in the vicinity of the CRN Site, as described in Subsection 2.5.2.5.2, and in the region, as discussed in Subsection 2.5.1.3. Recreational areas within the CRN Site vicinity and region could potentially be impacted by the increased population of construction workers and their families and the increased competition for transient housing. Workers who relocate to the geographic area of interest would be expected to utilize recreational areas and facilities to a similar degree as the permanent population of the geographic area of interest. Because many of the recreational opportunities of the region are outdoor activities without associated maximum capacities, it is difficult to accurately estimate utilization by the permanent population. Considering that an in-migrating workforce of 1365 would increase the population in the

geographic area of interest by 3385 people, or 0.6 percent based on the 2010 population of 610,092 (as discussed on Subsection 4.4.2.1), sufficient recreational facilities are available to accommodate the associated increase in usage. Therefore, impacts to recreation resources during construction would be SMALL. Based on the regional supply of transient housing, including 2329 seasonal units and 1302 temporary housing sites at recreational facilities in the geographic area of interest (as discussed in Subsection 4.4.2.1), the impact on recreational facilities due to increased competition for transient housing also would be SMALL.

4.4.2.7 Community Infrastructure and Services

Construction demand from construction activities as well as associated population increases were considered when evaluating the effects of construction at the CRN Site on infrastructure and services. The peak overlap workforce is estimated to be 3666. During peak overlap period, an estimated 1365 workers would migrate into the geographic area of interest accompanied by 2020 family members, for a population increase of 3385 (as discussed in Subsection 4.4.2.1).

Water Supply Facilities

Potential impacts to potable water supplies would result from additional demands on water supply facilities associated with construction-related water needs and the increase in the local population (in-migrating construction workers). The total anticipated construction water use for the plant is 231,660 gpd, or 0.23 million gallons per day (mgd).The source of water for the potable and sanitary water systems, as well as concrete batch plant operation at the CRN Site, is municipal water from the City of Oak Ridge Public Works Department.. The U.S. Geological Survey (USGS) estimates that the average person uses 80 to 100 gpd of water at home, including bathing, laundry, and outdoor watering (Reference 4.4-12). Using the presumption that the construction workers would be present on site for 10 hr per day, it is assumed that a conservative estimate of 50 gpd of potable water per worker would be required. During construction, the peak overlap workforce of 3666 workers would require 183,300 gpd for potable and sanitary use. The balance would be used for concrete batch plant operation and other miscellaneous uses. Surface water from the Clinch River arm of the Watts Bar Reservoir (approximately 5000 gallons per day [gpd]) may be used during construction for purposes such as dust control. As described in Subsection 2.5.2.7.2, the Oak Ridge Department of Public Works obtains its raw water from the surface water in the Melton Hill Reservoir. As shown in Table 2.5.2-15, the utility has a maximum potable water capacity of 9.9 mgd and an average daily consumption of 7.7 mgd, for an excess capacity of 2.2 mgd. The onsite potable water usage of 0.23 mgd represents less than 11 percent of excess capacity and construction impacts to water supply facilities would be SMALL. Any future demands on the excess water capacity from the City of Oak Ridge would be evaluated for potential impacts on the municipality.

The impacts to the water supply systems within the geographic area of interest from construction-related population increase can be estimated by calculating the amount of potable water that is required by these individuals. Table 2.5.2-15 contains details regarding the more than 20 public water suppliers in the four counties of the geographic area of interest, including

their maximum daily capacity and current demand. Most of these water supply systems are operating well below capacity. The USGS estimates that the average person uses 80 to 100 gallons of water per day at home (Reference 4.4-12). This represents an increased demand of approximately 338,500 gpd based on 3385 in-migrating construction workers and families and a consumption rate of 100 gpd. Because all of the local utilities are operating below capacity and the in-migrating workforce would be spread out among four counties, an increase of 3385 persons in the geographic area of interest would not adversely affect the local utilities' capacity to supply potable water to their customers. Therefore, impacts to public water supply systems in the geographic area of interest would be SMALL.

Wastewater Treatment Facilities

Similar to potable water supplies, potential impacts to wastewater treatment facilities would result from onsite construction-related needs and the increase in the local population associated with in-migrating construction workers. The wastewater generated during construction activities at the CRN Site would be discharged to the City of Oak Ridge Rarity Ridge sanitary treatment facility. As previously stated, the average person in the United States uses 80 to 100 gpd of water at home, including such activities as dishwashing, laundry, and outdoor watering (Reference 4.4-12). During construction, a peak of 3666 workers would be onsite. Assuming that half of their water consumption would occur onsite, it is expected that 40 to 50 gallons of wastewater per worker per day would be generated. At the peak of the construction process, a maximum of 183,300 gpd of wastewater would be produced onsite based on 3666 workers and a wastewater production rate of 50 gpd per worker. As shown on Table 2.5.2-16, the City of Oak Ridge Rarity Ridge facility has a maximum treatment capacity of 0.6 mgd and an average daily utilization of 0.1 mgd, for an excess capacity of 0.5 mgd. The onsite wastewater production of 0.17 mgd represents approximately 36 percent of excess capacity. Accordingly, the construction-related impact to wastewater treatment facilities would be MODERATE. However, this impact would be temporary, with the peak overlap workforce onsite during only six months of the six-year construction period (Table 3.10-2).

Table 2.5.2-16 lists the wastewater treatment facilities in the geographic area of interest, their maximum daily capacity, and wastewater flows processed daily. The increase to the geographic area of interest population of an estimated 2765 construction-related residents would increase demand for wastewater treatment. Because the in-migrating population would not be expected to settle in one area exclusively, this increased demand would be spread among several facilities in the four counties. All of the wastewater treatment facilities in the geographic area of interest are operating below capacity, and would be able to absorb the increased demand without adversely affecting the current customers. Therefore, based on the current excess capacities of the existing wastewater treatment facilities in the geographic area of interest, impacts to wastewater treatment facilities would be SMALL.

Police Services

The number of sworn law enforcement officers and the resident-to-officer ratio for the four counties and the larger cities in the geographic area of interest are given in Table 2.5.2-17. The recommended ratio of officers to residents is between 1 and 4 officers to 1000 residents, or a police-to-resident ratio between 1:250 and 1:1000 (Reference 4.4-13). Table 2.5.2-17 shows that the cities within the geographic area of interest are within this ratio range and the counties are at or slightly above 1:1000. As previously stated, during the peak overlap period an estimated 2765 workers and family members would migrate into the geographic area of interest. It is expected that most of these workers would reside in the larger cities in the area, including Knoxville, Oak Ridge, Clinton, Harriman, Kingston, and Lenoir City, Tennessee. These cities would be able to absorb the additional residents without the necessity of hiring more police officers because their police forces are already larger than the size required to achieve the recommended ratio of officers to residents ratio. Distribution of the construction workforce among the four counties within the geographic area of interest and the resulting increased total populations by county are shown in Table 4.4-5. These population increases would increase the police-to-resident ratios slightly. The percent increase in ratio attributed to construction would be 1.2, 0.4, 0.4, and 1.1 percent in Anderson, Knox, Loudon, and Roane counties, respectively. Based on the percentage increase in police-to-resident ratios, the impact of in-migrating construction-related population to police services would be SMALL.

Fire Protection Services

The existing levels of fire protection services in the geographic area of interest are close to the national average, as described in Subsection 2.5.2.7.3. Firefighter-to-resident ratios range from 1:205 in Roane County to 1:715 in Knox County. During construction, the City of Oak Ridge Fire Department would provide fire and emergency medical services to the CRN Site. The first responder would be the station located at the East Tennessee Technology Park, just north of the CRN Site. Distribution of the peak overlap workforce among the four counties within the geographic area of interest and the effect of the larger populations are shown in Table 4.4-6. These population increases would increase the firefighter-to-resident ratios slightly. The percent increase in ratio attributed to construction would be 0.6, 0.4, 1.2, and 1.0 percent in Anderson, Knox, Loudon, and Roane counties, respectively. Therefore, the potential impacts of the in-migrating residents to fire protection services during construction would be SMALL.

Medical Services

The available medical services in the geographic area of interest, including health care facilities and nursing homes, are described in Subsection 2.5.2.7.3 and Tables 2.5.2-18 and 2.5.2-19. During construction of the CRN facility, onsite medical personnel would be expected to treat minor injuries to workers. More extensive injuries would be treated at one of the medical centers in the vicinity of the CRN Site. The influx of temporary workers to the geographic area of interest would not disrupt the existing medical services available in the area. An addition of approximately 3385 construction-related residents would increase the geographic area of

interest population by 0.6 percent and would not adversely affect existing medical services. Therefore, impacts to medical services would be SMALL.

Political and Social Structure

The political structure of the geographic area of interest is described in Subsection 2.5.2.7.1, including federal, state and local representation systems. Population centers range from large cities (Knoxville, Tennessee) to moderate-size municipalities (Oak Ridge and Farragut, Tennessee) to small unincorporated communities. Although many of the 3385 in-migrating construction-related population would likely settle in the larger cities in the geographic area of interest, they would not be likely to all relocate to the same population center. The influx of temporary workers and families to the geographic area of interest would not cause a change to the local political structure. Therefore, impacts to the political structure would be SMALL.

The social relations between members of a community, and the quality and quantity of their interactions, could potentially be affected by construction at the CRN Site. Regardless of the current state of the communities in the geographic area of interest, it is unlikely that an influx of 3385 new residents to the area would have a potentially significant effect on the current social structure and community cohesion. Small indirect changes could occur due to potential economic benefits to the geographic area of interest and individuals employed during construction. These changes would most likely be beneficial as they would involve a general increase in stability due to the availability of stable incomes and employment. Considering that the number of construction-related in-migrants to the area would be limited and that benefits to social structure and community cohesion are presumed to be small but beneficial, social impacts to communities in the geographic area of interest would be SMALL.

4.4.2.8 Education

NUREG-1437, Revision 1 presents criteria for the assessment of education impacts based on the baseline conditions of the potentially affected school system (e.g., whether it is below, at, or exceeding maximum allowed student/teacher ratio). These criteria are:

- SMALL: project-related enrollment increases of 3 percent or less; no change in the school systems' abilities to provide educational services and no additional teaching staff or classroom space is needed

- MODERATE: project-related enrollment increases of 4 to 8 percent; school system must increase its teaching staff or classroom space

- LARGE: project-related enrollment increases above 8 percent; current institutions not adequate to accommodate the influx of students or project-related demand can be met only if additional resources are acquired.

Schools and student populations are discussed in Subsection 2.5.2.8. In the 2010 US Census Bureau estimates, 17.1 percent of the population of Tennessee was 5 to 17 years old (i.e., school age) and students account for 15.1 to 16.3 percent of total county populations in the four-counties within the geographic area of interest. There would be a population increase of 3385 at the peak overlap period (based on an average household size in Tennessee of 2.48 persons) (Reference 4.4-5). The increase of 3385 persons includes an estimated 552 school-aged children. This represents an increase of 0.6 percent in current public school enrollment. Project-related school enrollment increases would be less than 3 percent within the geographic area of interest.

It is assumed that 27 percent of the in-migrating construction workforce would reside in Anderson County, 50 percent in Knox County, 6 percent in Loudon County, and 17 percent in Roane County, as described in Subsection 4.4.2.1. Table 4.4-7 applies the population distribution percentage assumptions to the number of school-aged children in the construction workforce population to estimate the number of construction-related school-aged children in each of the four counties. It is estimated that Knox County would experience the largest increase in school-age population (276 students). This represents less than 0.5 percent of the current public school population of 58,000. Roane County, with an additional 94 students, would experience the largest relative increase at 1.26 percent. Current (2011-12) public school teacher-to-student ratios in the geographic area of interest are 1:14 in Anderson County and 1:16 in Knox, Loudon, and Roane counties (Reference 4.4-14). The increase in number of students would not change the teacher-to- student ratios (Table 4.4-7).

Increased revenues from property taxes and sales taxes on purchases as a result of construction activities and workforce expenditures would help offset any additional education-related costs. Therefore, impacts to education within the geographic area of interest would be SMALL.

4.4.3 Environmental Justice Impacts

Executive Order 12898 (59 FR 7629) directs federal executive agencies to consider environmental justice under the National Environmental Policy Act (NEPA). This Executive Order ensures that minority and/or low-income populations do not bear a disproportionate share of adverse health or environmental consequences of a proposed project, which in this instance is construction and operation of two or more SMRs at the CRN Site. TVA’s policy is to consider environmental justice in its environmental reviews.

Subsection 2.5.4 describes the evaluation process used to identify minority and low-income populations living within the region that meet the conditions associated with the NRC guidance. Census blocks, block groups, and relative distances of minorities and low-income populations around the CRN Site are identified in Table 2.5.4-1 and Figures 2.5.4-1 and 2.5.4-2.

As shown in Figure 2.5.4-1, the spatial distribution of block groups with minority populations in the region is clustered in the City of Knoxville, in Knox County, Tennessee and the City of Alcoa,

in Blount County, Tennessee. No block groups in Roane County (in which the CRN Site is located) or in Anderson County contain minority populations as defined in Subsection 2.5.4.2. The identified aggregate minority population closest to the CRN Site is located approximately 20 mi to the east in Blount County, Tennessee. The closest Hispanic minority population is located in Loudon County, Tennessee, approximately 9 mi southeast of the CRN Site.

As shown in Figure 2.5.4-2, the majority of the low-income population in the geographic area of interest is in the City of Knoxville, in Knox County, Tennessee. There is one low-income population block group within Roane County, Tennessee and one within Anderson County, Tennessee. The closest low-income population block group is located in Loudon County, Tennessee, approximately 7 mi southeast of the CRN Site. As shown on Figures 2.5.4-1 and 2.5.4-2, there is some overlap between the locations of minority and low-income population groups.

As discussed below in Subsection 4.4.3.2, no other populations or groups (e.g., subsistence populations) were identified that represent environmental justice populations in the region. Two locations of potential significance to minority communities were identified, however. The Wheat Community Burial Ground is a mid-19th century African American cemetery located approximately 1 mi northwest of the northern boundary of the CRN Site on the east side of TN 58. The community of Scarboro, a small predominantly African American community established in 1950, is located in Anderson County approximately 0.5 mi from the Oak Ridge Reservation Y-12 plant.

4.4.3.1 Potential Physical Impacts

For the purposes of this environmental justice assessment, physical impacts under consideration due to facility construction include potential effects on land use, water, and ecology. Ecological resources are a concern in the event that any minority or low-income populations in the area are dependent on fishing or farming for subsistence. Potential impacts on land use are described in detail in Section 4.1. Impacts on water are described in Section 4.2. Ecological impacts are described in Section 4.3.

CRN Site construction would occur primarily within the CRN Site boundaries or the nearby and adjacent offsite construction areas. Offsite preconstruction or construction activities include the installation of the 69-kV underground transmission line, roadway modification, refurbishment of a rail siding, and improvements to the barge loading area, all located within property owned by the federal government and managed by the DOE or TVA and not in proximity to any residences. In addition, the potential offsite borrow areas currently identified as potential source areas for borrow material for the CR SMR Project are located in areas in closer proximity to residences and communities than the CRN Site. Most of the physical impacts would affect the properties adjacent to the CRN Site and the offsite construction areas.

As described in Section 4.1, the impacts on the surrounding public from any land use impacts as a result of CRN Site construction would be SMALL. Because the effects would be small and

because of the spatial distribution of minorities and low-income population in the region, the potential for disproportionate land use impacts on minority and low-income populations would be SMALL.

As described in Section 4.2, the impacts on the surrounding public from any water related impacts as a result of CRN Site construction would be SMALL. Because the effects would be small and because of the spatial distribution of minorities and low-income population in the region, the potential for disproportionate water related impacts on minority and low-income populations would be SMALL.

As described in Section 4.3, the impacts on the surrounding public from any ecological impacts as a result of CRN Site construction would be SMALL. Because the effects would be small and because of the spatial distribution of minorities and low-income population in the region, the potential for disproportionate ecological impacts on minority and low-income populations would be SMALL.

Based on the evaluations of land use impacts, water-related impacts, and ecological impacts presented in Sections 4.1, 4.2, and 4.3, respectively, physical impacts are expected to be SMALL. Based on the small impacts overall, combined with the distribution patterns of minority and low-income populations, the potential for disproportionate impacts to minority and low-income populations would be SMALL.

4.4.3.2 Potential Socioeconomic Impacts

The socioeconomic resource categories with the greatest potential to affect minorities and low-income populations are transportation and housing. The impacts associated with the remaining socioeconomic resource categories (i.e., noise and air quality, land use, social and public services, economy, tax revenues, and recreation) would be SMALL, regardless of their spatial distribution relative to the CRN Site, and some would have beneficial effects.

Transportation during construction would be expected to have a moderate impact on local roads, including TN 58 and Bear Creek Road. However, as described in Subsection 4.4.2.3, road modifications are proposed as mitigation for the potential adverse impacts. Few houses are located along these access roads in the areas likely to be impacted by the construction traffic. None of the minority or low-income census blocks are located along either TN 58 or Bear Creek Road. Although the Wheat Community Burial Ground is located off of TN 58, construction traffic would not impede access to the cemetery. No relocations of traffic to local offsite roads as a result of the construction of the CRN Site are anticipated. Therefore, minority and low-income populations and locations of potential significance to minority populations would not be adversely impacted by construction traffic or disproportionately affected.

The impact of plant construction on the housing market in the CRN Site vicinity is expected to be small due to the large number of available vacant housing units and the relatively small requirements for the in-migrating construction workforce. Due to the increased demand for

housing in the region, however, rental housing costs could increase and potentially displace low-income renters. Considering the available number of housing units and assuming construction workers would not be likely to need low-income housing, minority and low-income populations, including the Scarboro community, would not be adversely impacted or disproportionately affected by the construction-related demand for housing.

Positive socioeconomic impacts associated with construction are described in Subsection 2.5.2. These include increased employment opportunities, possible income increases, and generation of additional tax revenues, which are directly and indirectly related to facility construction. These beneficial impacts also would be realized by minority and low-income populations.

The possibility that uniquely vulnerable minority or low-income communities, such as subsistence populations, might be located near the CRN Site was also evaluated. As discussed in Subsection 2.5.4.4, inquiries were made to local agencies, such as planning departments and social services agencies, academic institutions, and local businesses. None of the persons contacted identified any unique economic, social, or human health circumstances and lifestyle practices through which the minority and low-income populations could be disproportionately adversely affected by the CR SMR Project.

Based on the evaluation of potential socioeconomic effects of construction, impacts are expected to be SMALL. Given the small impacts overall, combined with the distribution patterns of minority and low-income populations, the potential for adverse socioeconomic impacts that would disproportionately affect minority or low-income populations in the region would be SMALL.

4.4.4 References

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Reference 4.4-16. Federal Bureau of Investigation, Crime in the United States 2013, Table 78, Tennessee, Website: http://www.fbi.gov/about-us/cjis/ucr/crime-in-the-u.s/2013/crime-in-the-u.s.-2013/tables/table-78/table-78-cuts/table_78_full_time_law_enforcement_employees_tennessee_by_city_2013.xls, 2013.

Table 4.4-1
A-Weighted Sound Levels (dBA) of Construction Equipment and Modeled Attenuation at Various Distances[1]

Noise Source	50 ft	100 ft	200 ft	300 ft	400 ft	500 ft	1000 ft
Backhoe	78	72	66	62	60	58	52
Crane	81	75	69	65	63	61	55
Dump Truck	76	70	64	60	58	56	50
Excavator	81	75	69	65	63	61	55
Front end loader	79	73	67	63	61	59	53
Concrete mixer truck	79	73	67	63	61	59	53
Auger drill rig	84	78	72	68	66	64	58
Dozer	82	76	70	66	64	62	56
Pile driver	101	95	89	85	83	81	75

[1] The dBA at 50 ft is a measured noise emission. The 100-ft to 1000-ft results are modeled estimates.

Table 4.4-2
Typical Emission Factors (grams/bhp-hr) for Construction-Related Equipment[1]

Equipment	VOC	CO	PM_{10}	$PM_{2.5}$	SO_2	NO_X	CO_2
Concrete Pump	0.41	3.99	0.33	0.32	0.005	4.49	594.82
Portable Generator	0.19	1.00	0.24	0.23	0.005	2.52	530.41
Lifts	0.85	2.46	0.43	0.42	0.006	4.56	623.82
Off-Highway Trucks	0.19	1.42	0.15	0.14	0.005	4.15	536.23
Tractor	0.77	2.11	0.28	0.27	0.006	4.45	624.06
Dozer	0.35	1.26	0.15	0.14	0.005	3.82	535.71
Front End Loader	0.77	2.11	0.28	0.27	0.006	4.45	624.06
Excavator	0.19	1.42	0.15	0.14	0.005	4.15	536.23
Crane	0.19	0.92	0.11	0.10	0.005	4.38	530.44
Welding Machine	0.41	2.39	0.28	0.27	0.006	4.82	625.21
Motor Grader	0.35	1.26	0.15	0.14	0.005	3.82	535.71

[1] grams/bhp-hr = grams per brake horsepower-hour

Table 4.4-3
Emission Factors (grams/veh-mi) for Vehicles on Construction Site[1]

Vehicle	VOC	CO	PM_{10}	$PM_{2.5}$	SO_2	NO_X	CO_2
Car	0.136	2.767	0.071	0.014	0.002	0.180	357.4
Passenger Truck	0.205	4.355	0.108	0.021	0.003	0.390	471.4

[1] grams/veh-mi = grams per vehicle-mile

Table 4.4-4
Summary of Overall LOS and Delay by Intersection

Intersection	AM Peak		PM Peak	
	LOS[1]	Delay (sec.)	LOS[1]	Delay (sec.)
1. TN 58 at Bear Creek Road Ramp				
2013 Existing	B	10.1	C	15.2
2024 Background	B	10.7	C	19.2
2024 Background + Site Scenario *(Unsignalized)*	F	900+	F	900+
2024 Future + Site Scenario *(Interchange)*[2]	C	20.5	C	23.2
2. TN 58 at TN 327				
2013 Existing	A	9.5	A	6.9
2024 Background	B	11.1	A	7.5
2024 Background + Site Scenario	B	14.2	A	8.9
2024 Future + Site Scenario	B	14.2	A	8.9
3. TN 95 at Bear Creek Road				
2013 Existing	B	10.5	C	24.9
2024 Background	B	10.8	F	54.3
2024 Background + Site Scenario	F	57.9	F	435
2024 Future + Site Scenario	F	57.9	F	435
4. Bear Creek Road at US Government Property Road				
2013 Existing	A	9.3	A	8.6
2024 Background	A	9.5	A	8.6
2024 Background + Site Scenario	F	563	B	14,9
2024 Future + Site Scenario	D	31.9	A	10.0
5. Bear Creek Road at Site Driveway				
2024 Background + Site Scenario (*Unsignalized*)	F	900+	F	900+
2024 Future + Site Scenario (*Signalized*)	D	42.0	B	10.5
6. Bear Creek Road at Bear Creek Road Northbound Ramp (Proposed)				
2024 Future + Site Scenario (*Signalized*)	B	19.6	B	15.0
2024 Future + Site Scenario (*Roundabout*)	B	15.7	A	7.0

[1] Level of Service (LOS) Index:
A - Progression is extremely favorable and most vehicles do not stop at all
B - Good progression, some delay
C - Fair progression, higher delay
D - Unfavorable progression, congestion becomes apparent
E - Poor progression, significant delay
F - Poor progression, extreme delay

[2] AM Peak (Northbound Diverge), PM Peak (Southbound Merge)

Notes:
The LOS designations for *2024 Background + Site Scenario* represent traffic conditions at the intersections with the addition of proposed CRN Site construction based on existing roadways (without mitigation).
The LOS levels for *2024 Future + Site Scenario* represent project-related traffic conditions with the addition of roadway improvements (with mitigation).
Source: (Reference 4.4-8)

Table 4.4-5
Police Protection in the Four Counties of Interest, Adjusted for the Construction Workforce and Associated Population Increase

Counties in the Geographic Area of Interest	Total Population in 2010	Additional Population Due to New Facility Construction	Total with Additional Population	Number of Sworn Law Enforcement Officers[1]	Current Officer-to-Resident Ratio	Officer-to-Resident Ratio with Additional Population	Percent Increase from Current Officer-to-Resident Ratio
Anderson	75,129	914	76,043	148	1 : 508	1 : 514	1.0
Knox	432,226	1693	433,919	851	1 : 508	1 : 510	0.4
Loudon	48,556	203	48,759	73	1 : 665	1 : 668	0.5
Roane	54,181	575	54,756	63	1 : 860	1 : 869	1.0

[1] Including city police force(s) within each county.

Sources: (Reference 4.4-15; Reference 4.4-16)

Table 4.4-6
Fire Protection in the Four Counties of Interest, Adjusted for the Construction Workforce and Associated Population Increase

Counties in the Geographic Area of Interest	Total Population in 2010	Additional Population Due to New Facility Construction	Total with Additional Population	Number of Firefighters (Full time and Volunteer)	Current Firefighter-to-Resident Ratio	Firefighter-to-Resident Ratio with Additional Population	Percent Increase from Current Firefighter-to-Resident Ratio
Anderson	75,129	914	76,043	216	1 : 350	1 : 352	0.6
Knox	432,226	1693	433,919	604	1 : 715	1 : 718	0.4
Loudon	48,556	203	48,759	201	1 : 240	1 : 243	1.2
Roane	54,181	575	54,756	264	1 : 205	1 : 207	1.0

Table 4.4-7
School Enrollments and Teacher/Student Ratios

Counties in the Geographic Area of Interest	Students Enrolled in Public School System	Full-Time Equivalent Teachers	Teacher to Student Ratio	Construction-Related Population Increase - Percent by County	School-Age Population Increase	Percentage of Additional Public School Children per County	Teacher to Student Ratio with Additional Children
Anderson	12,598	925.1	1:13.62	27	149	1.18	1 : 13.8
Knox	58,815	3705.4	1:15.98	50	276	0.46	1 : 15.9
Loudon	7369	464.6	1:15.86	6	33	0.44	1 : 15.9
Roane	7413	475.2	1:15.6	17	94	1.26	1 : 15.8
Total	86,195	5570.3	NA	NA	552[1]	0.64	NA

[1] Based on addition of 552 school-aged children within geographic area of interest.

Note:
Na = Not Applicable

Source: (Reference 4.4-14)

Table 4.4-8
Construction and Operational Impacts in the Vicinity of the Clinch River Site

Roadway	Increase in Average Daily Traffic (ADT)	# of New Crashes per year	# of New Injuries per year	# of New Fatalities per year
TN 58 (L.M. 17.60 to L.M. 20.18)	4560	2.56	0.82	0.00
TN 95 (L.M. 0.00 to L.M. 3.00)	855	0.63	0.27	0.08
TN 327 (L.M. 0.00 to L.M. 2.20)	285	0.18	0.08	0.00
Total	5700	3.37	1.17	0.08

Notes:
ADT = Average Daily Traffic
L.M. = Log Mile

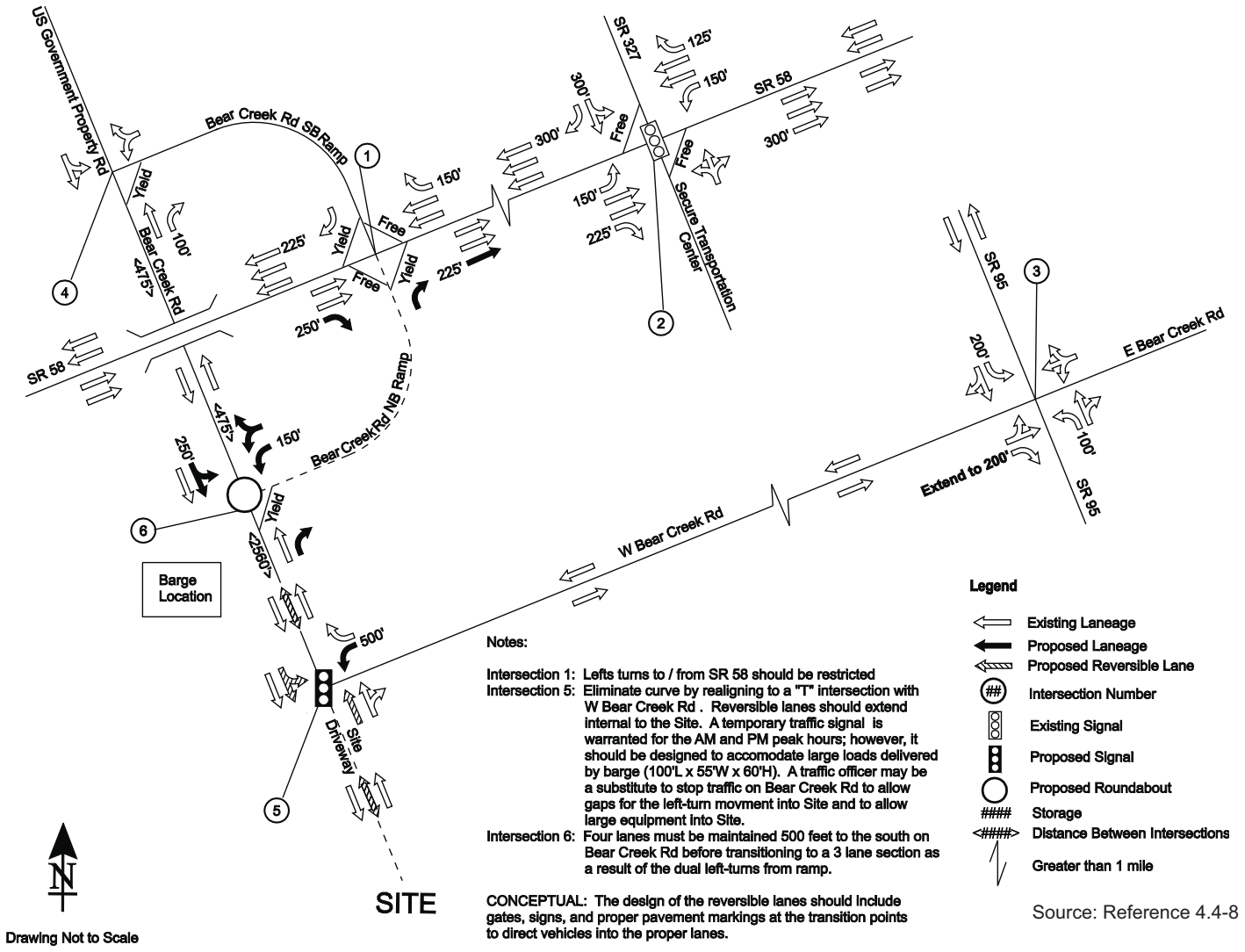

Figure 4.4-1. Proposed Geometry

4.5 RADIATION EXPOSURE TO CONSTRUCTION WORKERS

This section evaluates potential radiological impacts on construction workers during the period of construction of two or more small modular reactors (SMRs) at the Clinch River Nuclear (CRN) Site. At this site, it is assumed that multiple units are to be constructed sequentially, so that construction would occur adjacent to operating units. An exception to this is the NuScale SMR design where there is one structure containing multiple reactors, and for which construction work would be completed prior to installation and operation of the first reactor. As discussed in Section 3.9, the SMRs would be manufactured in factories, and large, fabricated components would be shipped to the CRN Site. Therefore, less onsite construction is required for installation of SMRs than for installation of a typical commercial reactor. The number of units would vary based upon the SMR design selected. In most SMR designs, the reactor containment vessel is underground. Because an SMR design has not yet been selected, a plant parameter envelope (PPE), described in Section 3.1, has been developed for use in evaluating potential environmental impacts.

As shown in Table 3.9-1, the projected construction schedule from the start of preconstruction and site preparation activities for the initial unit until the initiation of fuel load of the final unit is assumed to last 6 years (yr). For the purposes of this evaluation, it was assumed that there is a gap of at least 1 yr between the construction schedules of the new SMR units. This means that one or more units would be operating for 1 yr while construction continues on another unit. Because the number of units that ultimately would be constructed on the CRN Site is not yet known and all but one could be operational during construction of the last unit, the radiation dose to construction workers was conservatively calculated based on the assumption that all units are operating for the duration of the dose calculation.

4.5.1 Site Layout

The physical layout of the CRN Site is depicted in Figure 3.1-2. This layout was determined based upon representative layouts for each of the SMR designs under consideration and the PPE developed to bound these SMR parameters. Construction workers are expected to move around within the construction area during the course of their work in a given year. As the number of units on site is not known and all could be operational except the final unit under construction, the dose to the construction worker is conservatively modeled assuming all units are operating. For the purpose of calculating annual radiation doses to construction workers from one or more operating units, it was assumed that the average location of the workers is at the location representing the center of the reactor unit under construction.

4.5.2 Radiation Sources

This subsection describes the postulated location and characteristics of radiation sources and radioactive effluent emission sources to which construction workers could be exposed. Estimates conservatively assume that all units are operational when determining radiation dose rates to construction workers.

4.5.2.1 Direct Radiation

The SMRs are pressurized water reactors (PWR) designed for series construction, thus allowing multiple units to collectively function as a larger nuclear power plant. Contained sources of radiation in such light water reactors (LWRs) are shielded. Because when completed the SMR facility at the CRN Site is anticipated to produce 800 megawatts electric (MWe) or less, dose estimates for the larger 1000 MWe AP1000 LWR were used to determine that direct radiation from the SMR containment and other buildings would be SMALL (Reference 4.5-1).

Further, the U.S. Nuclear Regulatory Commission (NRC) conducted an evaluation of operating nuclear plants and stated the following in NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants,* Rev 0:

> Direct radiation from sources within a light water reactor plant is due primarily to ^{16}N, a radionuclide produced in the reactor core by neutron activation of ^{16}O from the water. Because the primary coolant of an LWR is contained in a heavily shielded area, dose rates in the vicinity of light water reactors are generally undetectable and are less than 1 mrem/year at the site boundary.

Three of the four proposed reactor designs (BWXT mPower, Holtec, and Westinghouse) include “heavily shielded areas” between reactor buildings containing an operating reactor(s) and adjacent reactor buildings under construction. After startup of the first reactor (for BWXT mPower, Holtec, and Westinghouse), the workers employed during construction of the subsequent units would be considered construction workers for the purpose of the construction worker dose analysis.

The NuScale design includes all reactors under a single structure. Building construction would be completed before the first reactor is installed and operated, so there would be no construction work on site after the first reactor is installed. Therefore, personnel installing additional NuScale reactor units after the initial facility startup will be radiation workers and are not considered construction workers for the purpose of the construction worker dose analysis.

4.5.2.2 Gaseous Effluents

As stated in Subsection 3.5.2, gaseous radioactive effluents may be released from stacks and vents of operating SMR units along with possible releases from steam exhauster systems and other radioactive waste management systems. Minor leakage of radioactive gases from plant systems may also provide radioactive gaseous effluents to the plant atmosphere.

Gaseous effluent release rates to the environment for the CRN Site were determined based on composite values from multiple vendors. As shown in Table 3.5-3, the total projected bounding site release activity in gaseous waste was estimated to be 7130 Curies (Ci)/yr.

4.5.2.3 Liquid Effluents

As discussed in Section 3.5 and Subsection 3.5.1, small amounts of liquid radioactive effluents may be released from normal operation of the SMR units, with monitored and controlled discharges into the Clinch River arm of the Watts Bar Reservoir.

Radioisotopes produced during normal plant operations may enter the reactor coolant by diffusing from the fuel and into the coolant. Another possible source of radioactive liquid effluents is corrosion and leachate products from plant components in the cooling water that may become activated by the reactor core neutrons during the cooling cycle.

Liquid effluent release rates to the environment for the CRN Site were determined based on composite values from multiple vendors. As shown in Table 3.5-1, the total projected bounding site annual release activity in liquid effluents was calculated to be 887 Ci/yr.

4.5.3 Construction Worker Dose Rates

Methodology for estimating the annual dose to the construction workforce for the Clinch River (CR) SMR Project included the use of conservative assumptions and the GASPAR II computer code.

4.5.3.1 Direct Radiation

An SMR design has not been selected for the CRN Site. In the absence of design-specific information, data available for larger operating PWRs provides an indication that the potential direct radiation doses to which construction workers next to operational SMRs would be small. TVA estimated an external dose to the SMR construction work based on doses measured using dosimeters placed on the protected area perimeter fence adjacent to two operating pressurized water reactors (Reference 4.5-1). These measurements were previously used to estimate the construction worker dose for the construction of Vogtle Electric Generating Plant Units 3 and 4. The average measure dose rate of 66.9 millirem per year (mrem/yr) is based upon continuous exposure for 24 hours (hr)/day or 8760 hr/yr (Reference 4.5-1). Because the exposure duration for the construction is 40 hr per week for 52 weeks per year, or 2080 hr/yr, the external dose for the construction worker is estimated to be 15.9 mrem/yr at a distance of about 410 feet (ft). Assuming up to two operating SMR units at the CRN Site during construction of a third and final unit and distances to the construction worker of 1162 and 387 ft from center of the first and second SMR nuclear islands, respectively, the total estimated dose to the construction worker would be 24 mrem/yr from direct radiation.

4.5.3.2 Gaseous Effluents

The GASPAR II computer program was used to calculate the anticipated dose to construction workers from onsite operational units. This program, prepared for NRC by Pacific Northwest Laboratory in 1987, implements the radiological exposure models described in NRC Regulatory Guide (RG) 1.109, *Calculation of Annual Doses to Man from Routine Releases of Reactor*

Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, to estimate the dose resulting from radioactive releases in gaseous effluent. As discussed in Subsection 2.7.6.2, routine diffusion and deposition estimates were determined using the XOQDOQ-82 modeling program, the NRC-recommended dispersion model for evaluating routine releases. Site-specific, validated meteorological data from June 1, 2011 through May 31, 2013 were used to quantitatively evaluate routine releases at the CRN Site.

GASPAR II evaluated both external and internal exposure to gaseous effluents from the SMR facility on the CRN Site, including:

- External exposure to gases
- External exposure to ground contaminated by gases
- Inhalation of gases

Input parameters for GASPAR are detailed in Section 5.4. All estimates assume the construction worker is located at the center of the power block under construction while all of the other proposed units are operational. The construction worker is assumed to spend 2080 hr out of the total 8760 hr in a year. As calculated using the GASPAR code, the construction worker is expected to receive a total body radiation dose of 28 mrem/yr and a maximum dose to another organ (skin) of 51 mrem/yr from normal radiological gaseous releases from the CR SMR Project.

4.5.3.3 Liquid Effluents

Potable water for construction workers would be supplied by the City of Oak Ridge Public Works Department and would not be affected by the liquid discharge from the operational SMRs at the CRN Site. Therefore, the construction worker would receive no dose from the liquid effluent pathway. This lack of exposure is consistent with NUREG-1555, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan*, guidance that discusses gaseous effluent exposure but does not mention liquid effluent exposure for the construction worker (NRC 1999).

4.5.4 Construction Worker Dose Estimates

The maximum construction worker dose was estimated for each exposure pathway for the period of construction of SMRs at the CRN Site. Associated dose estimates from direct radiation, gaseous effluents, and liquid effluents are discussed below. These annual dose estimates were conservatively based on the following assumptions:

- The average location of the construction worker is at the location representing the center of the reactor unit under construction.
- All SMR units are operating for the duration of the dose calculation.

- The construction worker is expected to spend 40 hr per week for 52 weeks per year, or 2080 hr/yr, at the CRN Site.
- The maximum number of workers during any period that a unit is under construction while another unit is operating, the peak workforce, is 3300.
- Dose calculation for the peak workforce is determined assuming the peak lasts one year.

4.5.4.1 Direct Radiation

As stated in Subsection 4.5.3.1, the total average annual direct radiation dose rate to the construction worker from two operating SMR units at the CRN Site is conservatively assumed to be 24 mrem/yr. The direct radiation dose to skin also is estimated to be 24 mrem/yr.

4.5.4.2 Gaseous Effluents

As stated in Subsection 4.5.3.2, the gaseous effluent dose to the construction worker calculated using the GASPAR II code is 28 mrem/yr, and the maximum dose to another organ (skin) is 51 mrem/yr. These dose estimates incorporate the construction worker onsite exposure duration of 2080 hr/yr. In accordance with NRC guidance, the total effective dose equivalent (TEDE) value for the construction worker was estimated by weighting the thyroid dose (48 mrem/yr) by 0.03 and summing with the total body dose of 28 mrem/yr, resulting in a TEDE of 29 mrem/yr from gaseous effluents (Table 4.5-1).

4.5.4.3 Liquid Effluents

As stated in Subsection 4.5.3.3, potable water for construction workers would be supplied by the City of Oak Ridge and would not be affected by the liquid discharge from the operational SMRs at the CRN Site. Therefore, the construction worker would receive no dose from the liquid effluent pathway. Doses from liquid effluent pathways to members of the public, including construction workers when not on the job, are evaluated in Section 5.4.

4.5.4.4 Workforce Dose

The collective workforce dose is determined for the maximum number of workers during any period that a unit is under construction while another unit is operating. This peak workforce for the CRN Site is 3300 workers. Although this peak workforce is expected to last less than 1 yr, it is conservatively assumed to last for 1 yr. The collective workforce dose is conservatively bounded by multiplying the total dose to an individual construction worker by the peak workforce of 3300 workers. Table 4.5-1 shows the calculated workforce dose from all units and all pathways for total body, thyroid, skin, and TEDE. The estimated total body workforce dose and the TEDE for the workforce is estimated as 170 person-rem per year (person-rem/yr).

4.5.5 Compliance with Dose Regulations

Annual doses to the construction worker at the CRN Site are summarized in Table 4.5-1. The annual total body dose for the construction worker is 52 mrem, which includes direct radiation, gaseous effluent, and liquid effluent doses. Similarly, the annual total doses for the thyroid and the skin pathways are 48 and 51 mrem, respectively. Using these annual total doses, the TEDE was estimated to be 53 mrem/yr.

The annual construction worker dose is compared to the dose limits for individual members of the public in 10 CFR 20.1301 to determine whether the CRN Site construction worker can be treated as a member of the public rather than being classified as a radiation worker. As shown in Table 4.5-2, the dose rates for CRN Site construction worker are lower than the 100 mrem/yr threshold for treatment as a radiation worker. Therefore, with the exception of certain specialty contractors loading fuel or using industrial radiation sources for radiography (who would receive specialized training and be treated as radiation workers when appropriate), construction workers will not be required to be qualified as radiation workers.

NRC regulations govern dose rates to members of the general public. Dose rate limits to the public are provided in 10 CFR Part 20.1301 and 10 CFR Part 50, Appendix I. The design objectives of 10 CFR Part 50, Appendix I apply to maintaining dose as low as reasonably achievable (ALARA) for construction workers. Compliance with these regulations is discussed below.

10 CFR Part 20.1301

The 10 CFR Part 20.1301 limits annual doses from licensed operations to individual members of the public to 100 mrem TEDE. In addition, the dose from external sources to unrestricted areas must be less than 2 mrem in any one hour. This applies to the public both outside and within access-controlled areas. Given that the relevant radiation sources operate at a relatively constant level over time, the hourly limit is met if the annual limit is met. Estimated construction worker doses are compared with 10 CFR Part 20.1301 criteria in Table 4.5-2. For an occupational year, i.e., 2080 hr on site, dose at the plant construction area would be 53 mrem TEDE. The use of 2080 hr assumes the worker works 40 hr per week for 52 weeks per year. The maximum unrestricted area dose rate would be 0.02 mrem/hr. Estimations of this maximum dose assume that the construction worker remains at the center of the unit under construction during all working hours of the year while all other SMR units (which are assumed to have been previously constructed) are operating. This value is less than the limits specified in 10 CFR Part 20.1301 for members of the public. Therefore, construction workers can be considered to be members of the general public and are not required to have radiation protection or monitoring.

10 CFR Part 50, Appendix I

The 10 CFR Part 50, Appendix I criteria apply only to effluents. These criteria ensure adequate design of effluent controls by establishing design objectives for releases from each reactor to

limit doses to individuals in unrestricted areas. For gaseous effluents, the relevant limits are 5 mrem to the total body and 15 mrem to organs, including skin. As shown in Table 4.5-3, there is no estimated dose rate to construction workers from gaseous effluents that exceeds the Appendix I dose limits and construction workers would not be exposed to liquid effluents. Therefore, these criteria have been met.

4.5.6 Summary of Radiation Exposure to Construction Workers

All operations conducted at the CRN Site would be governed by the radiation protection and ALARA programs in accordance with the guidance of NRC RG 8.8, *Information Relevant to Ensuring the Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable,* and 10 CFR Part 20.1302. These programs would be established as part of the combined license for the first operating SMR and would also cover construction activities of additional SMRs. Based on the analysis presented in this section, the project radiation dose to the construction worker from licensed operations would be less than 100 mrem/yr, and impacts to construction workers from radiation exposure would be SMALL.

4.5.7 References

Reference 4.5-1. Southern Nuclear Operating Company, Inc., Vogtle Electric Generating Plant, Units 3 & 4 COL Application, Part 2 Final Safety Analysis Report, Revision 5, Website: http://pbadupws.nrc.gov/docs/ML1118/ML11180A100.pdf, December 4, 2012.

Table 4.5-1
Total Doses to Construction Workers from All Units (mrem/yr)

Pathway	Total Body	Thyroid	Skin	TEDE[1]
Direct Radiation[2]	24	0	24	24
Gaseous Effluent	28	48	51	29
Liquid Effluent[3]	0	0	0	0
Total	52	48	75	53
Workforce Dose[4] from All Units (person-rem/yr)				
All pathways	170	160	250	175

[1] TEDE value is estimated by weighting the thyroid dose by 0.03 and summing with the total body dose.
[2] Direct radiation estimate is based on the occupational exposure measured adjacent to a commercial pressurized water reactor adjusted for differing distances from two operating small modular reactor (SMR) nuclear islands to the approximate construction area of a third SMR.
[3] Liquid effluent dose to construction workers is zero. Water would be supplied to construction workers by the City of Oak Ridge, a source that is not affected by the liquids discharged from operational SMRs at the CRN Site.
[4] Workforce dose is calculated by multiplying the total dose in rems to an individual construction worker by the peak workforce of 3300 workers. The peak work force of 3300 workers is conservatively assumed to remain onsite for a full year.

Notes:
mrem/yr = millirem per year
person-rem/yr = person-rem per year
TEDE = total effective dose equivalent

Table 4.5-2
Compliance of Construction Worker Doses from All Units with 10 CFR 20.1301 Criteria

	Construction Worker Dose	Limit
Annual Dose (mrem TEDE)	53[1]	100
Unrestricted Area Dose Rate[2] (mrem/hr)	0.006	2

[1] From Table 4.5-1.

[2] The unrestricted area dose rate is the sum of the total body gaseous effluent dose rate from all units (28 mrem/yr) and the direct radiation dose rate (24 mrem/yr) divided by 2080 hr/yr.

Notes:
mrem = millirem
TEDE = total effective dose equivalent

Table 4.5-3
Compliance of Construction Worker Doses from Each Unit with 10 CFR 50, Appendix I Criteria (mrem/yr)

Type of Dose from Gaseous Effluents	Construction Worker Dose	Limit[4]
Total Body Dose[1]	1.7	5
Skin[2]	4.5	15
Iodine and Particulates[3] (maximally exposed organ – thyroid)	0.31	15

[1] Total body annual gaseous dose for construction worker is estimated as external gaseous effluent dose from each unit to adult MEI at site boundary weighted by the fraction of hours worker is onsite (2080 hr of 8760 hr) per year.

[2] Skin annual gaseous dose for construction worker is estimated as external gaseous effluent dose from each unit to adult MEI at site boundary weighted by the fraction of hours worker is onsite (2080 hr of 8760 hr) per year.

[3] Annual iodine and radioactive particulate dose for the construction worker is estimated as the sum of ground and inhalation dose to the organ receiving the highest dose from iodines and particulates, the thyroid, weighted by the fraction of hours a worker is onsite (2080 hr of 8760 hr) per year.

[4] Dose limits in 10 CFR 50, Appendix I are based on each reactor unit.

Notes:
MEI= maximally exposed individual
mrem/yr = millirem per year

4.6 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING CONSTRUCTION

This section summarizes the principal adverse environmental impacts of construction of the Clinch River (CR) Small Modular Reactor (SMR) Project and the associated measures and controls to limit these impacts. A modified Leopold Matrix has been developed to assess the cause-and-effect relationships between potential environmental disturbances and the corresponding affected environmental resources/receptors (Table 4.6-1).

The table compares environmental disturbances versus environmental resources (receptors). The top left horizontal axis on the measures and controls summary represents the principal environmental disturbances that could result from construction activities. The left vertical axis depicts the environmental resources or receptors that could potentially be affected by those disturbances. The table also summarizes the impact descriptions and measures and controls that have been identified for mitigating construction impacts.

The significance indicators provided in Table 4.6-1 are designated using the following descriptors: SMALL (S), MODERATE (M), or LARGE (L). The significance indicators are defined in Section 4.0. A blank cell in the environmental disturbance column denotes no impact of that type on the environmental resource.

The assignment of significance levels (S, M, L) in Table 4.6-1 is based on the assumption that for each impact description or activity corresponding mitigation measures and controls (or equivalents) are implemented. On Table 4.6-1, each impact description or activity has been assigned a number, and each corresponding mitigating measures and controls has been assigned the same number in parentheses.

The measures and controls in Table 4.6-1 are considered reasonable from a practical, engineering, and economic view. They are based on statutes and regulatory requirements, or they are accepted practices within the construction industry that do not present an unreasonable or undue hardship on the operator/owner.

Based on a review of the ecological surveys that have been completed and construction impacts described in this chapter, some general measures and controls for reducing these impacts at the Clinch River Nuclear (CRN) Site include:

- Cultural Resource surveys have been completed and are described in Subsection 2.5.3.1.
- Planning and engineering studies are to be conducted to determine how best to locate and construct infrastructure facilities (e.g., parking lots, storage facilities, office buildings, roads, etc.) so as to reduce construction impacts.
- Geologic borings, soil tests, and groundwater well data are to be used in combination with the planning and engineering studies to develop a stormwater pollution prevention plan (SWPPP).

- Fugitive dust emissions are to be suppressed by spraying water on excavated soil and unpaved roadways during dry weather.
- Standard Tennessee Valley Authority (TVA) safety plans are to be prepared and construction employees are to receive appropriate training in safety procedures, such as the use of hazardous materials and measures to be taken in the event of leaks, spills, or releases. All chemicals must be on the CRN Site-approved chemical list prior to being brought onsite and handled/stored in accordance with the site's chemical traffic control program.
- Safety data sheets are to be required for use of applicable hazardous materials at the CRN Site. Construction employees are to be trained in the appropriate use of hazardous materials. Hazardous materials are to be used in accordance with applicable federal, state, and local law and regulations.
- Hazardous wastes are to be treated, stored, and disposed of in accordance with the Resource Conservation and Recovery Act (RCRA), and any other applicable federal, state, and local law and regulations. Hazardous wastes are to be disposed using a TVA-approved vendor. Construction employees are to be trained in the appropriate handling and disposal of hazardous wastes, such as waste paints and oils.
- A safety/environmental officer is to oversee and inspect construction activities.
- Construction activities are to be performed in accordance with applicable local, state, and federal ordinances, laws, regulations, and permits intended to prevent or minimize adverse environmental effects of construction activities on air, water, and land, and on workers and the public.
- Construction activities are to comply with applicable permits and licenses.
- Construction activities are to be performed in compliance with applicable TVA safety and construction procedures.
- Pertinent construction permits and environmental requirements are to be included in construction contracts.

More specific mitigation measures are detailed in Table 4.6-1.

Principal adverse environmental impacts of construction of the CR SMR Project were considered for Land Use, Water, Ecological, and Socioeconomic Impacts and Radiation Exposure to Construction Workers. The impacts were separated on the basis of preconstruction and construction impacts and assigned a potential impact significance level of SMALL, MODERATE, or LARGE. Table 4.6-2 provides a summary of potential adverse environmental impacts for resource areas with an assigned potential impact significance level greater than SMALL. Estimates of the percentage of impacts attributable to preconstruction activities and to construction activities and the basis for the estimates are identified in the table. Preconstruction activities, which may include site exploration, preparing the CRN Site for construction of the SMRs, excavation, and other activities described in Title 10 of the Code of Federal Regulations

(10 CFR) 50.10(a)(2), are not related to nuclear safety and are generally more site-wide in scope. Conversely, construction activities are more likely to be unit-specific and include activities associated with safety-related structures, systems, and components (SSCs), certain fire- and security-related SSCs, and other activities as described in 10 CFR 50.10(a)(1). Activities constituting construction are the driving of piles, subsurface preparation, placement of backfill, concrete, or permanent retaining walls within an excavation, installation of foundations, or in-place assembly, erection, fabrication, or testing, which are for:

- SSCs of a facility, as defined in 10 CFR 50.2;
- SSCs relied upon to mitigate accidents or transients or used in plant emergency operating procedures;
- SSCs whose failure could prevent safety-related SSCs from fulfilling their safety-related function;
- SSCs whose failure could cause a reactor scram or actuation of a safety-related system;
- SSCs necessary to comply with 10 CFR part 73;
- SSCs necessary to comply with 10 CFR 50.48 and criterion 3 of 10 CFR part 50, appendix A; and
- Onsite emergency facilities, that is, technical support and operations support centers, necessary to comply with 10 CFR 50.47 and 10 CFR part 50, appendix E.

Only two resources areas, land use and socioeconomics, are assigned a potential impact significance level greater than SMALL in the Environmental Report. The evaluation of preconstruction-related versus construction-related impacts is based primarily on the consideration of two factors: the land area and the labor hours associated with construction of SSCs. Table 4.6-2 provides the percentage of those impacts attributable to preconstruction activities and to construction activities for those resources areas.

The construction-related impacts presented for Section 4.1 Land Use Impacts are based on an analysis of activity-specific considerations. The potential impacts to local roadways and waterborne transportation facilities in the vicinity of the CRN Site are related to roadway improvements and refurbishment of a barge terminal, which are preconstruction activities. The potential for impacts to historic properties also is related to preconstruction activities, including cleaning, grading, and excavation activities, which will precede any construction activities. Accordingly, 100 percent of the land use impacts for the CRN Site and vicinity and for historic properties are considered attributable to preconstruction.

The construction-related impacts for Section 4.4 Socioeconomic Impacts are based on labor hours associated with construction of SSCs. Per the construction schedule presented in Section

3.9, the total onsite construction workforce assumes an estimated 22 million construction hours associated with the preconstruction and construction activities. Construction activities are estimated to require approximately 65 percent of the total estimated labor hours. The remaining 35 percent of labor hours are considered to be associated with preconstruction activities. Construction labor versus preconstruction labor is considered a reasonable basis to separate the impacts given that factors such as noise and vibration levels and labor-related social and economic impacts are proportional to the labor percentage associated with construction and preconstruction activities.

Table 4.6-1 (Sheet 1 of 11)
Summary of Measures and Controls to Limit Adverse Impacts During Construction

Environmental Resources (Section Reference)	Environmental Disturbance													Impact Description or Activity	Mitigating Measures and Controls
	Noise	Erosion	Air Quality	Traffic	Effluents and Wastes	Surface and Ground Water	Land Use	Water Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomics	Rad Exposure	Other		
4.1 Land Use Impacts															
4.1.1 The Site and Vicinity				S-M			S				S		S	1. Construction of new buildings and impervious surfaces. 2. Ground-disturbing activities, including excavation, grading and re-contouring. 3. Removal of existing vegetation. 4. Removal of hazardous wastes/materials. 5. Stockpiling of soils onsite. 6. Use of borrow material. 7. Construction of offsite transportation improvements, relocation of existing transmission lines, and construction of underground transmission line.	(1 and 2) Limit ground disturbances to the smallest area practical to construct and maintain the units. (1 and 2) Conduct ground-disturbing activities in accordance with regulatory and permit requirements; use adequate erosion control measures to minimize impacts. (3) Limit vegetation removal to the area within the CRN Site designated for construction activities. (4) Removal of hazardous wastes/materials in rigorous compliance with applicable regulations using properly trained personnel with monitoring of handling procedures. (5) Restrict soil stockpiling and reuse to designated areas on the CRN Site. (6) Use best management practices (BMPs) and minimize footprint to the degree feasible. (7) Limit ground-disturbing activities and vegetation removal to smallest practical areas. Monitor construction activities for compliance with TVA procedures.

Table 4.6-1 (Sheet 2 of 11)
Summary of Measures and Controls to Limit Adverse Impacts During Construction

Environmental Resources (Section Reference)	Environmental Disturbance													Impact Description or Activity	Mitigating Measures and Controls
	Noise	Erosion	Air Quality	Traffic	Effluents and Wastes	Surface and Ground Water	Land Use	Water Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomics	Rad Exposure	Other		
4.1.2 Historic Properties		S					S						S - M	1. Erosion and ground disturbing activities.	(1) Conduct Phase II cultural resource surveys for any known archaeological or historic resources potentially eligible or of undetermined National Register of Historic Places (NRHP) eligibility within the Area of Potential Effect (APE). (1) Consult with the State Historic Preservation Officer (SHPO) with the results of the Phase II surveys to determine NRHP eligibility. (1) For all NRHP eligible archaeological and historic resources, implement avoidance mitigation measures from the Programmatic Agreement (PA) developed in consultation with the SHPO to mitigate impacts. Avoidance mitigation measures could include avoiding NRHP eligible resources, delineating sensitive areas and placing conditions on activities within these areas, and avoiding placing structures within the viewshed of NRHP-eligible resources.

Table 4.6-1 (Sheet 3 of 11)
Summary of Measures and Controls to Limit Adverse Impacts During Construction

Environmental Resources (Section Reference)	Environmental Disturbance													Impact Description or Activity	Mitigating Measures and Controls
	Noise	Erosion	Air Quality	Traffic	Effluents and Wastes	Surface and Ground Water	Land Use	Water Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomics	Rad Exposure	Other		
4.1.2 Historic Properties (continued)															(1) For all NRHP eligible resources that cannot be avoided, implement and comply with minimization and mitigation measures identified and agreed to in the PA in consultation with the SHPO. Mitigation would include additional consultation with the SHPO and development and implementation of data recovery plans for the impacted resources. (1) For all NRHP eligible historic architectural properties that cannot be avoided, develop mitigation in consultation with the SHPO. Mitigation could include vegetation screening, Historic American Building Survey or (Historic American Engineering Record -equivalent documentation, preparation of a Tennessee Historical and Architectural Resource form, preparation of an NRHP nomination, development of interpretative panels, and/or presentation of historic papers at public meetings or professional conferences.

Table 4.6-1 (Sheet 4 of 11)
Summary of Measures and Controls to Limit Adverse Impacts During Construction

Environmental Resources (Section Reference)	Environmental Disturbance													Impact Description or Activity	Mitigating Measures and Controls
	Noise	Erosion	Air Quality	Traffic	Effluents and Wastes	Surface and Ground Water	Land Use	Water Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomics	Rad Exposure	Other		
4.1.2 Historic Properties (continued)															(1) If a potential prehistoric, historic, cultural or paleontological resource is discovered during any construction activities, halt work within a 50-foot radius of the discovery, consult with the SHPO, protect and stabilize the site, and evaluate the NRHP eligibility of the site as described in the PA. (1) If previously unknown human remains are discovered during preconstruction or construction activities, all ground-disturbing activities would cease within a 10 foot radius of the discovery. The SHPO and Roane County Coroner would be notified within 24 hours (hr) and any PA signatories and potentially affiliated federally-recognized tribal governments would be notified within 72 hr and invited for comment on plans for treatment of the remains. The remains would be treated in accordance with all state and federal laws.

Table 4.6-1 (Sheet 5 of 11)
Summary of Measures and Controls to Limit Adverse Impacts During Construction

Environmental Resources (Section Reference)	Environmental Disturbance													Impact Description or Activity	Mitigating Measures and Controls
	Noise	Erosion	Air Quality	Traffic	Effluents and Wastes	Surface and Ground Water	Land Use	Water Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomics	Rad Exposure	Other		
4.2 Water Related Impacts															
4.2.1 Hydrological Alterations		S			S	S				S				1. Disturbance of soil and sediments during excavation and underwater excavation along the shoreline for construction at the intake and discharge locations. 2. Impacts of groundwater dewatering during excavation. 3. Changes in stormwater run-off resulting from construction of paved surfaces, buildings, and retention ponds.	(1) The activity would need to occur under the terms of the 1991 Interagency Agreement. (2) Installation of horizontal gravity drains in the excavated rock faces and pumping from sumps located around the perimeter of the excavation and at the base of the excavation. (3) Use of BMPs in addition to TVA, U.S. Army Corps of Engineers (USACE), and Tennessee Department of Environment and Conservation (TDEC) controls to protect affected water bodies. Establish and implement a SWPPP.
4.2.2 Water-Use Impacts		S				S		S			S			1. Surface water used in dust suppression and other construction-related activities. 2. Increased worker population would result in a small increase in potable water use.	(1 and 2) No measures or controls are necessary because impacts are expected to be too small to warrant consideration of any mitigation measures.

Table 4.6-1 (Sheet 6 of 11)
Summary of Measures and Controls to Limit Adverse Impacts During Construction

Environmental Resources (Section Reference)	Environmental Disturbance													Impact Description or Activity	Mitigating Measures and Controls
	Noise	Erosion	Air Quality	Traffic	Effluents and Wastes	Surface and Ground Water	Land Use	Water Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomics	Rad Exposure	Other		
4.2.3 Water Quality Impacts		S			S	S	S							1. Potential maintenance or refurbishment of the barge facility. 2. Potential erosion and sediment and stormwater runoff from construction activities into water bodies. 3. Potential minor spills of hazardous materials (i.e., fuels, oils, etc.).	(1) Use of BMPs in addition to TVA, USACE, and TDEC controls to protect affected water bodies. (2) Install stormwater drainage system at construction sites and stabilize disturbed soils. (2) Use BMPs to minimize erosion and sedimentation and establish and implement a SWPPP. (3) Use best construction practices to maintain equipment and prevent spills and leaks. (3) Establish and implement an Integrated Pollution Prevention Plan (IPPP) for construction practices.

Table 4.6-1 (Sheet 7 of 11)
Summary of Measures and Controls to Limit Adverse Impacts During Construction

Environmental Resources (Section Reference)	Environmental Disturbance													Impact Description or Activity	Mitigating Measures and Controls
	Noise	Erosion	Air Quality	Traffic	Effluents and Wastes	Surface and Ground Water	Land Use	Water Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomics	Rad Exposure	Other		
4.3 Ecological Impacts															
4.3.1 Terrestrial Ecosystems	S	S	S		S		S		S					1. Habitat loss due to clearing and grading; animals, such as birds and mammals, displaced from the construction site; less mobile animals killed. 2. Wildlife startled or frightened away by construction noises. 3. Potential impacts from bird collisions with manmade structures (cranes, buildings) during construction. 4. Release of hazardous materials or wastes into the ecosystem. 5. Disturbance or destruction of wetlands.	(1) Limit clearing to the smallest area practical. (1) Use established procedures for minimizing erosion and revegetating terrestrial habitats not permanently utilized for facilities. (1) Monitor site use by listed bat species if required by U.S. Fish and Wildlife Service. Monitor osprey nest on 161-kilovolt line if active during nearby construction activities. (2) Whenever practicable, schedule construction activities to avoid impacts to important susceptible species. (3) Impact is small and no reasonable mitigation measures have been identified. (4) Use best construction practices to maintain equipment and prevent spills and leaks. (5) Consult with USACE regarding any applicable wetlands permitting requirements. (5) Avoid wetlands to the extent possible.

Table 4.6-1 (Sheet 8 of 11)
Summary of Measures and Controls to Limit Adverse Impacts During Construction

Environmental Resources (Section Reference)	Environmental Disturbance													Impact Description or Activity	Mitigating Measures and Controls
	Noise	Erosion	Air Quality	Traffic	Effluents and Wastes	Surface and Ground Water	Land Use	Water Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomics	Rad Exposure	Other		
4.3.2 Aquatic Ecosystems		S			S	S				S				1. Potential impacts to surface water from stormwater pollution and spills associated with clearing and grading. 2. Disturbance of soil and sediments during excavation along the shoreline for construction at the intake and discharge locations and at the barge facility and construction of the Melton Hill by-pass. 3. Erosion and sediment transport into nearby water bodies. 4. Potential impacts to surface water from increased sediment deposition and disturbance during construction.	(1) Develop and implement a construction SWPPP. (1) Implement an IPPP for construction activities. (2) Conduct activities under the terms of the 1991 Interagency Agreement. (3 and 4) Implement erosion and sediment control plans that incorporate recognized BMPs. (3 and 4) Install appropriate barriers and use BMPs to protect reservoir prior to and during construction in water and on shoreline. (1, 2, 3, and 4) Monitoring of the effectiveness of BMPs in preventing erosion and sediment transport and deposition in aquatic habitats.
4.4 Socioeconomic Impacts															
4.4.1 Physical Impacts	S - M		S		S									1. Potential temporary and limited noise impacts to workers. 2. Potential temporary and limited noise impacts to the public. 3. Potential for worker accidents.	(1,2) Make public announcements or give prior notification of atypically loud construction activities. (1,2) Use of engineering controls such as noise mufflers, earthen berms and placing foliage between sources and receptors.

Table 4.6-1 (Sheet 9 of 11)
Summary of Measures and Controls to Limit Adverse Impacts During Construction

Environmental Resources (Section Reference)	Environmental Disturbance													Impact Description or Activity	Mitigating Measures and Controls
	Noise	Erosion	Air Quality	Traffic	Effluents and Wastes	Surface and Ground Water	Land Use	Water Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomics	Rad Exposure	Other		
4.4.1 Physical Impacts (continued)														4. Increased onsite air and dust emissions from construction equipment. 5. Increased offsite air and dust emissions from construction equipment. 6. Increased debris to existing landfills.	(1, 3, and 4) Train and appropriately protect employees and construction workers to reduce the risk of potential exposure to noise, dust, and exhaust emissions. (1, 3, and 4) Manage concerns from workers on a case-by-case basis through an employee-concerns resolution program. (2 and 5) Manage concerns from adjacent residents or visitors on a case-by-case basis through a public-concerns resolution program. (3) Provide onsite services for emergency first aid and conduct regular health and safety monitoring. (3) Provide appropriate job training to construction workers. (4 and 5) Use dust control measures such as watering, stabilizing disturbed areas, covering trucks. (4 and 5) Prepare a dust suppression plan and water unpaved roads and construction areas. (6) Establish procedures for, and perform audits to verify, waste disposal according to applicable regulations such as the RCRA. (6) Establish a waste minimization program.

Table 4.6-1 (Sheet 10 of 11)
Summary of Measures and Controls to Limit Adverse Impacts During Construction

Environmental Resources (Section Reference)	Environmental Disturbance													Impact Description or Activity	Mitigating Measures and Controls
	Noise	Erosion	Air Quality	Traffic	Effluents and Wastes	Surface and Ground Water	Land Use	Water Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomics	Rad Exposure	Other		
4.4.2 Social and Economic Impacts				M			S	S			S		S-M	1. Traffic congestion impacts in the vicinity of CRN Site due to increased traffic during peak construction period. 2. Potential short-term housing shortage. 3. Potential for increased housing construction impacts. 4. Potential short-term ability of infrastructure and schools to accommodate influx of students without additional facilities and teachers. 5. Potential for increased traffic accidents with increased construction traffic. 6. Beneficial impact on economy. 7. Beneficial impact on tax revenue. 8. Potential for aesthetic (visual) impacts to the general public, nearby residents, and recreational users of the Clinch River arm of the Watts Bar Reservoir.	(1 and 5) Construct improvements to roads adjacent to CRN Site and, if necessary, use traffic officers during peak hours. (2, 3 and 4) No measures or controls are necessary because impacts are expected to be too small to warrant consideration of any mitigation measures. (6, 7 and 8) No measures or controls required.

Table 4.6-1 (Sheet 11 of 11)
Summary of Measures and Controls to Limit Adverse Impacts During Construction

Environmental Resources (Section Reference)	Environmental Disturbance													Impact Description or Activity	Mitigating Measures and Controls
	Noise	Erosion	Air Quality	Traffic	Effluents and Wastes	Surface and Ground Water	Land Use	Water Use	Terrestrial Ecosystems	Aquatic Ecosystems	Socioeconomics	Rad Exposure	Other		
4.4.3 Environmental Justice														1. No disproportionately high adverse impacts to minority populations.	(1) No disproportionately high adverse impacts to minority populations.
4.5.4 Radiation Exposure to Construction Workers (Dose Estimates)															
4.5.4 Radiation Exposure												S		1. Construction worker exposure to radiation sources while the first unit is operating and additional units are being built.	(1) Controlling radiation exposure time, distance, and shielding; monitoring construction worker exposures; providing radiation worker training; and developing work plans and procedures that minimize construction worker radiation exposure and ensure it is within safe limits.

Table 4.6-2
Summary of Construction- and Preconstruction-Related Impacts for Safety-Related Structures, Systems, or Components

ER Section Reference	Combined Preconstruction and Construction Impact Significance[1, 2]	Preconstruction Impacts (%)	Construction Impacts (%)[3]	Basis of Estimate
4.1 Land Use Impacts				
4.1.1 The Site and Vicinity	SMALL to MODERATE	100	0	The potential for impacts to local roadways (modifications and construction of ramps) and to waterborne transportation facilities (refurbishment of barge terminal) is related to preconstruction activities, which will precede any construction activities.
4.1.3 Historic Properties	SMALL to MODERATE	100	0	The potential for impacts to historic properties is related to preconstruction activities, including clearing, grading, and excavation activities, which will precede any construction activities.
4.4 Socioeconomic Impacts				
4.4.1 Physical Impacts	SMALL to MODERATE	35	65	Construction worker traffic would have an effect on noise levels along local roadways surrounding the CRN Site. If the construction activities occur in close proximity to the CRN Site border, then the residences closest to the CRN Site border could temporarily experience noise and vibration impacts from the construction equipment. The percentage of labor hours associated with SSC construction is 65 percent. The remaining labor hours (35 percent) are associated with preconstruction activities. Estimated preconstruction and construction impact percentages are defined by the labor breakdown (35 percent and 65 percent, respectively).
4.4.2 Social and Economic	Employment and Income-MODERATE	35	65	
	Transportation - SMALL to MODERATE	35	65	Estimates of the impacts of preconstruction and construction are based on plant labor. The percentage of labor hours associated with SSC construction is 65 percent. The remaining labor hours (35 percent) are associated with preconstruction activities. Estimated preconstruction and construction impact percentages are defined by the labor breakdown (35 percent and 65 percent, respectively).

[1] This table includes only impacts greater than SMALL.
[2] The impact significance levels provided are based on the assumption that mitigation measures and controls would be implemented.
[3] Construction refers to the construction of safety-related SSCs of a facility, as defined in 10 CFR 50.2. These SSCs are primarily located within the power block area and turbine area.

4.7 CUMULATIVE IMPACTS RELATED TO CONSTRUCTION ACTIVITIES

Section 4.7 contains a summary of potential cumulative environmental impacts associated with construction activities for the Clinch River (CR) Small Modular Reactor (SMR) Project. The term *cumulative impact* is defined in the regulations of the Council on Environmental Quality implementing the National Environmental Policy Act (NEPA) (Title 40 of the Code of Federal Regulations [40 CFR] 1508.7) as follows:

> "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

Past actions are projects prior to the Early Site Permit Application, while future actions commence upon U.S. Nuclear Regulatory Commission (NRC) issuance of an Early Site Permit. This section focuses on cumulative impacts of construction, so future activities in this context consist of reasonably foreseeable activities associated with subsequent NRC-authorized construction of the proposed SMR (including preconstruction activities) and continue through operation and decommissioning of the proposed SMR. For the purposes of this evaluation, reasonably foreseeable actions are projects that are clearly indicated in an available long-term master plan or comparable document and/or have received funding and/or have applied for a permit associated with construction or operation. Cumulative impacts can result from individually minor, but collectively significant, actions over time upon the same resources. The affected environment for the CR SMR Project is described in Chapter 2. Impacts due to construction of the CR SMR Project are described in Chapter 4.

This section presents a cumulative impact assessment for each geographic area of interest that may be affected by the proposed CR SMR Project. Potential impacts would include changes to any of the analyzed resources which would not occur if the CR SMR Project were not constructed.

4.7.1 Contributors to Cumulative Effects

4.7.1.1 Past, Present, and Reasonably Foreseeable Future Projects

A summary of past, present, and reasonably foreseeable projects that could have a cumulative effect within the geographic area of interest are listed in Table 4.7-1 and shown on Figure 4.7-1. The modifications to the existing transmission lines in conjunction with the CR SMR project, described in Subsection 3.7.1, would likely be limited to the current rights-of-way (ROWs) within the geographical area of interest. There would be no new corridors cleared and, other than the underground line, no new lines constructed off the site. Therefore, there would likely be essentially no contribution to cumulative impacts from these activities.

4.7.1.2 Global Climate Change

This subsection describes the general effect that greenhouse gas emissions have had, and are predicted to have, on climate in the vicinity of the Clinch River Nuclear (CRN) Site. The effects of these changes on each specific resource are addressed in each subsection associated with that resource.

Climate models forecast three trends that may affect resources: warmer mean annual temperatures, greater frequency of intense rainfall events, and drier summers with more severe droughts (Reference 4.7-1). These changes may affect overall water availability, as well as the timing and intensity of precipitation, which may in turn affect ecosystems and land uses. In the southeastern United States, climate change has already resulted in higher average temperatures, an increase in daily and five-day rainfall intensities, and an increase in the number of Category 4 and 5 hurricanes in the Atlantic basin (Reference 4.7-1).

In general, climate change is expected to result in drier conditions in the southwestern United States, and wetter conditions in the northeastern United States. Because East Tennessee is situated in a transition zone between these two regions, global climate change is expected to cause only small changes in precipitation relative to natural variation in the southeastern United States. The CRN Site, while located in the southeast region, is situated closer to the northeastern states and may experience wetter conditions (Reference 4.7-2).

Although the change in precipitation rates in the region is unknown, global climate change is still expected to reduce water availability through an increase in evaporation and transpiration rates as a result of increasing temperatures (Reference 4.7-2). In eastern Tennessee, one source predicts that the reduction in water availability in the CR SMR Project area as a result of global climate change would be small, on the order of less than 5 percent (Reference 4.7-2). Another source estimates that the combination of changes in rainfall and evapotranspiration would range from 6 percent drier to 8 percent wetter (Reference 4.7-3). Thus, the region overall may not experience major changes in water availability due to climate change, but there may be localized changes in precipitation patterns that could impact water availability and ecosystems in specific areas (Reference 4.7-3)).

4.7.2 Cumulative Land Use Impacts

This subsection addresses the land use impacts from the proposed CR SMR Project along with past, present and reasonably foreseeable future projects. Section 2.2 describes the land affected by the proposed CR SMR Project. Section 4.1 describes impacts to that land during preconstruction and construction activities at the CRN Site. As described in Section 4.1, overall the impacts of preconstruction and construction activities on land use would be SMALL and no mitigation beyond standard best management practices (BMPs) and compliance with federal regulations would be warranted.

The geographic area of interest for land-use impacts is a 50-mile (mi) radius around the CRN Site. There are 33 counties at least partially within 50-mi of the center point of the CRN Site. Three of these counties are in North Carolina, two are in Kentucky, and the rest are in Tennessee. The largest city in the 50-mi radius is Knoxville, Tennessee. Other population centers with populations of over 20,000 include Oak Ridge, Maryville, and Farragut, Tennessee. The geographic area of interest includes the primary counties, communities, and recreational areas (such as campgrounds) where the construction workforce and their families would reside and, therefore, are most likely to experience land use effects as a result of the proposed project.

Prior to World War II, land use within the immediate vicinity of the CRN Site was primarily forested and agricultural, with industrial pockets near the larger population centers. In 1942, the City of Oak Ridge was created to produce fissile material for the Manhattan Project (Reference 4.7-4). Shrouded in secrecy, this fenced military project evicted the sparse native population from the immediate area (60,000 acres [ac]) and built three industrial production plants along with a supporting city complete with temporary and permanent housing, roads, and schools for the workers and their families (Reference 4.7-4; Reference 4.7-5). In 1941, the 1200-ac CRN Property was acquired by the U.S. Army Corps of Engineers as part of the Manhattan Project. The Manhattan Project facilities shifted to civilian control in 1947 (Reference 4.7-6; Reference 4.7-5).

After the war, operations at the nuclear materials production plants continued to evolve. K-25 continued gaseous diffusion uranium enrichment until 1985, was demolished in 2013, and the reclaimed land became the East Tennessee Technology Park (ETTP) (Reference 4.7-7; Reference 4.7-8). The former electromagnetic uranium separation facility Y-12 has become a national security complex processing and storing highly enriched uranium for the U.S. Department of Energy (DOE). Similarly, the former graphite reactor X-10 has become the DOE's Oak Ridge National Laboratory (ORNL), a nuclear and high-tech research facility. (Reference 4.7-9) Operations at the Oak Ridge Reservation (ORR) continue to employ a large population and generate development in the surrounding area (Reference 4.7-10). Some of the buffer zones and undeveloped areas within the ORR are part of the Oak Ridge Wildlife Management Area (WMA). Tennessee Wildlife Resources Agency manages active hunting programs in these undeveloped areas (Reference 4.7-11).

The CRN Site was transferred to TVA in 1965. In 1982 and 1983, 240 acres of the CRN Site peninsula were under preparatory activities for the DOE's Clinch River Breeder Reactor Project (CRBRP). As discussed in Subsection 2.2.1.1, the CRBRP was terminated in late 1983 and the site was stabilized. Site redress included partial backfilling of the large excavated area in the central portion of the site and stabilization of stormwater runoff ditches, culverts, and ponds. In addition, grass was reseeded and vegetation was planted to further stabilize the site (Reference 4.7-12).

Because of continued growth in the region, much of the forest and farmland has been converted into urban developments around Knoxville, Oak Ridge, and Maryville/Alcoa with attendant growth in surrounding communities. Reasonably foreseeable urbanization could continue

development within the geographic area of interest; thus contributing to cumulative impacts resulting from the proposed CR SMR Project.

As discussed in Subsection 4.7.1.2, the effects of global climate change are expected to include warmer mean annual temperatures, greater frequency of intense rainfall events, and drier summers with more severe droughts. Anticipated changes in the natural environment may lead to attendant modifications of zoning with an emphasis upon increased greenways and undeveloped areas (Reference 4.7-13).

As discussed in Subsection 4.1.1.1, Tennessee Valley Authority (TVA) expects to construct and operate an onsite landfill for construction, site clearing, and grading debris. Construction debris and associated waste not placed in the onsite disposal landfill would be shipped from the CRN Site via road, rail, and/or barge. Associated road, rail, and barge improvements within vicinity of the CRN Site are discussed in Subsection 4.1.1.2. Nonhazardous solid waste would be managed by a TVA-approved solid waste disposal vendor and disposed in a state-approved sanitary landfill such as the Sanitary Chestnut Ridge Landfill. Hazardous wastes, including oil wastes, paint wastes, solvent wastes, laboratory wastes, and universal wastes, as well as radioactive and mixed (hazardous and radioactive) waste, would be managed by TVA-approved vendors and disposed in accordance with TVA management procedures.

Because the majority of the preconstruction and construction waste would be disposed of in an onsite landfill, the volume of waste sent to an offsite sanitary landfill would be minimal and the duration of waste generation and disposal during preconstruction and construction would be brief. The Chestnut Ridge Landfill has a 50 year capacity to accept 1000 tons per day. Therefore, the impact of the minimal volume of nonhazardous waste disposed offsite during the brief duration of the preconstruction and construction activities to the cumulative impact of nonhazardous waste disposal would be SMALL. TVA's use of hazardous waste management and minimization practices would also minimize the volume of hazardous waste generated and disposed of during the CRN Site preconstruction and construction activities. The volume of hazardous waste generated and disposed of in the immediate vicinity of the CRN Site in 2014 included contributions from the ORR and exceeded 81 metric tons; by comparison, the incremental increase of hazardous waste disposal associated with the CRN Site would be SMALL.

Cumulative impacts associated with the operational facilities listed in Table 4.7-1, including continued operation of ORNL's Spallation Neutron Source and High Flux Isotope Reactor along with Y-12's ongoing mercury cleanup activities, have already occurred in the form of land use and land cover changes. These cumulative impacts would be considered LARGE. These changes are reflected in the existing conditions described in Section 2.2 and in the impact analysis presented in Section 4.1. Cumulative impacts from preconstruction and construction activities at the CRN Site, the Barge/Traffic Area, and from other past, present, and future projects within the land use geographic area of interest could occur as a result of land use/land cover changes.

The future projects most likely to result in cumulative impacts in conjunction with the CR SMR Project are the land use and land cover changes in the geographic area of interest associated with new facilities including: the Sludge Build-Out Project at the Transuranic (TRU) Waste Processing Center, the proposed new Uranium Processing Facility (UPF) at the Y-12 Complex, the potential ETTP property transfer, and the Environmental Management Disposal Facility on the ORR. These projects involve potential land use and land cover changes from current conditions. Land use and land cover changes would occur such as conversion of non-developed land use types (forested areas, grasslands, etc.) to developed land use types (including facilities, parking lots, and roadways). These projects occur on land currently designated for the respective projects; therefore, these land use changes would not constitute significant impacts individually or cumulatively. The Sludge Buildout Project, new UPF, and ETTP property transfer would occur in already developed areas and are expected to involve limited, if any, land clearing activities. Substantial impacts to wetlands or changes to land cover from these projects are unlikely because the sites are developed. The Environmental Management Disposal Facility may involve clearing of forested land, adjacent to a developed area. However, the change in land cover would be negligible within the geographic area of interest. The combined change in land use and land cover resulting from these projects could contribute to cumulative impacts to land use in association with the CR SMR Project preconstruction and construction activities. However, overall, these incremental cumulative impacts would be SMALL and no mitigation is warranted.

4.7.3 Cumulative Water Impacts

This subsection addresses the cumulative water use and water quality impacts from the proposed CR SMR Project along with past, present and reasonably foreseeable future projects. Section 2.3 describes the surface water and groundwater affected by the proposed CR SMR Project. Section 4.2 describes impacts to water use and water quality during preconstruction and construction activities at the CRN Site.

4.7.3.1 Surface Water Hydrology Impacts

Subsection 2.3.1.1 describes the surface water bodies present on and near the CRN Site, and serves as the baseline for the analysis of cumulative impacts to surface water hydrology. As discussed in Subsection 2.3.1.1.1.5, the current surface water hydrology of the CRN Site is the result of the construction of a stormwater management system, so surface water hydrology has already been impacted by past projects. Subsection 4.2.1.1 describes further impacts to these onsite water bodies during preconstruction and construction activities. As discussed in Subsection 4.2.1.1, construction of the SMRs would directly impact one small perennial stream (S01) and 11 ephemeral streams/wet weather conveyances (WWCs). The perennial stream and six of the WWCs would be located within the footprint of the areas to be permanently developed, and would be removed. Portions of five WWCs are within an area to be temporarily disturbed, but would be revegetated and restored after construction. Additional impacts to onsite and adjacent surface water bodies would be minimized through the use of BMPs and

compliance with the National Pollutant Discharge Elimination System (NPDES) permit. Therefore, impacts of pre-construction and construction activities would be SMALL.

For purposes of this cumulative impact analysis, the geographic area of interest for surface water hydrology impacts is the Clinch River arm of the Watts Bar Reservoir. Although projects within the drainage basin of the Tennessee River both upstream and downstream of the CRN Site can affect surface water hydrology throughout the entire basin, the potential for the CR SMR Project to contribute to such impacts is expected to be highest in close proximity to the CRN Site, and to decrease substantially with distance from the CRN Site. Generally, when impacts from a project within a local area are SMALL to none, it is expected that there would be no cumulative impacts greater than SMALL in the remainder of the geographic area of interest.

As discussed in Subsection 4.7.1.2, global climate change may affect the intensity and duration of precipitation events, but it is not expected to change the overall amount of precipitation in the vicinity of the CRN Site, and therefore is unlikely to have a substantial impact on the number or area of perennial streams or WWCs. However, past and present projects listed in Table 4.7-1 have cumulatively impacted perennial streams and WWCs throughout the region. These impacts have occurred through the disturbance of the land area associated with each project, and occupation of the original land area by a new facility or feature. The largest impacts to perennial streams and WWCs associated with the past and present projects likely resulted from the development of land area associated with agriculture, urban development, industrial development of the ORR, and development of the reservoirs operated by TVA. As a result, the total number and area of perennial streams and WWCs in the region has been reduced, and the impact of these cumulative projects has been MODERATE.

The number and area of perennial streams and WWCs would be further reduced by construction of the SMRs. However, given that the impacts of project construction would be SMALL, their cumulative contribution to the overall impact would also be SMALL.

4.7.3.2 Water Use Impacts

Cumulative water-use impacts are presented separately for surface water and groundwater.

4.7.3.2.1 Surface Water Use Impacts

Subsection 2.3.2.1 describes the use of surface water in the vicinity of the proposed CR SMR Project, and serves as the baseline for the analysis of cumulative impacts to surface water use. Subsection 4.2.2.1 describes impacts to surface water use during preconstruction and construction activities at the CRN Site. As discussed in Subsection 4.2.2.1, the use of surface water for dust suppression during preconstruction and construction activities would withdraw and consume less than 0.002 percent of the daily flow rate of the Clinch River arm of the Watts Bar Reservoir. The impacts of this withdrawal would be SMALL.

For purposes of this cumulative impact analysis, the geographic area of interest for surface water use impacts is the seven-county area (Anderson, Knox, Loudon, Meigs, Morgan, Rhea, and Roane counties) surrounding the CRN Site. This geographic area of interest incorporates all of the past, present, and reasonably foreseeable future projects listed in Table 4.7-1. Although water use within the drainage basin of the Tennessee River both upstream and downstream of the CRN Site can affect the availability of surface water throughout the entire basin, the potential for the CR SMR Project to contribute to such impacts is expected to be highest in close proximity to the CRN Site, and to decrease substantially with distance from the Site. Generally, when impacts from a project within a local area are SMALL to none, it is expected that there would be no cumulative impacts greater than SMALL in the remainder of the geographic area of interest.

As discussed in Subsection 2.3.1.1.1.2, the Tennessee River system is a network of dams and reservoirs that generates power, controls flooding, provides recreational opportunities, and boosts the regional and national economies. TVA owns or operates 49 dams and reservoirs in the mainstem Tennessee and Cumberland watersheds, including nine dams on the Tennessee River (Reference 4.7-14). The dams and reservoirs are operated year-round by TVA for the purposes of navigation, flood control, power generation, water supply, water quality, and recreation. (Reference 4.7-15)

The dams operated by TVA were installed starting in 1911, with the most recent, Tellico Dam, having been installed in 1979. The three dams in closest proximity to the CRN Site, having the highest potential to contribute to cumulative water use impacts, are Watts Bar Dam (constructed in 1942), Melton Hill Dam (constructed in 1963), and Fort Loudoun Dam (constructed in 1943). (Reference 4.7-15) TVA adopted its current reservoir operating policy in 2004 based upon the comprehensive Reservoir Operations Study (ROS), so the period from 2004 to the present was used as the baseline in the discussion of surface water flow conditions presented in Subsection 2.3.1.1.2 (Reference 4.7-16). Because the dams and their associated water users have been affecting surface water flow rates since before 1979, the baseline surface water flow conditions presented in Subsection 2.3.1.1.2.1 represent the ongoing cumulative effect of the construction and operation of all of the past and present dams in the system on surface water flow. In addition, because the ROS included long-range planning for the system to the year 2030, the analysis also represents all reasonably foreseeable conditions that may contribute to cumulative impacts on the river and reservoir system.

TVA’s reservoir operations system has been designed, with the purpose of moderating flow rates throughout the year by releasing water flow in periods of low precipitation, and by storing flow in periods of high precipitation. As discussed in Subsection 4.2.2.1, withdrawal and consumption of surface water for dust suppression during construction of the SMRs would be less than 0.002 percent of the minimum daily flow rate in the Clinch River arm of the Watts Bar Reservoir. Therefore, construction of the SMRs would not modify the beneficial cumulative effect of the system of dams and reservoirs on surface water flow rates in the geographic area of interest.

In addition to moderating flow rates, TVA's system of dams and reservoirs serves to provide water supply for a variety of municipal, industrial, and agricultural users in the geographic area of interest. In 2014, TVA conducted a Regional Surface Water Use Study for the Clinch River Small Modular Reactor Project to evaluate all past and projected water uses within the seven-county area surrounding the CRN Site from 1995 to 2035 (Reference 4.7-16). The baseline data presented for surface water use in Subsection 2.3.2.1 represents the cumulative effect of past and present projects within the geographic area of interest on surface water use. In addition, because the analysis included projections of water use to the year 2035, it incorporates reasonably foreseeable water uses.

Many of the surface water uses in the geographic area of interest include substantial return flows; therefore, these uses do not have an adverse impact on surface water. However, some uses result in evaporation or transpiration of water by humans, livestock, or crops and are therefore consumptive. These consumptive uses reduce the availability of surface water in the geographic area of interest, and can result in adverse impacts to other users of surface water, including aquatic species.

TVA's reservoir operating policy was designed to meet the off-stream water needs of the Tennessee Valley until the year 2030 (Reference 4.7-16). The analysis was based on a geographic area of interest that includes the seven-county area surrounding the CRN Site, and therefore incorporates all of the past, present, and future projects listed in Table 4.7-1. The estimates used to develop the reservoir operating policy were a total withdrawal of 13,990 million gallons per day (mgd) with a return of 13,010 mgd resulting in a net water demand of 980 mgd. As discussed in Subsection 2.3.2.1.1, the net water demand in the geographic area of interest in 2010 was 471 mgd, or 3.9 percent of the total withdrawals. The current watershed projection of water demand to 2035 indicates a total withdrawal of 9449 mgd with a return of 8737 mgd resulting in a net water demand of 712 mgd. (Reference 4.7-16) Therefore, both the current and projected future water demands are within the limits established for the reservoir operating policy, and cumulative impacts to surface water uses would be SMALL.

Global climate change may affect surface water flows and water availability through changes in the timing and magnitude of precipitation. As discussed in Subsection 4.7.1.2, although the region as a whole may not experience major changes in water availability due to climate change, localized changes in precipitation patterns may impact water supply in specific areas. (Reference 4.7-3)

Overall, past, present, and reasonably foreseeable future projects, combined with the additional potential for a decrease in surface water availability due to global climate change, have resulted in cumulative impacts on surface water availability that are SMALL, and have included both adverse and beneficial effects. Surface water uses for municipal, agricultural, and industrial purposes, including many of the projects listed in Table 4.7-1, remove surface water from the geographic area of interest, resulting in adverse impacts to surface water availability. TVA's management of the dam and reservoir system stores excess surface water for use during periods of low precipitation. While this action does not increase the amount of surface water in

the system, it does provide a beneficial impact on surface water availability by making water available during periods of low precipitation, except for periods of extreme drought. The incremental additional cumulative impact associated with surface water use for pre-construction and construction of the SMRs would be adverse, because it would remove surface water from the system. However, because the amount of surface water to be removed would be small in comparison to the total amount available in the reservoir and the total amount projected to be needed for future use, the additional cumulative impact would be SMALL.

4.7.3.2.2 Groundwater Use Impacts

Section 2.3 describes the groundwater affected by the proposed CR SMR Project. In general, groundwater at the CRN Site recharges through precipitation. Periodic recharge from the Clinch River arm of the Watts Bar Reservoir during high water stages may also be occurring.

Subsections 4.2.1.2 and 4.2.2.2 describe impacts to groundwater use during preconstruction and construction activities at the CRN Site. There are no planned uses for groundwater during preconstruction and construction activities. Potable water will be supplied to the CRN Site by the City of Oak Ridge. Planned construction activities include temporary dewatering activities localized to power block area excavations; previous groundwater conditions are expected to resume upon completion and no subsidence is anticipated. Therefore groundwater use impacts from dewatering would be SMALL.

This cumulative analysis considers impacts from preconstruction and construction activities along with impacts from past, present, and reasonably foreseeable actions that may contribute to cumulative impacts to groundwater use within the geographic area of interest, the geographic area most likely to be affected by the proposed CR SMR Project. For the purposes of this cumulative impact analysis, the geographic area of interest for groundwater use impacts is the Lower Clinch River Watershed from Melton Hill Reservoir down to the confluence of the Clinch, Emory, and Tennessee Rivers.

Current and future operations at ORR include institutional controls and remedial activities to minimize impacts to groundwater. Impacts to groundwater from present and future activities could be affected by potential intense drought periods followed by intense precipitation events predicted by many of the climate change models for the region could result in less permeable soils and thus less infiltration and recharge of the groundwater system. These resultant changes to the groundwater system could result in different groundwater flow patterns; thus potentially changing contaminant transport through the groundwater system and thereby potentially reducing water availability. Although readily abundant surface water is expected to remain the chosen water source for the foreseeable future, potential changes in the groundwater quality could stress the water cycle system. In summary, because there are no planned uses for groundwater during CR SMR preconstruction and construction activities, the incremental additional cumulative impact associated with groundwater use would be SMALL.

4.7.3.3 Water-Quality Impacts

Cumulative water-quality impacts are presented separately for surface water and groundwater.

4.7.3.3.1 Surface Water Quality Impacts

Subsection 2.3.3.1 describes surface water quality in the vicinity of the proposed CR SMR Project, and serves as the baseline for the analysis of cumulative impacts to surface water quality. Subsection 4.2.3.1 describes impacts to surface water quality during preconstruction and construction activities at the CRN Site. As discussed in Subsection 4.2.3.1, compliance with the Site's NPDES permit, including the implementation of a site-specific Stormwater Pollution Prevention Plan (SWPPP) and the use of BMPs, would result in SMALL impacts from the proposed CR SMR Project to the quality of surface water during preconstruction and construction activities.

This cumulative analysis considers impacts from preconstruction and construction activities along with impacts from past, present, and reasonably foreseeable actions that may contribute to cumulative impacts to surface water quality within the geographic area of interest, the geographic area most likely to be affected by the proposed CR SMR Project. For purposes of this cumulative impact analysis, the geographic area of interest for surface water use impacts is the Clinch River arm of the Watts Bar Reservoir. Although projects within the drainage basin of the Tennessee River both upstream and downstream of the CRN Site can affect surface water quality throughout the entire basin, the potential for the CR SMR Project to contribute to such impacts is expected to be highest in close proximity to the CRN Site, and to decrease substantially with distance from the CRN Site. Generally, when impacts from a project within a local area are SMALL to none, it is expected that there would be no cumulative impacts greater than SMALL in the remainder of the geographic area of interest.

Subsection 2.3.3.1 presents surface water quality results from a variety of sources, including studies of the U.S. Geological Survey in the Upper Tennessee River Basin, the Tennessee Department of Environment and Conservation (TDEC) 303(d) list, TVA's Reservoir Ecological Health Program, TVA's Site Preparation Monitoring Program, and TVA's Biological Monitoring Program. These studies provide a baseline for surface water and sediment quality based on analyses which occurred from 1994 to 2015, and have documented water quality impacts that resulted from the 1940s. Therefore, this baseline effectively represents the cumulative impact of all past and present projects.

Surface water quality in the Upper Tennessee River Basin usually meets existing guidelines for drinking water, recreation, and the protection of aquatic life (Reference 4.7-17). All sample results from the Site Preparation Monitoring Program for the Clinch River arm of the Watts Bar Reservoir upstream and downstream of the CRN Site indicate that TDEC's most stringent numeric criteria are being met and that site runoff (should it occur) would not have a significant impact to water quality (Reference 4.7-18). However, as discussed in Subsection 2.3.3.1, impacts to surface water and sediment quality as a result of industry, mining, agriculture,

urbanization, and toxic spills and releases have been identified. Surface water quality impacts include elevated bacteria, nutrients, and herbicides as a result of agriculture; elevated concentrations of polychlorinated biphenyls (PCBs), dioxin, and mercury in water, and semivolatile organic compounds in sediment, due to industrial sources and coal mining; and the presence of mercury, PCBs, and cesium-137 in sediment, as a result of past operations at the ORR.

Several of the present and reasonably foreseeable future projects listed in Table 4.7-1 have the potential to cause adverse or beneficial impacts to surface water quality in the geographic area of interest in the future. All projects that involve site disturbance during construction, active work within surface water bodies, surface water withdrawal, and/or discharges to surface water bodies have the potential to affect water quality within the geographic area of interest. In general, each of these present projects are currently conducted, and future projects will be conducted, in accordance with applicable permits in order to protect surface water quality.

Global climate change may adversely affect surface water quality as increasing air and water temperatures, more intense precipitation and runoff, and intensifying droughts can result in increases in sediment, nitrogen, and other pollutant loads (Reference 4.7-2). Changes in agricultural practices, in response to climate change, can lead to increase in the release of pollutants to streams. Other factors, including operation of new projects under the regulation of the Clean Water Act, and the inclusion of water quality in the development of TVA's ROS, have had the opposite effect, resulting in improvement of surface water quality.

TVA's ROS has had a beneficial impact on water quality by managing water flows to increase aeration and dilute industrial discharges. As part of the CR SMR Project, TVA would manage construction-related discharges in accordance with the CRN Site's SWPPP and NPDES permit and by following standard BMPs.

Overall, past and present projects, combined with the additional potential for a decrease in surface water quality due to climate change, result in MODERATE cumulative impacts on surface water quality. However, the incremental additional cumulative impact associated with preconstruction and construction of the SMRs on surface water quality would be SMALL.

4.7.3.3.2 Groundwater Quality Impacts

Section 2.3 describes the groundwater affected by the proposed CR SMR Project. In general, groundwater at the CRN Site recharges through precipitation and periodic recharge from the Clinch River arm of the Watts Bar Reservoir during high water stages.

Subsection 4.2.3.2 describes impacts to groundwater quality during preconstruction and construction activities at the CRN Site. There are no planned uses for groundwater during preconstruction and construction activities at the CRN Site and current plans include the use of BMPs to minimize potential releases to the environment of groundwater from dewatering

activities in the power block area. Section 4.2.3.2 concludes that impacts to groundwater quality from minor releases of very small amounts of localized contaminants would be SMALL.

This cumulative analysis considers impacts from preconstruction and construction activities along with impacts from past, present, and reasonably foreseeable actions that may contribute to cumulative impacts to the quality of groundwater within the geographic area of interest. The geographic area of interest for cumulative impacts to the quality of groundwater is the same as the groundwater use geographic area of interest which includes the Lower Clinch River Watershed from Melton Hill Reservoir down to the confluence of the Clinch, Emory, and Tennessee Rivers near Kingston.

Cumulative impacts to groundwater quality from past and present activities have occurred, and are MODERATE. Subsection 2.3.3.2.2.2 discusses the baseline groundwater sampling for the CRN Site. Legacy radionuclides strontium-90, tritium, and technetium-99 were detected along with legacy metals barium, cadmium, and chromium at the CRN Site. Arsenic, mercury, or uranium were not detected at the CRN Site. As discussed in Subsection 2.3.3.2.2.2, legacy contamination from historic ORR operations has resulted in contaminated groundwater plumes in various areas of the Reservation. Contaminant plumes on ORR include volatile organic compounds along with cesium-137, strontium-90, and tritium at ORNL along with uranium, nitrate, and mercury at Y-12. Plumes at ETTP also include chromium-6 and technetium-99. In addition, legacy groundwater contamination from the American Nuclear Corporation includes cobalt-60 and cesium-137.

In addition to these legacy groundwater contaminants, anticipated climate change may also contribute to groundwater quality cumulative impacts. As mentioned in Subsection 4.7.3.2.2, the increased incidence of both drought and flooding events predicted by some of the models would reduce the amount of infiltration recharging the groundwater system and thus possibly changing the favored flow patterns. These changes may include changes in contaminant transport through the groundwater system, thus changing water quality in the geographic area of interest.

Overall, past and present projects, combined with the additional potential for a decrease in groundwater quality due to climate change, result in MODERATE cumulative impacts on groundwater quality. However, the incremental additional cumulative impact associated with preconstruction and construction of the SMRs would be SMALL.

4.7.4 Cumulative Ecological Impacts

This subsection describes the cumulative impacts on terrestrial and aquatic ecological resources that may result from preconstruction and construction activities associated with the proposed CR SMR Project. The analysis considers these impacts in conjunction with other past, present, and reasonably foreseeable future activities within the geographic area of interest for each of these resources. Terrestrial and aquatic ecology impacts are discussed separately in the following subsections.

4.7.4.1 Terrestrial Ecology and Wetlands Impacts

Subsection 2.4.1 describes the terrestrial ecology resources, including wetlands, potentially affected by the proposed CR SMR Project and provides the baseline for analysis of cumulative impacts to terrestrial ecology. Subsection 4.3.1 describes impacts to terrestrial ecosystems during preconstruction and construction activities at the CRN Site and within the offsite Barge/Traffic Area and the offsite segment of the existing 500-kilovolt (kV) transmission line ROW in which an underground 69-kV transmission line is to be installed.

For the purposes of this cumulative analysis of the impacts of preconstruction and construction on terrestrial ecology, the geographic area of interest is defined as the area within approximately a 6-mi radius of the CRN Site. This area encompasses the CRN Site and associated offsite areas (Barge/Traffic Area and underground transmission line), and encompasses other projects potentially capable of interacting with the CR SMR Project during preconstruction and construction to affect terrestrial ecological resources.

Table 4.7-1 identifies the past, present, and reasonably foreseeable projects and facilities considered in the cumulative impacts analysis. Eleven of these are within the geographic area of interest for cumulative impacts on terrestrial ecology. Five of these projects may involve construction activities that potentially could affect terrestrial ecological resources relevant to those affected by the CR SMR Project. These include the following projects: transfer of property on the ETTP to private companies, which could subsequently construct facilities on the ETTP; the Roane Regional Business and Technology Park, where sites could be developed; and three roadway improvement projects by the Tennessee Department of Transportation (TDOT) on Tennessee State Highway (TN) 95 and TN 73. These five projects could involve land clearing and earth moving activities that may have the potential to produce erosion and sedimentation impacts in nearby water bodies. The other six projects in the geographic area of interest are not expected to have the potential to produce such effects. The Sludge Buildout Project and the CVMR Corporation relocation would occur in already developed areas; the ORNL and its associated Spallation Neutron Source and High Flux Isotope Reactor have been in operation for many years and would not involve construction; and the ongoing operation of the Melton Hill Hydroelectric Facility would not have cumulative effects in conjunction with effects from preconstruction and construction of the CR SMR Project.

Terrestrial Habitats

Past land uses on the CRN Site and in its vicinity, described in Subsection 2.2.1.1, have cumulative effects on the terrestrial ecology of the area. Historically, several small farmsteads were scattered across the Clinch River Property, and aerial photographs indicate that by 1936 substantial portions of the CRN Site peninsula had been cleared of forest for use as farmland. Natural succession led to reforestation of some areas before major portions (240 ac) of the peninsula were disturbed in 1982 and 1983 during site preparation for the CRBRP. The CRBRP was terminated in late 1983, and site redress plans were implemented to stabilize the site including reseeding of grass, and planting of trees, mulching cleared areas, installation of straw

bales in shallow ditches, installation of small berms of riprap in larger ditches, installation of culverts to direct water from steep slopes, modification of the holding ponds for long-term stability, and partial backfilling of the large excavated area in the central portion of the site.

As described in Subsection 2.2.1.2, the vicinity of the CRN Site is primarily rural and covered by forest and pasture/hay cultivation. To the north, the CRN Site is adjoined by the ORR, which is largely undeveloped and includes forests, grasslands and old agricultural fields, bottomlands and wetlands, utility corridors, and ridges (Reference 4.7-19). Facilities within the ORR currently include the ORNL, the Y-12 National Security Complex, and the ETTP. To the east, south, and west across the Clinch River arm of the Watts Bar Reservoir, the land use in the geographic area of interest is rural and includes interspersed wooded areas, pastures, farm fields, and residences.

Subsection 4.3.1 describes the terrestrial ecological communities and acreages to be permanently and temporarily impacted by preconstruction and construction activities on the CRN Site, the Barge/Traffic Area, and the ROW for the proposed underground transmission line. Section 4.3.1 concludes that impacts to terrestrial ecological communities, including wetlands, would be SMALL.

This cumulative analysis considers impacts from preconstruction and construction activities along with impacts from past, present, and reasonably foreseeable actions that may contribute to cumulative impacts to the terrestrial habitats within the geographic area of interest. The underground transmission line is planned within an existing aboveground transmission line ROW; therefore minimal temporary and no permanent development is anticipated within this area. The upland plant communities that would be permanently affected by the construction of facilities on the CRN Site comprise predominantly mixed evergreen-deciduous, deciduous, and evergreen forest (162 ac) and herbaceous (152 ac) habitats that are common in the vicinity. Of the approximately 45 ac in the Barge/Traffic Area that would be temporarily or permanently disturbed, approximately 20 ac are classified as developed and 25 ac are undeveloped (mainly forest) and potentially could be impacted permanently or temporarily by the planned improvements. These acreages are minor relative of the expanse of such communities within the geographic area of interest and the region. The ORR to the east, north, and west, encompasses more than 33,100 ac of federally-owned land that is mostly a relatively undisturbed ecosystem of nearly continuous forest within a surrounding region that is more fragmented by agriculture and development. The areas on the CRN Site that are cleared for temporary uses may be revegetated or otherwise restored after construction is completed. Over time, some of these areas likely would undergo succession and gradually transition from herbaceous to forest habitat. Therefore, it is expected that the additional incremental cumulative impacts on terrestrial habitats from preconstruction and construction activities on the CRN Site, the adjacent Barge/Traffic Area and the proposed underground transmission line ROW would be SMALL.

The total area of wetlands impacted by preconstruction activities on and off the CRN Site potentially would be approximately 2 ac, so impacts on wetlands would be SMALL and would

likely be further reduced by mitigation. The five relevant projects planned for the geographic area of interest would require permitting and potential mitigation of any wetland impacts. Substantial impacts to wetlands from these projects are unlikely because the ETTP and the Roane Regional Business and Technology Park comprise areas of existing development and areas suitable for development, and the three TDOT projects involve improvements to existing roads that would be unlikely to affect more than small areas of wetlands, if present, adjacent to the roadways. Accordingly, cumulative impacts on wetlands in the geographic area of interest are expected to be SMALL.

Wildlife

Subsection 2.4.1.4 describes the terrestrial wildlife that could be affected by the proposed CR SMR Project, including listed and other important species on the CRN Site, Barge/Traffic area, and the underground 69 kV transmission line ROW. Table 2.4.1-7 summarizes the important terrestrial habitats, wetlands, and listed species that occur in ROWs of the segments of the transmission system outside the CRN Site that would require modifications (uprating, reconductoring, or rebuilding). Only small portions of two of these segments are within the geographic area of interest. Subsection 4.3.1.4 describes the impacts to wildlife from preconstruction and construction activities on the CRN Site and the Barge/Traffic Area. Because the underground transmission line location is within an existing ROW for an aboveground transmission line, the wildlife community has previously been altered by clearing of forest and ongoing vegetation maintenance. This is also the case for the offsite line segments to be modified. Temporary disturbance for installation of the underground line and modification of existing lines is anticipated to have a SMALL impact on wildlife within these ROWs.

The disturbance of approximately 494 ac of habitat (approximately 167 ac temporarily disturbed and 327 ac permanently disturbed) at the CRN Site and 45 ac (approximately 15 ac temporarily disturbed and 30 ac permanently disturbed) in the Barge/Traffic Area would result in mortality or temporary displacement of wildlife in those areas. However, this acreage would be a small component of the accessible, undeveloped habitat in the geographic area of interest to which animals can disperse with minimal effects on populations in the area. Similarly, wildlife seeking to avoid noise by moving away from areas where preconstruction and construction activities are occurring would be temporarily displaced, but their populations would be minimally affected. The low likelihood of collisions with structures also indicates that such collisions would have a negligible impact on bird or bat populations in the area. Subsection 4.3.1.4 concludes that, overall, impacts on terrestrial wildlife from preconstruction and construction are expected to be SMALL. Impacts to wildlife from five relevant projects planned for the geographic area of interest are expected to be SMALL because the ETTP and the Roane Regional Business and Technology Park comprise areas of existing development and areas suitable for development with minimal wildlife habitat, and the three TDOT projects involve improvements to existing roads that would be unlikely to affect more than small areas of marginal wildlife habitat adjacent to the roadways.

In addition to the specific, reasonably foreseeable projects and activities within the geographic area of interest identified above, cumulative effects on terrestrial ecological resources may result from ongoing activities and processes in the region (e.g., agriculture, silviculture, and commercial, industrial, and residential development) and on a national or global scale (e.g., climate change). These development and land use activities are likely to continue to contribute to the processes of forest reduction and fragmentation and associated decreases in habitat that have occurred historically. The cumulative effects of development in the geographic area of interest could alter attributes of the terrestrial environment by reducing wildlife habitat in localized areas. However, this would not substantially affect the overall availability of wildlife habitat near the CRN Site or the general extent of forests or other habitat types in the geographic area of interest. Extensive areas of relatively unfragmented and undisturbed forest habitat have been maintained in the geographic area of interest and the region, minimizing the cumulative impacts of the relatively small areas affected by current and reasonably foreseeable activities. Accordingly, cumulative impacts on wildlife in the geographic area of interest are expected to be SMALL, and cumulative impacts on listed species similarly are expected to be SMALL.

A report by the Electric Power Research Institute summarizes existing research on the effects of climate change on natural resources in the region of the southeastern United States served by TVA. The authors found that literature describing how climate change specifically would impact ecological resources of the TVA region is very limited. This region currently is one of the richest in the country in terms of biological diversity, and the TVA region provides habitat to an unusually high concentration of threatened and endangered species. (Reference 4.7-3) Some analyses indicate a slightly warmer dryer climate, other climate models indicate the opposite effects (lower temperatures and higher precipitation). Higher temperatures without additional precipitation could adversely affect forests, but higher carbon dioxide concentrations potentially could compensate by increasing water use efficiency by trees. By 2050, however, larger temperature increases and potential decreases in precipitation could make forest disturbances (e.g., fire, drought, and insect outbreaks) more prevalent, and shifts in forest species composition could become more important. Forests in the TVA region currently are dominated by hardwoods, but several studies suggest that climate change could make conditions in the region more suitable for southern pine species. (1373 Electric Power Research Institute 2009)

Some of the more modest changes in forest ecosystems that might result from climate change in the TVA region may have more substantial effects on terrestrial habitats and species that currently are rare, threatened, or endangered. Specific predictions about which areas and species might be most affected are difficult due to the limited studies of these effects. (1373 Electric Power Research Institute 2009) Available studies indicate that resident non-game birds, a category that includes the state-status species observed at the CRN Site (the bald eagle and sharp-shinned hawk), may not be greatly affected by climate change. The federally-listed Indiana bat could be adversely affected if winter temperatures are not sufficiently low and stable in the caves where they hibernate. (Reference 4.7-1) The other two federally-listed bat species occurring at the CRN Site, the gray bat and northern long-eared bat, may be similarly adversely

affected if temperatures increase in the caves in which they hibernate. Thus, although individuals of these listed bat species would be minimally affected by construction of the proposed CR SMR Project, their populations may be vulnerable to cumulative impacts from climate change over the long-term.

Summary of Cumulative Terrestrial Ecology Impacts

Cumulative impacts on terrestrial ecological resources were assessed for the past, present, and reasonably foreseeable future activities and processes occurring in the geographic area of interest. The assessment considered impacts on terrestrial communities from factors such as the effects of preconstruction and construction for the CR SMR Project, the loss of vegetation and wildlife habitat, increased habitat fragmentation from continued development, and global climate change. These large-scale processes are ongoing and likely to continue. Based on this analysis, the cumulative impacts on terrestrial ecological resources in the geographic area of interest from past, present, and reasonably foreseeable future actions, including preconstruction and construction of the proposed CR SMR Project on the CRN Site, would range from SMALL to MODERATE. The incremental contribution from preconstruction and construction activities for the CR SMR Project to these cumulative impacts on terrestrial ecology within the geographic area of interest would be SMALL.

4.7.4.2 Aquatic Ecology Impacts

Subsection 2.4.2 describes the aquatic ecology resources potentially affected by the proposed CR SMR Project at the CRN Site and provides the baseline for analysis of cumulative impacts to aquatic ecology. Subsection 4.3.2 describes impacts to aquatic ecosystems during preconstruction and construction activities at the CRN Site, on the offsite Barge/Traffic Area, and within the offsite, 500-kV transmission line ROW in which an underground 69-kV transmission line is to be installed.

The geographic area of interest for this analysis of cumulative impacts on aquatic ecological resources is defined as the CRN Site, Barge/Traffic Area, and 69-kV underground transmission line ROW, and the Clinch River arm of the Watts Bar Reservoir in the vicinity (within approximately a 6-mi radius) of the CRN Site. This geographic area of interest encompasses drainages associated with the CRN Site and associated offsite areas where project-related preconstruction and construction would occur. It also includes the limited area within the Clinch River arm of the Watts Bar Reservoir that may be affected by activities on the CRN Site as well as other activities capable of having aquatic effects that could interact with the CR SMR Project during preconstruction and construction to cumulatively affect aquatic ecological resources. This portion of the Clinch River arm of the Watts Bar Reservoir generally includes the area of the reservoir downstream to the confluence with the Emory River arm of the Watts Bar Reservoir and upstream to Melton Hill Dam (approximately Clinch River Mile [CRM] 5 to 23). The potential for the CR SMR Project to contribute to such impacts is expected to be highest in close proximity to the CRN Site and to decrease substantially with distance from the CRN Site.

Aquatic Habitats and Organisms

Past uses of the CRN Site and the Clinch River arm of the Watts Bar Reservoir in its vicinity have had cumulative effects on the aquatic ecology of the geographic area of interest. As discussed in Subsection 4.7.3.2.1, past projects to regulate the Tennessee River system have substantially altered the natural flow regime of the Tennessee River and its tributaries, including the Clinch River. The Tennessee River system is described in Subsection 2.3.1.1.1.2.

As stated in Section 4.7.3.1.1, the three dams in closest proximity to the CRN Site are Watts Bar Dam (constructed in 1942), Melton Hill Dam (constructed in 1963), and Fort Loudoun Dam (constructed in 1943). (Reference 4.7-15) The TVA system has been designed and is operated with the purpose of moderating flow rates throughout the year by releasing water flow in periods of low precipitation and by storing flow in periods of high precipitation. TVA adopted its current reservoir operating policy in 2004 based on the comprehensive ROS (Reference 4.7-16). Because the dams and their associated water users have been affecting surface water flow rates since before 1979, the baseline surface water flow conditions described in Subsection 2.3.1.1.2.1 and the ecological community described in Subsection 2.4.2.1.1 represent the cumulative effects on surface water flow from the ongoing operation of all of the dams in the system. In addition, because the ROS included long-range planning for operation of the system to the year 2030, the analysis also represents all reasonably foreseeable flow conditions that may contribute to cumulative impacts on aquatic ecology.

The cumulative effects of the system of dams and reservoirs on surface water flow in the Tennessee River system has had a LARGE impact on the aquatic community that historically existed in formerly free-flowing riverine ecosystems. Construction of Norris Dam in 1936 at CRM 80 and Melton Hill Dam in 1963 at CRM 23, both on the main channel of the Clinch River, dramatically altered the aquatic fauna and likely had a great impact on native aquatic species in this area. Additionally, Watts Bar Reservoir, completed on the Tennessee River mainstem in 1942, impounded the lowermost portion of the Clinch River. In the Clinch River arm of the Watts Bar Reservoir, the relatively low abundance and species richness of the mollusk community and poor habitat relative to historical conditions are presumed to be the result of the impoundment of the Clinch River by Melton Hill Dam and Norris Dam and of the mainstem Tennessee River by Watts Bar Dam. (Reference 4.7-20)

The effects of these impoundments on aquatic fauna in the Clinch River have included fragmentation and loss of riverine habitats, disruption of the natural flow regime, altered temperature regimes, extreme water level fluctuations, changes in water quality parameters such as turbidity and oxygen concentrations, increases in concentrations of heavy metals, and impeding migrations of fish that are hosts to mussel larvae. A 1968 study of changes in freshwater fish populations after construction of Melton Hill Dam documented a reduction in nongame fish species. Rare and uncommon riverine fish species, such as the federally-threatened sender chub and the state-protected blue sucker, have not been documented in the Clinch River since 2002. Studies also have found mussel diversity and abundance are low in

comparison to preimpoundment surveys, likely due to the construction of impoundments, channelization, and dredging of the waterway for navigation. (Reference 4.7-20)

Additionally, the lower Clinch River arm of the Watts Bar Reservoir also has been subject to contamination from the Manhattan Project and ORNL many decades ago, which has contributed to legacy sediment toxicity issues between White Oak Creek (near CRM 21) upstream of the CRN Site and the Watts Bar Dam downstream of the CRN Site. These releases also likely contributed to mussel declines in this area. In 1991 TVA began a Reservoir Release Improvement program at Melton Hill Dam (CRM 23) and other dams to increase dissolved oxygen levels and water flow in the lower Clinch River arm of the Watts Bar Reservoir, which may have improved habitat conditions for mussels since its implementation. (Reference 4.7-20) Due to the passage of time and remedial actions to improve water quality in the Reservoir, cumulative impacts from past projects have had been MODERATE. Because the CR SMR Project would comply with all BMPs, permits and regulations, preconstruction and construction activities would not contribute to the cumulative effects of sediment contaminants on aquatic organisms in the geographic area of interest.

As discussed in Subsection 4.2.2.1, the withdrawal and consumption of surface water for dust suppression during construction of the SMRs would be less than 0.002 percent of the minimum daily flow rate in the Clinch River arm of the Watts Bar Reservoir. Therefore, preconstruction and construction activities for the CR SMR Project would not modify the cumulative effects of the system of dams and reservoirs on surface water flow rates in the geographic area of interest and would not contribute to the cumulative effects of the system on aquatic ecological resources in the geographic area of interest.

As discussed in Subsection 4.3.2, the effects of preconstruction and construction activities on the CRN Site and in adjacent offsite areas (Barge/Traffic Area and 69-kV underground transmission line ROW) would not disrupt or alter important aquatic ecosystems. Impacts on aquatic habitats would be SMALL based on the lack of high quality or unique habitats in the areas to be developed or the adjacent reservoir and also the presence of extensive reservoir, pond, and stream habitats in the vicinity and the region. Impacts on most streams would be SMALL and would be further reduced by mitigation. Important aquatic habitats (e.g., natural areas, managed areas, or other designated areas) on the CRN Site or the Barge/Traffic Area would not be within the footprint of preconstruction or construction activities or otherwise adversely affected by these activities, and the impact of these activities on important aquatic species would be SMALL. Impacts on components of the aquatic ecosystem within transmission ROWs similarly would be SMALL.

Historical impacts affecting aquatic habitats on the CRN Site principally occurred during preparatory activities for the CRBRP. These activities resulted in the alteration of site topography, changes in drainage patterns, and the development of multiple stormwater retention ponds, described in Subsection 2.4.2.1.3. The CR SMR Project would retain the preexisting ponds, and incremental impacts on these small aquatic habitats on the CRN Site would be SMALL.

Other activities in the geographic area of interest potentially contributing to cumulative aquatic impacts include activities not directly related to the CR SMR Project, such as the development or operation of other facilities (e.g., those identified in Table 4.7-1), residential and agricultural water use, and water-based recreational activities such as fishing and boating. Natural environmental stressors contributing to cumulative aquatic impacts include short-term and long-term changes in precipitation or temperature and the spread of invasive aquatic organisms.

Factors not directly associated with preconstruction or construction activities for the CR SMR Project also may contribute to cumulative impacts on the aquatic biota of the Clinch River arm of the Watts Bar Reservoir and other aquatic habitats in the geographic area of interest. These impacts include habitat loss due to development that directly impacts streams or ponds; non-point-source pollution related to increased development within the watershed of the Clinch River arm of the Watts Bar Reservoir; and hydrological and water quality alterations resulting from changes in stormwater runoff and infiltration as a result of development in the watershed. Such impacts could result from increased development in the geographic area of interest. Excessive sedimentation is the principal non-point-source pollutant in Tennessee, smothering substrates that are critical habitats for many species of fish and mussels (Reference 4.7-1). As discussed in Subsection 4.3.2, BMPs would be used to prevent or minimize erosion and sediment transport to the Clinch River arm of the Watts Bar Reservoir and to streams on and off the CRN Site, and a SWPPP would prescribe methods for collection and control of runoff from preconstruction and construction areas in accordance with state and federal regulations and NPDES permit requirements. As a result, the incremental contribution to sedimentation impacts from the CR SMR Project during the period of preconstruction and construction activities in conjunction with other development activities in the watershed would be SMALL.

The geographic area of interest for aquatic resources around the CRN Site is likely to continue to be predominantly rural in character and covered mainly by forest. However, reductions in natural vegetation and open space due to increased development or agricultural land uses likely would result in increased stormwater runoff and associated increases in nonpoint source pollutants such as nutrients, pesticides, and petroleum compounds. The cumulative effects on aquatic biota of development of other facilities in the geographic area of interest in combination with preconstruction and construction activities for the CR SMR Project are expected to be SMALL.

As discussed in Subsection 4.7.1.2, climate models forecast three trends that may affect aquatic habitats: warmer mean annual temperatures, greater frequency of intense rainfall events, and drier summers with more severe droughts. Such changes may affect water levels and flows in Tennessee reservoirs through increased evaporation. Increases in temperatures and the intensity of storms may affect reservoir water levels and flows. This higher climate variability may result in less predictable management of reservoir hydrology, with resulting effects on fish habitat, abundance, community composition, and population dynamics. (Reference 4.7-1)

Climate change could result in additional erosion and sedimentation during intense rain events. Increased precipitation may increase runoff and sedimentation in areas where riparian buffers

are poor or inadequate. (Reference 4.7-1) The ongoing maintenance of riparian buffers around streams and reservoirs on and in the vicinity of the CRN Site is expected to minimize sedimentation effects from climate change in the geographic area of interest. As discussed in Subsection 4.3.2, the use of BMPs, a SWPPP, and compliance with regulations would prevent or minimize erosion and sediment transport to the Clinch River arm of the Watts Bar Reservoir and to streams on and off the CRN Site. As a result, the incremental cumulative contribution to sedimentation impacts from the CR SMR Project during the period of preconstruction and construction activities in conjunction with global climate change would be negligible or SMALL.

Summary of Cumulative Aquatic Ecology Impacts

Cumulative impacts on aquatic ecological resources were assessed for the past, present, and reasonably foreseeable future activities and processes occurring in the geographic area of interest. The assessment considered impacts on aquatic communities from factors such as the effects of preconstruction and construction for the CR SMR Project, consumptive water loss, regulation of water levels and flows by dams, construction and operation of other commercial and industrial facilities in the watershed, and other natural and anthropogenic stressors, including climate change. This assessment indicates that cumulative impacts from past, present, and reasonably foreseeable future actions on aquatic resources in the geographic area of interest would range from SMALL to LARGE. The incremental contribution from preconstruction and construction activities for the CR SMR Project to impacts on aquatic resources of the water bodies in the geographic area of interest would be SMALL.

4.7.5 Cumulative Socioeconomics and Environmental Justice Impacts

The following subsections describe the evaluation of cumulative impacts on socioeconomics and environmental justice that may result from preconstruction and construction activities at the CRN Site.

4.7.5.1 Socioeconomic Impacts

Socioeconomic resources addressed in this subsection include physical impacts (air quality and noise) and social and economic impacts.

4.7.5.1.1 Physical Impacts

Sections 2.7 and 2.8 address air quality and noise, respectively, in the vicinity of the CRN Site and serve as the baseline for analysis of cumulative impacts to these resource areas. Subsection 4.4.1 describes the potential impacts of preconstruction and construction activities at the CRN Site on air quality and noise levels.

Air Quality

Subsection 2.7.2 describes current air quality conditions for Roane County in which the CR SMR Project would be located. Air quality-related activities during the preconstruction and construction phases for the CR SMR Project are addressed in Subsection 4.4.1.2.

As discussed in Subsection 2.7.2.1, the CRN Site location is in attainment for all criteria pollutants, indicating pollutant levels are below air quality standards. Because preconstruction and construction emissions (fugitive dust and engine exhaust from construction equipment) are generated from ground level or near ground level sources and because they are temporary (not operating continuously and only for the preconstruction and construction phases) and transient (activity does not encompass the entire site at all times), a relatively small geographic area of interest is indicated. Therefore, the geographic area of interest for the preconstruction and construction phases has been defined as a 6-mi radius from the CRN Site. As discussed in Subsection 4.4.1.2, the CR SMR Project plans to utilize a preconstruction and construction-related mitigation plan to minimize these temporary emissions.

Emissions from motor vehicles, used for both the workforce commute and deliveries to the CRN Site, and construction equipment would generate additional air emissions. As noted in Subsection 4.4.1.2, these emissions would be temporary as with other preconstruction and construction activities, and would be mitigated through measures provided in the construction mitigation plan and roadway improvements. Further, emissions from the workforce traffic would be limited to the hours of shift changes.

Table 4.7-1 provides a list of proposed projects, ongoing construction projects, and operational facilities in the region around Oak Ridge, with 13 of these facilities proposed or currently located within 6 mi of the CRN Site. All new significant projects, including the CR SMR Project, are required to secure air related “permits to construct” prior to initiating preconstruction and construction activities. For major air quality sources, projects are also required to obtain a Title V Operating Permit (40 CFR 70). In general, all newly proposed projects for which either state and/or federal air permits are required must have a construction mitigation plan to mitigate construction-related emissions. Through the state and federal air permitting process, proposed projects must demonstrate that air quality would not violate state and Federal ambient air quality standards. Under the reviews that occur through these regulatory processes, along with the State of Tennessee’s ambient air quality monitoring program, air quality in Roane County is expected to remain in attainment for all criteria pollutants during the preconstruction and construction phases of the CR SMR project. Further, state and federal air permitting would ensure cumulative impacts from existing and proposed new sources would comply with the Clean Air Act. A cumulative modeling impact analysis, if required, would include the CRN project plus any existing sources that emit significant air emissions or have significant downwind impacts (based on air regulatory significance definitions). Larger sources in Table 4.7-1, beyond 6 mi from the plant, such as the Bull Run Fossil Plant and Kingston Fossil Plant would also be considered as potential sources for a cumulative air quality modeling study.

As a result of these air permitting requirements, the temporary and limited nature of preconstruction and construction emissions, and mitigation measures to limit onsite construction activity emissions and mobile source emissions, project impacts would be expected to be SMALL for criteria pollutants.

Because climate change is global in nature and currently focuses on the policies established by national governing agencies, the project's region of influence needs to be considered in the context of United States policy and national greenhouse gas (GHG) emissions. Further, individual states are developing GHG regulations, thus consideration of GHG emissions under state regulations would in all likelihood also be necessary. Thus for GHG emissions, the project's geographic area of interest is national in scale.

In 1992, the United States signed and ratified the United Nations Framework Convention on Climate Change (UNFCCC). Under the requirements of the UNFCCC agreement, the U.S. Environmental Protection Agency (EPA) tracks and periodically publishes GHG emissions. In EPA's recent April 15, 2015 report entitled *Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2013* (EPA-430-R-15-004), the EPA estimates the United States annual GHG emissions for 2013 were 6673 million metric tons (MMT). (Reference 4.7-21) For the State of Tennessee, the EPA provides a 2012 estimate of 99.91 MMT of carbon dioxide (CO_2) for fossil fuel combustion (Reference 4.7-22). The State of Tennessee GHG emissions are estimated to be 122 MMT of GHGs using a GHG to CO_2 scaling factor of 1.22. (This scaling factor is based on EPA's April 15, 2015 report and national data provided for the year 2012 for the various GHG.)

Estimated annual GHG emissions from the CR SMR Project are only a small fraction of national and State of Tennessee GHG emissions. Because GHG emissions and associated impacts require a global perspective, small incremental changes from individual projects must be evaluated collectively. This is beyond the scope of an individual project and is therefore addressed by the US under the authority of the EPA at the national scale. Mitigation measures, however, provide individual projects with the ability to minimize GHG emissions. Generally, measures to alleviate emissions of criteria pollutants from fossil fuel-fired equipment would likewise reduce GHG emissions. In summary, cumulative GHG impacts are expected to be MODERATE due to the global nature of the GHG issue. However, the incremental cumulative contribution GHG emissions from the CR SMR Project would be SMALL.

Noise

Ambient noise levels at sensitive receptors site within 5 mi of the CRN Site are described in Section 2.8. This discussion provides a baseline for analysis of cumulative impacts on sensitive receptors. As discussed in Subsection 4.4.1.1, based upon the projected noise and vibration levels at various CRN Site and surrounding area receptors and the duration of preconstruction and construction activities, noise and vibration impacts from CRN Site construction are expected to be SMALL for the surrounding communities and the nearest residents. The noise and vibration impacts to the public from construction-related traffic on local roads associated

with preconstruction and construction activities at the CRN Site would be SMALL to MODERATE.

The geographic area of interest for noise includes the CRN Site and the areas within 5 mi of the CRN Site. As shown in Table 4.7-1, 12 of the proposed projects, ongoing construction projects, and operational facilities in the region around Oak Ridge, Tennessee are located within 5 mi of the CRN Site. The closest noise-generating projects or facilities are approximately 3 mi from the CRN Site. Due to the distance, the potential for cumulative impact on noise levels associated with these projects and facilities in conjunction with noise levels generated by CRN Site construction would be SMALL. Construction workers and delivery vehicles for proposed and ongoing construction projects could potentially use the same roadways as traffic associated with construction at the CRN Site. Therefore, there would be the potential for SMALL to MODERATE cumulative impacts on noise levels associated with construction-related traffic on local roads.

4.7.5.1.2 Social and Economic Impacts

Subsections 2.5.1 and 2.5.2 describe the social and economic characteristics potentially affected by the proposed CR SMR Project, including population, economy, transportation, taxes, land use, aesthetics and recreation, housing, community infrastructure and public services, and education. These discussions provide the baseline for analysis of cumulative impacts to these resource areas. Subsection 4.4.2 evaluates the social and economic impacts of preconstruction and construction activities at the CRN Site. Impacts associated with activities at the CRN Site would be SMALL with the exception of transportation. Construction-related traffic would have a LARGE impact on local roadways. However, with the recommended modifications, impacts to traffic flow during construction would be MODERATE and temporary. Taxes as well as TVA tax-equivalent payments would have a SMALL and beneficial economic impact.

This cumulative analysis considers impacts from preconstruction and construction activities along with impacts from past, present, and reasonably foreseeable future actions that may contribute to cumulative impacts to communities within the geographic area of interest, the geographic area most likely to be affected by the proposed CR SMR Project. The geographic area of interest for socioeconomic impacts includes Roane, Anderson, Knox, and Loudon counties. As described in Subsection 2.5.2.1, the services, government, and manufacturing sectors employ the greatest number of workers in the geographic area of interest. The services sector employs the greatest number of workers and experienced the largest growth from 2001 to 2011 in all four counties within the geographic area of interest. Farming experienced the largest decline in Anderson and Loudon counties during this period, while manufacturing had the largest decline in Knox and Roane counties.

The socioeconomic impacts associated with the operational facilities (past and present projects) listed in Table 4.7-1 have already been addressed in the baseline conditions presented in Subsections 2.5.1 and 2.5.2 and in the impact analysis presented in Subsection 4.4.2. This cumulative impacts evaluation focuses on reasonably foreseeable projects and ongoing (present) construction projects.

Cumulative impacts from preconstruction and construction activities at the CRN Site and from other past, present, and reasonably foreseeable future projects within the socioeconomic geographic area of interest could temporarily contribute to adverse cumulative effects on some socioeconomic resources, primarily transportation. Road improvements, including TDOT pending projects and CRN SMR-related improvements proposed for roadways near the CRN Site, would have temporary MODERATE cumulative impacts. The potential improvements associated related to the rail siding would have temporary and SMALL cumulative impacts. The influx of temporary construction workers for the proposed projects and ongoing construction projects would have a MODERATE and temporary cumulative impact on traffic within the geographic area of interest.

Construction employment, including in-migration of construction workers, as well as new indirect service jobs created by the spending of the construction workers' income would produce a positive cumulative effect on employment and income in the geographic area of interest. Therefore, the cumulative economic impact on the geographic area of interest of construction of the CR SMR Project and other ongoing construction projects and reasonable foreseeable projects on employment, income, and taxes would be beneficial and MODERATE. Although the amount of income, sales, and property taxes (as well as TVA tax-equivalent payments) generated by the projects would be large in absolute terms, it would be SMALL when compared to the total amount of taxes collected within the geographic area of interest.

4.7.5.2 Environmental Justice Impacts

Executive Order 12898 (59 FR 7629) directs federal executive agencies to consider environmental justice under the NEPA. This Executive Order ensures that minority and/or low-income populations do not bear a disproportionate share of adverse health or environmental consequences of a proposed project.

Subsection 2.5.4 provides baseline information on minority and low-income populations within the region (i.e., within a 50-mi radius of the CRN Site) for the cumulative impacts assessment of environmental justice. As shown in Figure 2.5.4-1, the spatial distribution of block groups with minority populations in the region is clustered in the City of Knoxville, in Knox County, Tennessee and the City of Alcoa, in Blount County, Tennessee. No block groups in Roane County (in which the CRN Site is located) or in Anderson County contain minority populations as defined in Subsection 2.5.4.2. The identified aggregate minority population closest to the CRN Site is located approximately 20 mi to the east in Blount County, Tennessee. The closest Hispanic minority population is located in Loudon County, Tennessee, approximately 9 mi southeast of the CRN Site. As shown in Figure 2.5.4-2, the majority of the low-income population in the geographic area of interest is in the City of Knoxville, in Knox County, Tennessee. There is one low-income population block group within Roane County, Tennessee and one within Anderson County, Tennessee. The closest low-income population block group is located in Loudon County, Tennessee, approximately 7 mi southeast of the CRN Site. No other populations or groups (e.g., subsistence populations) were identified that represent environmental justice populations in the region.

Subsection 4.4.3 evaluates the potential environmental justice impacts from preconstruction and construction activities at the CRN Site. Subsection 4.4.3.2 discusses the potential for impacts to the Wheat Community Burial Ground, located off TN 58 about 1 mi from the CRN Site and concludes that the CR SMR Project would not adversely impact the burial ground, which is of cultural significance to the African American community. Based on the location and expected impacts of the projects listed in Table 4.7-1, no adverse cumulative effects to the Wheat Community Burial Ground are expected. Because of the spatial distribution of the minority and low income populations across the region, the potential for disproportional impacts to low-income and minority populations from preconstruction and construction activities is SMALL. No uniquely vulnerable low-income or minority community, such as a subsistence population, was identified in the region. In summary, the overall SMALL impact of the CR SMR Project, combined with the spatial distribution of the low-income and minority population, results in a SMALL potential for adverse socioeconomic impacts that would disproportionately affect low-income and minority communities.

The cumulative analysis considers impacts from preconstruction and construction activities at the CRN Site along with past, present, and reasonably foreseeable actions that could cause disproportionately high and adverse impacts on minority and low-income populations. The environmental justice analysis presented in Subsection 4.4.3 provides a baseline comparison for consideration of cumulative environmental justice impacts associated with the projects and activities listed in Table 4.7-1. Given that the reasonably foreseeable projects are located within the region assessed for the CRN Project, and no uniquely vulnerable low-income or minority populations were identified within the region, there would be no cumulative impacts on environmental justice populations. The incremental additional impacts from future projects, in combination with preconstruction and construction activities at the CRN Site, would be SMALL.

In summary, there would be no disproportionately high or adverse cumulative impacts to minority or low-income populations within the 50-mi geographic area of interest. Therefore, there would be no (SMALL) cumulative environmental justice impacts.

4.7.5.3 Historic Properties Impacts

Subsection 2.5.3 describes the historical and cultural resources affected by the proposed CR SMR Project.

The geographic area of interest for the analysis of cumulative impacts to historic properties includes:

- The archaeological resources and historic properties within the CR SMR Project Area of Potential Effect (APE) defined in Subsection 2.5.3 as the approximately 1200-ac Clinch River Property, an additional approximately 105 ac northwest of the property near the CRN Site entrance and along Bear Creek Road and Tennessee State Highway (TN) 58, the Melton Hill Dam, and a 0.5 mi radius around the Melton Hill Dam.
- The Historic Architecture APE is 0.50-mi radius surrounding the proposed cleared areas.

- The historic properties (those eligible for listing on the National Register of Historic Places [NRHP]) within a 10-mi radius of the center of the CRN Site (Figure 2.5.3-2).

Subsection 4.1.3 describes impacts to historic and cultural resources during preconstruction and construction activities at the CRN Site. Fifty-nine recorded archaeological sites, four isolated finds, one non-site locality, one NRHP-eligible historic district, and one cemetery have been identified within or immediately adjacent to the CR SMR Project APE. Of the archaeological sites, one is considered eligible for listing on the NRHP; 16 are considered potentially eligible for the NRHP; and 42 are considered not eligible for the NRHP. Ten of the eligible and potentially eligible sites are avoidable. Within the CRN Site, sites 40RE0107, 40RE0595, 40RE0549, 40RE0104, and 40RE0105 would potentially be impacted by CR SMR Project preconstruction and construction activities. In the Barge/Traffic Area, sites 40RE138 and 40RE233, may be affected by CR SMR Project preconstruction and construction activities. The NRHP-eligible Melton Hill Hydroelectric Project/Melton Hill Dam and historic district would potentially be impacted by preconstruction and construction activities and potentially by operational activities. As described in Subsection 4.1.3, impacts to historic properties would be SMALL to MODERATE.

This cumulative analysis considers impacts from preconstruction and construction, along with impacts from past, present, and reasonably foreseeable actions that may contribute to cumulative impacts to historic and cultural resources within the geographic area of interest, the geographic area most likely to be affected by the proposed CR SMR Project. The geographic area of interest for archaeological resources is the CR SMR Project APE. For historic architectural resources the geographic area of interest is the 0.5-mi radius around the CRN Site.

As discussed in Subsection 4.1.3, TVA has developed a Programmatic Agreement (PA) pursuant to 36 CFR 800.14(b)(3). Signatories are TVA, the Tennessee State Historic Preservation Officer (SHPO) and invited concurring party, the Eastern Band of the Cherokee Indians. The PA records the terms and conditions agreed upon to resolve potential adverse effects of the undertaking. It provides for modifications to the CR SMR Project APE, evaluating the NRHP eligibility of unevaluated resources (archaeological sites and historic architectural resources), evaluating project effects to resources, and resolution of adverse effects. A discovery plan will be developed in consultation with the SHPO and any federally-recognized Native American tribe that attaches religions significance and cultural significance to the historic property affected by the undertaking, to deal with the subsequent discovery or identification of additional historic properties affected by the undertaking. This plan would be implemented in the unlikely event that an unanticipated discovery occurs during preconstruction and construction activities. (Reference 4.7-24)

Cumulative impacts to historic and cultural resources from past and present activities have occurred, and are MODERATE. The impacts from past activities have resulted in the destruction, removal, and/or disturbance, of historic and cultural resources within the geographic area of interest. Cultural resources are nonrenewable and therefore impacts are cumulative in nature. The preconstruction and construction activities associated with the CR SMR Project

would contribute additional cumulative impacts to some cultural resources within the geographic area of interest in association with other reasonably foreseeable future projects listed in Table 4.7-1, including development within Roane Regional Business and Technology Park and the ETTP, the new general aviation airport, various projects within ORR, and relocation of CVMR Corporation. Most of these projects are located within areas previously developed and therefore have a limited potential to impact historic properties within the geographic area of interest. Several of these projects are also located on federal land and would therefore be subject to Section 106 reviews to examine the potential for impacts to historic properties. A final assessment of impacts and any required mitigation associated with the CR SMR Project are dependent on the outcome of the Phase II testing, in consultation with the SHPO and any federally-recognized Native American tribes that attach religious and cultural significance to the historic property that is potentially impacted. Because the extent of impacts from the CR SMR project are not yet known, cumulative impacts to cultural resources from preconstruction and construction of the CR SMR Project could range from SMALL to MODERATE.

4.7.6 Radiological Health Impacts

As described in Section 4.5, the radiological impacts on the construction worker from construction of the CR SMR Project would be SMALL. During the construction period, operating reactors may also have an impact on the public. Details of the evaluation of the potential dose to the public from all operating reactors are provided in Section 5.4. Specifically, as described in Subsection 5.4.3, the total body dose to a hypothetical maximally exposed individual (MEI) member of the public from the operation of all SMRs at the CRN Site is estimated to be 11 mrem/yr.

For this analysis of cumulative radiological impacts, the geographic area of interest was considered to be the area within a 50-mi radius of the CRN Site. The NRC historically has used 50 mi as the radius bounding the geographic area for evaluating doses to the public from routine releases from nuclear power plants. Table 4.7-1 summarizes past, present, and reasonably foreseeable future projects and actions that could contribute to cumulative effects. Among these are several radiological projects or facilities. Within the geographic area of interest, planned federal projects on the ORR, including the Transuranic (TRU) Waste Processing Center, Uranium Processing Facility (UPF) at Y-12 complex, and Environmental Management Waste Management Facility (EMWMF), have the potential to contribute to cumulative radiation exposures in conjunction with the CR SMR Project. In addition, currently operating facilities on the ORR include the High Flux Isotope Reactor (HFIR), a nuclear research located at Oak Ridge National Laboratory (ORNL), and the ORNL Spallation Neutron Source. Off the ORR, TVA's Watts Bar Nuclear (WBN) Units 1 and 2 and American Nuclear Corporation will continue to operate. These four facilities identified in Table 4.7-1 have the potential to contribute to cumulative radiation exposures in conjunction with the CR SMR Project. Each of these facilities would be constructed and operated or continue to operate in accordance with environmental regulations that limit the radiation exposures received by members of the public, as discussed in Subsection 4.5.5.

Ongoing activities within the ORR likely will continue to release small quantities of radionuclides to the environment in the future. The ORR *Annual Site Environmental Report* provides results from a detailed analysis of radiation doses to a hypothetical MEI from all pathways of exposure to radionuclides released from all DOE facilities on the ORR. The maximum radiation dose that a hypothetical MEI could have received from DOE activities on the ORR in 2014 was estimated to include approximately 0.6 millirem (mrem) from air pathways, 1 mrem from water pathways (i.e., drinking, consuming fish, swimming, and other recreational uses of the water and shoreline), and 1 mrem from consumption of wildlife (e.g., deer, geese, and turkey) harvested on ORR. The annual dose to an MEI from the combination of all these potential exposure pathways was estimated to be approximately 3 mrem. (Reference 4.7-23)

There are several non-DOE facilities on or near the ORR that could also contribute to radiation doses to the public. DOE requested information from these facilities regarding their potential radiation doses to members of the public, and nine facilities responded with information about their dose contributions. DOE estimated that maximum annual doses to members of the public from air and water emissions and external radiation from both non-DOE and DOE sources on and near the ORR were less than 100 mrem. Of the less than 100 mrem total dose, 45 mrem is from direct radiation reported from onsite dose monitors at one of the nine responding facilities. (Reference 4.7-23) The CRN Site MEI would be outside the physical range of this direct radiation. Therefore, the dose to an MEI from the non-DOE facilities on or near ORR is estimated at maximum of 55 mrem/yr.

The WBN Units 1 and 2 are located within the 50-mi geographic area of interest. According to NUREG-0498, Supplement 2 – *Final Environmental Statement: Related to the Operation of Watts Bar Nuclear Plant*, the combination of potential doses from the ongoing operation of WBN Unit 1 with estimated doses from the operation of the new WBN Unit 2 result in a total body dose of 2.6 mrem/yr for an MEI at the WBN site.

Other facilities in the geographic area of interest, such as industrial facilities and hospitals, may use radiological materials, but their potential contributions to the cumulative dose received by the CRN Site MEI during the construction period would be negligible. Because radiation dose is highly location dependent and an individual in one location cannot receive the maximum possible dose from all of the multiple sources, the sum of the doses estimated above is conservative. Summing the doses of 11 mrem/yr from the CRN Site, 3 mrem/yr from DOE facilities, 55 mrem/yr from non-DOE facilities, and 2.6 mrem/yr from WBN Units 1 and 2, provides an estimate of the cumulative dose impact from radiation sources in the geographic area of interest during construction. The CRN Site contribution to this total is well below the annual dose limit of 100 mrem/yr from 10 CFR Part 20.1301, and the total cumulative impact is significantly less than the approximately 300 mrem average annual dose to individuals from natural or background radiation in the United States (Reference 4.7-23). Therefore, the cumulative dose impact will be SMALL.

4.7.7 Nonradiological Health Impacts

Sections 2.2, 2.3, and 2.7 describe the land, water, and air affected by the proposed SMR project at the CRN Site. Sections 4.1, 4.2, and 4.4 describe impacts to health and the physical environment during preconstruction and construction activities at the CRN Site. Compliance with the site permits coupled with BMPs, would result in SMALL impacts from the proposed SMR project to nonradiological health from preconstruction and construction activities.

Nonradioactive health impacts from preconstruction and construction at the CRN Site include localized impacts from noise, vibrations, and dust along with occupational injuries to the construction workers. Cumulative noise and vibration impacts from preconstruction and construction activities would include current ongoing and planned developments at ETTP and at Bull Run Fossil Plant. Future cumulative noise and vibration impacts would include possible roadway improvements and urbanization within 10 mi of the CRN Site. Cumulative dust impacts would behave similarly.

Cumulative health impacts to construction workers also include occupational injuries coupled with noise, vibration, and emission impacts from current and future activities within the worker's commute region. Current and future activities within a 50-mi radius of the CRN Site including road, airport, and building construction along with decommissioning and demolition activities at ORR would contribute to cumulative health impacts to construction workers.

Further nonradioactive health impacts include effects from GHG emissions and particulates from transport of construction crew and supplies and from preconstruction and construction activities at the CRN Site. Cumulative health impacts to workers and the public from these GHG and particulate emissions would include state and national contributors. State and federal air permitting coupled with the use of BMPs would help mitigate contributions from the proposed SMR project along with current and future projects; thus helping minimize the health impacts from these emissions.

In addition, projected climate change for the region contributes to the potential nonradiological health of the populace in the geographic area of interest. Climate change has already resulted in warmer, wetter weather patterns with greater incidence of severe storm events. These severe storms tend to increase water pollution from runoff including increased fertilizers, herbicides, and pesticides along with increased sedimentation impairing the water quality and contributing to adverse health effects (Reference 4.7-2). Additionally, less regular precipitation events coupled with increased evaporation and transpiration from increased air and water temperatures, may also lead to reduced availability of timely water resources and a need for crop irrigation; thus reducing the local availability of fresh water and food. Further, global changes in climate are expected to result in decreasing availability of food and water and thus negatively impact human health through increased competition for more limited resources (Reference 4.7-2).

Although the nonradiological health impact of the proposed project at the CRN Site is SMALL, the cumulative impact of the observed and projected increase in temperature and storm severity along with impacts from preconstruction and construction activities at the CRN Site would be SMALL to MODERATE.

4.7.8 References

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Reference 4.7-17. U. S. Geological Survey, "Water Quality in the Upper Tennessee River Basin, 1994-1998," Circular 1205, 2000.

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Reference 4.7-21. U.S. Environmental Protection Agency, "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2013," EPA 430-R-15-004, April 15, 2015.

Reference 4.7-22. U.S. Environmental Protection Agency, State Energy CO2 Emissions, Website: http://www3.epa.gov/statelocalclimate/resources/state_energyco2inv.html, July 8, 2015.

Reference 4.7-23. Oak Ridge National Laboratory, "Oak Ridge Reservation Annual Site Environmental Report," DOE/ORO-2502, September, 2015.

Reference 4.7-24. Tennessee Valley Authority and Tennessee State Historic Preservation Officer, "Programmatic Agreement between the Tennessee Valley Authority and the Tennessee State Historic Preservation Office regarding the management of historic properties affected by the Clinch River SMR Project," July 20, 2016.

Table 4.7-1 (Sheet 1 of 3)
Past, Present and Reasonably Foreseeable Future Projects and Other Actions Considered in the Cumulative Analysis of Oak Ridge Reservation

Project Name	Summary of Project	Relative Location (from center of CRN Site)	Status
CRBRP	Site preparation for the construction of a liquid metal fast breeder reactor	On the CRN Site	Site preparation from 1972-1983. Site redress through the mid-1980s.
Sludge Build-Out Project at the TRU Waste Processing Center	Changes to the method of sludge processing and changes to waste shipping routes	Approximately 3 mi east	Projected to begin in 2016
UPF at Y-12	New building in Y-12 complex	Approximately 10 mi northeast	Planning documents, no explicit schedule
Mercury Cleanup Activities at Y-12	Mercury environmental remediation	Approximately 10 mi northeast	Ongoing
Old Y-12 Steam Plant	Burned 51,000 tons coal producing 5000 tons ash (used as cover material at Y-12 landfill.)	Approximately 10 mi northeast	Operational 1950s through 2010. Coal yard capped.
New Y-12 Steam Plant	Natural gas power generation for Y-12 operations.	Approximately 10 mi northeast	Operational since 2010
Potential ETTP Property Transfer	Transfer of property to private companies	Approximately 2 mi north	Ongoing
Roane Regional Business and Technology Park	Business and Industrial Park with sites for development	Approximately 0.5 mi east	Operational since 2001
ORNL	DOE Nuclear and High Tech Research Facility	Approximately 5 mi northeast	Operational since 1942
ORNL - Spallation Neutron Source	Accelerator-based neutron pulse for research and development (R&D).	Approximately 5 mi northeast	Operational since 2006
ORNL - High Flux Isotope Reactor	Critical reaction providing a stable beam of neutrons for R&D.	Approximately 5 mi northeast	Operational since 1965. Decommission anticipated after 2060.
Environmental Management Disposal Facility on ORR	New onsite landfill east of existing EMWMF	Approximately 10 mi northeast	Preliminary schedule; Construction could start in 2018
TDOT Projects	Roadway improvements	TN 95 (Bear Creek)- Approximately 4 mi northeast	By 2019, pending Federal funding
TDOT Projects	Roadway improvements	TN 95 and Bethel Road – Approximately 3 mi northeast	By 2019, pending Federal funding
TDOT Projects	Roadway improvements	TN 29 – Approximately 10 mi west	By 2019, pending Federal funding

Table 4.7-1 (Sheet 2 of 3)
Past, Present and Reasonably Foreseeable Future Projects and Other Actions Considered in the Cumulative Analysis of Oak Ridge Reservation

Project Name	Summary of Project	Relative Location (from center of CRN Site)	Status
TDOT Projects	Roadway improvements	TN 73 – Approximately 3 mi southeast	By 2019, pending Federal funding
McGee Tyson Airport	Public and military airport	Alcoa; approximately 22 mi southeast	Operational
Island Home Downtown Airport	Public aviation facility	Knoxville; approximately 28 mi to the east	Operational
Construction of a General Aviation Airport	Development of a general aviation airport	Approximately 3 mi north	Potential Construction Starting in 2017. Not considered in cumulative evaluation because it does not meet the criteria established in 4.7
CVMR Corporation	Relocation of Global Headquarters and operation of a refining facility on the old Steam Plant property of the former K-25	Approximately 4 mi northeast	Ongoing
City of Oak Ridge Sanitary Sewer System Upgrades	Sanitary Sewer Improvements	Approximately 11 mi northeast	Ongoing
Sequoyah Unit 1 Nuclear Reactor	Power Generation	Approximately 61 mi southwest	Operational since 1981
Sequoyah Unit 2 Nuclear Reactor	Power Generation	Approximately 61 mi southwest	Operational since 1982
Watts Bar Unit 1 Nuclear Reactor	Power Generation	Approximately 30 mi southwest	Operational since 1996
Watts Bar Unit 2 Nuclear Reactor	Operation of Watts Bar Unit 2	Approximately 30 mi southwest	Scheduled for commercial operation June 2016
Melton Hill Hydroelectric Facility	Hydroelectric power and Melton Hill Reservoir	5 mi east	Operational since 1963
Bull Run Fossil Plant	Net capability 870 MWe	Bull Run Creek; approximately 15 mi northeast	Operational since 1967
Kingston Fossil Plant	Net capability 1379 MWe	Watts Bar Reservoir; approximately 8 mi west	Operational since 1955
Fort Loudoun Dam	Hydroelectric power and Fort Loudoun Reservoir	Tennessee River; approximately 11 mi southeast	Operational since 1943
Norris Dam	Hydroelectric power and Norris Reservoir	Clinch River; approximately 28 mi northeast	Operational since 1936

Table 4.7-1 (Sheet 3 of 3)
Past, Present and Reasonably Foreseeable Future Projects and Other Actions Considered in the Cumulative Analysis of Oak Ridge Reservation

Project Name	Summary of Project	Relative Location (from center of CRN Site)	Status
Douglas Dam	Hydroelectric power and Douglas Dam Reservoir	French Broad; approximately 47 mi east	Operational since 1943
Cherokee Dam	Hydroelectric power and Cherokee Reservoir	Holston River; approximately 53 mi northeast	Operational since 1941
Great Falls Dam	Hydroelectric power and Great Falls Reservoir	Caney Fork River (not on the Tennessee River watershed); approximately 70 mi west	Operational since 1916
Tellico Dam	Flood Control and Tellico Reservoir	Little Tennessee River; approximately 11 mi southeast	Operational since 1979
Watts Bar Dam	Hydroelectric power and Watts Bar Reservoir	Tennessee River; approximately 30 mi southwest	Operational since 1942
American Nuclear Corporation	Production of radioactive sources and detectors	Braden Branch Creek (CRM 50.5); approximately 15 mi northeast	Operational1962-1970. Cleaned and fenced. Decay in place.
Former Anderson County Landfill	28 ac waste disposal	CRM 51 to CRM 52 (Blockhouse Valley Road); approximately 15 mi northeast	Operational 1973-1981. Non-NPL. Deer hunting permitted.
Whiteoak Dam	Manhattan Project impoundment on White Oak Creek with 25 ac settling pond. Formed to reduce radioactive waste runoff into Clinch River arm of the Watts Bar Reservoir	Approximately 3 mi east-northeast	Operational since 1943

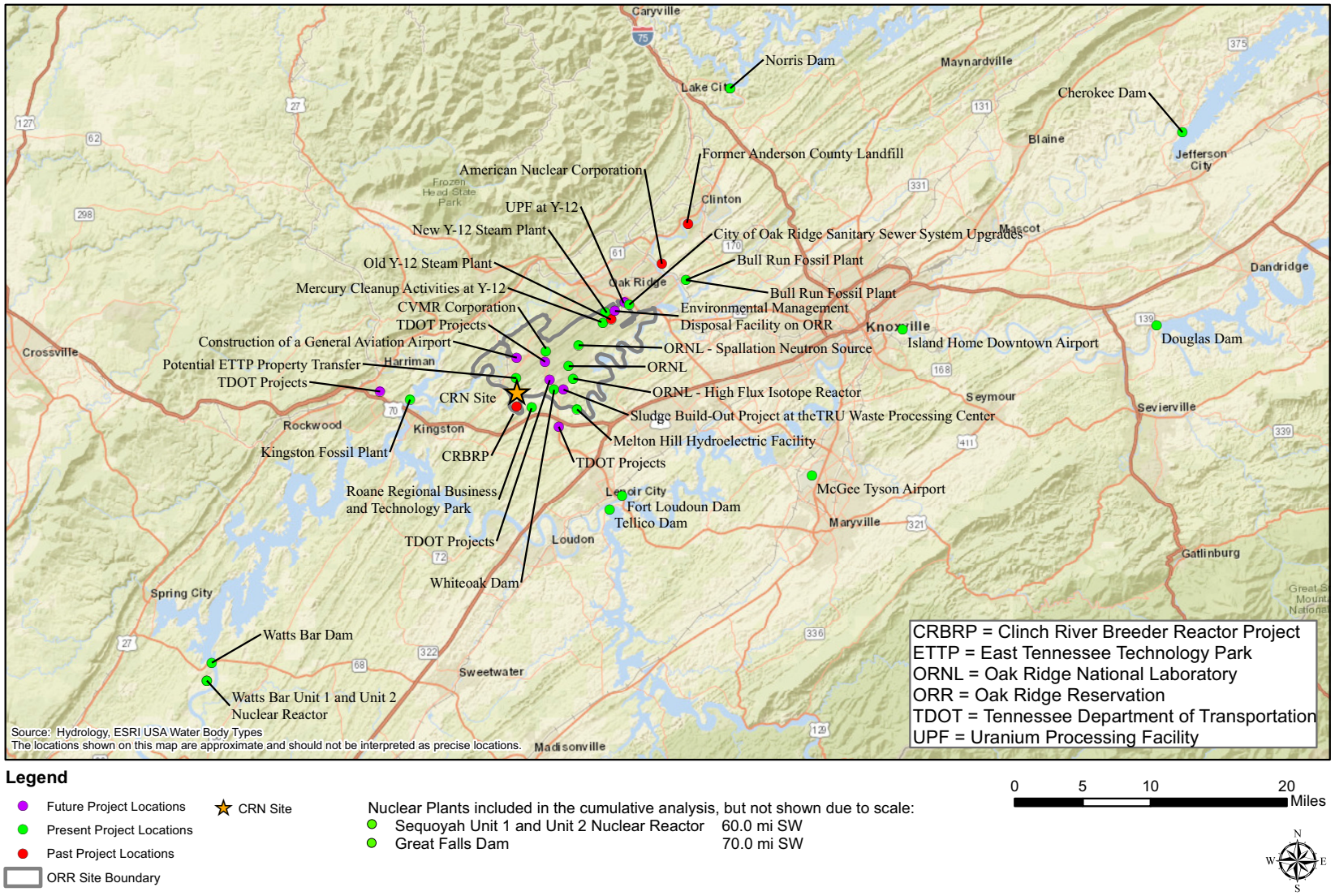

Figure 4.7-1. Oak Ridge Reservation Past, Present and Reasonably Foreseeable Future Projects