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CLINCH RIVER NUCLEAR SITE ADVANCED NUCLEAR REACTOR TECHNOLOGY PARK DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

Roane County, Tennessee

Prepared by:
TENNESSEE VALLEY AUTHORITY
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February 2022

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COVER SHEET

Clinch River Nuclear Site Advanced Nuclear Reactor Technology Park

Proposed action:	The Tennessee Valley Authority has prepared this Programmatic Environmental Impact Statement to address the environmental impacts associated with site preparation, construction, operation, and decommissioning of facilities at an advanced nuclear reactor technology park at TVA's Clinch River Nuclear Site.
Type of document:	Draft Programmatic Environmental Impact Statement
Lead agency:	Tennessee Valley Authority
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Comments due date:	Comments may be submitted online www.tva.com/nepa or sent to Ms. Johnson at the above address. Comments must be submitted by April 4, 2022.

Abstract:

TVA is considering alternatives for the construction and operation of an advanced nuclear technology park at TVA's Clinch River Nuclear (CRN) Site. In addition to the No Action Alternative (Alternative A), TVA considered alternatives for advanced nuclear reactors at two different locations on the CRN Site – Area 1 and Area 2. Alternative B includes a Nuclear Technology Park at Area 1 with small modular reactors (SMRs) and/or advanced non-light water reactors (LWRs). Alternative C includes a Nuclear Technology Park at Area 2 with advanced non-LWRs; Alternative D includes a Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or advanced non-LWRs. The PEIS uses a bounding approach to the evaluation of impacts from the proposed action using a Plant Parameter Envelope established in TVA's Early Site Permit Application to the Nuclear Regulatory Commission in 2019.

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SUMMARY

Introduction

The Tennessee Valley Authority (TVA) prepared this Draft Programmatic Environmental Impact Statement (PEIS) to assess the environmental impacts associated with the proposed action including site preparation, construction, operation, and decommissioning of various facilities at an advanced nuclear reactor technology park (Nuclear Technology Park) at TVA's Clinch River Nuclear (CRN) Site. The proposed action provides an opportunity to evaluate and demonstrate the feasibility of deploying advanced nuclear reactors at the CRN Site, and to evaluate emerging nuclear technologies as part of TVA's technology innovation efforts aimed at developing future generation capabilities.

The CRN Site is located on the northern bank of the Clinch River arm of the Watts Bar Reservoir (the Reservoir) in the City of Oak Ridge, Roane County, Tennessee, approximately 7 miles east of the City of Kingston, Tennessee, and approximately 25 miles west-southwest of the City of Knoxville, Tennessee. The CRN Site comprises 935 acres of TVA-managed land adjacent to the U.S. Department of Energy's (DOE) approximately 33,000-acre Oak Ridge Reservation (ORR). The site is situated on the historical Clinch River Breeder Reactor Project (CRBRP) Site.

In May 2016, TVA submitted an application to the Nuclear Regulatory Commission (NRC) for an Early Site Permit (ESP) at the CRN Site for two or more new nuclear power units demonstrating small modular reactor (SMR) technology, with a total combined nuclear generating capacity not to exceed 800 megawatts electric. The NRC prepared and released a Final Environmental Impact Statement (NRC ESP FEIS) to assess the environmental impacts of the action proposed in the TVA ESP application (ESPA). The NRC ESP FEIS identified issuance of an ESP for the CRN Site as the preferred alternative.

Following the NRC ESP FEIS publication in April 2019, the NRC issued an ESP to TVA on December 19, 2019. The ESP represents NRC's approval of the CRN Site as suitable for the future demonstration of the construction and operation of two or more SMRs with characteristics presented in the ESPA, but it does not authorize TVA to construct or operate a nuclear facility. The ESP establishes early resolution of numerous site safety, environmental, and emergency preparedness issues, providing enhanced predictability and stability in future TVA licensing actions related to the CRN Site. The ESP is valid until December 2039. Prior to initiating construction or operation of advanced nuclear reactors at the CRN Site, TVA must apply for and receive additional licenses from the NRC.

In June 2019, TVA released the Final 2019 Integrated Resource Plan (IRP) and the associated IRP Final EIS. The IRP identified the various generating resources that TVA intends to pursue to meet the energy needs of the Tennessee River Valley (the Valley) over a 20-year planning period. The 2019 IRP recommended that TVA continue to evaluate emerging nuclear technologies, including SMRs, as part of technology innovation efforts aimed at developing future electricity generation capabilities. This Draft PEIS is TVA's next step in exploring the potential for new nuclear generation on the TVA system, to advance the recommendations of the IRP.

In December 2021, the TVA Board of Directors (Board) authorized the implementation of a New Nuclear Program to advance SMR planning efforts at the CRN site, and to explore plans for potential additional reactors to support TVA's 2050 decarbonization aspirations.

TVA's New Nuclear Program does not prejudice or foreclose any of the alternatives under consideration in this PEIS. Rather, it facilitates the possibility that a reliable, affordable, and flexible advanced nuclear reactor option could be potentially available by 2032, and it advances necessary planning for future required TVA decision making for the potential deployment of innovative new nuclear technology, in line with TVA's 2019 IRP and 2021 Strategic Intent and Guiding Principles (TVA 2021i). The implementation of the New Nuclear Program authorizes the expenditure of resources not to exceed $200 Million for the period Fiscal Year 2022 through Fiscal Year 2024.

Purpose and Need for Action

The purpose of the proposed action is to support TVA's goal of demonstrating the feasibility of deploying advanced nuclear reactor technologies at the CRN Site capable of incrementally supplying clean, secure, and reliable power that is less vulnerable to disruption. The proposed action is needed to support the recommendations outlined in TVA's 2019 IRP of continuing to evaluate emerging nuclear technologies, including SMRs, as part of technology innovation efforts. Further, a Nuclear Technology Park at the CRN Site would expand future generation optionality and support TVA's mission of innovation towards a low carbon future for the Valley. In addition to providing a place to demonstrate advanced nuclear technologies, a Nuclear Technology Park at the CRN site could potentially include microgrid power generation demonstration; grid resiliency analysis and support; and use of nuclear generation for hydrogen production, water desalination, waste heat energy storage for grid support, and the intentional production of valuable isotopes, all in support of TVA's statutory missions.

Programmatic Approach

As defined by the Council on Environmental Quality (CEQ), a programmatic review "…describes any broad or high-level National Environmental Policy Act (NEPA) review" in which subsequent actions would be implemented that would "tier" to the programmatic NEPA review (CEQ 2020). This Draft PEIS programmatically considers the site preparation, construction, operation, and decommissioning of various types of advanced nuclear reactors bounded by the plant parameter envelope (PPE) and the supplemental bounding site development attributes and parameters. Supplemental NEPA analyses would tier from this Draft PEIS for any potential project- or site-specific TVA actions at the CRN Site that are not evaluated in this Draft PEIS.

The programmatic analysis included in this Draft PEIS is consistent with the PPE that was evaluated in TVA's ESPA. The PPE developed for this proposed action consists of a set of reactor-vendor and owner-engineered parameters or values that TVA used to bound the characteristics of a reactor (or reactors) that could later be deployed at the CRN Site. The PPE represents an "envelope" that encompasses a range of reactor types having varying levels of design maturity. Analysis of environmental impacts based on a PPE allows TVA to defer the selection of a reactor design until a future licensing stage, when more detailed site-specific and technology-specific information would be available to make a technology selection decision. For the present analysis, TVA has supplemented the ESPA PPE with information about advanced nuclear reactor technologies not discussed in the ESPA and additional areas of potential disturbance for transmission line and site access. This Draft PEIS provides a bounding analysis of maximum potential impacts of implementing each of the alternatives considered, based on a PPE approach.

Alternatives

This PEIS evaluates the environmental impacts associated with the deployment of one or more advanced nuclear reactors at the CRN Site shown on Figure ES-1. TVA is currently considering negotiating and entering into one or more contracts with one or more SMR vendors to: (1) perform design, engineering, scoping, estimating, and planning associated with potential future deployment of a SMR at the CRN Site, and (2) develop content for a potential future licensing application submittal to the NRC. TVA also plans to continue to study potential future deployment of advanced nuclear reactors, light water reactors (LWR) and non-light water reactors (non-LWR) at the CRN Site. These contemplated actions would not prejudice any of the alternatives under consideration in this PEIS, as the contemplated actions would not: (a) authorize or commit TVA to submit a licensing application to the NRC, (b) allow any construction activities at the CRN Site, or (c) result in any potential environmental impacts to the CRN Site.

TVA is considering a range of alternatives for site preparation, construction, operation, and decommissioning of a Nuclear Technology Park at the CRN Site, including two different Areas on the site and roughly 14 different reactor designs.

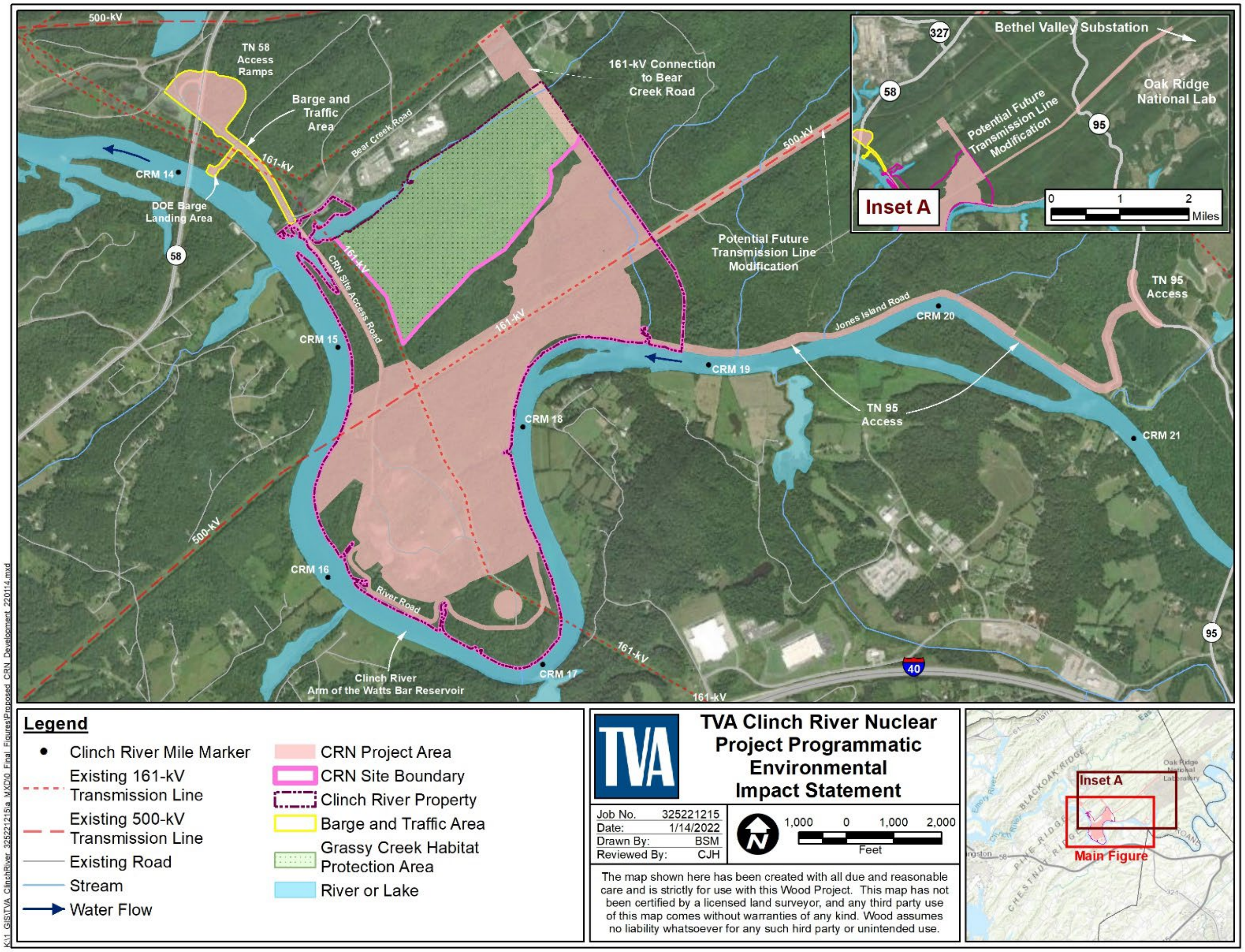

Figure ES-1. CRN Project Area

TVA identified two areas – Area 1 and Area 2 –within the 935-acre CRN Site that are best suited for the Nuclear Technology Park development. Area 1 includes the area previously disturbed by the CRBRP evaluated in the ESPA ER. A portion of Area 2 was also evaluated in the ESPA ER for a proposed temporary laydown area.

TVA plans to evaluate four discrete alternatives (A-D) for the Nuclear Technology Park:

- Alternative A: No Action Alternative
- Alternative B: Nuclear Technology Park at Area 1 with SMRs and/or Advanced non-LWRs
- Alternative C: Nuclear Technology Park at Area 2 with Advanced non-LWRs
- Alternative D: Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced non-LWRs

Under action Alternatives B thru D, activities would be undertaken within each of the following areas that are referred to in the analyses of this PEIS:

1. CRN Site – lands contained within the boundaries of the CRN Site.
2. Associated Offsite Areas – a collective term that includes the following:
    a. Barge and Traffic Area (BTA): Area outside of the CRN Site boundary that encompasses proposed improvements to the intersection of Tennessee Highway 58 (TN 58) with Bear Creek Road. Improvements include those at Bear Creek Road and the existing DOE barge landing facility on the Reservoir.
    b. TN 95 Access: Area containing a proposed roadway access that extends from TN 95 southwesterly, following Jones Island Road to the CRN Site boundary.
    c. 161-kV Offsite Transmission Corridor: Area containing a proposed segment of 161-kV transmission line that extends outside of the CRN Site boundary to an interconnection with the existing 161-kV line along Bear Creek Road.
3. Existing 500-kV Offsite Transmission Corridor: Segment of 500-kV transmission line that extends northeast, outside of the CRN Site boundary to the Bethel Valley substation that includes a potential future transmission upgrade.

TVA considered, but dismissed two alternatives:

- Alternative E: Construction of SMRs at Alternative Sites
- Alternative F: Construction of Alternative Energy Generation Sources

Overview of Environmental Impacts Associated with the Proposed Action

The environmental consequences of the proposed action were assessed in this Draft PEIS in multiple phases, including those associated with site preparation, construction, operation, and decommissioning activities at the CRN Site. For the purposes of this Draft PEIS the project consists of construction phase activities that include pre-construction or site preparation (grading, excavation, infrastructure development, and other actions), actual fabrication and erection of the nuclear reactor and associated facilities, and other site improvements and related interfaces; and operation of the Nuclear Technology Park.

The proposed action was determined to result in primarily minor adverse impacts to resources within the Project Area and a 6-mile vicinity surrounding the CRN Site. Minor adverse impacts during construction of the Nuclear Technology Park include: stormwater discharge into local surface waters and groundwater; alteration of stream habitat; loss of vegetated land cover; impact to wetlands; and increased noise, dust, traffic, and air emissions. Minor to moderate adverse impacts during construction were determined to occur as a result of soil disturbance and erosion; impacts to onsite streams; and shoreline alteration. Moderate impacts would include loss of upland plant and animal communities; loss of habitat for listed bat species; disruption of views from adjacent properties; removal of low quality forest and herbaceous habitat; impacts to three small areas of native cedar glades, and cumulative traffic increases on the local transportation network.

Potential impacts to the state-listed rigid sedge and pale green orchid could occur from the proposed development of the 161-kV offsite transmission line. TVA would ensure that these species are not significantly impacted under all action alternatives by consulting with the TVA botanist during design to avoid the plants and their associated calcareous wetland habitat to the greatest extent possible. Consultation with the U.S. Fish and Wildlife Service (USFWS) under Section 7 of the Endangered Species Act (ESA) would occur when specific designs have been selected and scope of the project has been refined. By implementing minimization measures such as winter tree removal and any additional conservation measures that may result from Section 7 consultation, large impacts to gray bat, Indiana bat, northern long-eared bat, little brown bat, and tricolored bat are not expected.

Additionally, moderate impacts to six archaeological sites eligible for the National Historic Register would occur due to construction disturbance from the project. However, effects to these sites would be mitigated through a Programmatic Agreement between TVA and the Tennessee State Historic Preservation Officer. The proposed action would also result in minor to moderate beneficial impacts associated with increased employment, payroll, and tax revenues.

Minor impacts during operation of the Nuclear Technology Park would include localized alteration of hydrologic patterns, limited scour diversion from the use and discharge of cooling water from and into the Reservoir, noise, and increased traffic. The combined environmental impacts from the uranium fuel cycle, the storage of spent fuel onsite, radioactive waste management, and the transportation of unirradiated fuel and radioactive waste would be minor. Additionally, the impacts associated with design basis accidents (DBAs), severe accidents, and plant security would be minor.

Best Management Practices (BMPs), mitigation measures, and commitments designed to avoid, minimize, or reduce adverse impacts to the environment are identified by TVA in Chapter 3 of this Draft PEIS. Minor and moderate impacts resulting from construction and operation would be minimized through the use of mitigative measures committed to by TVA through regulatory permit processes and final design. Additional project specific BMPs may be applied as appropriate on a site-specific or technology-specific basis to enable efficient maintenance of construction projects and further reduce potential impacts on environmental resources.

The environmental impacts of each of the alternatives under consideration are summarized in Table ES-1. The summaries presented are derived from the information and analyses provided in the Affected Environment and Environmental Consequences sections in Chapter 3 of the PEIS.

TVA's Preferred Alternative

TVA's preferred alternative is Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced non-LWRs. Alternative D provides the greatest flexibility to meet the purpose and need of the project to support TVA's goal of demonstrating the feasibility of deploying advanced nuclear reactor technologies at the CRN Site capable of incrementally supplying clean, secure, and reliable power that is less vulnerable to disruption. Alternative D also supports the recommendations outlined in TVA's 2019 IRP and TVA's 2021 Strategic Intent and Guiding Principles.

Table ES-1. Summary and Comparison of Alternatives by Resource Area

Resource Area	Alternative A—No Action	Alternative B1—Nuclear Technology Park at Area 1 with SMRs	Alternative B2—Nuclear Technology Park at Area 1 with SMRs and/or Advanced non-LWRs	Alternative C—Nuclear Technology Park at Area 2 with Advanced non-LWRs	Alternative D—Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced non-LWRs
Geology and Soils	No impacts	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**
Water Resources	No impacts	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**
Floodplains and Flood Risk	No impacts	*Construction:* **Minor** *Operation:* **None**	*Construction:* **Minor** *Operation:* **None**	*Construction:* **Minor** *Operation:* **None**	*Construction:* **Minor** *Operation:* **None**
Wetlands	No impacts	*Construction:* **Minor**	*Construction:* **Minor**	*Construction:* **Minor**	*Construction:* **Minor**
Aquatic Ecology	No impacts	*Construction:* ***Minor to Moderate*** *Operation***: Minor**	*Construction:* ***Minor to Moderate*** *Operation***: Minor**	*Construction:* ***Minor to Moderate*** *Operation***: Minor**	*Construction:* ***Minor to Moderate*** *Operation***: Minor**
Terrestrial Ecology	No impacts	*Construction:* **Moderate** *Operation:* **Minor**	*Construction:* **Moderate** *Operation:* **Minor**	*Construction:* **Moderate** *Operation:* **Minor**	*Construction:* **Moderate** *Operation:* **Minor**
Threatened and Endangered Species	No impacts	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**
Managed and Natural Areas	No impacts	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation***: Minor**	*Construction:* **Minor to Moderate** *Operation***: Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**
Recreation	No impacts	*Construction:* **Minor** *Operation***: Minor**	*Construction:* **Minor** *Operation***: Minor**	*Construction:* **Minor** *Operation***: Minor**	*Construction:* **Minor** *Operation***: Minor**
Meteorology, Air Quality, and Climate Change	No impacts	*Construction and Operation***: Minor**	*Construction and Operation***: Minor**	*Construction and Operation***: Minor**	*Construction and Operation***: Minor**

Resource Area	Alternative A—No Action	Alternative B1—Nuclear Technology Park at Area 1 with SMRs	Alternative B2—Nuclear Technology Park at Area 1 with SMRs and/or Advanced non-LWRs	Alternative C—Nuclear Technology Park at Area 2 with Advanced non-LWRs	Alternative D—Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced non-LWRs
Transportation	No impacts	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**
Visual Resources	No impacts	*Construction and Operation:* **Minor to Moderate**	*Construction and Operation:* **Minor to Moderate**	*Construction and Operation:* **Minor to Moderate**	*Construction and Operation:* **Minor to Moderate**
Noise	No impacts	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**
Socioeconomics					
Land Use	No impacts	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**
Demographics	No impacts	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**
Employment and Income	No impacts	*Construction and Operation*: **Beneficial, Minor to Moderate**	*Construction and Operation*: **Beneficial, Minor to Moderate**	*Construction and Operation:* **Beneficial, Minor to Moderate**	*Construction and Operation*: **Beneficial, Minor to Moderate**
Community Characteristics	No impacts	*Construction:* **Minor** *Operation*: **Minor to Moderate**	*Construction:* **Minor** *Operation*: **Minor to Moderate**	*Construction:* **Minor** *Operation*: **Minor to Moderate**	*Construction:* **Minor** *Operation:* **Minor to Moderate**
Environmental Justice	No impacts	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**
Archaeological Resources and Historic Structures	No impacts	*Construction:* **Moderate**	*Construction:* **Moderate**	*Construction:* **Moderate**	*Construction:* **Moderate**
Solid and Hazardous Waste	No impacts	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**

Resource Area	Alternative A—No Action	Alternative B1—Nuclear Technology Park at Area 1 with SMRs	Alternative B2—Nuclear Technology Park at Area 1 with SMRs and/or Advanced non-LWRs	Alternative C—Nuclear Technology Park at Area 2 with Advanced non-LWRs	Alternative D—Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced non-LWRs
Radiological Effects of Normal Operations	No impacts	*Construction and Operation:* **Minor**	*Construction and Operation:* **Minor**	*Construction and Operation:* **Minor**	*Construction and Operation:* **Minor**
Uranium Fuel Effects	No impacts	*Construction and Operation:* **Minor**	*Construction and Operation:* **Minor**	*Construction and Operation:* **Minor**	*Construction and Operation:* **Minor**
Nuclear Plant Safety and Security	No impacts	*Construction and Operation:* **Minor**	*Construction and Operation:* **Minor**	*Construction and Operation:* **Minor**	*Construction and Operation:* **Minor**
Decommissioning	No impacts	**Minor**	**Minor**	**Minor**	**Minor**

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Symbols, Acronyms, Abbreviations, and Glossary of Terms

AADT	Annual Average Daily Traffic
AC	Alternating Current
ACE	Affordable Clean Energy
ACS	American Community Survey
AIA	Aircraft Impact Assessment
ALARA	As Low as Reasonably Achievable
AMSL	Above Mean Sea Level
APE	Area of Potential Effects
ARAP	Aquatic Resource Alteration Permit
B/CTP	Biocide/Corrosion Treatment Plan
bgs	Below Ground Surface
BMP	Best Management Practice
BP	Containment Bypass
BTA	Barge and Traffic Area
Btu	British Thermal Units
BWR	Boiling Water Reactor
CAA	Clean Air Act
CDC	U.S. Centers for Disease Control and Prevention
CDF	Core Damage Frequency
CEC	Categorical Exclusion Checklists
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEUS SSC	Central and Eastern United States Seismic Source Characterization
CFE	Early Containment Failure
CFI	Intermediate Containment Failure
CFL	Late Containment Failure
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
CH_4	Methane
Ci	Curies
CI	Containment Isolation Failure
Ci/yr	Curies per Year
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CPP	Clean Power Plan
CRBRP	Clinch River Breeder Reactor Plant
CRM	Clinch River Mile
CRN	Clinch River Nuclear
CWA	Clean Water Act
CWIS	Cooling Water Intake Structure
CWS	Circulating Water System
dB	decibel
dBA	A-weighted Decibels
DBA	Design Basis Accidents
DC	Direct Current
DO	Dissolved Oxygen
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DRH	TDEC Division of Radiological Health
EAB	Exclusion Area Boundary
EIS	Environmental Impact Statement
EMF	Electromagnetic Field
EMS	Emergency Medical Services

EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPZ	Emergency Planning Zone
ER	Environmental Report
ESA	Endangered Species Act
ESF	Engineered Safety Features
ESP	Early Site Permit
ESPA	Early Site Permit Application
ESPA ER	Early Site Permit Application Environmental Report
ESPA PPE	Early Site Permit Application Plant Parameter Envelope
ETSZ	Eastern Tennessee Seismic Zone
ETTP	East Tennessee Technology Park
FAA	Federal Aviation Administration
FBI	Federal Bureau of Investigation
FEIS	Final Environmental Impact Statement
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FPPA	Farmland Protection Policy Act
FSLG	Flood Storage Loss Guideline
FSZ	Flood Storage Zone
ft^3/yr	Cubic Feet per Year
FTE	Full-Time Equivalent Employee
GEH	General Electric Hitachi
GHG	Greenhouse Gas
gpd	Gallons per Day
gpm	Gallons per Minute
GW	Gigawatt
HALEU	High-Assay Low-Enriched Uranium
HPA	Habitat Protection Area
HUC	Hydrologic Unit Code
HUD	U.S. Department of Housing and Urban Development
HWEL	Headwater Elevation
IAEA	International Atomic Energy Agency
IC	Intact Containment
IPaC	Information for Planning and Consultation
IPPP	Integrated Pollution Prevention Plan
IRP	Integrated Resource Plan
ISFSI	Independent Spent Fuel Storage Installation
ISL	In-situ Leaching
kV	Kilovolt
LERF	Early Release Frequency
LLW	Low-level Waste
LOCA	Loss-of-coolant Accident
LOS	Level of Service
LPZ	Low Population Zone
LWR	Light Water Reactor
MBtu/hr	Million British Thermal Units per Hour
MCFR	Molten Chloride Fast Reactor
MCL	Maximum Contaminant Level
MEI	Maximally Exposed Individual
MGD	Million Gallons per Day
MMI	Modified Mercalli Intensity
mph	Miles per Hour
mrad	Millirad
mrem	Millirem
MT	Metric Ton

MTU	Metric Ton of Uranium
MWd	Megawatt-days
MWe	Megawatts Electric
MWh	Megawatt-hours
MWt	Megawatts Thermal
N_2O	Nitrous Oxide
NAAQS	National Ambient Air Quality Standards
NCRP	National Council on Radiation Protection and Measurements
NDC	Nationally Determined Contribution
NEI	Nuclear Energy Institute
NEPA	National Environmental Policy Act
NESC	National Electrical Safety Code
NFIP	National Flood Insurance Program
NHPA	National Historic Preservation Act
NLCD	National Land Cover Database
NO_2	Nitrogen Dioxide
NO_X	Nitrogen Oxides
NOI	Notice of Intent
NOTAM	Notice to Airmen
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NPG	Nuclear Power Group
NRC	Nuclear Regulatory Commission
NRC ESP FEIS	Final Environmental Impact Statement for an Early Site Permit at the Clinch River Nuclear Site, April 2019
NRHP	National Register of Historic Places
NRI	Nationwide Rivers Inventory
NSSS	Nuclear Steam Supply System
NWI	National Wetlands Inventory
NWS	National Weather Service
O_3	Ozone
ORR	Oak Ridge Reservation
OSHA	Occupational Safety and Health Association
PA	Programmatic Agreement
Pb	Lead
PCB	Polychlorinated Biphenyls
PEIS	Programmatic Environmental Impact Statement
PM	Particulate Matter
PMC	Plant Management Corporation
PPE	Plant Parameter Envelope
PRA	Probabilistic Risk Assessment
PSD	Prevention of Significant Deterioration
PSDAR	Post-Shutdown Decommissioning Activities Report
PWR	Pressurized Water Reactor
RBI	Reservoir Benthic Index
RCRA	Resource Conservation and Recovery Act of 1976, as amended
RFAI	Reservoir Fish Assemblage Index
RG	Regulatory Guide
RIMS II	Regional Input-Output Modeling System
RLMP	Watts Bar Reservoir Land Management Plan
RM	River Mile
ROW	Right-of-Way
RPV	Reactor Pressure Vessel
Ryr	Reactor Year
SACTI	Seasonal and Annual Cooling Tower Impact
SHPO	State Historic Preservation Officer

SMR	Small Modular Reactor
SMZ	Streamside Management Zone
SNA	State Natural Area
SO_2	Sulfur Dioxide
SO_X	Sulfur Oxides
SVOC	Semi-Volatile Organic Compounds
SWPPP	Stormwater Pollution Prevention Plan
TDEC	Tennessee Department of Environment and Conservation
TDOT	Tennessee Department of Transportation
TDS	Total Dissolved Solids
TL	Transmission Line
TN 58	Tennessee Highway 58
TN 95	Tennessee Highway 95
TOC	Total Organic Carbon
TRAM	Tennessee Rapid Assessment Method
TRC	TRC Environmental Corporation
TRISO	Tri-structural Isotropic
TRM	Tennessee River Mile
TSS	Total Suspended Solids
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
U.S.	United States of America
U-235	Uranium-235
U-238	Uranium-238
UCO	Uranium Oxycarbide
UF_6	Uranium Hexaflouride
UFC	Uranium Fuel Cycle
UHS	Ultimate Heat Sink
UN	Uranium Nitride
UO_2	Uranium Dioxide
U_3O_8	Uranium Oxide
UPF	Uranium Processing Facility
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCB	U.S. Census Bureau
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UT	University of Tennessee
veh/day	Vehicles per Day
VOC	Volatile Organic Compounds
WBN	Watts Bar Nuclear
WOTUS	Waters of the U.S.
WSEL	Water Surface Elevation
WWC	Wet Weather Conveyance

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CHAPTER 1 – PURPOSE AND NEED FOR ACTION

1.1 Introduction

The Tennessee Valley Authority (TVA) prepared this Draft Programmatic Environmental Impact Statement (PEIS) to assess the environmental impacts associated with the proposed action including site preparation, construction, operation, and decommissioning of various facilities at an advanced nuclear reactor technology park (Nuclear Technology Park) at TVA's Clinch River Nuclear (CRN) Site (Figure 1-1). The proposed action provides an opportunity to evaluate and demonstrate the feasibility of deploying advanced nuclear reactors at the CRN Site, and to evaluate emerging nuclear technologies as part of TVA's technology innovation efforts aimed at developing future generation capabilities.

TVA's goal is to demonstrate emerging nuclear technologies are capable of incrementally supplying clean, secure, reliable power that is less vulnerable to disruption, by constructing and operating one or more advanced nuclear reactors at the CRN Site (Figure 1-1). This goal is informed by four objectives, demonstrating:

(1) power generated by advanced nuclear reactors could be used to address critical energy security issues;

(2) advanced nuclear reactors can assist TVA, stakeholders, and federal government facilities with meeting various carbon reduction objectives;

(3) advanced nuclear reactor design features include underground containment and inherent safe-shutdown features, longer station blackout coping time without external intervention, and core and spent fuel pool cooling without the need for active heat removal; and

(4) advanced nuclear reactor power generating facilities are designed to be deployed in an incremental fashion to more precisely meet the power generation needs of a service area.

This Draft PEIS was developed in accordance with the National Environmental Policy Act (NEPA), at 42 United States Code (USC) § 4321 *et seq.*; the 2020 Council on Environmental Quality's (CEQ) regulations for implementing NEPA, at 40 Code of Federal Regulations (CFR) Parts 1500-1508 (85 FR 17434, Mar. 27, 2020); TVA's corollary NEPA regulations at 18 CFR Part 1318 and associated guidance from various federal and state agencies.

1.2 Background

The CRN Site is located on the northern bank of the Clinch River arm of the Watts Bar Reservoir (the Reservoir) in the City of Oak Ridge, Roane County, Tennessee (Figure 1-1), approximately 7 miles east of the City of Kingston, Tennessee, and approximately 25 miles west-southwest of the City of Knoxville, Tennessee. The CRN Site comprises 935 acres of TVA-managed land adjacent to the U.S. Department of Energy's (DOE) approximately 33,000-acre Oak Ridge Reservation (ORR). The site is situated on the historical Clinch River Breeder Reactor Project (CRBRP) Site. At the time of the CRBRP cancellation in 1983, preliminary site work was essentially completed, including all necessary sediment ponds, construction shops, concrete batch plants, the nuclear island excavation, extensive site grading, and a foundation for a ringer crane needed for the Breeder Reactor project. After the U.S. Congress terminated the CRBRP, DOE's Site Redress Plan was approved and implemented to leave the site in a safe and environmentally stable condition. Subsequently, management of the CRN property was transferred back to TVA in 1989.

In May 2016, TVA submitted an application to the Nuclear Regulatory Commission (NRC) for an Early Site Permit (ESP) at the CRN Site for two or more new nuclear power units demonstrating small modular reactor (SMR) technology, with a total combined nuclear generating capacity not to exceed 800 megawatts electric (MWe). The NRC prepared and released a Final Environmental Impact Statement (NRC ESP FEIS) to assess the environmental impacts of the action proposed in the TVA ESP application (ESPA). The Nashville District, Regulatory Division, U.S. Army Corps of Engineers (USACE) was a cooperating agency with the NRC during preparation of the EIS to verify that the information presented was adequate to support a Department of the Army permit application, should TVA submit a permit application at a future date.

The NRC ESP FEIS identified issuance of an ESP for the CRN Site as the preferred alternative. Following the NRC ESP FEIS publication in April 2019, the NRC issued an ESP to TVA on December 19, 2019. The ESP represents NRC's approval of the CRN Site as suitable for the future demonstration of the construction and operation of two or more SMRs with characteristics presented in the ESPA, it but does not authorize TVA to construct or operate a nuclear facility. The ESP establishes early resolution of numerous site safety, environmental, and emergency preparedness issues, providing enhanced predictability and stability in future TVA licensing actions related to the CRN Site. The ESP is valid until December 2039. Prior to initiating construction or operation of advanced nuclear reactors at the CRN Site, TVA must apply for and receive additional licenses from the NRC.

In June 2019, TVA released the Final 2019 Integrated Resource Plan (IRP) and the associated IRP Final EIS. The IRP identified the various generating resources that TVA intends to pursue to meet the energy needs of the Tennessee River Valley (the Valley) over a 20-year planning period. The 2019 IRP recommended that TVA continue to evaluate emerging nuclear technologies, including SMRs, as part of technology innovation efforts aimed at developing future electricity generation capabilities. This Draft PEIS is TVA's next step in exploring the potential for new nuclear generation on the TVA system, to advance the recommendations of the IRP.

In December 2021, the TVA Board of Directors (Board) authorized the implementation of a New Nuclear Program to advance SMR planning efforts at the CRN site, and to explore plans for potential, additional reactors to support TVA's 2050 decarbonization aspirations. Further, TVA's Chief Executive Officer was delegated the authority to enter into one or more contracts with one or more advanced nuclear reactor vendors and other private entities, as necessary and appropriate, to pursue the initial planning for this Program. The New Nuclear Program includes a multi-stage decision making process with three discrete "decision gates", referred to as (1) Authorize Planning, (2) Authorize Project, and (3) Authorize Construction. A multi-stage decision gate process is consistent with both industry and TVA enterprise best practices for potential projects on a similar scale to potential new nuclear deployment. The Board approval of the New Nuclear Program at the first Decision Gate does not authorize the subsequent Decision Gate actions, which would require future Board approvals.

TVA's New Nuclear Program does not prejudice or foreclose any of the alternatives under consideration in this PEIS. Rather, it facilitates the possibility that a reliable, affordable, flexible, and clean advanced nuclear reactor option could be potentially available by 2032, and it advances necessary planning for future required TVA decision making for the potential deployment of innovative new nuclear technology, in line with TVA's 2019 IRP and 2021 Strategic Intent and Guiding Principles (TVA 2021i). The implementation of the New Nuclear

Program authorizes the expenditure of resources not to exceed $200 Million for the period Fiscal Year 2022 through Fiscal Year 2024.

1.3 Purpose and Need

The purpose of the proposed action is to support TVA's goal of demonstrating the feasibility of deploying advanced nuclear reactor technologies at the CRN Site capable of incrementally supplying clean, secure, and reliable power that is less vulnerable to disruption. The proposed action is needed to support the recommendations outlined in TVA's 2019 IRP and TVA's 2021 Strategic Intent and Guiding Principles, and to support TVA's mission of innovation towards a low carbon future for the Valley. In addition to providing a place to demonstrate advanced nuclear reactor technologies, a Nuclear Technology Park at the CRN Site could potentially include microgrid power generation demonstration; grid resiliency analysis and support; and use of nuclear generation for hydrogen production, water desalination, waste heat energy storage for grid support, and the intentional production of valuable isotopes, all in support of TVA's statutory missions.

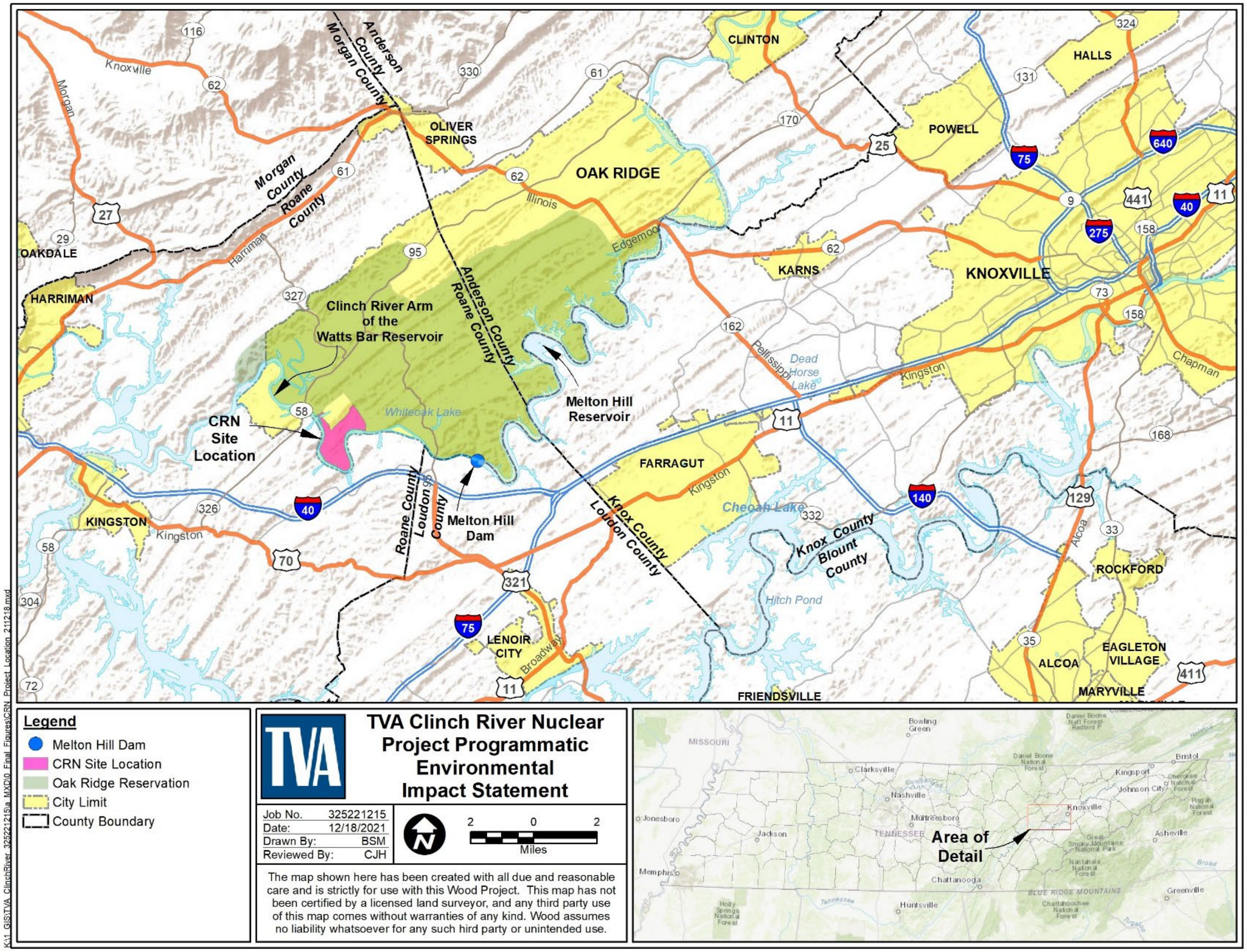


Figure 1-1. CRN Site Location

1.4 Decision to be Made

This Draft PEIS is being prepared to inform TVA decision makers and the public about the potential environmental impacts of the proposed action. Specifically, the decision to be made by TVA is whether to conduct site preparation, construct, operate, and decommission facilities at a Nuclear Technology Park at the CRN Site to evaluate and demonstrate the feasibility of deploying advanced nuclear reactors, and to evaluate emerging nuclear technologies as part of TVA's technology innovation efforts aimed at developing future generation capabilities.

1.5 Programmatic Approach

As defined by CEQ, a programmatic review "…describes any broad or high-level NEPA review" in which subsequent actions would be implemented that would "tier" to the programmatic NEPA review (CEQ 2020). This Draft PEIS programmatically considers the site preparation, construction, operation, and decommissioning of various types of advanced nuclear reactors bounded by the plant parameter envelope (PPE) and the supplemental bounding site development attributes and parameters as discussed in Section 2.4. NEPA analysis for any potential construction and operation of selected, specific nuclear reactors for the CRN Site by TVA would tier from this Draft PEIS as a supplementary NEPA analysis for those project- or site-specific elements not evaluated in this Draft PEIS.

The programmatic analysis included in this Draft PEIS is consistent with the PPE that was evaluated in TVA's ESPA. The PPE developed for this proposed action consists of a set of reactor-vendor and owner-engineered parameters or values that TVA used to bound the characteristics of a reactor (or reactors) that could later be deployed at the CRN Site. The PPE represents an "envelope" that encompasses a range of reactor types of varying levels of design maturity. Analysis of environmental impacts based on a PPE allows TVA to defer the selection of a reactor design until a future licensing stage, when more detailed site-specific and technology-specific information would be available to make a technology selection decision. The PPE used by TVA for the ESP is located in Appendix A of this Draft PEIS. For the present analysis, TVA has supplemented the ESPA PPE with information about advanced nuclear reactor technologies not discussed in the ESPA and additional areas of potential disturbance for transmission line and site access. This Draft PEIS provides a bounding analysis of maximum potential impacts of implementing each of the alternatives described in Chapter 2, based on a PPE.

1.6 Related Environmental Reviews

The following previous environmental reviews were prepared for actions related to the CRN Site:

- *Final Environmental Statement Related to Construction and Operation of Clinch River Breeder Reactor Plant (CRBRP)* NRC, *February 1977*. The Environmental Statement was prepared for the NRC by Project Management Corporation (PMC) for the issuance of a construction permit for construction and operation of the CRBRP at the CRN Site in 1977.
- *Environmental Report Volumes I & II, PMC, 1982*. The CRN Site was selected as the location for construction of a liquid metal fast breeder reactor in 1972. Site preparation for the CRBRP began in 1982 and disturbed approximately 240 acres. CRBRP site preparation activities included leveling a ridge that originally reached 880 feet above mean sea level (AMSL) to 780 AMSL and excavation of an

approximately 24-acre area to a depth of as much as 100 feet, resulting in excavation of approximately three million cubic yards of earth and rock. Structures installed at the CRBRP site included a cement crane pad, quality control test laboratory, construction shops, concrete batch plants, and sediment ponds. An approximately 6,450-foot-long 8-inch water line from the DOE's Bear Creek Filtration Plant was also installed at the CRBRP site. The CRBRP project was terminated in 1983.

- *Clinch River Breeder Reactor Plant DOE/TVA/PMC Site Redress Planning Task Force Report, DOE, TVA, and PMC, January 1984*. The CRBRP site redress plans included measures to stabilize the CRBRP site such as reseeding of grass, 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, and modification of the holding ponds for long-term stability. Portable buildings and structures were removed from the CRBRP site with the exception of the crane pad, meteorological tower, and two meteorological instrumentation buildings. The approximately 6,450-foot-long 8-inch water line was terminated at a hydrant and left in place. Stormwater runoff/collection ponds and associated piping was left in place. The 80-foot by 80-foot crane pad was left in place. The excavated area was partially backfilled in a manner to sustain site drainage. Rock bolts within the excavated area were left in place. Level areas of the CRBRP site were graded and compacted.
- *Grading of Clinch River Site for Potential Industrial Development Environmental Assessment, May 1998.* The site is the previous location of the canceled CRBRP on TVA property. The Environmental Assessment considered the impacts from grading the site because the existing topographic features that were created from the CRBRP, which included the "hill" and the "hole", had discouraged the use of the site for industrial development. The proposed action of grading the site was evaluated to allow for enhanced marketability for industrial development consistent with TVA's Watts Bar Reservoir Land Management Plan.
- *Clinch River Nuclear Site Early Site Permit Application, Environmental Report, Part 3, May 2016* (ESPA ER). The ESPA ER was prepared and submitted as part of the TVA application for an ESP for the CRN Site in Oak Ridge, Roane County, Tennessee. TVA prepared this ER to analyze the environmental effects of construction, operation, and decommissioning of two or more SMRs at the CRN Site having a maximum electrical output not to exceed 800 MWe. The application used four potential SMR designs to develop a bounding analysis of the potential engineering, safety, and environmental impacts. The NRC used this ER to develop an EIS that evaluated TVA's proposed action and informed NRC's decision on whether to issue TVA an ESP.
- *Final Environmental Impact Statement for an Early Site Permit at the Clinch River Nuclear Site, April 2019* (NRC ESP FEIS). NRC issued the NRC ESP FEIS in response to the TVA application for an ESP for new nuclear power units demonstrating SMR technology in Oak Ridge, Roane County, Tennessee. The NRC EIS evaluated the proposed action and the potential impacts of the proposed action, to make a recommendation to the Commission regarding whether or not to issue an ESP. After considering the environmental aspects of the proposed action before the NRC, NRC staff recommended that an ESP be issued for the CRN Site.

- *Early Site Permit, December 2019*. The NRC issued Early Site Permit No. ESP-006 to TVA for the CRN Site.

Other minor actions at the CRN Site that qualified as Categorical Exclusions include the following Categorical Exclusion Checklists (CECs) completed by TVA:

- Clinch River SMR Project Met Tower Road Culvert Installation – CEC 24366, May 2011
- Clinch River Site Meteorological Tower – CEC 23403, June 2011
- Clinch River Site Characterization – CEC 23595, November 2012
- Clinch River Small Modular Reactor (SMR) Site Meteorological Tower Removal – CEC 28783, August 2013
- Portable Bridge Installation at the Clinch River Nuclear CRN Site – CEC 40907, August 2019

1.7 Scope of the Draft PEIS and Summary of Proposed Action

This Draft PEIS provides a bounding analysis of the potential environmental impacts of the proposed site preparation, construction, operation, and decommissioning of various facilities at the proposed Nuclear Technology Park at the CRN Site. A detailed description of the proposed action and alternatives considered is provided in Chapter 2. The scope of this Draft PEIS includes evaluation of impacts associated with the proposed activities within the CRN Project Area (Figure 1-2), which includes the CRN Site and associated offsite areas: the Barge and Traffic Area (BTA), the offsite 161-kilovolt (kV) transmission line corridor, and the Tennessee Highway 95 (TN 95) Access. Because the design, location, and requirements for other potential future offsite transmission line upgrades are too speculative at this time, the potential environmental impacts from these actions are not evaluated in this Draft PEIS. In addition, the specific need and modification of a potential future transmission line along a segment of the 500-kV transmission line that extends northeast, outside of the CRN Site boundary to the Bethel Valley substation is also unknown at this time; therefore, only a description of the area affected and a general environmental impact analysis within this corridor is included in Chapter 3 of this Draft PEIS for those resources that would be affected. These potential actions would be considered in future supplementary TVA and NRC NEPA analyses, as necessary and appropriate.

TVA prepared this Draft PEIS to comply with the NEPA statute, associated regulations promulgated by CEQ and TVA, and related procedures from various agencies for implementing NEPA. TVA considered the possible environmental effects of the bounding parameters of the proposed action and determined that potential effects to the environmental resources listed below were relevant to the decisions to be made, and therefore, assessed the potential impacts on these resources using the PPE and additional site development parameters in detail in this Draft PEIS.

- Geology and Soils
- Water Resources
- Floodplains and Flood Risk
- Wetlands
- Aquatic Ecology
- Terrestrial Ecology
- Threatened and Endangered Species
- Natural Areas
- Recreation
- Meteorology, Air Quality, and Climate Change
- Transportation
- Visual Resources
- Noise
- Socioeconomics
- Environmental Justice
- Archaeological Resources and Historic Structures
- Solid and Hazardous Waste
- Non-radiological Public Health & Safety
- Radiological Effects of Normal Operation
- Uranium Fuel Use Effects
- Nuclear Plant Safety and Security

The Draft PEIS also addresses specific requirements associated with a number of federal laws and regulations, such as National Historic Preservation Act (NHPA), Endangered Species Act (ESA), Clean Water Act (CWA), and Clean Air Act (CAA), and would satisfy the requirements of pertinent executive actions, including Executive Order (EO) 11988 (Floodplains Management), EO 11990 (Protection of Wetlands), EO 12898 (Environmental Justice), EO 13112 as amended by 13751 (Invasive Species), EO 13990 Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis, EO 14008 Tackling the Climate Crisis at Home and Abroad, EO 14057 Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability, and other applicable or relevant EOs.

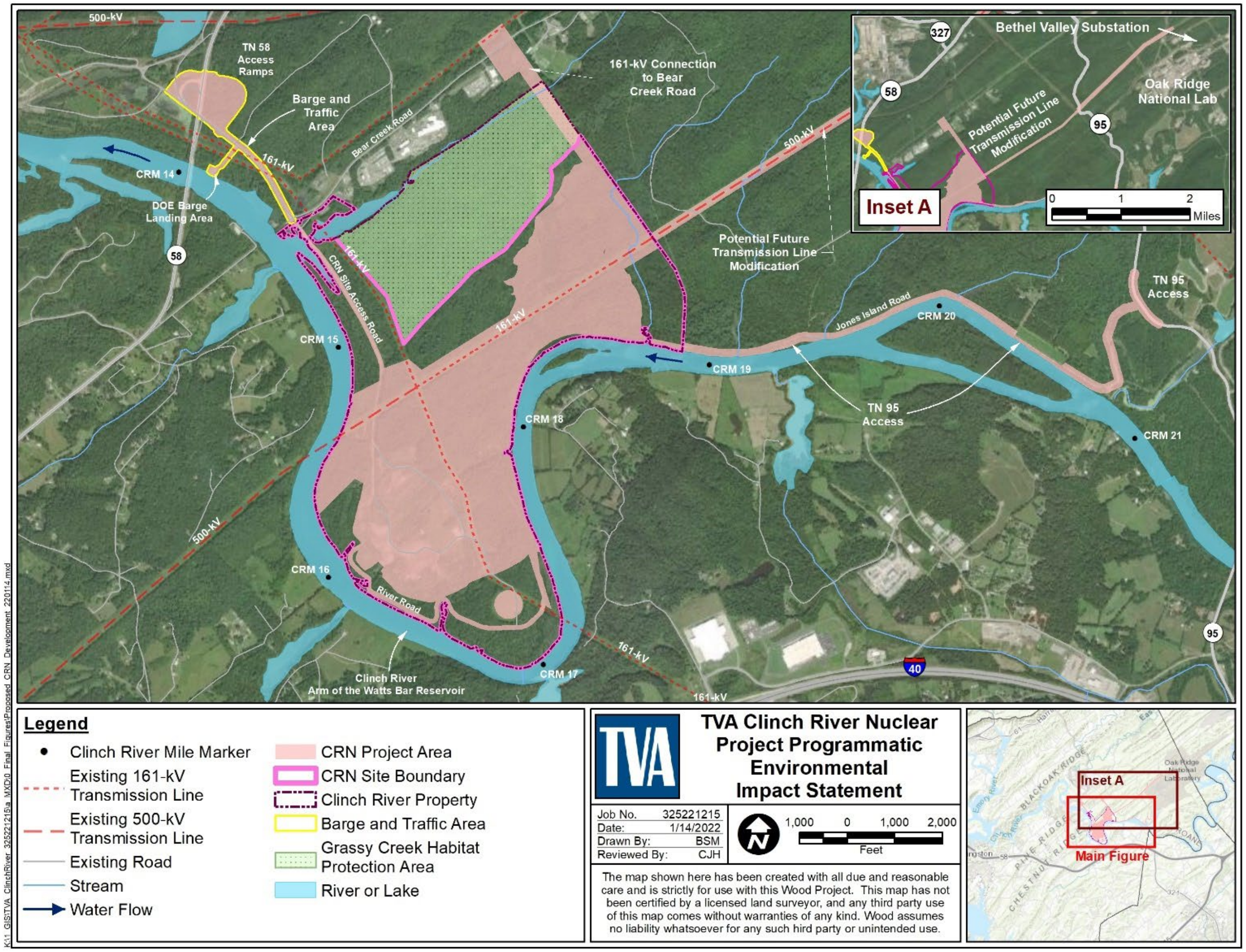


Figure 1-2. CRN Project Area

1.8 Public and Agency Involvement

1.8.1 Scoping

1.8.1.1 Scoping Period Public Outreach

Public scoping was initiated with the publication of the Notice of Intent (NOI) to prepare a Draft PEIS in the Federal Register on February 5, 2021 (Appendix B). Additionally, TVA posted a public notice about the scoping period and information regarding the Draft PEIS on the TVA external website (www.tva.com/nepa). A public scoping period was held from February 2 to March 19, 2021. To facilitate awareness of this opportunity, in addition to posting the NOI in the Federal Register and on the TVA website, TVA contacted local, state, and federal government agencies, local power companies, directly served customers, and sent a media advisory to news outlets across the TVA service area. A public notice advertisement was also placed in the *Roane County News*, *Knoxville News Sentinel*, *News-Herald*, *Oak Ridger*, *Courier News*, and on the TVA website.

TVA encouraged the public to comment on the scope of the Draft PEIS, alternatives under consideration, and the range of environmental issues to be addressed. TVA invited the public to submit formal comments via email (nepa@tva.gov), the TVA website (www.tva.com/nepa), or by postal mail. In addition to the website, TVA established a "virtual meeting room", accessible through the www.tva.com/nepa website, which offers virtual public engagement throughout the NEPA process. During the scoping period, the virtual meeting room provided information on the scheduled virtual scoping meeting, links for submitting scoping comments, and a scoping meeting registration link. Further, the virtual meeting room provides access to project information in the form of posters and links to additional project documentation, maps, graphics, and project-related webpages. In addition to the NEPA website and virtual meeting room that focuses on plans to develop the CRN Site, there is TVA's Nuclear Technology Innovation webpage that focuses on the types of advanced nuclear reactor technologies under consideration.

As part of scoping, TVA hosted a live virtual scoping webinar on March 1, 2021, to gather input and answer questions from the public and stakeholders. The public was invited to attend this virtual meeting and submit formal comments. During the scoping webinar, TVA gave a presentation outlining the CRN Site history, the proposed project description, project schedule, and NEPA regulatory framework as well as site layouts and a drone video tour of the site. A total of 98 individuals, including members of the general public and representatives of a variety of organizations as well as TVA, registered for the meeting. Among those registered, 69 were not affiliated with TVA and 58 attended the question-and-answer session following the presentation.

1.8.1.2 Summary of Scoping Feedback

TVA received a wide variety of comments and opinions regarding the construction, operation, and decommissioning of a Nuclear Technology Park at the CRN Site and considered this input in developing the Draft PEIS.

TVA received 45 formal comment submissions from members of the public, local government, and state and federal agencies. The submissions consisted of:

- One submission from a federal agency, U.S. Environmental Protection Agency (EPA)
- Three submissions from state agencies, Tennessee Department of Environment and Conservation (TDEC) Division of Water Resources, TDEC Division of Air Pollution Control, and Tennessee Department of Transportation (TDOT)
- One submission from a local government, Roane County Environmental Review Board
- Fourteen submissions from organizations including the Sierra Club, Savannah River Site Watch, Tennessee Environmental Council, Bellefonte Efficiency & Sustainability Team of the Blue Ridge Environmental Defense League, Nuclear Information and Resource Service, Coalition for A Nuclear Free Great Lakes, and Erwin Citizens Awareness Network, Inc.
- Twenty-seven submissions from members of the public that did not state an affiliation with an organization

The 45 comment submissions were reviewed to identify specific issues of concern by each commenter and were grouped in general categories for identification and review. In total, 128 separate comments were identified. Additional detail regarding comments received during the scoping process including information and analyses submitted by State, Tribal, and local governments are included in the Scoping Report, which is available in Appendix C and on TVA's website. TVA considered and addressed these comments during preparation of this Draft PEIS.

1.8.2 Public and Agency Review of the Draft PEIS

TVA's public and agency involvement for the Draft PEIS included publication of a public notice and a 45-day public review of the Draft PEIS. To solicit public input, the availability of the Draft PEIS was announced in regional and local newspapers serving Oak Ridge and the Knoxville area. A news release was issued to the media and posted on TVA's website on February 18, 2022. The Draft PEIS was posted on TVA's NEPA website (www.tva.com/NEPA), and hard copies were made available by request.

TVA's agency involvement included sending notices to local, state, and federal agencies as well as federally recognized tribes to inform them of the availability of the Draft PEIS.

1.9 Necessary Permits and Licenses

TVA would seek and obtain all necessary permits, licenses, and approvals required for the alternative selected. Appendix D provides a complete list of potential permits and authorizations that are expected to be required, depending upon the alternative selected. Representative permits, licenses, and approvals include the following:

- Federal Aviation Administration (FAA) Construction Notice for erection of structures more than 200 feet high that potentially may affect air navigation
- Certificate of Registration from the U.S. Department of Transportation (DOT) for transportation of hazardous materials
- Entrance and right-of-way (ROW) permits from the TDOT for ramps, driveways, and other access points and installation of utilities within highway ROWs along Tennessee Highway 58 (TN 58) and TN 95
- CWA Section 404 Permit through the USACE for disturbance, crossing, or filling of wetland areas or jurisdictional waters
- Rivers and Harbors Act Section 10 permit from the USACE for dredge and fill actions within navigable waters
- U.S. Coast Guard Private Aids to Navigation Permit for construction of discharge pipeline in navigable waters
- EPA and TDEC acknowledgement of notification of hazardous waste activity, facility response plan approval, and spill/discharge prevention plan
- Consultation with the U.S. Fish and Wildlife Service (USFWS) regarding effects on species listed under the ESA
- TDEC permits including CWA Section 401 Aquatic Resource Alteration Permit (ARAP) and Section 402 National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges Associated with Construction Activities or an Individual Construction Stormwater Permit, NOI for NPDES General Permit of Discharges from the application of pesticides, water withdrawal registration, and CAA Title V Operating Permit for discharge of air pollutants
- TDEC Division of Radiological Health (DRH) for transportation of radioactive waste within Tennessee to a disposal/processing facility
- Compliance with NHPA Section 106 for protection of archaeological and historical resources
- Municipal site plan approval, sanitary sewer and potable water connections, and construction permits from the City of Oak Ridge

Actual permit requirements would be evaluated based on site-specific conditions and technology selection and details of the permitting requirements would be determined based upon final design.

Future actions at the CRN Site relating to construction and operation of a Nuclear Technology Park would also require the preparation of Environmental Reports (ERs) for NRC licensing such as a Construction Permit, Operating License, Combined License and/or Limited Work Authorization, in addition to any necessary and appropriate supplementary NEPA analyses.

CHAPTER 2 – ALTERNATIVES

TVA is considering a range of alternatives for site preparation, construction, operation, and decommissioning of a Nuclear Technology Park at the CRN Site in the City of Oak Ridge, Roane County, Tennessee (Figure 1-1). This chapter presents an overview of the advanced nuclear reactor technologies under consideration, the specific project alternatives being evaluated by TVA, and a summary and comparison of alternatives by resource area.

2.1 Overview of Nuclear Reactor Technologies

An advanced nuclear reactor is defined as a nuclear fission reactor with significant improvements over the most recent generation of nuclear fission reactors (*see* 42 USC 16271(b)(1)(A)). Such reactors include light water reactor (LWR) designs, both pressurized and boiling water reactors (PWR and BWR), and non-LWR designs, which use various moderators, coolants, and types of fuel. SMRs are a type of advanced LWR with an electrical output of generally no more than 300 MWe, which is considerably less than the electrical output of approximately 1,000 MWe provided by a typical commercial reactor in the United States of America (U.S.) (IAEA 2021). Many SMRs are designed to be manufactured in factories as large, fabricated components and shipped to a project site for assembly. Therefore, less onsite construction would be required for installation of SMRs than for installation of a typical commercial reactor. SMRs may provide the benefits of nuclear-generated power in situations where large nuclear units are not practical because of constraints related to transmission system requirements, limited space or water availability, or limited available capital for construction and operation.

Advanced nuclear reactor designs use combinations of new and existing technologies and materials to improve upon earlier generations of nuclear reactors. SMRs are considered to be among the most mature of the advanced nuclear reactor technologies. Advanced non-LWRs are less mature and therefore further from commercialization.

This section provides an overview of the reactor technologies and other technology park development characteristics being considered for each of the alternatives discussed in the PEIS, including both SMRs and advanced non-LWRs.

2.1.1 Nuclear Reactor Designs Under Consideration by TVA

This PEIS evaluates the environmental impacts associated with the potential future deployment of one or more advanced nuclear reactors at the CRN Site. TVA is currently considering negotiating and entering into one or more contracts with one or more SMR vendors to: (1) perform design, engineering, scoping, estimating, and planning associated with potential, future deployment of a SMR at the CRN Site, and (2) develop content for a potential, future licensing application submittal to the NRC. TVA also plans to continue to study potential, future deployment of advanced nuclear reactors (LWR and non-LWR) at the CRN Site. These contemplated actions would not prejudice any of the alternatives under consideration in this PEIS, as the contemplated actions would not: (a) authorize or commit TVA to submit a licensing application to the NRC, (b) allow any construction activities at the CRN Site, or (c) result in any potential environmental impacts to the CRN Site.

As part of the New Nuclear Program and delegation discussed in Section 1.2, TVA has begun discussions with General Electric Hitachi (GEH) to initially pursue advancing the design work, gather permitting and licensing information, and perform preliminary site-specific analyses for the GEH BWRX-300 SMR. These activities are required preliminary planning steps to license and build any nuclear technology, and these planning actions related specifically to GEH's BWRX-300 will be done while continuing to evaluate other advanced nuclear reactor designs for the CRN Site.

Initial pursuit of the GEH BWRX-300 does not pre-determine any subsequent development; in accord with the approach described in this Draft PEIS, TVA will continue to evaluate various SMR designs for potential deployment at the CRN Site while advancing the design of the GEH BWRX-300. TVA may later decide to pursue similar evaluations of other new nuclear technologies suitable for the CRN Site. Depending upon subsequent decision making and approval processes, and after appropriate environmental reviews, TVA may eventually choose between available detailed designs for potential deployment at the CRN Site.

Initial pursuit of the GEH BWRX-300 does not limit TVA's alternatives, either under consideration in this PEIS or otherwise. As discussed in this PEIS, TVA is considering a range of alternatives for site preparation, construction, operation, and decommissioning of a Nuclear Technology Park at the CRN Site, including two different areas and roughly 14 different reactor designs discussed in the following sections. Advancing the GEH BWRX-300 detailed design work only enables future TVA decision-making amongst the reasonably considered alternatives, and it does not compel TVA to select this or any reactor design over any others in consideration.

Technology alternatives being considered by TVA for the CRN Site include SMRs listed in Table 2-1, and/or advanced non-LWRs, listed in Table 2-2.

Table 2-1. Potential SMR Technologies

SMR Reactor Type	Pressurized Water Reactor – Low or High Power Unit	Boiling Water Reactor
Fuel Type	Fuel assemblies containing Uranium-235	Fuel assemblies containing Uranium-235
Heat Transfer Mechanism	Indirect steam generation from heat transfer between high pressure primary reactor coolant and secondary feedwater.	Direct steam generation from lower pressure reactor coolant
Power Conversion System	Steam Cycle	Steam Cycle
Reactor Coolant	Light Water	Light Water

Table 2-2. Potential Advanced Non-LWR Technologies

Reactor Type	Thermal, Molten Salt, Graphite Moderated	Thermal, Fluoride Salt Coolant, Graphite Moderated	High Temperature Gas, Graphite Moderated, Helium	Molten Chloride Fast Reactor (MCFR)	Micro Reactor
Fuel Type	Homogenous Fuel-Salt	TRISO Pebble High-Assay Low-Enriched Uranium (HALEU)	TRISO Pebble HALEU	Homogenous U-Cl Fuel-Salt	TRISO Pebble HALEU
Heat Transfer Mechanism	Salt Loop(s)	Salt Loop(s)	Primary Helium and Secondary Steam	Salt Loop(s)	Salt Loop(s)
Power Conversion System	Steam Cycle	Steam Cycle	Steam Cycle or Brayton Cycle[1]	Steam Cycle	Steam Cycle
Reactor Coolant	Molten Chloride Salt	Molten Fluoride Salt	Helium	Molten Chloride Salt	Molten Fluoride Salt

[1] The Brayton Cycle is a thermodynamic cycle that uses air, or some other gas, as the working fluid such as that used in combustion turbines

A brief description is provided below for each of the reactor technologies being considered by TVA for the CRN Site.

2.1.1.1 Potential SMR Technologies

The SMRs under consideration and analyzed in this Draft PEIS consist of both PWRs and BWRs and include the NuScale Power Module, GEH BWRX-300, Holtec SMR-160, Last Energy Mini-PWR, and the Rolls-Royce SMR. PWRs are LWRs where the primary reactor coolant is maintained at high pressure during operation such that it does not boil. Heat from the primary reactor coolant is transferred to a lower pressure secondary system, via a steam generator, where steam is generated to drive a steam turbine. BWRs are LWRs where the primary reactor coolant is maintained at a lower pressure during operation such that it boils, turns into steam, and drives a steam turbine directly. The process of generating steam to drive the steam turbine to produce electricity is referred to as the steam cycle. The SMRs use uranium dioxide (UO_2) fuel. The typical refueling cycle for these SMRs is every 12 to 24 months, with a maximum interval of approximately 6 years for certain designs. The expected design life for the overall facility ranges from 40 to 60 years.

The standard SMR designs under consideration include single units (or modules) with a power output of up to 470 MWe (1,358 megawatts thermal [MWt]), or multiple modules, with up to 15 units per site, with a power output as low as 18-22 MWe (83 MWt) per unit. In the electric power industry, MWe refers to the electric power produced by a generator, while MWt refers to thermal power produced by the plant.

The SMRs under consideration use steam turbines for power conversion. The normal heat sink (i.e., the means used for dissipation of waste heat to the ambient environment, such as bodies of water and the atmosphere) design has not been selected for the CRN Site, but the SMR designs included in the PPE allow for different options including wet or dry-type cooling towers, cooling ponds, air-cooled condensers, and/or discharges to a receiving waterbody via diffuser pipes. The quantities of heat that are generated, dissipated to the atmosphere, and released in liquid discharges would depend on the reactor technology selected. The primary source of cooling water makeup for the Nuclear Technology Park at the CRN Site would be the Reservoir.

To address the potential for accidental releases, a range of engineered safety feature (ESF) systems are included in the SMR designs being considered. These include both active and passive types of ESF systems. In general, active safety systems rely on electric-powered components to supply water and provide reactor core and containment cooling. In the event of a loss of the normal alternating current (AC) power supply, the active systems would be powered by onsite auxiliary power sources, such as diesel generators. Alternatively, passive safety systems rely almost exclusively on natural forces, such as density differences, gravity, or stored energy, to supply coolants (e.g., water) and to provide core and containment cooling. All reactor designs being considered allow for passive cooling of the core (i.e., natural circulation of reactor coolant without the need for pumps). Certain reactor designs require direct current (DC) power to ensure cooling after an accident. Some of the designs do not require AC or DC power to provide cooling. The safety-related ultimate heat sink (UHS) (i.e., the heat sink that provides cooling in the event of an accident) would typically be a dedicated reservoir of water within the facility and would not require any safety-related makeup water from external sources.

2.1.1.2 Potential Advanced Non-LWR Technologies

The advanced non-LWRs under consideration and analyzed in this Draft PEIS include a wide range of reactor technologies and consist of the BWXT Advanced Nuclear Reactor, Flibe Energy Liquid Fluoride Thorium Reactor, Kairos Power KP-X, Moltex Energy Stable Salt Reactor-Waste Burner, Oklo Natural Circulation Sodium Fast Reactor, Terrestrial Energy Integral Molten Salt Reactor, Ultra Safe Nuclear Corporation High Temperature Gas Cooled Micro Modular Reactor, and the X-energy XE-100. The non-LWR fuel types under consideration mostly fall into two categories: (1) molten fuel salts (e.g., thorium and uranium fuel salts), and (2) tri-structural isotropic (TRISO) coated fuel particles which contain High-Assay Low-Enriched Uranium (HALEU) (e.g., UO_2, uranium oxycarbide [UCO], or uranium nitride [UN]-based TRISO particles contained in a spherical fuel “pebble” or cylindrical fuel “pellet”). Molten fuel salt reactors use a homogenous mixture of fuel and primary coolant (i.e., the fuel is dissolved directly into the coolant), made from molten metals (e.g., sodium), or salts. The TRISO fuel-based reactors either use molten salt or gas (e.g., helium) as the primary coolant. One of the reactor designs under consideration uses recycled nuclear waste as a fuel with molten salt as a coolant. Some of the advanced non-LWR designs may use a metallic fuel (e.g., uranium- zirconium) where the fuel is not dissolved directly into the coolant. TRISO particles include layers of porous carbon, pyrolytic carbon (which is similar to graphite), and silicon carbide so that the particles act as their own containment and can withstand extreme temperatures without melting. The “pebble” design means that these TRISO particles are then contained inside small spheres of graphite.

The expected design life for advanced non-LWRs ranges from 20 to 60 years. Depending on the design, the reactor could be continuously refueled (e.g., for a pebble bed design) or may need to be refueled every 5 to 20 years, depending on fuel uranium-235 (U-235) enrichment level.

The designs under consideration include single units (or modules) with a power output of up to 300 MWe (750 MWt), or multiple modules with a power output as low as 10 MWe (30 MWt) per unit.

Depending on the design, either natural circulation or forced circulation (i.e., the use of pumps to provide adequate flow) of coolant is used during normal operation. The non-LWR technologies under consideration primarily use steam turbines for power conversion but some may use gas turbines. Some of the non-LWRs may have power conversion systems that reject heat directly to the atmosphere, such as air-cooled gas turbines. Multiple heat sink designs are possible for the advanced non-LWR(s) options. The quantities of heat that are generated, dissipated to the atmosphere, and released in liquid discharges (if any) would depend on the reactor technology selected.

The advanced non-LWR reactor designs all allow for the use of passive systems for safe shutdown and cooling of the reactor. Certain reactor designs may require DC power to ensure cooling whereas some of the designs do not require AC or DC power to provide cooling. Some of the designs allow for passive heat removal directly to the atmosphere.

2.2 Project Alternatives

The proposed CRN Site layout is presented in Figures 2-1 through 2-3. TVA identified two areas within the 935-acre CRN Site that are best suited for the Nuclear Technology Park development. Area 1 includes the area previously disturbed by the CRBRP evaluated in the ESPA ER. A portion of Area 2 was also evaluated in the ESPA ER for a proposed temporary laydown area.

TVA plans to evaluate four discrete alternatives (A-D) for the Nuclear Technology Park:

- Alternative A: No Action Alternative
- Alternative B: Nuclear Technology Park at Area 1 with SMRs and/or Advanced non-LWRs
- Alternative C: Nuclear Technology Park at Area 2 with Advanced non-LWRs
- Alternative D: Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced non-LWRs

Under action alternatives B thru D, activities would be undertaken within each of the following areas that are referred to in the analyses of this PEIS:

4. CRN Site – lands contained within the boundaries of the CRN Site.

5. Associated Offsite Areas – a collective term that includes the following:

    a. Barge and Traffic Area (BTA): Area outside of the CRN Site boundary that encompasses proposed improvements to the intersection of TN 58 with Bear Creek Road, improvements to Bear Creek Road, and improvements to the existing DOE barge landing facility on the Reservoir.

   b. TN 95 Access: Proposed roadway access that extends from TN 95 southwesterly, following Jones Island Road to the CRN Site boundary.

   c. 161-kV Offsite Transmission Line: Segment of proposed 161-kV transmission line that extends outside of the CRN Site boundary to an interconnection with the existing 161-kV line along Bear Creek Road.

6. 500-kV Offsite Transmission Line: Segment of 500-kV transmission line that extends northeast, outside of the CRN Site boundary to the Bethel Valley substation.

TVA considered, but dismissed two alternatives:

- Alternative E: Construction of SMRs at Alternative Sites
- Alternative F: Construction of Alternative Energy Generation Sources

The No Action Alternative, the individual action alternatives, and the alternatives considered but dismissed are described in the following sections.

2.2.1 Alternative A – No Action

Under the No Action Alternative, TVA would not seek additional approvals from the NRC for the CRN Site. A Nuclear Technology Park and advanced nuclear reactors would not be further explored, constructed, operated, or potentially decommissioned at the CRN Site. The CRN Site would continue to be managed in accordance with the Watts Bar Reservoir Land Management Plan (RLMP). TVA would continue routine maintenance and clearing associated with the transmission lines that currently traverse the CRN Site.

Under the No Action Alternative, TVA would not evaluate and demonstrate the feasibility of deploying advanced nuclear reactors at the CRN Site as part of TVA's technology innovation efforts aimed at developing future generation capabilities. The No Action Alternative would not meet the project purpose and need. However, it is included in this PEIS review as it provides a baseline for describing the anticipated environmental effects of the proposed action for comparison to the Action Alternatives.

2.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced non-LWRs

To meet the purpose and need, the project considers an array of potential activities, including the potential site preparation, construction, operation, and decommissioning of one or more advanced nuclear reactor(s) at Area 1 of the CRN Site (Figure 2-1).

Options to be considered under this alternative include:

- Alternative B1 – Construction of one or more SMR(s). Under this alternative, one or more of the reactor types shown in Table 2-1 would be constructed and operated on Area 1.
- Alternative B2 – Construction of one or more SMR(s) and/or advanced non-LWR(s). Under this alternative, one or more of the reactor types shown in Table 2-1 and/or one or more of the reactor types shown in Table 2-2 would be constructed and operated on Area 1.

2.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced non-LWRs

To meet the purpose and need, the project considers an array of potential activities, including the site preparation, construction, operation, and potential decommissioning of one or more advanced non-LWR(s) at Area 2 on the CRN Site (Figure 2-2).

2.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced non-LWRs

To meet the purpose and need, the project considers an array of potential activities, including the site preparation, construction, operation, and potential decommissioning of one or more advanced nuclear reactor(s) at Area 1 and Area 2 on the CRN Site (Figure 2-3). Specifically, one or more SMR(s) shown in Table 2-1 and/or advanced non-LWR(s) shown in Table 2-2 could be constructed at Area 1 and one or more advanced non-LWR(s) could be constructed at Area 2.

2.3 Alternatives Eliminated from Consideration

2.3.1 Alternative E – Construction of SMRs at Alternative Sites

As part of the ESPA process, TVA conducted a siting study with the overall objective of identifying a nuclear power plant site that:

1. Meets TVA's business objectives for the project as outlined in Section 1.1,
2. Satisfies applicable NRC site suitability requirements, and
3. Complies with NRC's implementation guidance for NEPA requirements regarding the consideration of alternative sites.

Site selection was conducted in accordance with the process outlined in the *Advanced Nuclear Technology: Site Selection and Evaluation Criteria for New Nuclear Power Generation Facilities* (EPRI Siting Guide), June 2015, Report 3002005435 (EPRI 2015) and defined in NUREG-1555, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan*, Revision 1, July 2007 (NRC 2007). The results of the study were published in the *Tennessee Valley Authority Site Selection Report* (TVA 2016).

After a rigorous screening process described in the report, three alternative sites were considered in detail for construction of SMRs: the Clinch River Site, a site on the ORR, and a site at the Redstone Arsenal in Alabama. TVA's ESPA ER described (1) the TVA region of interest for identification of alternative plant sites, (2) the methods used by TVA to select the proposed site and alternative sites, and (3) generic issues that are consistent among the alternative sites. The ESPA ER also compared the environmental impacts at the CRN Site to those at the alternative sites. The ESPA ER and NRC ESP FEIS qualitatively determined that none of the alternative sites are obviously superior from an environmental or nuclear safety perspective to the proposed site. The NRC ESP FEIS recommended that an ESP should be issued for the Clinch River Site in Roane County, Tennessee. Following publication of the NRC ESP FEIS in April 2019, the NRC issued an ESP to TVA in December 2019. TVA does not have such an authorization for any other site. For these reasons, TVA finds that Alternative E does not meet the purpose and need of this PEIS to develop a Nuclear Technology Park at the CRN Site, and this Alternative is dismissed from further consideration.

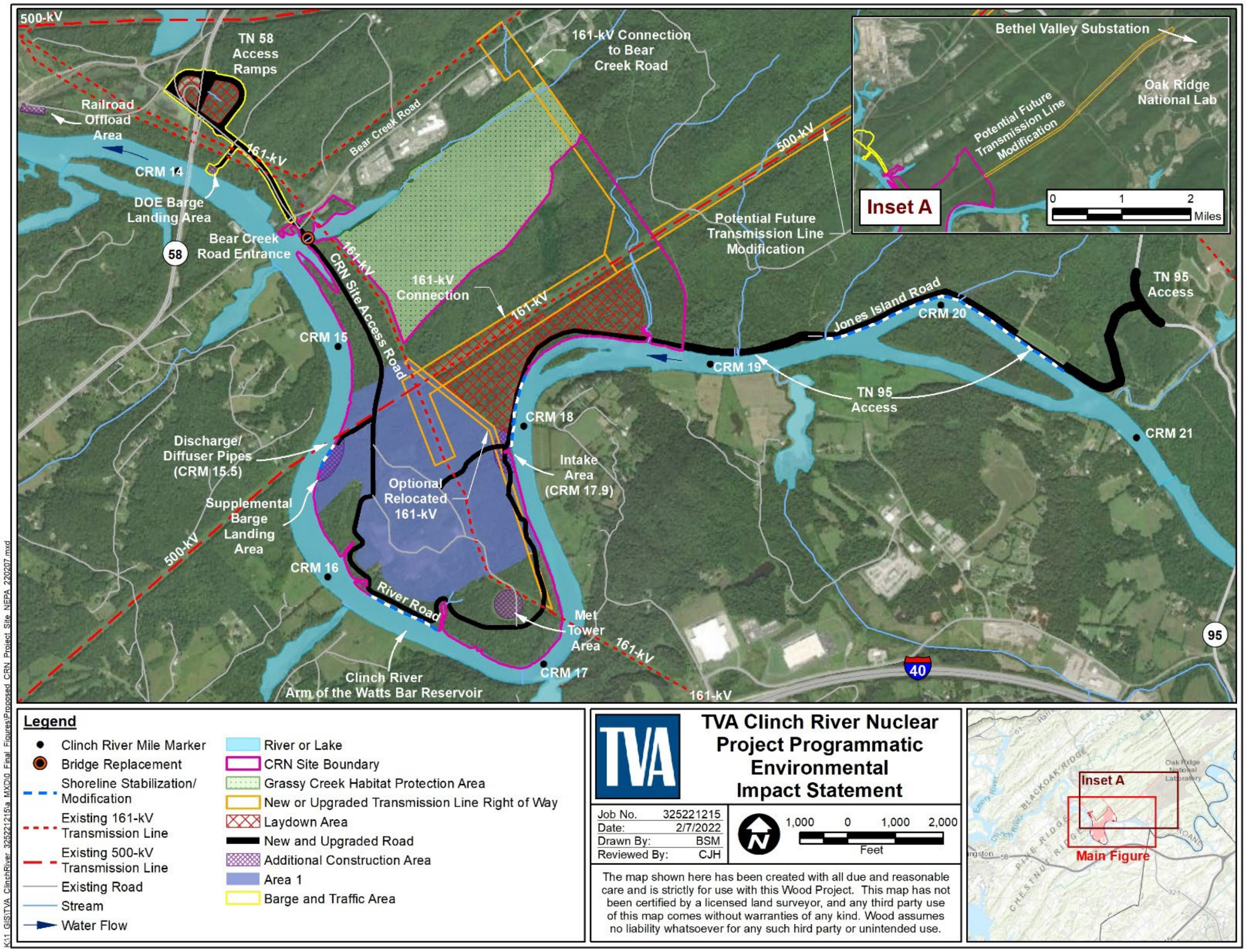


Figure 2-1. Alternative B: Nuclear Technology Park at Area 1 with SMRs and/or Advanced non-LWRs

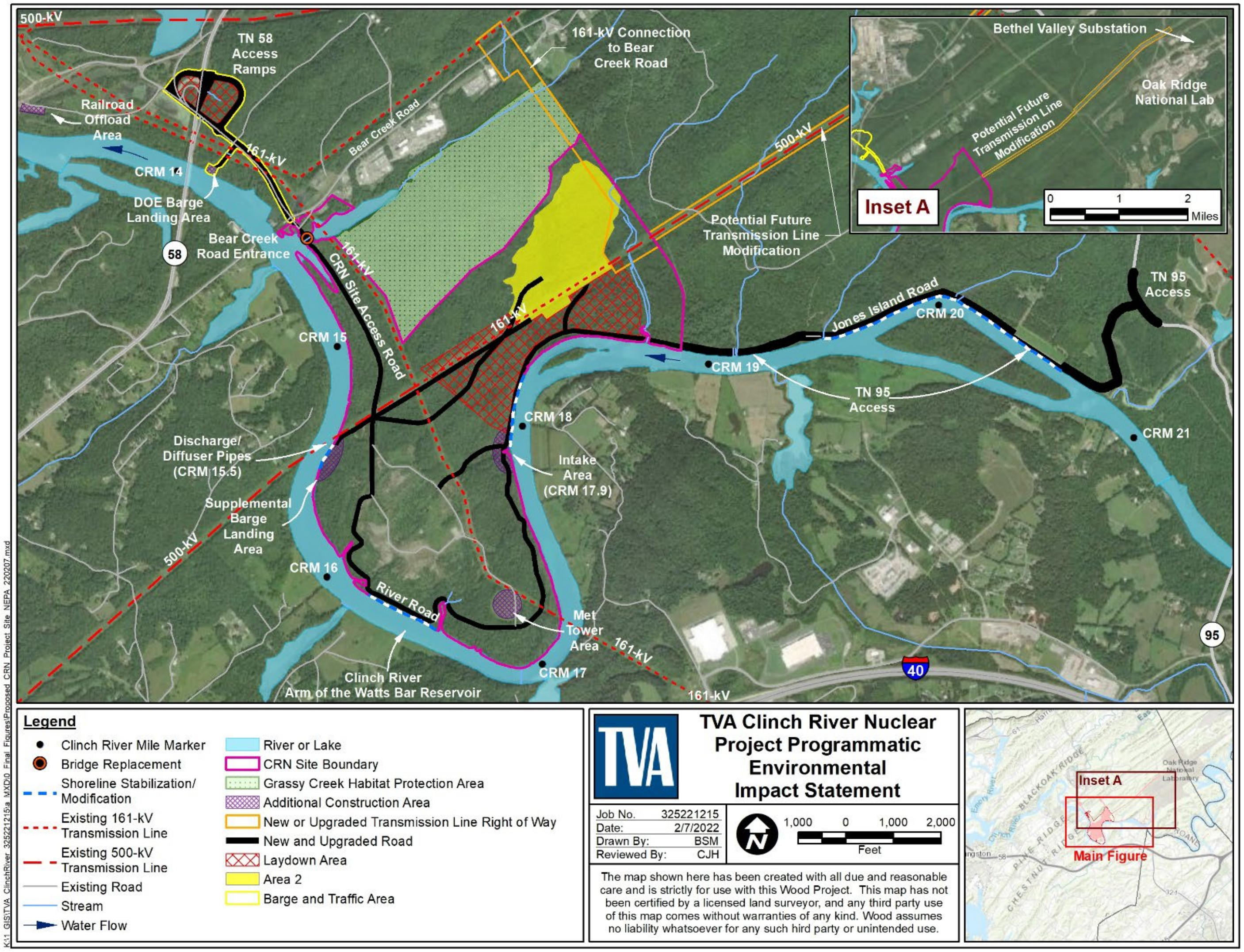


Figure 2-2. Alternative C: Nuclear Technology Park at Area 2 with Advanced non-LWRs

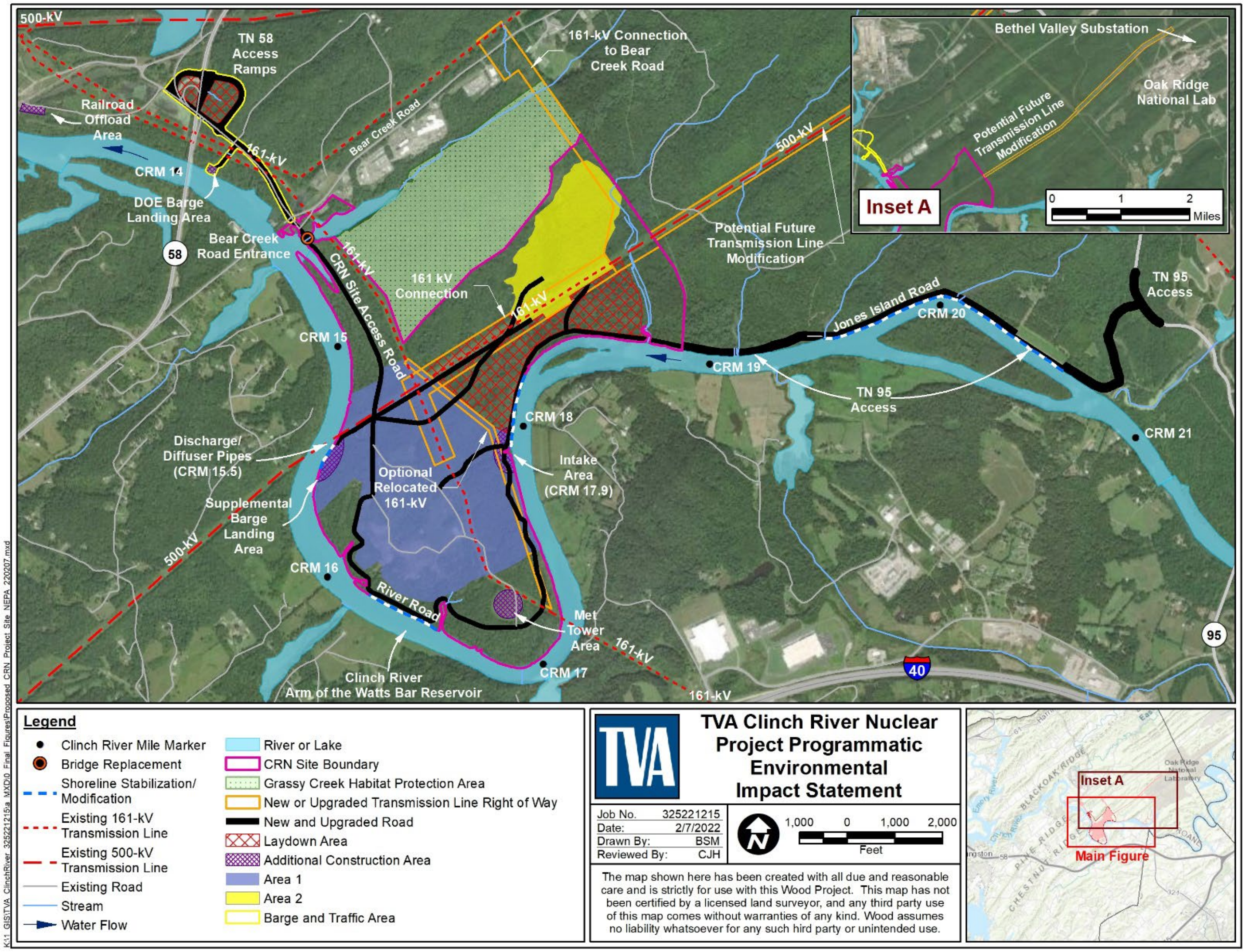


Figure 2-3. Alternative D: Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced non-LWRs

2.4 Alternative F – Construction of Alternative Energy

Construction of other generation systems (e.g., solar, coal, etc.) would not meet the purpose and need of this Project. TVA considered various generating technologies in the 2019 Final IRP that would meet the anticipated future demand for power with low-cost, increasingly clean, reliable electricity supply. This includes up to 14 gigawatts (GW) of solar and up to 5 GW of electricity storage added to the TVA mix of power generation resources. Alternative energy generating sources are being considered for other locations in the TVA system, and they are being evaluated and pursued under separate analyses, as appropriate. For these reasons, TVA finds that Alternative F does not meet the purpose and need of this PEIS to develop a Nuclear Technology Park at the CRN Site and is dismissed from further analysis

2.5 Nuclear Technology Park Development Characteristics

The following sections provide descriptions of the activities required for site preparation, construction, operation, and decommissioning of any of the nuclear technologies that might become part of a Nuclear Technology Park at the CRN Site. The descriptions encompass the activities that could occur under all alternatives being considered. Specific considerations relating to permitting or authorizations for those certain actions that are currently contemplated, including decommissioning, are addressed in Chapter 3. Any additional specific considerations relating to permitting or authorizations not currently contemplated would be analyzed in supplemental NEPA analyses at the appropriate time.

2.5.1 General Site Development

2.5.1.1 Primary Use Areas on the CRN Site

Land clearing, grading, and excavation would be required in conjunction with any development of the CRN Site. Areas proposed for use include Area 1, Area 2, laydown areas, transmission line ROWs and the roadway network. Major site infrastructure that could be constructed or installed within Areas 1 and/or 2 include the reactor and turbine buildings, cooling towers, transmission lines, transformers, switchyard, administration/control building, and associated parking.

Major cut and fill activities are expected with the grading of Area 1 and/or Area 2 in preparation for any nuclear foundation construction. As such, for the purposes of impact analysis, all lands within the footprint of Area 1, Area 2, and the laydown area are assumed to be disturbed in conjunction with site development for each alternative, as appropriate. TVA intends to use onsite cut/fill material to balance and minimize the need for offsite borrow material. If borrow material is needed, the associated actions would be addressed in a supplemental NEPA analysis. Topsoil typically contains organic material, such as vegetation, leaves, roots, etc., and as such it is not expected to be suitable for reuse as fill material. The excess topsoil would be spread outside the reactor Power Block (the area containing the reactor, turbine, cooling tower, transmission lines, transformers, switchyard, admin/control building, and associated parking) perimeter fences and reseeded instead of being hauled off the CRN Site. It is assumed that other in-situ soils would be suitable for general and structural fill. Importing sand, rock, or other similar materials may still be required for pipe bedding, surfacing, riprap use, etc. Blasting may be required in certain areas due to the known presence of bedrock on the site. Details regarding the need for blasting and its associated impacts would be evaluated in a subsequent NEPA review when more design and construction information is available. The existing stormwater management system in Area 1 consisting of stormwater runoff/collection ponds and associated piping remaining from the CRBRP would be re-used as practicable.

Area 1 and Area 2

Area 1 is located on a relatively flat plateau within the southwest part of the CRN Site (Figures 2-1 and 2-3). The existing grade in Area 1 varies from 800 AMSL to 770 AMSL. Approximately 240 acres within Area 1 were disturbed in 1982-1983 during CRBRP site preparation activities which included leveling a ridge from 880 feet AMSL to 780 AMSL, excavation of the reactor area, and the installation of various structures. The excavation totaled approximately 24 acres with a depth of up to 100 feet. After the CRBRP termination in 1983, site redress plans were implemented by DOE. The excavated area was partially backfilled in a manner to sustain site drainage. Level areas of the CRBRP site were graded and compacted. The hilly terrain northeast of Area 1 directs the flow of stormwater runoff toward Area 1.

Area 2 is located on the northeast part of the CRN Site (Figures 2-2 and 2-3) and consists of forested rolling hills with the exception of the cleared, 500-kV ROW. Elevation ranges between approximately 780 ASML to 950 AMSL. Some cut work or grading would be required to level Area 2 for construction.

The final determination of the reactor locations and elevations would require detailed geotechnical analysis for slope stabilization, erosion protection, and stormwater discharge. Some fill may be required for both Area 1 and Area 2 to raise the existing grade; as stated earlier, the plan is to use a balanced cut/fill process to minimize the need for offsite borrow material.

Laydown Areas

Approximately 129 acres of onsite and offsite laydown areas would be required for material staging and storage in support of construction on the CRN Site (see Figures 2-1 through 2-3). Much of the onsite laydown area is currently heavily vegetated and wooded. Clearing, grubbing, and grading for construction of the gravel or paved laydown area and potential crane pad would be necessary. Haul roads would be constructed within the onsite laydown area to both Areas 1 and 2. A 50-foot buffer would be maintained to protect the large wetland complex near the east boundary of the onsite laydown area. An additional offsite laydown area would be required for improvements of the TN 58 ramps and Bear Creek Road. Improvements for the TN 95 access would utilize onsite laydown areas as appropriate. Following CRN Site construction activities, some or all the laydown area would be revegetated with non-invasive plant species. A portion of it may be retained for use as laydown for future plant outage and maintenance work.

Landscape and Stormwater Drainage

Large portions of the CRN Site would be cleared and graded during site preparation. Therefore, drainage runoff controls would be established early in the process. Activities related to installing site drainage would include grading, creation of berms around temporary spoils disposal areas, and shallow trenching for ditches, drainpipes, and culverts.

Slopes, swales, ditches, and pipes would direct runoff to aboveground stormwater management ponds. Existing retention ponds in Area 1 would be redesigned and rebuilt as needed to accommodate excavation dewatering effluent and runoff from the future plant design. Establishing the redesigned stormwater management ponds would involve shallow excavation and emplacement of geotextile fabric, drainpipe, rock, cover material, and grading as needed. The surface would be re-vegetated, graveled or paved, depending on the use, to stabilize the surface.

Drainage crossings have been identified along the site access road in addition to the existing bridge/culvert at the Grassy Creek crossing. The existing bridge/culvert crossing at Grassy Creek is in poor condition and would need to be removed and replaced to accommodate heavy construction vehicles. Similarly, additional drainage crossings have been identified along the new access road to Area 2. An entirely new site drainage system would be required at Area 2.

The stormwater system design is assumed to be sheet runoff to swales and inlets, which would discharge to the Reservoir at permitted discharge point(s). Site stormwater discharge would be controlled through detention in accordance with NPDES requirements. New culverts and improvements to existing culverts would be required in support of site development.

2.5.1.2 Road Development

Development of the CRN Site would require the construction and/or improvements of roadways within both the CRN Site and associated offsite areas to provide access (see Figures 2-1 through 2-3). Roadways within the CRN Project Area include the following existing and proposed new roads: site access road from the Bear Creek Road entrance, River Road; site access road from TN 95; access road to Area 2 from the Bear Creek Road access; additional access roads to Area 2; roads to the intake and discharge areas; and temporary haul roads. All roads would be 2-lane roadways of sufficient width (up to 50-foot width) to accommodate heavy civil construction equipment and industrial traffic. The limits of disturbance for any road construction on the CRN Site is assumed to be 100 feet in width. Clearing and grading would be required to construct the new roads with the applicable maximum grade requirements.

Proposed roadways would be either asphalt or gravel and designed to support heavy haul traffic required for construction and plant maintenance using the following criteria:

1. An approximate 24-foot-wide asphalt pavement with 3-foot-wide gravel shoulder on each side, a total width of up to 50 feet. This road width would need to be verified in Phase 2 Site Development studies.

2. Minimum radius of horizontal curvature: 500 feet.

3. Maximum vertical slope: 4 percent.

4. Design speed for plant access road: 30 mph.

New culverts or culvert replacements would be required in several locations along the TN 95 Access, River Road and the road connecting to Area 2. Blasting of rock to widen the road and tie backs or rock anchors to stabilize rock faces may be required in localized areas. This work would result in periodic high levels of noise and vibration that may be heard offsite. Details to quantify any amount of blasting and associated impacts would be described in a subsequent NEPA review when more design and construction information is available.

Roads within the BTA

TN 58 represents the primary access point for the CRN Site as it is expected that approximately 80 percent of traffic entering and exiting the site would use this route. The

ESPA ER and NRC EIS evaluated 100 percent of the traffic entering the site from TN 58 through the Bear Creek Road Entrance and identified specific mitigation measures to prevent deterioration of traffic levels below Tennessee acceptable standards at the TN 58 and Bear Creek Road intersection due to the substantial increase in traffic associated with the Nuclear Technology Park. These measures have been incorporated into the overall project and include the following:

- Adding a northbound access ramp between TN 58 and Bear Creek Road
- Widening of Bear Creek Road to three lanes, including a reversible traffic lane between TN 58 and the CRN Site entrance
- Signalizing the intersection of Bear Creek Road and the CRN Site entrance
- Adding a two-lane roundabout at the intersection of the proposed northbound ramp and Bear Creek Road
- Adding a northbound exit and entry lanes on TN 58 for accessing and exiting the proposed ramp to Bear Creek Road.

In addition, Bear Creek Road could be realigned to a “T” intersection, eliminating the existing curve at the CRN Site entrance, and widened and upgraded to create a heavy haul road between the rail delivery area and the CRN Site entrance.

TN 95 Access

The TN 95 Access is expected to carry up to 20 percent of traffic entering and exiting the CRN Site. This access starts at the gated entrance to the DOE property on TN 95 and extends southwesterly, intersecting with Jones Island Road near Clinch River Mile (CRM) 20.75. The route then follows Jones Island Road west to the CRN Site boundary where it becomes River Road on the CRN Site. River Road and Jones Island Road are currently gated and not used by the public. Use of Jones Island Road for CRN Site access would require a change in DOE’s current use of the road. Both River Road and Jones Island Road would require significant improvements to roadway geometry, shoulders, and clear zones for use as heavy haul and construction roadways. Where these roads are located close to the Reservoir, shoreline stabilization and other measures would also be required in certain areas. Benching back of slopes, riprap work, retaining walls, concrete or asphalt paving would be required for this upgrade, as appropriate. Limits of roadway construction for primary site access roads are assumed to be up to 100 feet wide to accommodate construction traffic, grading requirements, and utility location, but would be minimized as appropriate during final design.

There are some radiologically contaminated areas along the TN 95 Access on the ORR that have been previously remediated by DOE’s Environmental Management program. These remediated areas would be avoided to the extent practicable. In the event the remediated areas cannot be avoided, plans to use these remediated areas would be made in accordance with DOE, EPA and TDEC guidance and approvals, including existing land use and institutional controls, and the appropriate TVA guidelines.

2.5.1.3 Shoreline Stabilization and Restoration

Improvements to the TN 95 access road and barge landing, both on DOE land, and River Road on TVA land may require stabilization measures on up to 9,050 feet of shoreline between CRM 20.75 and CRM 16.2. Riprap would be required in certain areas to rebuild, stabilize, and protect shoreline and would protrude into the river at a maximum of +/- 10 feet. Based on design, rock riprap of sufficient size would be installed from the toe (2 feet below normal pool) to the top of the eroding bank. Delivery and placement of the riprap would be conducted by barge, and filter fabric would be applied where practical. The banks are covered with limited grasses, forbs, shrubs, and trees. Disturbed ground outside of the shoreline stabilization area that is not covered by existing shoreline buffer plantings would be revegetated utilizing non-invasive woody and herbaceous plants. Clearing of trees along the riverbank would also be required. Sheet piles or other similar type retaining wall pylons may be required in areas where the riverbed is too deep for practical use of riprap.

2.5.2 Transmission System

2.5.2.1 Existing Transmission System

Two transmission corridors cross the CRN Site as shown on Figures 2-1 through 2-3. The Kingston FP–Ft Loudoun HP 161-kV No.1 transmission line crosses the site from the southeastern tip of the peninsula (Figure 2-1) to the northwestern corner of the CRN Site near the entrance gate off Bear Creek Road. The Bull Run FP-Watts Bar NP 500-kV transmission line transverses the CRN Site from the northeast to the southwest. Both of these lines are owned and operated by TVA.

2.5.2.2 Transmission System Upgrades

Every alternative other than the No Action Alternative would require transmission upgrades to complete the connection between the CRN Site and existing power transmission systems. As summarized in Table 2-3, the need for these upgrades is dependent upon the project alternative and specific reactor technologies selected for the Park. The following list describes the potential types of transmission upgrades required to support the construction of one or more advanced nuclear reactors generating up to 800 MWe and to connect the CRN Site to the grid, considering the use of both Area 1 and/or Area 2.

- Construction of a new 500-kV switchyard on the CRN Site.
- Construction of a new 161-kV switchyard on the CRN Site.
- Construction of a small substation, likely near the 161-kV line on the CRN Site.
- Potential future transmission line modification along segment of 500-kV transmission line that extends northeast, outside of the CRN Site boundary to the Bethel Valley substation.
- A new 161-kV above ground transmission line extending from the existing 500-kV transmission line, across the CRN Site, and then offsite perpendicular to Bear Creek Road. This proposed transmission line would require a 120-foot-wide ROW but would be located within a corridor that is up to 280 feet wide (see Figures 2-1 through 2-3).
- For alternatives proposing development of Area 1, relocation of the 161-kV transmission line that bisects Area 1 of the CRN Site. Based on reactor siting needs, the transmission line could be shifted eastward as shown on Figure 2-1 and 2-3.
- For alternatives proposing development of Area 2, construction a new 120-foot-wide transmission line ROW that would extend from the proposed Area 1 switchyard across the entire length of the site to provide power to Area 2.

Development of the corridor connecting the Area 1 switchyard to Area 2 would consist of clearing and grubbing approximately 1-2 miles of new transmission ROW. Some grading may be required depending on terrain along the new ROWs. Construction of transmission towers and lines would be consistent with standard TVA Transmission and Power Supply construction methods. Table 2-3 lists the transmission elements and potential ROW areas expected to be needed to support the proposed Nuclear Technology Park.

Table 2-3. Transmission System Upgrades Parameters

CRN Site Feature/Attribute	Design Description	Alternative
New Switchyards (500-kV, 161-kV)	Location and size within Area 1 or 2 subject to design	B, C, D
New Substation (161-kV)	Small substation near the existing 161-kV line and existing tap from the CRBRP.	B, C, D
161-kV connection from the existing 161-kV line along Bear Creek Road southeast to 500kV-line near northern CRN Site boundary and Area 2	120-foot ROW to be developed within a 280-foot corridor	B, C, D
Potential future 500-kV transmission line modifications; extends northeast, outside of the CRN Site boundary to the Bethel Valley substation.	Extent of upgrades would be determined based on final design.	B, C, D
161-kV transmission line (TL) relocated along edge of Area 1	120-foot ROW	B, D
Connection from Area 1 switchyard to Area 2	Additional 120 feet of the existing 161-kV ROW and the 500-kV ROW	B, D

Other Potential Offsite Transmission System Upgrades

In addition to the upgrades listed in Table 2-3, TVA expects that upgrades may be required for multiple offsite transmission lines in conjunction with the development of the Nuclear Technology Park at the CRN Site including potential modifications to the 500-kV transmission line which extends northeast, outside of the CRN Site boundary to the Bethel Valley substation (Figures 2-1 through 2-3). Potential modifications within this transmission line corridor would occur under Alternatives B, C, and D, however the extent of upgrades would be determined during final design. Because details regarding these upgrades are not yet available, specific environmental impacts from these actions cannot be fully evaluated in this PEIS. However, the area within this segment of the 500-kV transmission line is described and general environmental impacts from potential upgrades in this corridor are determined by affected resource in Chapter 3.

TVA also identified a number of other potential offsite transmission upgrades during the development of the ESPA based on the PPE. Because such upgrades are highly dependent upon the type of reactor technology selected, as well as regional grid stability issues at the time of project development, specific needs for offsite transmission upgrades cannot be determined at this time. Needs for all offsite transmission development would be determined following the selection of a particular reactor technology and would be the subject of additional NEPA review as necessary and appropriate.

2.5.2.3 Transmission Development Activities

Installation of new transmission lines and relocation of the existing 161-kV transmission line on the CRN Site would involve the removal of vegetation, including trees and shrubs, along portions of the transmission line corridors and access roads, movement of construction equipment along the ROW, and excavation for the foundations of the transmission line towers. Temporary dewatering may be needed to build footings for transmission towers.

These activities would involve access by standard transmission line equipment (e.g., bulldozers, bucket trucks, boom trucks, forklifts) in the expanded ROWs described above. Transmission structure replacement or new structure installation would involve limited clearing and shallow excavation, usually within 100 feet of the structure location. Conductor modification would involve using a bucket truck to access existing lines.

2.5.3 Cooling Water System

2.5.3.1 Cooling Water Intake System

Preparing the cooling water intake structure location would require clearing, grubbing, and grading the structure location; placement of a temporary cofferdam in the Reservoir; and shallow excavation along the shoreline to form the forebay for the cooling water intake structure (CWIS). The intake system is expected to be approximately 50 feet wide and 50 feet in length with four intake channels. Each channel likely would include a debris raking system and trash racks, and they may require fish returns.

The design of the intake structure would comply with the CWA 316(b) regulations by providing aquatic life protection. The maximum through-screen velocity at the water screens would be less than 0.5 feet per second. A common CWIS is expected for all reactors to be located within the Nuclear Technology Park.

The flow velocities for operational modes other than full power operation have not yet been defined, pending selection of specific reactor technologies. The quantities of chemicals used for treatments of intake or process waters to prevent biological fouling would be in accordance with a site and technology-specific Biocide/Corrosion Treatment Plan (B/CTP) that would be permitted and approved by TDEC and submitted as required with the NPDES permit application for the facility. Underwater excavation would be used to install the intake structure. Additionally, localized dredging would be used to support installation.

2.5.3.2 Cooling Water Discharge System

The discharge structure for the CRN Site is proposed to be located at approximately CRM 15.5. This structure is expected to consist of a concrete or riprap headwall, two 3-foot-diameter outfall diffuser conduits each, approximately12 feet long, extending from the discharge structure on the shoreline into the Reservoir. The system would be designed to minimize erosion instream and on land. Underwater excavation would likely be used to install the discharge system, with localized dredging to support installation.

Installing the cooling water discharge system would require clearing, shallow excavation, and backfilling. Any excavated material would be disposed of appropriately depending on the characterization of the material and in accordance with CWA Section 404 permit conditions.

2.5.3.3 Cooling Towers
The conceptual design for the plant(s) developed in support of the PPE includes mechanical draft cooling towers to dissipate heat. The mechanical draft cooling towers would be no more than 65 feet in height and disturb no more than approximately 6 acres in the CRN Project Area.

2.5.3.4 Melton Hill Dam Flow Augmentation
In the ESPA, TVA proposed to add a bypass flow system (conduit) through an existing part of the Melton Hill Dam structure to maintain a minimum flow of 400 cubic feet per second (cfs) independent of the hydroelectric generating system. This supplemental flow was proposed in conjunction with TVA's management of thermal conditions of the river. Depending on the technology selected for deployment at the CRN Site, it is possible that instead of modifying the Melton Hill Dam structure, TVA could manage releases from the Melton Hill Dam to augment flow and maintain water quality. Such flow augmentation would be accomplished using the existing dam and would not substantially disturb the Clinch River sediments. Details regarding the need for augmentation of Melton Hill Dam Flow and its associated impacts would be evaluated further in a subsequent NEPA review when more technology-specific design and construction information is available.

2.5.4 Other Infrastructure

2.5.4.1 Barge Facilities
With DOE's permission, TVA expects to use the previously developed offsite barge unloading area in the BTA as the primary barge facility. This facility (Figures 2-1 through 2-3) includes a gravel pad, an access road, and a sheet pile retaining wall on the edge of the Reservoir. The depth of the Reservoir in this area is sufficient to allow barge access. Only minimal improvements would be needed to use this facility in support of CRN Site development. The landside area would be cleared of vegetation, re-graveled, and refurbished as needed to support barge offloading activities. The access road would be widened according to the roadway specifications stated in Section 2.4.1.2. No instream work or disturbance is expected to be required to make this facility usable for TVA's purposes. Should instream work be required for the existing offsite barge facility in the future, additional NEPA evaluation would be conducted.

As a back-up to using the DOE barge facility, a supplemental onsite barge landing is being evaluated for the Nuclear Technology Park. The supplemental onsite barge landing would be located within the CRN Site a short distance upstream of the discharge location (Figures 2-1 through 2-3). This onsite barge landing would be constructed out of riprap and engineered fill. Sheet piles may be required during construction. Dredging is not expected but may be required as a part of this activity. A concrete crane pad may be constructed. Permanent upland disturbance area for the proposed barge landing is estimated to be up to 1 acre. Additionally, the barge landing area is expected to entail the disturbance of approximately 200 feet of shoreline and up to 0.23 acres of instream habitat. Localized dredging would also be used to support installation.

The supplemental onsite barge landing would require a new 0.5-mile access road from the main CRN Site entrance road. This road would be consistent with the other access roads described in Section 2.4.1.2.

2.5.4.2 Rail
The Energy Solutions Heritage Railroad is an existing, privately owned, 11.5-mile rail line between the Norfolk Southern Railway line and the East Tennessee Technology Park

(ETTP), north-northwest of the CRN Site. A spur of the Energy Solutions Heritage Railroad ends at an offload area just west of the TN 58 and Bear Creek Road intersection (Figures 2-1 through 2-3). TVA is considering using this rail spur for building material, equipment, and component deliveries to the CRN Site. Use of the railroad would primarily occur during the construction and preconstruction period, but it could also be used for delivery of large parts or components during operation. To meet this anticipated purpose, the railroad would require refurbishment of the lines in the offload area and possibly elsewhere on the line.

2.5.4.3 Other Supporting Infrastructure and Site Development

Development of a Nuclear Technology Park at the CRN Site would require the installation of temporary utilities to support construction activities including power, lighting, communications, potable water and waste treatment, fire protection, construction gases, air systems, and pre-operational monitoring equipment. Temporary facilities would also be required including parking lots, laydown, storage, and fabrication areas. Temporary construction facilities, including offices, warehouses, workshops, sanitary facilities, locker rooms, training facilities, storage facilities, and access facilities would also be installed. In addition to temporary construction facilities, TVA may choose to construct and operate an onsite landfill for construction, site clearing, and grading debris. The landfill would be constructed in accordance with relevant permits and licenses. All construction activities, facilities, and supporting infrastructure would occur within the CRN Project Area shown on

Development of the CRN Site would also entail the construction and refurbishment of permanent infrastructure to support plant operation that includes onsite utilities, potable water (from the City of Oak Ridge) and sewage pipelines, fire water lines, stormwater runoff ponds, security systems, administration and warehouse buildings, training, and other miscellaneous support facilities.

2.5.5 Traffic

Over the course of the initial estimated 6-year construction period, approximately 100,000 transport construction vehicles would be expected to enter and exit the CRN Site from either the main entrance within the BTA or via the TN 95 Access. Per the traffic assessment performed for the ESPA ER, up to 5,700 vehicles could enter the site per day at the peak construction period. TVA projects that 80 percent of the construction traffic would use the Bear Creek Road entrance and 20 percent would use the TN 95 Access. It is anticipated that the intersection of Bethel Valley Road and TN 95 would require modification to facilitate safe traffic flow.

Existing transportation routes would be affected by an increase in commuter traffic to and from the CRN Site associated with the construction and operation workforces. The workforce for the new plant would use the same access routes identified for plant construction. Approximately 80 percent of the operation traffic for Areas 1 and 2 is anticipated to access the CRN Site via Bear Creek Road with the other 20 percent accessing the site via the TN 95 Access. In addition to serving as a secondary entrance to the site, the TN 95 entrance could serve as an alternate site emergency egress.

2.5.6 Staffing

Staffing would be dependent on selected reactor type(s); see Table 2-1 and Table 2-2. The total peak construction workforce (including some operational staff) evaluated in the ESPA was up to 3,300 workers. It is anticipated the construction, operational, and support workforces for Area 1 and Area 2 would be less than, and bounded by, the analysis in the ESPA ER.

The total facility operation workforce for a Nuclear Technology Park built out to 800 MWe capacity is estimated to be not more than 500, as presented in Table 2-4 and the PPE in Appendix A, item 16.3.1. It is assumed that operation staffing would begin at the same time as site preparation to allow time for simulator training and startup testing support, and it would increase to full staffing at the time of the initial unit(s) operation. Staffing would continue to ensure a full complement of operation personnel at the time of the additional unit(s) operation. Up to an additional 1,000 workers (Appendix A, item 16.3.2) are expected to temporarily work at the CRN Site during periodic refueling and major maintenance activities. Detailed staffing analyses related to refueling activities would be analyzed in a future, supplementary NEPA analysis.

2.5.7 Operational Water Use

Water is required to support the facility during construction and operation. Typical water uses for facility operation include the circulating water system (CWS), potable and sanitary water system, fire protection systems, and other auxiliary systems such as demineralized water and a liquid radioactive waste treatment system. All reactor technologies evaluated in this PEIS would require some quantity of makeup water. The primary water makeup source for plant operation would be water withdrawn from the Reservoir via a new intake structure. During construction activities, water for concrete batch plant operation would be provided by the City of Oak Ridge. Surface water from the Reservoir may be used during construction for purposes such as dust control. Water for potable and sanitary uses during both construction and operation would be obtained from the City of Oak Ridge.

The ESPA assumes a closed loop CWS with the use of mechanical draft cooling towers, but this is not expected for all reactor types considered in this PEIS as discussed in Section 2.1.1. For reactor technologies that would utilize mechanical draft cooling towers, per the ESPA ER and PPE (Appendix A), the intake is expected to withdraw an average of approximately 18,500 gallons per minute (gpm) and a maximum of approximately 31,000 gpm. Of this total, approximately 17,000 gpm average (approximately 26,000 gpm maximum) is to serve as makeup water for the CWS. These values are intended to serve as bounding values to evaluate maximum environmental impacts The proposed CWS would likely use mechanical draft cooling towers for heat dissipation from the plant systems.

The mechanical draft cooling towers would consume some water through evaporation and drift. The average and maximum drift rate is estimated to be 8 gpm, and the average and maximum evaporation rate is estimated to be 12,800 gpm (Appendix A, item 3.3.9). For discharge mixing, blowdown from the cooling towers could be distributed to a holding pond on the western edge of the site. The blowdown rate is estimated to be an average of 4,270 gpm, and a maximum of 12,800 gpm (Appendix A, item 3.3.4). The holding pond would discharge water back to the Reservoir through the proposed discharge located at CRM 15.5. Note that the operational modes for the CWS would be defined as specific reactor designs are selected.

For reactor technologies that would not utilize mechanical draft cooling towers, the assumptions of operational water usage and actual operational water usage captured in the ESPA ER and PPE would conservatively bound any operational water use impacts.

Of the total intake withdrawal volume, an average of 1,345 gpm (and a maximum of 5,100 gpm) would be directed to the plant and facilities, from which it would be distributed for use to various auxiliary systems (Appendix A, item 3.2.3). The consumptive uses of water within these systems are estimated to be negligible. The specific water volumes distributed to each of these individual uses have not been defined but are to be developed once the reactor design has been selected. Estimated effluent from the miscellaneous raw water users, miscellaneous demineralized water users, and fire protection system are distributed to the holding pond at an average flow rate of 445 gpm and maximum flow rate of 4,200 gpm (Appendix A, item 3.2.4). The effluent from the liquid radioactive waste treatment system could be discharged directly to the Reservoir through the proposed discharge at CRM 15.5, at a maximum flow rate of 900 gpm (Appendix A, item 10.2.1).

Water for potable and sanitary purposes during operation is estimated to have a normal demand of 50 gpm and a maximum demand of 100 gpm (Appendix A, items 5.1.1, 5.1.2). Potable water would be provided from the City of Oak Ridge for restrooms, emergency safety showers, and as required for drinking water in both Areas 1 and 2. Because the use of City of Oak Ridge water during operation is less than during construction, impacts of that use would be bounding for operation. No onsite or offsite groundwater would be used during operation and no permanent dewatering system is planned.

2.5.8 Waste Management

2.5.8.1 Radioactive Waste Management

Radioisotopes are produced during the normal operation of nuclear reactors through the processes of fission and activation. Fission products may enter the reactor coolant by diffusing from the fuel and then passing through the fuel cladding via leaks or by diffusion. The primary coolant may contain dissolved or suspended corrosion products and nonradioactive materials leached from plant components. These products and materials can be activated by the neutrons in the reactor core as the water passes through the core. These radioisotopes leave the reactor coolant via plant systems designed to remove impurities, via small leaks that occur in the reactor coolant system and auxiliary systems, or via breaching of systems for maintenance. Therefore, each plant generates some quantity of radioactive waste that can be liquid, solid, or gaseous. This PEIS uses a PPE (see Table 24 and Appendix A) to provide an upper bound on liquid effluents, gaseous radioactive effluents, and solid radioactive waste releases. Because a preferred reactor design has not been selected for the project, bounding values (Appendix A) have been developed for the projected quantities of radioactive wastes to be generated, processed, and then stored or shipped as waste, whether in solid, liquid, or gas form. Following selection of the reactor technology, if radioactive waste parameters that are not bounded by the PPE are identified, future NEPA analysis would be required. Radioactive waste management systems would be designed and maintained to meet the requirements of 10 CFR Part 20 and 10 CFR Part 50, Appendix I and associated NRC guidance. However, TVA has not identified specific radioactive waste-management systems for the various reactor technologies that may be deployed on the CRN Site. As more details become available on forecasted radioactive waste generation, TVA would supplement this PEIS appropriately with additional analysis of any potential environmental effects.

For context purposes, note that SMRs are currently anticipated to generate comparable amounts, and the same types, of spent fuel and wastes on a per megawatt basis as the currently operating 1,000 MWe TVA nuclear fleet. Alternatively, advanced non-LWRs consist of many technologies with different existing and proposed nuclear fuel types that in many cases are yet untested and unproven in commercial settings; most proposed technologies have not been through the full testing and licensing processes for approval by the NRC or other regulators to allow for a complete understanding of their operational impacts.

At this time, TVA cannot provide an analysis of the anticipated environmental effects from these potential radioactive waste streams. As TVA better refines its proposal for this location, and as additional analysis and understanding is developed for these potential radioactive waste streams, TVA would supplement this NEPA analysis as appropriate.

2.5.8.1.1 Liquid Radioactive Waste

All liquid radioactive waste systems would be designed to control, collect, process, handle, store, and dispose of liquid radioactive waste generated as the result of normal operation, including anticipated operational occurrences. Sources of liquid radioactive waste include leakage from systems, wastes generated by processing systems, and maintenance activities.

NRC's regulations require proper accounting of all discharges of radioactive materials from commercial nuclear power plants. Liquid radioactive wastes present the potential of groundwater contamination. In all the cases of groundwater contamination evaluated by the NRC to date in the US, none have exceeded any of the NRC's dose limits or any of the licensee's Technical Specification Limits. Although no limits have been exceeded, some of the events evaluated by the NRC have exceeded the reporting thresholds, which require licensees to notify local, state, and/or federal authorities through an approved reporting system. Licensees report radioactive discharges and the results of all groundwater monitoring efforts in annual reports to the NRC.

The NRC licensing process for nuclear power plants includes a thorough review of all the plant's radioactive, gaseous, liquid, and solid waste systems, components, and programs to ensure that radioactive material is safely controlled in accordance with NRC regulations. The licensing process evaluates the plant's ability to safely handle, store, monitor, and discharge radioactive effluents in accordance with NRC requirements.

As with TVA’s current operating fleet of nuclear plants, any discharges of liquid waste from a point source would be to the Reservoir, after appropriate measurements and subject to monitoring and controls, to ensure any discharges would meet authorized requirements. Liquid waste processing systems would be designed to maintain the radiation exposures of plant personnel as low as reasonably achievable (ALARA). Appendix A, item 10.3.1 in the ESPA PPE provides the total projected bounding annual release activity in liquid effluents from the CRN Site as 887 curies per year (Ci/yr). Table 3.5-2 from the ESPA ER provides the total projected bounding annual release activity in liquid effluents from a single unit as 221 Ci/yr.

2.5.8.1.2 Gaseous Radioactive Waste

Typical gaseous radioactive waste release pathways include vents from collection tanks and processing equipment and non-condensable gases in steam systems. Regulated gaseous wastes would be collected and processed to decrease the radioactivity content to the point that they can be released to the environment through a controlled and monitored release point (plant vent or plant stack). Gaseous radioactive waste discharges would be controlled consistent with the requirements of 10 CFR 20 and the ALARA principles of 10 CFR Part 50, Appendix I, as well as applicable National Emission Standards for radioactive Hazardous Air Pollutants and all applicable Federal and state permit requirements. Gaseous radioactive waste system equipment would be designed to ensure occupational exposures to plant personnel are ALARA. Appendix A, item 9.5.1 in the ESPA PPE provides the total projected bounding release activity in gaseous waste from the CRN Site as 7,130 Ci/yr. Table 3.5-4 from the ESPA ER provides the total projected bounding annual release activity in gaseous waste from a single SMR unit as 1,550 Ci/yr.

2.5.8.1.3 Solid Radioactive Waste

The solid radioactive waste management system would be designed to collect, monitor, segregate, process, and prepare solid radioactive wastes prior to and for their shipment or onsite storage. The system design would ensure that any radioactive wastes are handled, processed, and stored in a manner that minimizes exposure to plant personnel and the public in accordance with 10 CFR 20 and 10 CFR Part 50, Appendix I.

Wastes would be packaged to meet DOT (49 CFR 173 and 178) and NRC (10 CFR 71) regulations for transportation of radioactive material. Radioactive waste would be transported to either a licensed waste processing facility or a licensed low-level radioactive waste disposal facility. As noted in the ESPA PPE (Appendix A, item 11.2.1), the projected bounding total annual activity of solid radioactive waste from the CRN Site was projected to be 57,200 Ci/yr, and, as noted in Appendix A item 11.2.3, the projected bounding generated volume of solid radioactive waste from the CRN Site would be no more than 5,000 cubic feet per year.

2.5.8.2 Non-Radioactive Waste Management

Typical non-radioactive waste streams include cooling water that may contain water treatment chemicals or biocides, water-treatment wastes, waste from floor and equipment drains, stormwater runoff, water pumped from excavations during construction, laboratory waste, trash, hazardous waste, effluents from the sanitary sewer system, and miscellaneous gaseous, liquid, and solid effluents. All waste streams would be managed in accordance with applicable permit and regulatory requirements.

2.5.8.2.1 Effluents Containing Chemicals or Biocides

Water used in various reactor operational systems requires treatment using chemicals and/or biocides to avoid scaling or fouling. The rates of inflow into and blowdown out of the water systems are to be managed, and effluents from the systems would be processed to minimize the concentrations of the chemicals and biocides contained in facility discharges. However, facility discharges may contain low-level concentrations of chemicals and/or biocides. The chemical concentrations in effluent streams would be controlled through engineering and operational/administrative controls to meet the requirements of a TDEC-approved Biocide/Corrosion Treatment Plan, which would be part of the site’s NPDES permit, as well as requirements and limitations set by relevant federal, regional, or local regulatory agencies at the time of construction and operation. The specific chemicals and biocides to be used depend upon the characteristics of the water to be treated and the design requirements of the reactor systems. The anticipated constituents and their concentrations in the facility’s non-radioactive liquid waste discharges are provided in Appendix A, item 3.3.3.

2.5.8.2.2 Sanitary System Effluents

The projected effluent flow from the facility’s potable/sanitary water system to the City of Oak Ridge sanitary treatment system is included in Appendix A, item 5.1.1, and is estimated to average 50 gpm. This equates to an average daily flow of 72,000 gallons per day (gpd). The estimated maximum flow rate, included in Appendix A, item 5.1.2, is 100 gpm, or a maximum daily flow of 144,000 gpd.

2.5.8.2.3 Gaseous Effluents

Nuclear reactors emit gaseous and particulate emissions to the air. For reactor technologies using cooling towers, the cooling towers are expected to be the primary source of particulate emissions. The primary sources of emissions from auxiliary systems are expected to be auxiliary boilers, standby diesel generators, and emergency standby gas turbine generators. These effluents commonly include particulates, sulfur oxides, carbon monoxide, hydrocarbons, and nitrogen oxides. Estimated emissions are provided in Appendix A, items 13.1, 13.2, 14.1, 14.2, and 14.3. TVA would consult with TDEC on air permit requirements following technology selection and would obtain operational air permits as required.

2.5.8.2.4 Liquid Effluents

Nonradioactive wastewater discharges to surface water from construction include water pumped from excavations and stormwater. Nonradioactive wastewater discharges to surface water from reactor units during operation include cooling tower blowdown; wastewater from the demineralized water system; and wastewater from floor drains, sinks, laboratories, and stormwater runoff. Additional aqueous waste streams may include raw cooling water, air conditioning condensate, steam generator blowdown, and high-pressure fire protection water. Non-radioactive liquid effluents would be discharged to the Reservoir, consistent with applicable regulatory and permit requirements.

2.5.8.2.5 Solid Waste

Operation of nuclear reactors result in the generation of hazardous and nonhazardous nonradioactive solid waste. Nonradioactive solid wastes include typical industrial wastes such as metal, wood, and paper, as well as process wastes including hazardous and universal wastes. Solid waste management practices and procedures would comply with applicable federal, state, and local requirements and standards for handling, transporting, and disposing of solid waste, as well as multiple internal TVA practices and procedures.

2.6 Programmatic Bounding Analysis

In order to programmatically assess potential effects associated with the development of a Nuclear Technology Park at the CRN Site, attributes of reactor technologies, facility siting requirements, construction characteristics, and operational features were compiled and summarized as bounding attributes and characteristics to support the analysis of potential environmental impacts. The PPE values described in the ESPA ER and contained in Appendix A of this PEIS summarize the bounding attributes of the SMR technologies included in the ESPA.

In conjunction with this PEIS, TVA requested further input from vendors to provide information that describes their technology (both SMR and advanced non-LWR) and associated parameter values for comparison against the ESPA PPE. Requested information included reactor type, coolant, moderator, cooling system, flow conditions, power output, electric conversion system, heat sink, and fuel type. TVA also requested physical plant structure parameters including structure heights, required excavation/foundation embedment, disturbance acreage, and water use requirements. TVA performed a confirmatory analysis utilizing the values provided by the vendors (SMR and advanced non-LWRs) to confirm that the contemplated reactor designs fit within the bounds of the ESPA PPE, as appropriate.

Selected values of the PPE in Appendix A are summarized in Table 2-4. The PPE defines a set of plant design parameter values that TVA expects would bound the characteristics of potential reactors that could be constructed at the CRN Site. The values in the PPE are based on a composite of advanced nuclear reactor owner-engineered data for all the technologies listed in Table 2-1 and Table 2-2. Similarly, the values in Table 2-5 represent site development attributes and bounding values associated with the development of the CRN Site. The values in the PPE bound the analysis in the PEIS for both SMR and advanced non-LWR technologies. TVA would supplement the PEIS if and where any reactor technology is selected; the use of the PPE approach should limit the quantity of topics required to be addressed in future reviews, and the level of detail of review necessary for each topic. Table 2-4 is a summarized version of the PPE table within Appendix A intended to provide a general representation of these contemplated design parameters.

Table 2-4. Representative PPE Bounding Parameters for SMRs and Advanced Non-LWRs

PPE Parameters	Value
Megawatts electrical (MWe) generated by the CRN Site	800 MWe
Megawatts thermal (MWt) generated by the CRN Site	2,420 MWt
Normal plant heat sink	Clinch River arm of the Watts Bar Reservoir / Atmosphere
Waste heat rejected to the CRN Site	5,593 MBtu/hr
Cooling tower blowdown flow to the reservoir in gallons per minute (gpm)	12,800 gpm
Cooling tower evaporation rate for CRN Site in gpm	12,800 gpm
Raw water consumption for the CRN Site in gpm	12,800 gpm
Discharge flow rate of potentially radioactive effluent streams in gpm	900 gpm
Volume of solid radioactive waste generated in cubic feet per year (ft^3/yr)	5,000 ft^3/year
Acreage to support plant operation	153 acres
Height of power block structure from plant grade	160 feet
Depth of power block structure from plant grade	138 feet
Expected sound produced by cooling towers in A-weighted decibels (dBA)	< 70 dbA measured at 1,000 feet from noise source
Expected sound level due to construction activities in dBA	101 dBA measured at 50 feet
Estimated number of permanent plant workers to support operation	500 workers
Estimated number of onsite workers during construction	2,200 workers[1]
Estimated number of workers to support refueling or major maintenance activities	1,000 workers

[1]However, the maximum number of construction personnel onsite during a 24-hour period is estimated to be 3,300, due to the potential use of multiple shifts.

Table 2-5. CRN Site Characteristics and Bounding Values of Site Development Attributes

CRN Site Feature/Attribute	Quantitative Value (area, length, etc.) and Assumptions
CRN SITE CHARACTERISTICS	
Clinch River Property (including the Grassy Creek Habitat Protection Area [HPA])	• 1,200.8 acres • Includes land adjacent to the Clinch River arm of the Watts Bar Reservoir, located west of the Oak Ridge Reservation, within the City of Oak Ridge, Tennessee. The land is owned by the U.S. and managed by TVA as the agent of the federal government. The Clinch River Property includes all or part of the Watts Bar Reservoir Land Management Plan parcels 137a, 142, 143, 144, 145, 146, 147, and 148 (Figure 1-2).
CRN Site	• 935 acres • Includes that portion of the Clinch River Property that is proposed to be used as the location of the Nuclear Technology Park. The CRN Site is 935 acres, and includes the Watts Bar Reservoir Land Management Plan parcels 137a, 142, 143, 144, 145, and 148. Parcel 146, the Grassy Creek HPA is excluded from the CRN Site (Figure 1-2).
CRN Project Area	• 868 Acres • Includes that portion of the CRN Site where impacts are evaluated and associated offsite areas: the Barge and Traffic Area (BTA), the offsite 161-kilovolt (kV) transmission line corridor, and the Tennessee Highway 95 (TN 95) Access (Figure 1-2).
Clinch River Mile (CRM) Markers	• Intake: approximately CRM 17.9 • Outfall: approximately CRM 15.45 • Melton Hill Dam: CRM 23.1
Low Population Zone (LPZ)	• The LPZ is defined as a circular area with a radius of 1 mile (1,609 meters) from the site centerpoint.
Exclusion Area Boundary (EAB)	• The EAB is defined as the total 1,200 acres that makes up the Clinch River Property. This encompasses the analytical EAB of an 1,100-foot distance from the effluent release boundary.
Emergency Planning Zone (EPZ)	• TVA developed two “major features” Emergency Plans as part of the ESPA: one with a two-mile plume exposure pathway EPZ (with an onsite and offsite component), and one with a site boundary plume exposure pathway EPZ (with an onsite plan and reference to an offsite “all-hazards” approach to emergency planning).
Water Depth at Site	• At approximately between CRM 16 and CRM 18 the mean thalweg depth is 22±0.5 feet.
Land Elevation of the Site	• The site elevations range from approximately 750 feet above mean sea level (AMSL) to approximately 940 feet AMSL.

CRN Site Feature/Attribute	Quantitative Value (area, length, etc.) and Assumptions
SITE DEVELOPMENT ATTRIBUTES	
Primary Use Areas	
Area 1	• Size: approximately 341 acres • Use: Permanent use area, assume total site disturbance (including grading), all vegetation removed
Area 2	• Size: approximately 88 acres • Use: Permanent use area, assume total site disturbance, all vegetation removed
Laydown Areas	• Size: approximately 129 acres (15 acres offsite, 114 acres onsite) • Use: Temporary use area, assume full disturbance, restoration with non-invasive vegetation following construction
Site Roadways	
CRN Site Access Road from Bear Creek Road – Primary Access	• Length: 1.2 miles (based on existing alignment) • Width of disturbance (includes grading/utilities, etc.): 100 feet • Roadway surface: asphalt • Width: 50 feet

TN 95 Access (via Jones Island Road) – Secondary Access	• Length outside CRN Site: 2.3 miles (based on existing configuration)
	• Length of intersection improvement at TN 95: approximately 0.3 mile (based on existing configuration)
	• Maximum width of disturbance (includes grading/utilities, etc.): 100 feet
	• Road surface: asphalt
	• Maximum width: 50 feet
	• Reservoir Shoreline Disturbance:
	  o Location of reach for bank stabilization: CRM 20.75 to CRM 19.5
	  o Length of disturbance along shoreline: up to 5,700 feet
	  o Width of instream disturbance area: up to 10 feet

River Road – Extending from CRN Site Entrance Road along Clinch River to the TN 95 Access at Jones Island Road	• Length: 3.0 miles (based on existing configuration) • Width of disturbance (includes grading/utilities, etc.): 100 feet • Road surface: asphalt • Width: 50 feet • Reservoir Shoreline Disturbance: o Location of reach for bank stabilization: CRM 18.9 to CRM 16.2

CRN Site Feature/Attribute	Quantitative Value (area, length, etc.) and Assumptions
	○ Length of disturbance along shoreline: up to 3,350 feet ○ Width of instream disturbance area: up to 10 feet
Roads to intake and discharge locations	• Approximate length: intake road – up to 2,000 feet, discharge road up to 1,000 feet • Width of disturbance – 100 feet • Road surface – asphalt • Roadway width – 50 feet
Interior Haul Roads	• Various lengths located within disturbed areas (onsite laydown area, Area 1, and Area 2) • Width of disturbance – up to 100 feet
Support Facilities	
Intake Structure	• Located at approximately CRM 17.9 • Localized dredging would be used to support installation (200 by 50 feet) • Area of instream work from bank: up to 0.23 acres
Discharge Structure	• Located at approximately CRM 15.45 • Localized dredging would be used to support installation (200 by 50 feet) • Length of disturbance along shoreline of Watts Bar Reservoir: up to 600 feet
Offsite Barge Unloading Facility (DOE property)	• Size: landside – 1.0 acre • Use: Permanent use area, assume vegetation clearing, no grading needed • Length of disturbance along bank/shoreline in reservoir: none • Access road to landing area: ○ Length: 0.12 mile ○ Width of disturbance: 100 feet ○ Roadway width: 50 feet ○ Road surface: gravel
Supplemental Onsite Barge Landing Area	• Located at approximately CRM 15.45 • Size: landside – 1.0 acre • Use: Permanent use area, assume total site disturbance • Length of disturbance along bank/shoreline in reservoir – up to 200 feet • Localized dredging to support installation (200 by 50 feet) • Area of instream work from bank – up to 0.23 acres • Access road to landing area:

CRN Site Feature/Attribute	Quantitative Value (area, length, etc.) and Assumptions
	o Length – 0.5 miles o Width of disturbance – 100 feet o Roadway width – 50 feet o Road surface – gravel
Transmission	
Connection from Area 1 switchyard to Area 2 (*Alternatives B and D*)	• Additional 120 feet
161-kV connection from the existing 161-kV line along Bear Creek Road southeast to 500-kV line near northern CRN Site boundary and Area 2 (*Alternatives B, C, and D*)	• 120-foot ROW to be developed within a 280-foot corridor
Optional 161-kV relocated transmission line along edge of Area 1 (*Alternatives B and D*)	• 120-foot ROW
Specialized Activities	
Blasting	• Expected to be localized. More detailed design and geotechnical investigation needed to determine extent and location.

2.7 Comparison of Alternatives

The environmental impacts of each of the alternatives under consideration are summarized in Table 2-6. These summaries are derived from the information and analyses provided in the Affected Environment and Environmental Consequences sections in Chapter 3. Tables that present summary impacts for each alternative are also included in the resource analyses contained in Chapter 3.

Table 2-6. Summary and Comparison of Alternatives by Resource Area

Resource Area	Alternative A—No Action	Alternative B1—Nuclear Technology Park at Area 1 with SMRs	Alternative B2—Nuclear Technology Park at Area 1 with SMRs and/or Advanced non-LWRs	Alternative C—Nuclear Technology Park at Area 2 with Advanced non-LWRs	Alternative D—Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced non-LWRs
Geology and Soils	No impacts	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**
Water Resources	No impacts	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**
Floodplains and Flood Risk	No impacts	*Construction:* **Minor** *Operation:* **None**	*Construction:* **Minor** *Operation:* **None**	*Construction:* **Minor** *Operation:* **None**	*Construction:* **Minor** *Operation:* **None**
Wetlands	No impacts	*Construction:* **Minor**	*Construction:* **Minor**	*Construction:* **Minor**	*Construction:* **Minor**
Aquatic Ecology	No impacts	*Construction:* **Minor to Moderate** *Operation***: Minor**	*Construction:* **Minor to Moderate** *Operation***: Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation***: Minor**
Terrestrial Ecology	No impacts	*Construction:* **Moderate** *Operation:* **Minor**	*Construction:* **Moderate** *Operation:* **Minor**	*Construction:* **Moderate** *Operation:* **Minor**	*Construction:* **Moderate** *Operation:* **Minor**
Threatened and Endangered Species	No impacts	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**
Managed and Natural Areas	No impacts	*Construction:* **Minor to Moderate** *Operation***: Minor**	*Construction:* **Minor to Moderate** *Operation***: Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation***:** **Minor**
Recreation	No impacts	*Construction:* **Minor** *Operation***: Minor**	*Construction:* **Minor** *Operation***: Minor**	*Construction:* **Minor** *Operation***: Minor**	*Construction:* **Minor** *Operation***: Minor**

Resource Area	Alternative A—No Action	Alternative B1—Nuclear Technology Park at Area 1 with SMRs	Alternative B2—Nuclear Technology Park at Area 1 with SMRs and/or Advanced non-LWRs	Alternative C—Nuclear Technology Park at Area 2 with Advanced non-LWRs	Alternative D—Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced non-LWRs
Meteorology, Air Quality, and Climate Change	No impacts	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**
Transportation	No impacts	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**	*Construction:* **Minor to Moderate** *Operation:* **Minor**
Visual Resources	No impacts	*Construction and Operation:* **Minor to Moderate**	*Construction and Operation:* **Minor to Moderate**	*Construction and Operation:* **Minor to Moderate**	*Construction and Operation:* **Minor to Moderate**
Noise	No impacts	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**
Socioeconomics					
Land Use	No impacts	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**
Demographics	No impacts	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**
Employment and Income	No impacts	*Construction and Operation*: **Beneficial, Minor to Moderate**	*Construction and Operation*: **Beneficial, Minor to Moderate**	*Construction and Operation*: **Beneficial, Minor to Moderate**	*Construction and Operation*: **Beneficial, Minor to Moderate**
Community Characteristics	No impacts	*Construction:* **Minor** *Operation*: **Minor to Moderate**	*Construction:* **Minor** *Operation*: **Minor to Moderate**	*Construction:* **Minor** *Operation*: **Minor to Moderate**	*Construction:* **Minor** *Operation*: **Minor to Moderate**
Environmental Justice	No impacts	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**	*Construction and Operation*: **Minor**
Archaeological Resources and Historic Structures	No impacts	*Construction:* **Moderate**	*Construction:* **Moderate**	*Construction:* **Moderate**	*Construction:* **Moderate**

Resource Area	**Alternative A—No Action**	**Alternative B1—Nuclear Technology Park at Area 1 with SMRs**	**Alternative B2—Nuclear Technology Park at Area 1 with SMRs and/or Advanced non-LWRs**	**Alternative C—Nuclear Technology Park at Area 2 with Advanced non-LWRs**	**Alternative D—Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced non-LWRs**
Solid and Hazardous Waste	No impacts	*Construction and Operation:* **Minor**	*Construction and Operation:* **Minor**	*Construction and Operation:* **Minor**	*Construction and Operation:* **Minor**
Radiological Effects of Normal Operations	No impacts	*Construction and Operation:* **Minor**	*Construction and Operation:* **Minor**	*Construction and Operation:* **Minor**	*Construction and Operation:* **Minor**
Uranium Fuel Effects	No impacts	*Construction and Operation:* **Minor**	*Construction and Operation:* **Minor**	*Construction and Operation:* **Minor**	*Construction and Operation:* **Minor**
Nuclear Plant Safety and Security	No impacts	*Construction and Operation:* **Minor**	*Construction and Operation:* **Minor**	*Construction and Operation:* **Minor**	*Construction and Operation:* **Minor**
Decommissioning	No impacts	**Minor**	**Minor**	**Minor**	**Minor**

2.8 TVA's Preferred Alternative

TVA's preferred alternative is Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced non-LWRs. Alternative D provides the greatest flexibility to meet the purpose and need of the project to support TVA's goal of demonstrating the feasibility of deploying advanced nuclear reactor technologies at the CRN Site capable of incrementally supplying clean, secure, and reliable power that is less vulnerable to disruption. Alternative D also supports the recommendations outlined in TVA's 2019 IRP and TVA's 2021 Strategic Intent and Guiding Principles.

Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced non-LWRs would also meet the purpose and need of the project and would have less impacts than Alternatives C and D as Area 2 would not be disturbed. However, as the project would be limited to only the use of Area 1, there would be less flexibility for project activities and less opportunity for exploring a variety of technologies which could assist in meeting the project goals.

Alternative C – Nuclear Technology Park at Area 2 with advanced non-LWRs would also meet the purpose and need of the project and would have somewhat less impacts than Alternative D, as the majority of Area 1 would not be disturbed. However, as the project would be limited to only the use of Area 2, and the advanced non-LWR technologies are less mature and further from commercialization than SMRs, there is limited flexibility to meet the purpose and need of the project.

2.9 Summary of Mitigation Measures and Best Management Practices

Best Management Practices (BMPs), mitigation measures, and commitments identified in Chapter 3 to avoid, minimize, or reduce adverse impacts to the environment are summarized below. Additional project specific BMPs may be applied as appropriate on a site-specific or technology-specific basis to enable efficient maintenance of construction projects and further reduce potential impacts on environmental resources.

2.9.1 Best Management Practices

- TVA would ensure that all safety related structures are properly designed to meet hazards and risks associated with seismic conditions for the CRN Site.
- BMPs would be implemented including those described in *A Guide for Environmental Protection and Best Management Practices for Tennessee Valley Authority* (TVA 2017), the Tennessee Erosion and Sediment Control Handbook (TDEC 2012), the project-specific stormwater pollution prevention plan (SWPPP), and site-specific Integrated Pollution Prevention Plan (IPPP).
- Discharge of chemicals to surface water would be specifically regulated by the conditions of the applicable NPDES permit issued and administered by TDEC.
- Permanent structures and facilities that are not water-use or water-dependent facilities would be located outside of the 100-year floodplain. If they cannot be located outside the 100-year floodplain, additional floodplain review would be required.
- Intake and outfall structures would be constructed using the least amount of fill practicable.
- Flood-damageable material and equipment would be stored outside the floodplain and/or above the 100-year flood elevation as a standard practice.

- Land clearing operations would be conducted in accordance with TVA BMPs (TVA 2017) and in a manner that would prevent any unnecessary damage to the remaining natural vegetation, would protect wetlands and streams, and would prevent soil erosion.
- Nonhazardous and hazardous solid waste would be managed by TVA-approved solid waste disposal vendors and disposed of at state-approved, licensed facilities in accordance with Tennessee solid waste regulations. The disposal vendor applicant would be required to confirm that they would comply with all applicable federal, state, and local requirements and standards for handling, transporting, and disposing of nonhazardous or hazardous solid waste, as applicable. Additionally, should TVA choose to construct and operate an onsite landfill for disposal of construction, site clearing, and grading debris, it would be designed in accordance with all applicable state, local, and federal regulations.
- Waste-minimization procedures would be implemented, and standard processes related to the handling of nonradioactive solid waste utilized at other TVA plants would be employed.
- Industry standard and regulatory compliant hazardous chemical control and radiological control measures would be applied during testing, handling, and storage (accumulation area) of hazardous and mixed wastes. Further, TVA Nuclear sites have instituted procedures that establish the requirements to control chemicals, expendable products, and hazardous materials used at TVA Nuclear Power Group (NPG) power plants. These procedures assign responsibilities for control of chemicals purchased, brought into, used, and disposed of from NPG Licensed Facilities.
- Industry BMPs included in TVA's Waste Minimization Plan for nuclear power facilities include inventory identification and control that utilizes a tracking system to manage waste generation data and waste minimization opportunities; work planning to reduce mixed waste generation; mixed waste reduction, recycling, and reuse methods that maximize opportunities for reclamation and reuse of waste materials are used whenever feasible; and training and education of employees on the principles and benefits of the waste minimization.
- Stormwater detention would be incorporated into detailed site design to ensure that runoff rates and discharge requirements are in compliance with all appropriate state and local requirements, including NPDES permit limits.
- TVA would implement detailed and robust security measures at the CRN Site in accordance with NRC regulations, similar to those implemented at TVA's other nuclear facilities, to help prevent physical intrusion by hostile forces seeking to gain access to nuclear reactors or materials. Furthermore, TVA would ensure that each of the designs for the reactor technologies being considered would follow the applicable requirements of 10 CFR 50.150 for Aircraft Impact Assessment.
- TVA would conduct surveys and additional NEPA reviews as necessary and appropriate based on future planning needs.
- TVA Nuclear sites have instituted procedures that establish the requirements to control chemicals, expendable products and hazardous materials used at TVA NPG power plants. These procedures assign responsibilities for control of chemicals purchased, brought into, used and disposed of from NPG Licensed Facilities. The

control of chemicals, expendable products, and hazardous materials is essential to: protect the health and welfare of employees; protect nuclear fuel reliability; protect plant systems from the intrusion of harmful chemicals or hazardous materials; and protect the environment.

2.9.2 Proposed Mitigation Measures

- Conduct additional site-specific investigations to evaluate the presence of karst features in areas proposed for structure development. Detailed designs for safety related features and other structures would include all appropriate karst related mitigative measures and a grouting plan would be implemented as applicable.
- Unavoidable alterations and impacts to jurisdictional waters would be minimized in conjunction with design and mitigated as appropriate in accordance with the CWA Section 10/404 permit issued by USACE and in accordance with the CWA Section 401 and the ARAP issued by TDEC.
- Disturbance of contaminated sediments within the Clinch River arm of the Watts Bar Reservoir would be subject to the terms of the Watts Bar Interagency Agreement that includes the USACE, DOE, TDEC, and the EPA, to coordinate review of permitting and authorization.
- To minimize the noise effects of blasting, TVA would require the construction contractor to develop a blasting plan to include notifications to local officials, emergency departments, and neighboring businesses and residents.
- To minimize the effect of construction dewatering on groundwater levels in the areas surrounding any potential excavation, and to reduce the need for dewatering, fractures and cavities transmitting large amounts of water would be appropriately blocked or grouted. As appropriate, TVA would assess the effects of dewatering by monitoring groundwater levels surrounding the excavation and water levels in potentially affected surface waterbodies.
- A groundwater monitoring program would be defined that would include water level, radiological, and chemical monitoring as well as groundwater modelling to assess future changes from baseline conditions.
- New construction to refurbish the existing rail line would be limited to the north side of the rail spur, and thereby avoid the 100- and 500-year floodplains.
- TVA would minimize permanent and temporary impact to wetlands and other sensitive resources during the design phase. If impacts to wetlands are not avoidable, CWA permitting with the USACE and TDEC would be required, as appropriate. TVA would ensure applicable permitting and required mitigation is obtained such that wetland impacts would be compensated through the wetland mitigation process.
- TVA would establish a buffer around forested wetland W019, which is rated with exceptional value, such that it would not be impacted by project activities.
- The cooling water intake structure would be fully compliant with Section 316(b) of the CWA, including applicable provisions related to entrainment and impingement mortality.

- The diffuser ports that are part of the discharge system would direct effluent upwards into the water column so that no physical alteration or scouring occurs, thereby minimizing impacts to benthic habitats.
- TVA would work to minimize and avoid impacts in native cedar glade areas during design, construction, and operation.
- If the timing of proposed actions within 660 feet of active osprey nests cannot be modified to avoid nesting seasons, then coordination with the U.S. Department of Agriculture (USDA) Wildlife Services would be required for guidance to ensure compliance under the EO 13186.
- When feasible, tree removal across the Project Area would occur in winter (October 15 - March 31) when most species of migratory birds would not be nesting and/or would be away from the region.
- Any proposed tree removal identified, once site-specific designs are completed, would be reviewed to determine if impacts to potentially suitable Indiana bat and northern long-eared bat habitat may occur. Consultation under Section 7 of the ESA would occur, if appropriate, when specific designs have been selected, scope of each project has been refined, and impacts to federally bats can be properly assessed. Where feasible, TVA would minimize impacts by removing trees in winter (October 15 – March 31) and add protective buffers around caves.
- TVA would ensure that state-listed rigid sedge and pale green orchid are not significantly impacted by designing the proposed offsite transmission line to avoid the species and their habitat to the greatest extent possible. TVA transmission engineers would consult with the TVA botanist during design to ensure the location of the habitat is considered early in the process. In conjunction with avoiding impacts to state-listed rigid sedge and pale green orchid, TVA would develop a plan to mitigate impacts associated with the loss of habitat in the Grassy Creek Habitat Protection Area (HPA).
- TVA will pursue expansion of the Grassy Creek HPA by about 14 acres to provide additional protection to the state-listed rigid sedge and pale green orchid.
- Site design would minimize and avoid impacts to streams and wetlands where feasible to minimize impacts to suitable habitat for the southeastern shrew and other riparian dependent rare species.
- Mitigation measures that may be considered for localized traffic congestion include staggering work shifts to avoid localized delays at key intersections, installation of traffic lights and stop signs, and addition of turning lanes.
- Air emission sources associated with new reactors would be managed in accordance with federal, state, and local air quality control laws and regulations. New reactors at the CRN Site would comply with all regulatory requirements of the CAA, as well as the TDEC requirements to minimize impacts on state and regional air quality. When the reactor design is selected, detailed air quality modelling would be conducted as required to demonstrate that project-related emissions would not result in exceedances of the National Ambient Air Quality Standards (NAAQS). Measures to reduce air quality impacts during onsite construction may include stabilizing construction roads and spoils piles, covering haul trucks, watering unpaved construction roads to control dust, and conducting routine inspections and maintenance on construction vehicles and equipment.

- Mechanical draft cooling towers would be equipped with efficient drift eliminators and/or other design attributes to reduce PM emissions.
- TVA would maintain the grounds of the Hensley Cemetery and would avoid the cemetery during operation and maintenance activities. The cemetery would remain accessible to those individuals that have family members buried at Hensley Cemetery
- To avoid and minimize impacts to archaeological resources, TVA has executed a Programmatic Agreement (PA) with 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 and remains in effect until construction of the project is complete or the project is otherwise terminated. Per the stipulations of the PA, TVA would seek ways to avoid or minimize adverse project impacts on National Register of Historic Places (NRHP)-eligible archaeological sites, and if avoidance or sufficient minimization are not possible, TVA would mitigate the adverse effects in accordance with the stipulations of the PA. TVA would consult with the Tennessee SHPO and federally recognized tribes throughout the process.
- When designs for specific reactor and cooling technologies are developed, TVA would conduct further analysis and/or modelling to determine offsite noise impacts. If needed, TVA would implement noise abatement measures in order to comply with Oak Ridge's residential noise level limits.

CHAPTER 3 – AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.1 Scope of Analysis

This chapter describes the baseline environmental conditions (affected environment) of environmental resources in the CRN Project Area and the anticipated environmental consequences (or impacts) that would occur from implementation of the alternatives identified for further study as described in Chapter 2.

3.1.1 Impact Assessment

Environmental consequences are and will continue to be assessed in multiple phases, including those associated with site preparation, construction, operation, and decommissioning activities at the CRN Site. For the purposes of this Draft PEIS the project consists of construction phase activities that include pre-construction or site preparation (grading, excavation, infrastructure development, and other actions), actual fabrication and erection of the nuclear reactor and associated facilities, other site improvements and related interfaces, and operations. Notably, the NRC differentiates between "preconstruction" and "construction" based on their particular licensing jurisdiction (10 CFR 51.4) and has clarified that construction with regard to a nuclear power plant refers to those activities having a nexus to radiological health and safety and/or common defense and security. Further, NRC has also clarified that preconstruction includes clearing and grading, excavating, erection of support buildings and transmission lines, and other associated activities. These preconstruction activities may take place before the application for an ESP, CP, or COL is submitted, but are subject to the authority of local, State, or other Federal agencies as appropriate. Because TVA is a federal agency subject to NEPA and other federal laws and regulations, both preconstruction (including site preparation) and construction activities are subject to TVA's decision-making. The impacts from these activities are evaluated in this chapter together as part of the "construction" phase.

Impacts may be beneficial or adverse and may apply to the full range of natural, aesthetic, historic, cultural, and socioeconomic resources within the CRN Project Area and within the surrounding area. Impact severity is dependent upon their relative magnitude and intensity and resource sensitivity. In this document, four descriptors are used to characterize the level of impacts in a manner that is similar to that described by the NRC (2021) and consistent with TVA's current practice. In order of degree of impact, the descriptors are as follows:

- No Impact (or "absent") – Resource not present or affected by project alternatives under consideration.
- Minor (similar to NRC's "SMALL") – Environmental effects are not detectable or are so minor that they would not noticeably alter any important attribute of the resource.
- 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 Draft PEIS provides a bounding analysis of maximum potential impacts of implementing each of the alternatives, based upon the application of the PPE values within the ESP and the attributes and bounding values associated with site development. Alternative B1 and Alternative B2 differ with respect to potential for deployment of advanced non-LWR technology in addition to SMRs, but both alternatives are still bounded by the PPE and site development attributes. As such, impacts associated with the two optional alternatives under Alternative B (B1 and B2) would not differ. Therefore, the impact analysis in this chapter describes these impacts in a singular approach as impacts associated with Alternative B.

3.1.2 Content Incorporated by Reference

The information and impact analyses presented in this chapter have largely been drawn from prior assessments in TVA's 2019 ESPA ER that have been previously validated, reviewed, and accepted. The ESPA ER and other supporting information were provided to NRC for its use in preparing the EIS for the ESP at the Clinch River Nuclear Site (NRC 2019).

As detailed in Chapter 2, the proposed action under evaluation in this PEIS is similar to the action evaluated in the 2019 CRN ESPA ER and the 2019 NRC EIS that considers the development of nuclear technologies within a Nuclear Technology Park at the CRN Site using a bounding PPE approach. As such, each of these documents shares the same general project setting, the same PPE, and many of the key environmental interfaces. However, in addition to the range in project alternatives, notable features evaluated in the analyses within this PEIS that differ from those in the ESPA ER and NRC EIS include the following:

- Adjustments to and/or expansion of the primary onsite use area to include Area 2, and an expanded laydown area
- New supplemental TN 95 access road that would carry approximately 20 percent of CRN Site traffic
- A new 161-kV transmission line extending from the CRN Site to Bear Creek Road
- Supplemental onsite barge access
- On- and offsite reservoir shoreline stabilization measures
- Additional improvements to River Road

Both TVA's 2019 CRN ESPA ER and NRC's 2019 EIS are, therefore, incorporated in this document by reference. However, where needed, new or updated information is presented and referenced to support resources analyses, as appropriate.

3.1.3 Reasonably Foreseeable Future Actions

CEQ's revised 2020 NEPA regulations (40 CFR 1508.1(g)) include the requirement that agencies simplify the definition of "effects" to focus on analysis of changes to the human environment from the proposed action or alternatives defining these effects as follows:

> "Effects or impacts means changes to the human environment from the proposed action or alternatives that are reasonably foreseeable and have a reasonably close causal relationship to the proposed action or alternatives, including those effects that occur at the same time and place as the proposed action or alternatives and may include effects that are later in time or farther removed in distance from the proposed action or alternatives."

The human environment includes the natural and physical environment and the relationship of present and future generations of Americans with that environment.

In accordance with the revised 2020 CEQ regulations, the affected environment for each resource describes the environment of the area(s) to be affected by the alternatives under consideration, including the reasonably foreseeable environmental trends and planned actions in the area(s). Table 3-1 identifies reasonably foreseeable future trends and planned actions that were identified during internal and external scoping to be in proximity to the proposed action. The projects listed are clearly presented in approved planning documents, have been funded to adequately support full construction and operation, or have applied for appropriate permits for construction or operation. Past and present actions inherently have environmental impacts that are integrated into the base condition for each of the resources analyzed in this chapter.

Accordingly, the affected environment described in this Draft PEIS considers changes to the human environment from reasonably foreseeable future actions that have a close causal relationship to the alternatives. Potential effects are generally considered in this Draft PEIS if they are projected to occur at the same time and place as the proposed action and may include those that overlap in time and geography.

Table 3-1. Summary of Reasonably Foreseeable Future Trends and Planned Actions in Proximity to the CRN Site

Project Name	Description	Approximate Distance from CRN Site	Status
Roane Regional Business and Technology Park	Business and Industrial Park (655 acres) with 10 sites for development	0.5 mile east	Operational since 2001, sites available for development
West End Corridor Intersection Improvements	Intersection improvements along Oak Ridge Turnpike (TN 95/TN 58) at Renovare Boulevard, Novus Drive, Heritage Center Boulevard, and Broadberry Avenue at Gallaher Road (Lead Agency: City of Oak Ridge)	2 miles north	Estimated completion by 2030
ETTP Property Transfer / Development of Heritage Center Industrial Park	Transfer of DOE property to private companies/Community Reuse Organization of East Tennessee and development of the 1,200-acre Heritage Center. Both new and renovated industrial buildings are available for sale or lease, as well as approximately 555 acres served by a robust, redundant utility system.	2 miles north	Ongoing, sites available for development. Completion of CERCLA and other cleanup activities ongoing.
Kairos Nuclear Reactor Demonstration at ETTP	Demonstration of Kairos' Hermes low-power test reactor at the ETTP	2 miles north	Subject to ongoing due diligence evaluations
Oak Ridge General Aviation Airport	Development of a general aviation airport. The airport, with a 5,000-foot runway, would support general aviation in the Oak Ridge Corridor region, as current capacity is limited in this market and is not expected to support projected growth and future demand.	3 miles north	City Council approved a resolution that authorizes actions related to the Oak Ridge General Aviation Airport in 2020, including seeking transfer of sponsorship of the airport from Metropolitan Knoxville Airport Authority to the City of Oak Ridge and initiating transfers of grants related to the airport to the City. Estimated completion by 2025.

Project Name	Description	Approximate Distance from CRN Site	Status
Horizon Center Industrial Park	Industrial park with sites containing approximately 320 acres remaining for development and approximately 500 acres set aside for environmental preservation.	3 miles north-northeast	Operational; sites available for development
Sludge Build-Out Project at the TRU Waste Processing Center	Changes to the method of sludge processing and changes to waste shipping routes	3 miles east	Site preparation began for the Sludge Processing Mock Test Facility in January 2020, and construction is slated for completion in 2022. Oak Ridge Environmental Management anticipates approximately two years of testing to gather the data needed to determine the best designs and approaches for the Sludge Processing Facility's final design.
Uranium Processing Facility (UPF) at Y-12	Construction of a multiple facility complex for a modern UPF; would have processing capabilities for enriched uranium casting, oxide production, and salvage and accountability operations to support the Nation's nuclear weapons stockpile, defense nuclear nonproliferation, and naval reactors.	10 miles northeast	Currently under construction, estimated to complete in 2025
Mercury Cleanup Activities at Y-12	Mercury environmental remediation	10 miles northeast	Ongoing and expected to continue into at least the 2030s.
DOE Environmental Management Disposal Facility on ORR	New onsite landfill potentially to the east of existing Environmental Management Waste Management Facility	10 miles northeast	DOE working with TDEC and EPA to resolve issues prior to landfill approval. TDEC and EPA have issued comments on DOE's draft ROD, dated July 2021, which must be addressed before a revised document is submitted.

Project Name	Description	Approximate Distance from CRN Site	Status
TDOT Roadway Improvement Projects	Widen TN 1 (US 70), from TN 382 to near Raritan Road, from 2-lane to 5-lane with center turn lane.	10 miles west	Funding for ROW phase approved 2020
City of Oak Ridge Water Treatment System Upgrades	The City of Oak Ridge will design and construct a new ultrafiltration membrane drinking water treatment plant to replace the existing 80-year-old conventional treatment plant at Y-12, which is currently at capacity and beyond its useful life. New plant will be located at the existing raw water intake off Pump House Road.	10 miles northeast	Plant is estimated to be completed by mid-to-late 2022.
Cardiff Valley Road Site	Roane Specialized Services, LLC (made up of Roane Transportation and Roane Metals) approved to purchase 45-acre Cardiff Valley Road Site in Rockwood's Roane County Industrial Park. Plans include the addition of a new corporate office and warehouse facility, truck fleet parking, and storage space for their existing customers. Roane Specialized Services employs 224 individuals, growing from 205 in 2019, and is expected to grow by an additional 25 jobs over the next two years.	13 miles west	Roane County Industrial Development Board accepted formal offer in February 2021.
Simulated Nuclear and Radiological Activities Center	Oak Ridge Enhanced Technology Training Center will construct the Simulated Nuclear and Radiological Activities Facility to train personnel in the safeguarding of nuclear and radioactive material with the latest nuclear operations, safeguards, cyber and emergency response.	10 miles northeast	Construction began in 2021; expected completion in 2023.

3.2 Geology and Seismology

3.2.1 Affected Environment

3.2.1.1 Geology

3.2.1.1.1 Geographic and Project Setting

The CRN Site is located within the southwestern part of the city limits of Oak Ridge, Roane County, Tennessee. The site is bordered to the south, east, and west by the Clinch River arm of the Watts Bar Reservoir (the Reservoir) and to the north by the ORR. Topography at the CRN Site is characterized by alternating northeast to southwest trending valleys and ridges. The terrain is gently and moderately rolling to steep, with elevations ranging from approximately 745 feet AMSL along the shoreline to 940 feet AMSL at the ridge tops. The Reservoir traces a meandering south and west course around the CRN Site with incised water gaps through the major ridges of the central and southern portion of the site. Smaller ephemeral and perennial tributary streams generally flow perpendicular to and drain down from the ridges and flow parallel to the valleys. Previous construction and site grading activities in the central portion of the CRN Site excavated portions of the ridges, and some of the valleys were filled creating a generally flat to gently sloping ground surface surrounding the partially filled abandoned CRBRP excavation.

3.2.1.1.2 Geology and Physiography

The CRN Site is located within the southwestern portion of the Valley and Ridge physiographic province. The Valley and Ridge province is approximately 50 to 100 miles wide (east-west) in eastern Tennessee and is bounded to the west by the Appalachian Plateaus physiographic province and to the east by the Blue Ridge physiographic province. The Valley and Ridge physiographic province is characterized by parallel valleys and ridges, typically aligned northeast to southwest, consisting of interbedded sequences of sedimentary rock composed of weak and strong formations exposed at the surface by erosion and exhumation of strongly folded and thrust-faulted terrain. The geomorphology of the province is a direct result of differential weathering and erosion of different folded and faulted Paleozoic strata. In the Valley and Ridge province, the ridges are typically composed of more erosion resistant strata such as sandstone, siltstone, and carbonate units with higher silica content, and valleys are typically composed of more soluble carbonate units and less erosion resistant shale formations. In the area of the CRN Site, thrust faulting of the Cambrian to Ordovician aged strata has resulted in an imbricate stack of south-east dipping thrust sheets and repetitive sequences of geologic units across the landscape as shown in Figure 3-1.

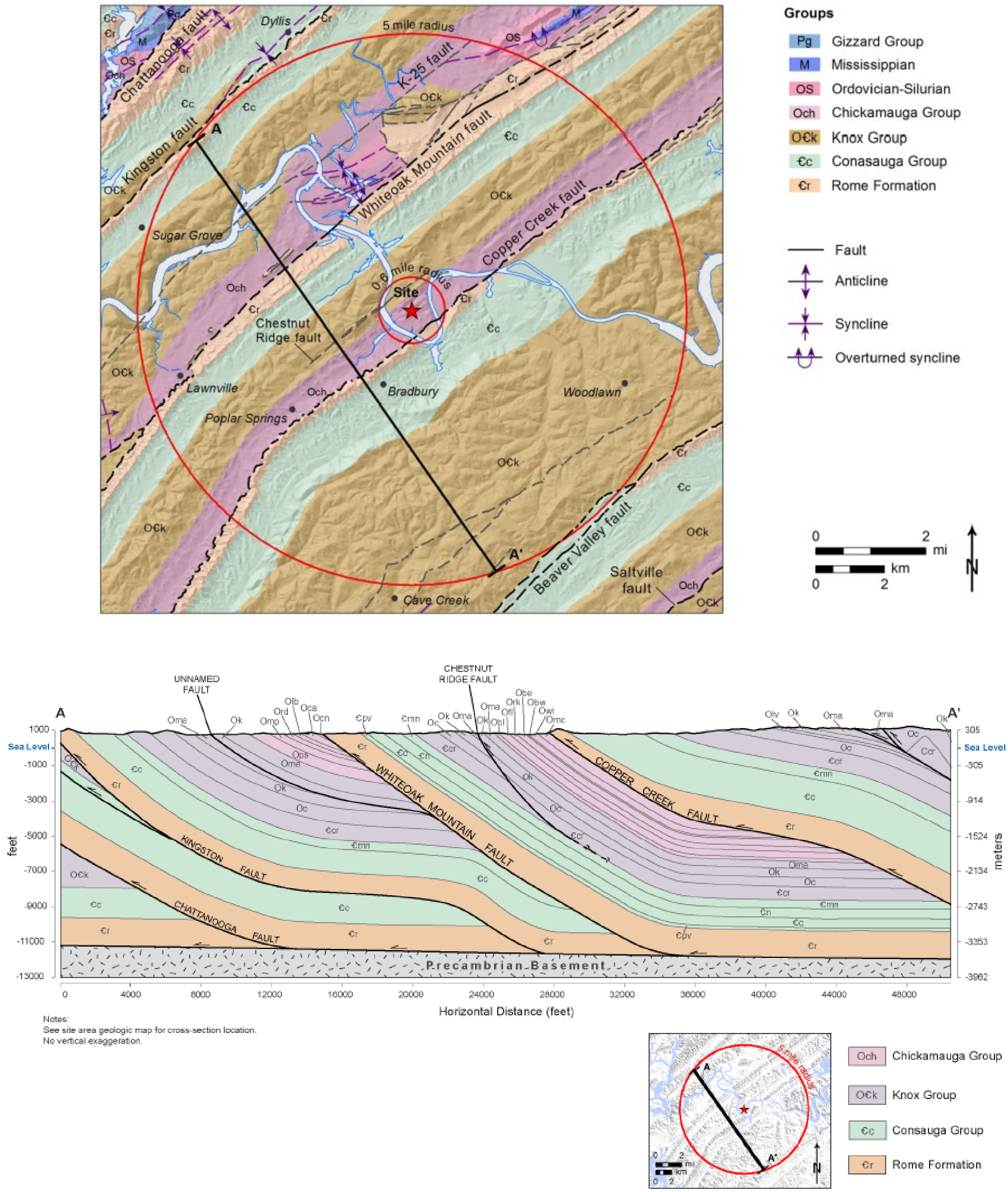


Figure 3-1. CRN Site Area Geology

The general stratigraphic sequence consists of the Rome Formation, Conasauga Group, Knox group, and Chickamauga Group geologic units (from oldest to youngest). The White Oak Mountain thrust fault, located approximately 2 miles northwest of the CRN Site, is a regional structure that displaces older Cambrian Rome Formation over younger Cambrian Knox Group and Ordovician Chickamauga Group strata. The CRN Site is on the White Oak Mountain thrust sheet. The Chestnut Ridge thrust fault, located in the northern portion of the CRN Site, is shown to be displacing geologic units within the Knox Group. The areal extent of the Chestnut Ridge fault is discontinuous but is thought to exist further northeast than its currently mapped extent and does not displace geologic units with significant stratigraphic or temporal differences. The Copper Creek thrust fault, a major structure of the Valley and Ridge province, is located along Haw/Hood ridge and crosses the southern portion of the CRN Site, displacing Cambrian aged Rome Formation (hanging wall) over the Ordovician aged Chickamauga Group units (footwall). The Clinch River has created a water gap through the erosion resistant Rome Formation that forms Haw/Hood Ridge.

Surface materials at the CRN Site consist of Quaternary aged alluvial and colluvial soils, artificial fill soils, and residual soils. The colluvial soils consist of weathered residuum transported by hillslope processes including slopewash and creep and deposited at the bottom of slopes and in hollows on the hillsides. The thickness and extent of colluvial soils varies widely, dependent on the subsurface bedrock, slope, and primary method of erosion. Bedrock units most susceptible to mechanical weathering such as the Rome Formation produce extensive colluvial deposits, while carbonate units, most susceptible to chemical weathering processes, only produce extensive colluvial deposits if the bedrock units contain significant amounts of erosion resistant chert such as some Knox Group units. Alluvial soils are deposited in hillside drainages and in the principal tributary valleys at the CRN site and along the banks of the Reservoir. Artificial fill soils are present at the CRN Site in construction and redress areas associated with the former CRBRP (Area 1). In contrast, the alluvial and colluvial deposits are most extensive in the north-eastern portion (Area 2), along Bear Creek valley and to a lesser extent in the southern portion of the CRN Site (Figure 3-2). Holocene era terraces are generally located along the Reservoir. The residual soils at the site are the result of in-situ weathering of the underlying bedrock material. The residual soils consist mostly of moderately to highly plastic clay. These surface materials vary in thickness and mantle the underlying weathered rock and bedrock, which outcrop in some portions of the site.

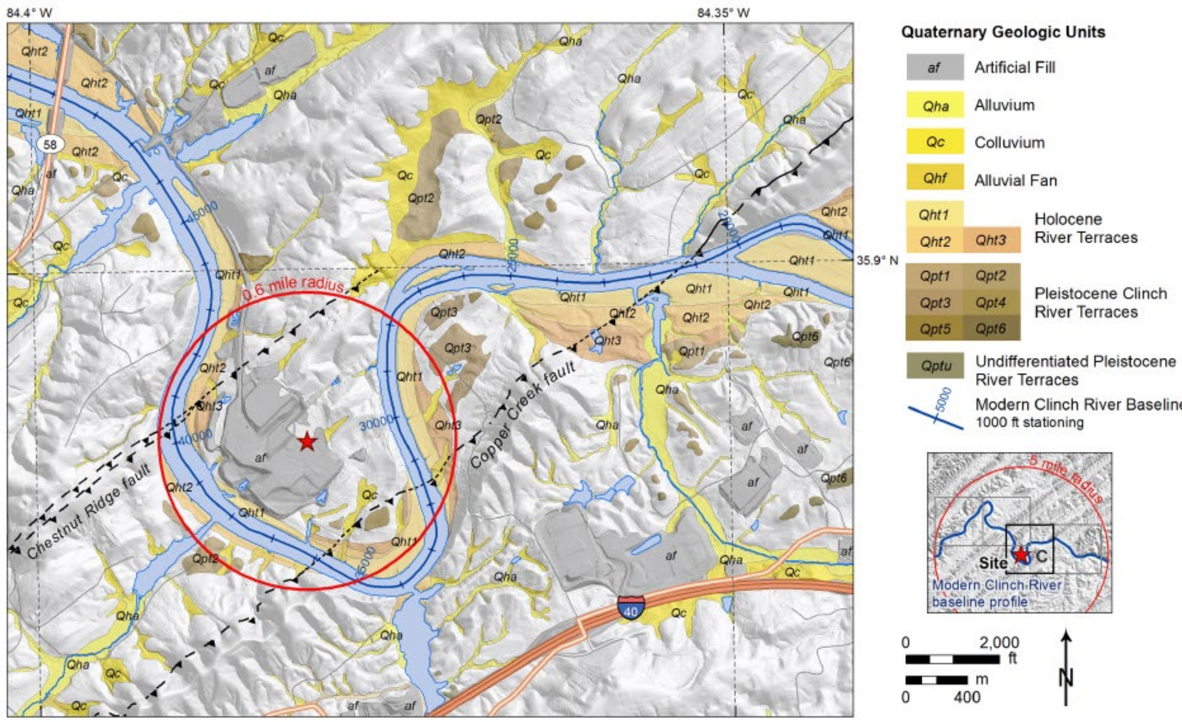


Figure 3-2. Quaternary Terrace Map Adjacent to the Clinch River Arm of the Watts Bar Reservoir Within the Clinch River Nuclear Site

The bedrock at the CRN Site consists of over 12,000 feet of bedded sedimentary rock units. These units strike approximately N 52°E, and dip consistently 32 to 35° southeast. Previous site investigations have identified stratigraphic layers (from oldest to youngest) corresponding to the Lower Cambrian Rome Formation, the Upper Cambrian through Lower Ordovician Knox Group, and the Middle Ordovician Chickamauga Group exposed at the surface or shallow subsurface within the boundaries of the CRN Site. Strata belonging to the Middle to Upper Cambrian Conasauga Group are not present at the surface within the CRN Site, occurring at estimated depths greater than 5,000 feet within the subsurface. Rocks of the Rome Formation do not outcrop at the CRN Site but were identified in two boreholes performed during previous subsurface investigations to locate and characterize the Copper Creek thrust fault in the southern portion of the site. In these boreholes the Rome Formation was encountered above and displacing the upper most Chickamauga Group unit. The contact between these units, represented by the weathered fault gouge between the calcareous siltstone of the Rome Formation and underlying limestones of the Chickamauga Group marks the location of the Copper Creek fault at the CRN Site. The geologic map and cross section shown on Figure 3-3 and Figure 3-4 illustrate the succession of stratigraphic units and bedrock structure encountered at the CRN Site.

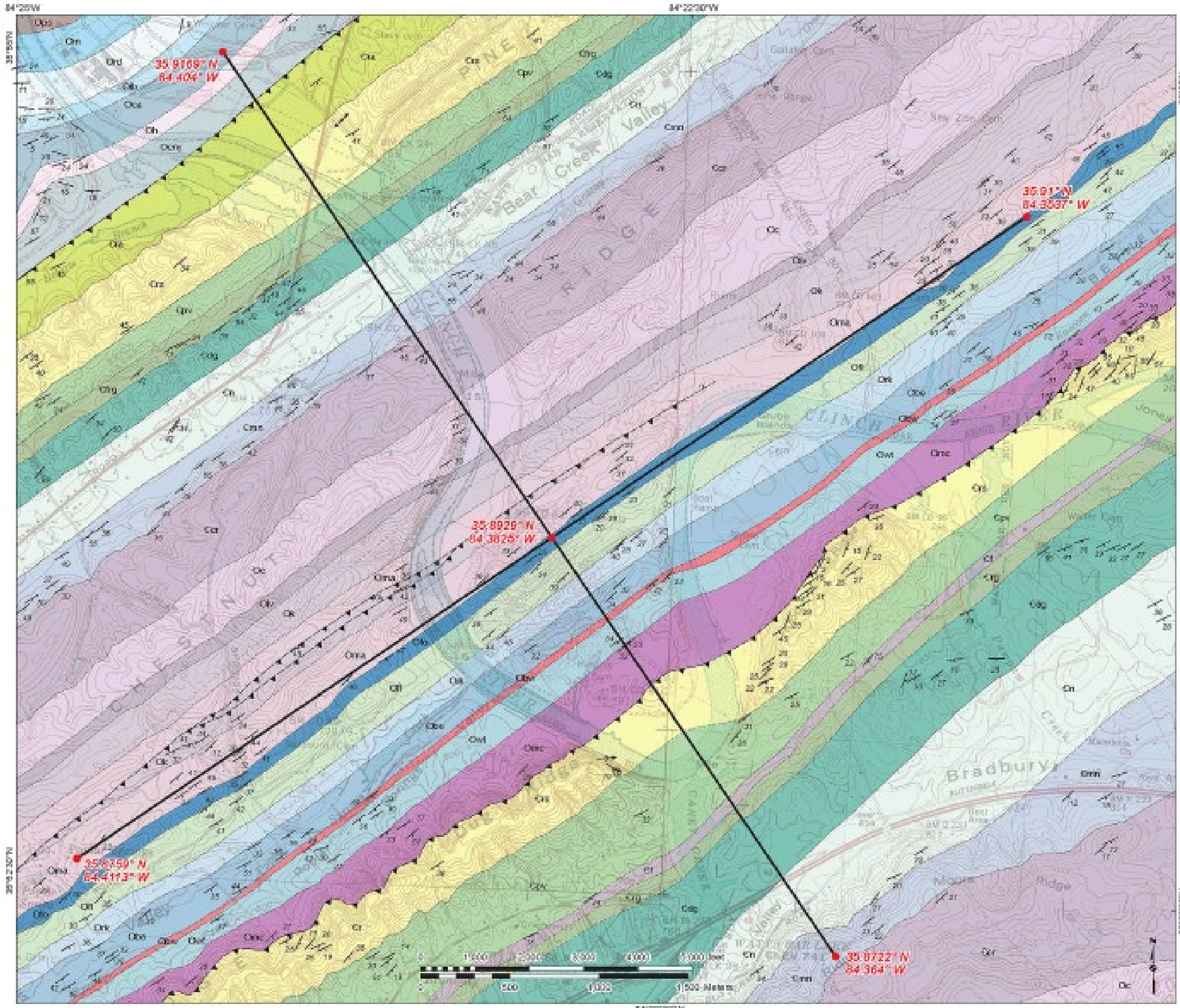
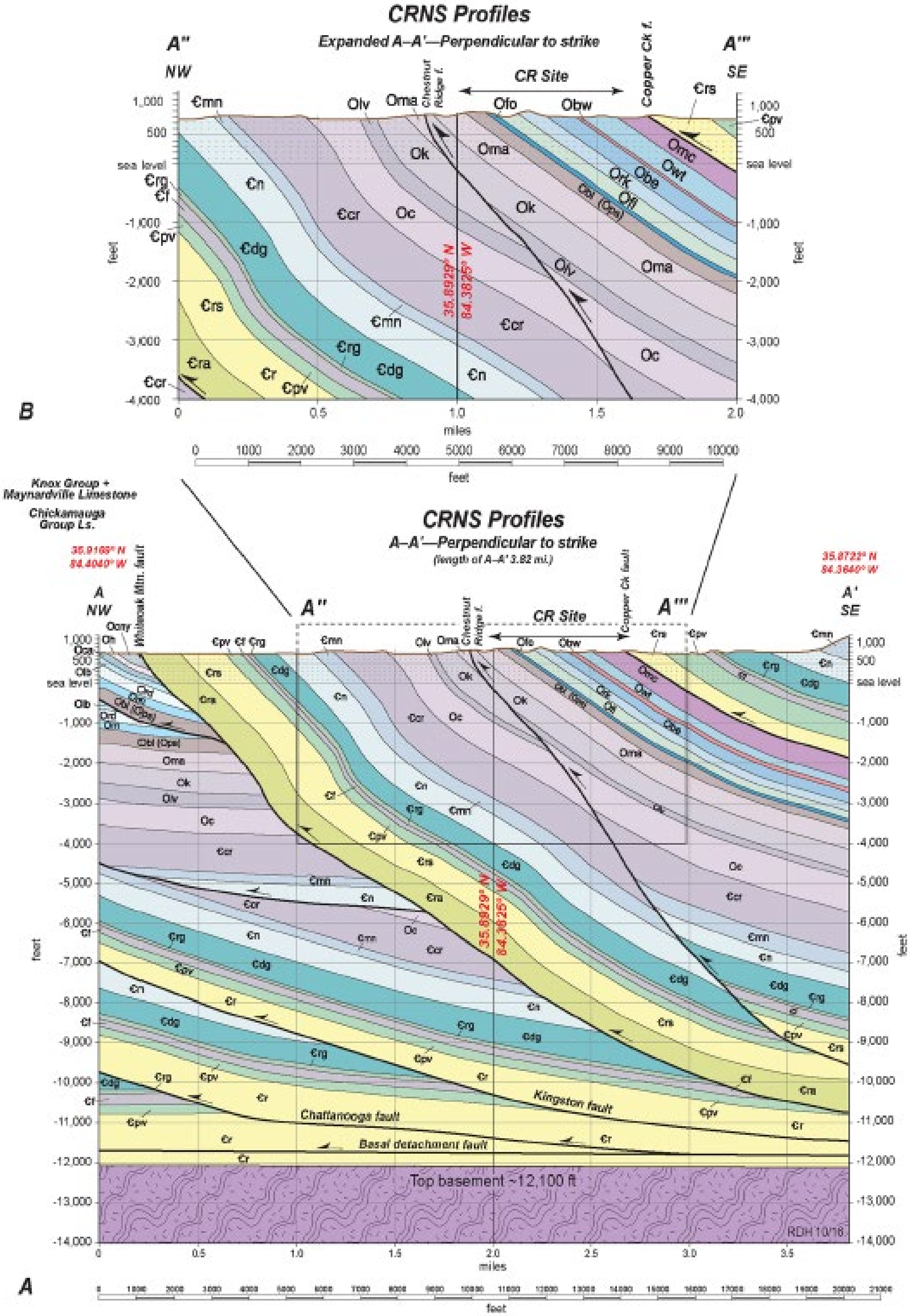


Figure 3-3. Geologic Map and Location of Cross-Section A-A' to Basement



Note: Across-strike geologic cross-section A-A' with an expanded section, the location of which is indicated in the rectangle in the center of the diagram.

Figure 3-4. Geologic Cross-Section A-A' Ground Surface to Basement (Sheet 1 of 2)

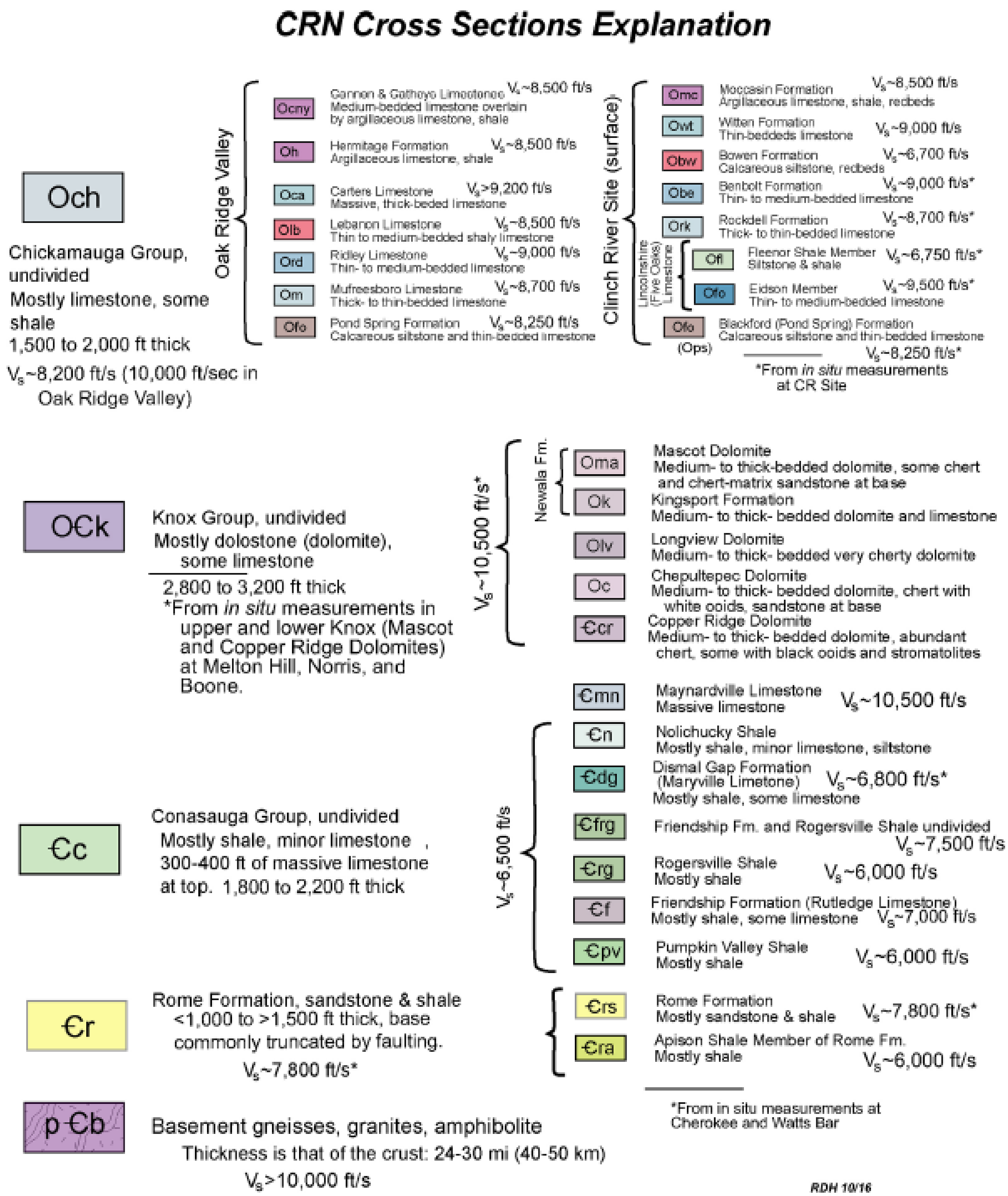


Figure 3-4. Geologic Cross-Section A-A' Ground Surface to Basement (Sheet 2 of 2)

Strata belonging to the Knox Group outcrop from the northwest boundary and progress southeast to the central portion of the CRN Site. The Knox Group is represented by five formations and include from the northwest to southeast (and oldest to youngest) the Upper Cambrian Copper Ridge Dolomite, the Lower Ordovician Chepultepec Dolomite, Longview Dolomite, Kingsport Formation, and the Mascot Dolomite. Where the Kingsport Formation and Mascot Dolomite contact is not recognized these units are combined and referred to as the Newala Formation. The Knox Group units are broadly similar and generally described as medium to thick bedded dolomite with variable amounts of interbedded sandstone, limestone, and chert. The contact of the Knox Group and the Chickamauga Group, located in the central portion of the CRN Site, marks a regional unconformity in which strata of the upper most Knox Group was exposed to extensive erosion due to regional uplift associated with the Taconic Orogeny and/or a drop in eustatic sea level at the end of the Early Ordovician. Eustatic sea level rise and inundation following the regional erosion event (Knox unconformity) resulted in the deposition of the Middle Ordovician Chickamauga Group on the disconformity surface. Paleotopographic relief in the Knox unconformity accounts for variable stratigraphic thicknesses and facies variation in the upper most Knox Group and lower most Chickamauga Group units in the region and at the CRN Site. Strata belonging to the Chickamauga Group outcrop starting from the central portion of the site and progress southeast towards the southern boundary of the CRN Site and the contact with the Rome Formation at the Copper Creek thrust fault. The Chickamauga Group is represented by seven formations at the site and include from the northwest to southeast (and oldest to youngest) the following formations:

- Blackford Formation, Middle Ordovician, a dolomitic limestone in the lower portion, and a calcareous siltstone in the upper portion of the unit
- Lincolnshire Formation – Eidson Member, Middle Ordovician, a laminated to thinly bedded argillaceous micritic limestone with few calcareous siltstone interbeds
- Lincolnshire Formation – Fleanor Shale Member, Middle Ordovician, a laminated to moderately bedded calcareous siltstone with few limestone interbeds
- Rockdell Formation, Middle Ordovician, a very thinly to moderately bedded micritic limestone with few calcareous siltstone interbeds
- Benbolt Formation, Middle Ordovician, a very thinly to moderately bedded limestone with few calcareous siltstone interbeds, locally fossiliferous
- Bowen Formation, Middle Ordovician, a maroon calcareous siltstone
- Witten Formation, Middle Ordovician, differentiated into three subunits including a lower fossiliferous nodular to ribbon limestone unit, a middle calcarenite unit, and an upper interbedded siltstone and limestone unit
- Moccasin Formation, Middle Ordovician, a laminated to moderately bedded argillaceous, micritic limestone with very thin calcareous siltstone interbeds; truncated by the Copper Creek thrust fault

3.2.1.1.3 Geologic Hazards

Carbonate rock dissolution and karst formation is the primary non-seismic geologic hazard in the Valley and Ridge Province. Karst features in the Valley and Ridge include sinkholes, caves, springs, seeps, sinking streams/underground drainage, and irregular soil-bedrock contact. Many of these features are common throughout the CRN Site area and some have been identified at the CRN Site (Figure 3-5).

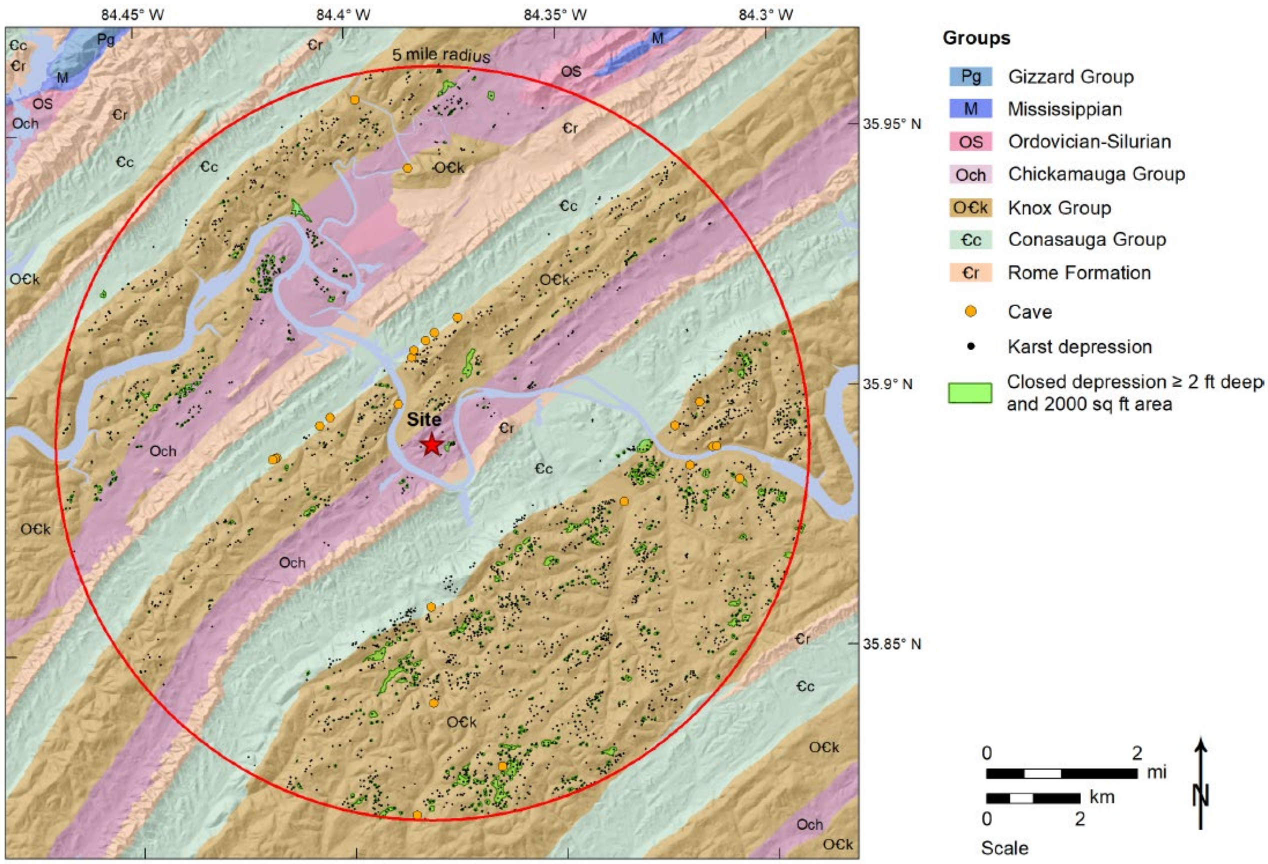


Figure 3-5. Distribution of Mapped Karst Features in the Site Area

The folded and faulted carbonates in the region contain fractures that provide conduits for fluid flow and enhanced carbonate dissolution. In general, the thickest and most pure carbonate units host the largest and most abundant karst features. Dissolution of the carbonate rock is dependent on several factors including bedrock geochemistry, location of the water table relative to the bedrock, and degree of fracturing. Karst development tends to follow geologic structural control such as bedding strike, joints, joint-bedding plane intersections and fractures. The Knox Group and Chickamauga Group strata present at the CRN Site contain formations that are susceptible to karst development and carbonate dissolution features. However, as illustrated in Figure 3-5 karst features are more abundant in the Knox Group formations (Area 2 and within the offsite 161-kV transmission line corridor) as compared to the Chickamauga Group (Area 1). Karstic features at the CRN Site are most common in the Knox Group formations and the Witten, Benbolt, Rockdell, and Eidson Member formations of the Chickamauga Group. Chickamauga Group units that contain interbedded carbonate and clastic lithologies such as the Bowen and Blackford Formations or mostly clastic lithologies such as the Fleanor Member have very few karstic features. In general, subsurface dissolution is most intense near the surface and decreases steadily with depth.

3.2.1.2 Soils and Prime Farmland

Land development projects are subject to Farmland Protection Policy Act (FPPA) (7 U.S.C. § 4201 et seq.) requirements if they may irreversibly convert farmland (directly or indirectly) to nonagricultural use and are completed by a federal agency or with assistance from a federal agency. For the Farmland Protection Policy Act, farmland includes prime farmland, unique farmland, and farmland of statewide or local importance.

Modern soil survey data produced by the USDA in which prime farmland soils are classified are not available for the CRN Site or associated offsite areas because they are federal land; however, the 1942 Soil Survey for Roane County includes the CRN Site and the ORR (Swann et al. 1942). This survey provides soil productivity classifications based on soil suitability for various uses including cropland, pasture, and forest. These soils have been previously disturbed by the CRBRP project.

Soils data from the 1942 USDA Soil Survey for Roane County was used to review the mapped soils and the Farmland Classifications of soils within the CRN Site and associated offsite areas (Swann et al. 1942). According to the survey, the majority of the mapped soils in the CRN Site are Clarksville cherty silt loam or Fullerton cherty silt loam with different phases (Swann et al. 1942). Other mapped areas within the CRN Site are Colbert silty clay loam or Upshur silt loam. These four soils are found in uplands of rolling, undulation topography, have developed from sedimentary rock residual and have good to excessive drainage. Smaller areas at the CRN Site are mapped as Armuchee silt loam, Wolftever silt loam, or Roane gravelly loam, and occupy uplands, terraces, and bottom lands, respectively. In the bottom lands near the Reservoir, soils are mapped as Pope very fine sandy loam and to a lesser extent Sequatchie very fine sandy loam. Both are second class soils and have good to slow drainage.

Clarksville soils are derived from highly cherty dolomitic limestone and occur on hilly ridge summits or side slopes. Fullerton soils are derived from moderately cherty dolomitic limestones and occur primarily on upper slopes or rolling ridge summits. Colbert soils come from highly clayey limestones that are primarily found in valley troughs (i.e., foot slopes). These soils are generally shallow to bedrock, free from chert, and have fair drainage. Upshur soils come from shaly limestones and occur in narrow strips in valleys. They are shallow to bedrock and free from chert with excessive drainage.

The modern prime farmland classification of soils is generally analogous to the first-class (good to excellent cropland) 1942 classification. There are no first-class soils within the CRN Site or associated offsite areas according to the 1942 soil classification. However, based on TVA coordination with the USDA Natural Resources Conservation Service in accordance with the FPPA, 178 acres of the CRN Site have been designated as prime and unique farmland (Appendix E).

3.2.1.3 Seismology

In 2012, the Central and Eastern United States Seismic Source Characterization for Nuclear Facilities (CEUS SSC) Project was published (EPRI et al. 2012). The study, co-sponsored by EPRI, DOE, and NRC, was conducted to provide a regional seismic source model for use in probabilistic seismic hazard analyses for nuclear facilities. The CEUS SSC Project devoted a major effort to developing a comprehensive and uniform earthquake catalog for use on the project. Starting with the U.S. Geological Survey (USGS) national catalog and a number of regional catalogs, the various catalogs were updated to include all earthquakes through 2008. Focusing on the earthquakes that occurred within 200 miles of the CRN Site, the CEUS SSC earthquake catalog concluded there were 355 earthquakes of uniform moment magnitude E[**M**] 2.9 and larger, of which 315 are identified as independent events (mainshocks), from 1568 to 2018. Greater detail regarding the catalog update methodology and findings is located in Appendix F.

Within the vicinity of the CRN Site, the Eastern Tennessee Seismic Zone (ETSZ), is a well-defined, northeasterly trending belt of seismicity, 186 miles long by less than 62 miles wide, within the Valley and Ridge and Blue Ridge physiographic provinces of eastern Tennessee and parts of North Carolina, Georgia, and Alabama. ETSZ is one of the most active seismic regions in eastern North America in terms of the rate of small earthquakes. Generally, earthquakes in the ETSZ produce minor or no damage (e.g., chimney collapse, cracks in plaster, and broken windows), consistent with MMI VI on the Modified Mercalli Intensity (MMI) scale. The MMI is a standard measure of the qualitative site-specific effects of an earthquake on a scale that ranges from Roman numeral I through XII.

3.2.1.4 Reasonably Foreseeable Future Actions in Proximity to the CRN Site

As noted in Section 3.1.3, TVA identified several foreseeable future actions in proximity to the CRN Site. The scope of these other proposed actions may entail the alteration of geologic and soil resources within their respective project footprints. While the specific details regarding the scope of many of these actions are lacking, it is expected that each would entail land disturbance and the alteration of soils. Furthermore, none of the identified reasonably foreseeable future actions is overlapping geographically with the CRN Project Area nor is considered to have a causal relationship to the proposed development of the CRN Site. However, because each of these projects has the potential to alter soils, further consideration of reasonably foreseeable future actions and their effects on soils and erosion are included in the following section as appropriate.

3.2.2 Environmental Consequences

3.2.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, there would be no construction or operation of a Nuclear Technology Park at the CRN Site. Therefore, there would be no impacts associated with geology, soils, or seismology under Alternative A.

3.2.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced Non-LWRs

Geologic impacts in conjunction with Alternative B construction relate to the stability of the underlying formation and the potential incidence of karst. Additional site-specific investigation would be conducted to evaluate the presence of karst features in areas proposed for structure development. Because the Chickamauga Group formation underlies much of Area 1 and the incidence of karst features is relatively low, impacts associated with the development of the CRN Site and most associated offsite areas is minor. While some localized karst may be evident within the offsite 161-kV transmission line corridor, it is expected that the designs of transmission tower foundations would either avoid karst features or would provide appropriate mitigative measures.

Impacts to soils are limited to disturbances during the construction phase. Under Alternative B, construction activities such as clearing, grubbing, grading, and excavation represent the largest source of soil related impacts in Area 1, the laydown area, and the associated offsite areas. Approximately 647 acres would be disturbed within the CRN Site and associated offsite areas under this alternative. Relatively minor additional soil disturbances are also expected in conjunction with tower construction for the 161-kV transmission line. Impacts from these soil disturbing activities would be localized within the CRN Project Area. Area 1 is dominated by uplands soils mostly mapped as Clarksville series with smaller areas consisting of terraces and bottom lands. This undulating topography can be susceptible to soil erosion from water and wind. Although much of Area 1 was previously disturbed and topsoil was removed as part of the CRBRP project, it was also revegetated and partially backfilled, graded, and compacted. Potential impacts from erosion are notably greater on sloped areas and in proximity to streams, other surface water resources, and in proximity to the Reservoir as well as in former areas of disturbance where soils have not fully recovered. BMPs as described in the Tennessee Erosion and Sediment Control Handbook (TDEC 2012) and outlined in the project SWPPP would be used to minimize soil erosion on the site. Impacts from these soil disturbing activities would be moderate and notable within the CRN Project Area, but with the implementation of erosion control procedures, would not destabilize the resource on a broader scale.

As part of the ESPA ER, TVA completed a Farmland Conversion Impact Rating (Form AD-1006) in consultation with the USDA's Natural Resources Conservation Service to quantify the potential impacts on prime farmland. The impact rating score 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. Based on the USDA form, impacts to 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. Therefore, because the impact score was below the threshold for adverse impacts, the impact of the Alternative B on prime farmland would be minor.

Impacts related to seismic conditions of the CRN site pertain to the operation phase. Given the historic record of seismic activity in the CRN region described above, TVA would ensure that all safety related structures would be properly designed to meet hazards and risks associated with seismic conditions for the CRN Site. Specific design considerations and seismic mitigative measures would be developed as appropriate based upon the reactor technology selected and would meet NRC requirements. Design-basis analyses would be performed to demonstrate compliance with regulatory requirements. As such, under Alternative B, impacts related to seismology would be minor and mitigated, as appropriate.

3.2.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced Non-LWRs

Under Alternative C, impacts related to geology are generally similar to those described for Alternative B. However, by comparison, the incidence of karst features is greater in the vicinity of Area 2 as compared to Area 1. Detailed designs for safety related features and other structures would include all appropriate karst related mitigative measures and a grouting plan would be implemented as applicable. Therefore, potential impacts under this alternative are greater than those described for Alternative B, but still minor.

Under Alternative C, construction activities such as clearing, grubbing, grading, and excavation represent the largest cause of soil related impacts in Area 2, the laydown area, and the associated offsite areas. Approximately 424 acres would be disturbed within the CRN Site and associated offsite areas under this alternative. Relatively minor additional soil disturbances are also expected in conjunction with tower construction for the 161-kV transmission line. Area 2 is dominated by uplands soils mostly mapped as Clarksville series with smaller areas consisting of terraces and bottom lands. Based on the acreage of soils affected, impacts to soils under Alternative C are moderate and notable within the CRN Project Area and are less than those under Alternative B, but with the implementation of erosion control procedures, would not destabilize the resource on a broader scale.

In Area 2, soils are identified as second class soils according to the 1942 soil survey and are therefore not considered prime farmland. The undulating topography in Area 2 can be susceptible to soil erosion from water and wind. As soils within the Area 2 footprint have not been previously disturbed, impacts to previously undisturbed soils would be greater than for Alternative B. However, BMPs, as described in the Tennessee Erosion and Sediment Control Handbook (TDEC 2012) and outlined in the project specific SWPPP, would be employed to minimize soil erosion on the site. Impacts to prime farmland are similar to those described for Alternative B and minor.

Impacts associated with seismology are similar to those described for Alternative B and are minor and mitigated, as appropriate.

3.2.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced Non-LWRs

Under Alternative D, impacts related to geology are predominantly associated with the incidence of karst and as such are incrementally greater than those described for Alternative C but are still considered minor.

Under Alternative D, a greater acreage of land would be disturbed in conjunction with the development of both Area 1 and Area 2. Approximately 728 acres would be disturbed within the CRN Site and associated offsite areas under this alternative. Relatively minor additional soil disturbances are also expected in conjunction with tower construction for the 161-kV transmission line. As such, impacts to soils and the potential for erosion would be incrementally greater than that described under Alternatives B and C, but still moderate and with the implementation of erosion control procedures, would not destabilize the resource on a broader scale. Impacts to prime farmland are similar to those described for Alternative B and minor.

Impacts associated with seismology are similar to those described for Alternative B and are minor and mitigated, as appropriate.

3.2.2.5 Potential Contributing Effects of Other Reasonably Foreseeable Future Actions

As described in Section 3.1.3, several reasonably foreseeable future actions were identified in proximity to the CRN Site. Depending on the local environmental setting and the design characteristics of these other proposed actions, direct land disturbance including site excavation and grading would be expected. As such, depending on the magnitude of soil disturbed, soil type and erodibility, slope and other factors, there is the potential for such erosion to affect receiving streams and water resources. None of the identified actions by others are adjacent to or geographically intersect with the same lands affected by the proposed project. Potential impacts from those reasonably foreseeable future projects are expected to be localized and minimized through use of BMPs and implementation of other soil erosion control measures. As such, these actions would likely have minimal cumulative impacts on soil resources in the area.

3.2.2.6 Summary of Impacts to Geology and Seismology

As shown in Table 3-2, TVA has determined that development for Alternatives B, C, and D would have minor construction impacts associated with geology and seismology and moderate impacts associated with soil. Impacts during operation are minor.

Table 3-2. Summary of Impacts to Geology and Seismology

Alternative	Project Phase	Impact	Severity
Alternatives B, C, D	Construction	Potential impacts associated with karst features and structure stability.	Minor impacts, mitigated by additional site-specific investigation during design to evaluate the presence of karst features in areas proposed for structure development. Potential karst features would be avoided or mitigated, as appropriate. Impacts magnitude: Alternative D is greater than Alternative C, which greater than Alternative B.
		Soil disturbance and potential for erosion related to construction activities Impacts would occur to prime farmland soils, but soil conversion impact rating less than 160.	Moderate impacts to soils mitigated by employment of BMPs and stormwater pollution prevention plan SWPPP. Impacts magnitude: Alternative D is greater than Alternative C, which is greater than Alternative B. Based on impact rating, impacts are minor for each alternative.
	Operation	Potential impacts associated with low probability seismic event in Eastern Tennessee Seismic Zone (ETSZ).	Minor impacts for all alternatives, mitigated in accordance with NRC requirements, as applicable.

3.3 Water Resources

3.3.1 Affected Environment

3.3.1.1 Surface Water Resources

3.3.1.1.1 Surface Water Hydrology

3.3.1.1.1.1 Hydrologic Setting

The headwaters of the Tennessee River watershed originate in the mountains of western Virginia and North Carolina, eastern Tennessee, and northern Georgia. The Tennessee River is formed by the confluence of the Holston and the French Broad Rivers near Knoxville, Tennessee. The river flows to the southwest and receives water from three principal tributaries: Little Tennessee, Clinch, and Hiwassee Rivers. As the Tennessee River flows south, west, and then north, two other major tributaries, the Elk and Duck rivers, contribute to the flow that eventually joins the Ohio River at Paducah, Kentucky.

The Tennessee River and its tributaries have a drainage area of approximately 41,910 square miles and pass through 125 counties that cover much of Tennessee and parts of Alabama, Kentucky, Georgia, Mississippi, North Carolina, and Virginia. The USGS divides the Tennessee River Basin into two subbasins: the Upper Tennessee River Basin and the Lower Tennessee River Basin. The CRN Site is located in the Upper Tennessee River

Basin but within the Lower Clinch River Watershed (USGS Hydrologic Unit Code [HUC] 06010207). The Lower Clinch River Watershed includes portions of eight counties in East Tennessee including Anderson, Campbell, Grainger, Knox, Loudon, Morgan, Roane, and Union.

3.3.1.1.1.2 The CRN Site and Vicinity

The CRN Site is within the City of Oak Ridge, Tennessee approximately 10.7 miles southwest of the city center, on a peninsula created by a bend in the Reservoir (Figure 3-6). The Reservoir is the primary source of surface water of the CRN Site, which extends from approximately CRM 14.5 to approximately CRM 19.0.

Watts Bar Reservoir is one of a series of multi-purpose dams and reservoirs built on the Tennessee River and its tributaries to fulfill the three primary purposes of the river system of navigation, flood control, and power generation, and secondary purposes of water quality, recreation, and water supply, among others. Norris Dam is the furthest TVA dam upstream on the Clinch River, at CRM 79.8. The next dam, about 57 miles downstream, is Melton Hill, TVA's only tributary dam with a navigation lock. The Clinch River continues downstream, picking up the Emory River at CRM 4.4 before itself emptying into the Tennessee River on Watts Bar Reservoir at Tennessee River Mile (TRM) 567.8.

The upstream boundary of the CRN Site is approximately 4.1 miles downstream of Melton Hill Dam, and approximately 52.4 miles upstream of Watts Bar Dam. As shown in Figure 3-7 and summarized in Table 3-3, there are five dams and reservoirs upstream of the CRN Site that may affect the hydrology of Watts Bar Reservoir in the vicinity of the CRN site:

- Norris Dam and Reservoir, closed in 1936, located at CRM 79.8, approximately 61 miles upstream from the CRN Site.
- Melton Hill Dam and Reservoir, closed in 1963, located at CRM 23.1, approximately 4.1 miles upstream of the CRN Site.
- Watts Bar Dam and Reservoir, closed in 1942, located at TRM 529.9 or approximately 52 miles downstream of the CRN Site.
- Fort Loudoun Dam and Reservoir, closed in 1943, located at TRM 602.3, about 35 miles upstream from the Clinch River confluence, and releases water into Watts Bar Reservoir.
- Tellico Dam and Reservoir, closed in 1979, located at Little Tennessee River Mile 0.3, and TRM 601.1, about 34 miles upstream from the Clinch River confluence, and releases water into Watts Bar Reservoir.

White Oak Dam and White Oak Creek Embayment Sediment Control Dam (located near CRM 21.0) on White Oak Creek (see Figure 3-6) may also periodically influence local hydrology of the Watts Bar Reservoir in the vicinity of the CRN Site.

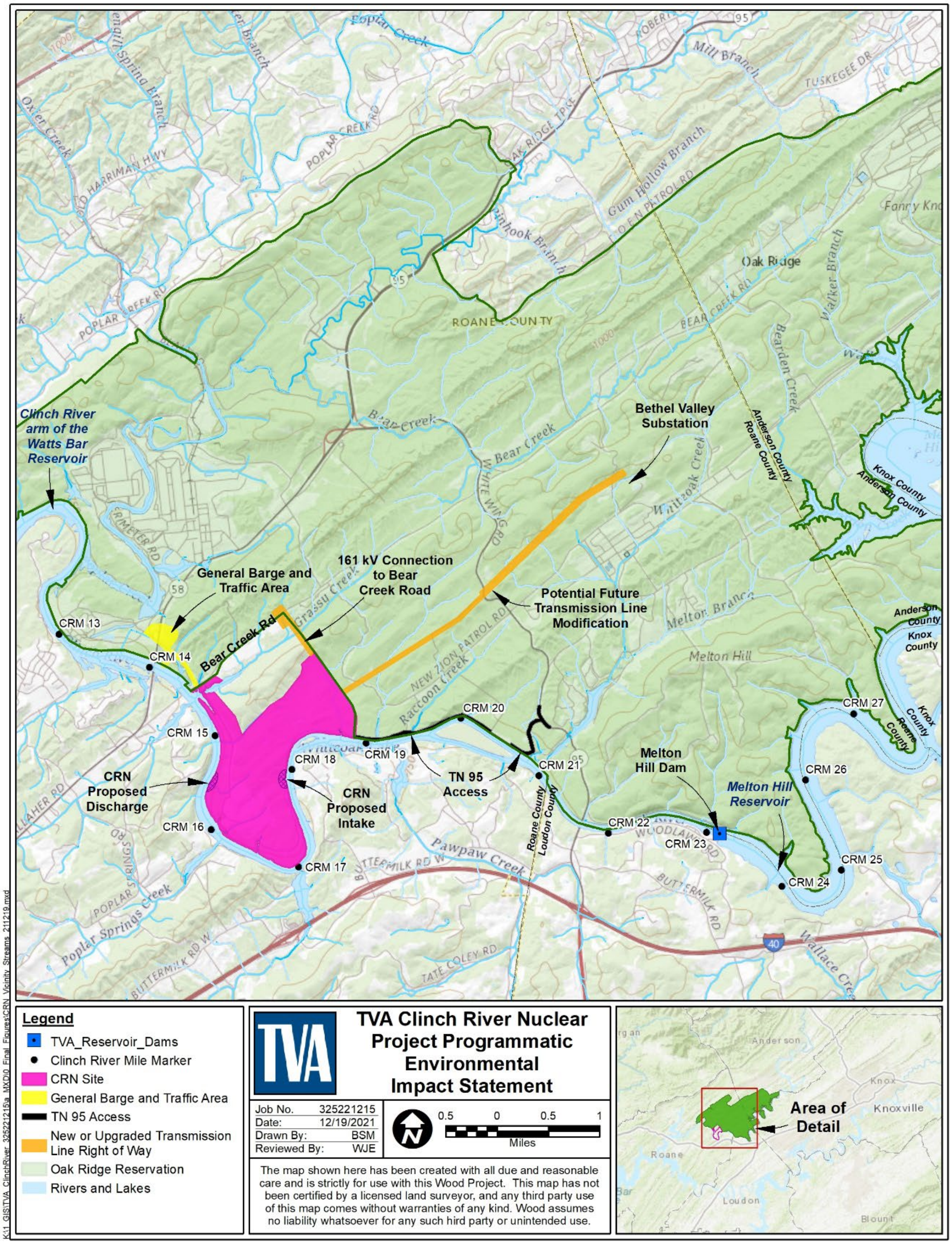


Figure 3-6. Local Hydrologic Features in the Vicinity of the CRN Site

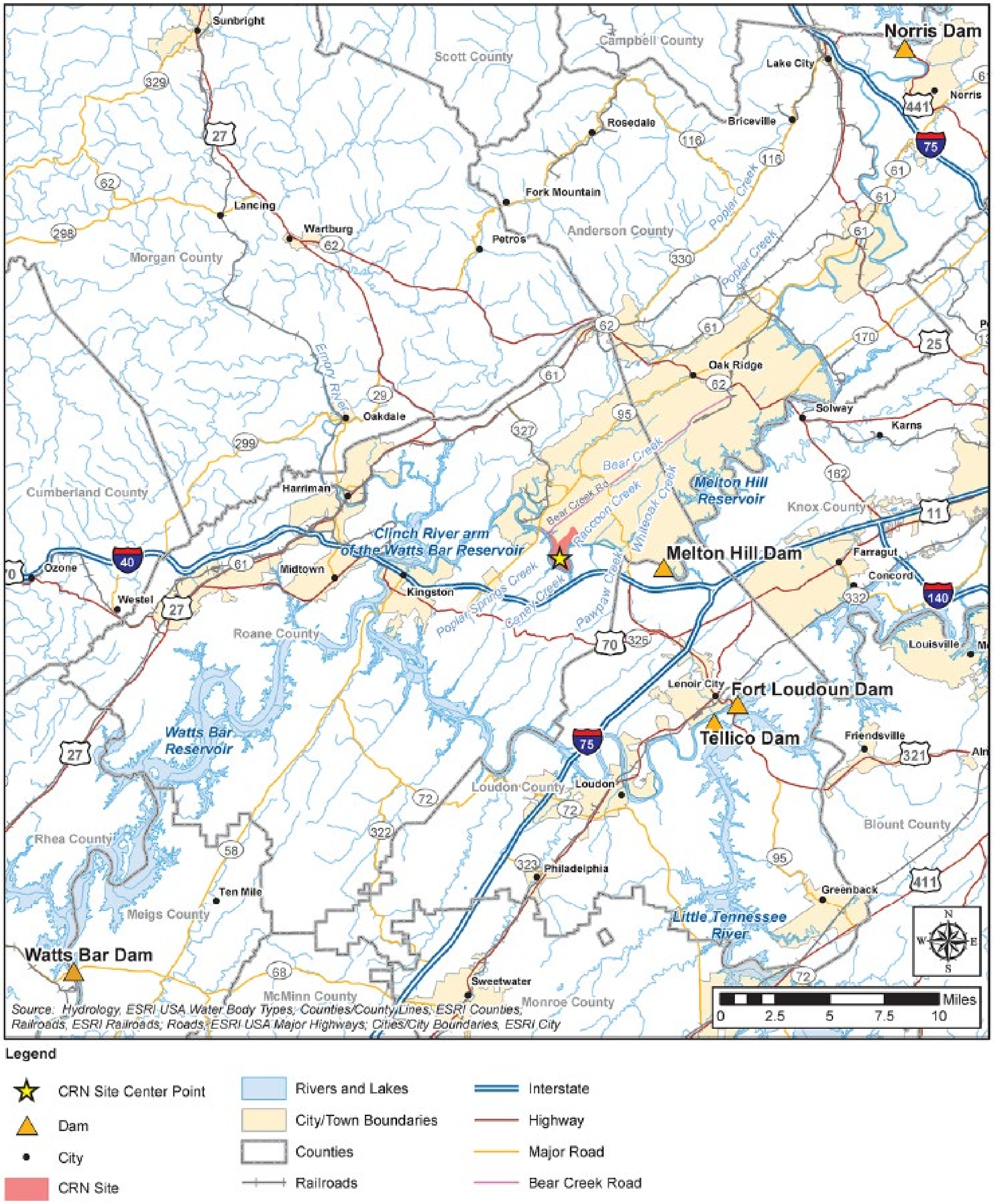


Figure 3-7. CRN Site Regional Water Resources

Table 3-3. Reservoirs that Influence Flows at the CRN Site

Reservoir	Waterbody	Purpose	Flood Storage (ac-ft)[1]	Area (ac)	Elevation Range (ft AMSL)
Norris	Clinch & Powell Rivers	Power Generation, Flood Control, Recreation	1,113,000	33,840	992-1,020
Melton Hill	Clinch River	Power Generation, Navigation, Recreation, Water Supply	negligible	5,470	793-795
Watts Bar	Tennessee, Clinch, & Emory Rivers	Power Generation, Flood Control, Navigation, Water Supply, Recreation	379,000	39,090	735-741
Fort Loudoun[2]	Tennessee River	Power Generation, Flood Control, Navigation, Water Supply, Recreation	111,000	14,600	807-812.8

(1) At January 1 Flood Guide
(2) Fort Loudoun Reservoir is connected by a canal to Tellico Reservoir on the Little Tennessee River. A regulated spillway on Tellico Dam is used only during extreme flooding

The CRN Site is located approximately 8.2 air miles east of the confluence of the Tennessee and Clinch Rivers. As shown on Figure 3-6, a number of creeks in the vicinity of the CRN Site discharge into the Reservoir from the right descending bank. These include: White Oak Creek, Raccoon Creek, Grassy Creek and Poplar Creek. Paw Paw Creek, Caney Creek and Poplar Springs Creek discharge to Watts Bar Reservoir from the left descending bank.

3.3.1.1.1.3 Clinch River Arm of Watts Bar Reservoir

The water surface elevation (WSEL) for the section of the Reservoir adjacent to the CRN Site generally follows the pool elevation at Watts Bar Dam (i.e., is backwater from the dam). Water flow is usually in the downstream direction but can be quiescent or in the upstream direction for short periods of time in conjunction with the peaking operations at the Watts Bar, Melton Hill, and Fort Loudoun hydroelectric plants.

The daily average WSEL at CRM 16.1 varies between 736 and 744.5 feet above mean sea level, a range of approximately 8.5 feet. The WSEL follows the general trend of Watts Bar Dam Headwater Elevation (HWEL) (Figure 3-8). However, differences occur between the WSEL at the CRN Site and WSEL at Watts Bar Dam due to hydraulic conditions between the site and Watts Bar Dam. At the CRN Site, discharges from Melton Hill Dam can influence Clinch River WSELs, especially as Melton Hill discharges increase. During periods when the daily average release from Melton Hill Dam was in excess of approximately 5,000 cfs (e.g., late January and early February 2013; January-March 2019; February-March 2020; and late March-early April 2021), it was not uncommon for the WSEL at the CRN Site to rise 1.0 feet or more above the HWEL at Watts Bar Dam. This dynamic also occurs at smaller time scales. For example, on an hourly basis, peaking operations at Melton Hill Dam can cause the WSEL at the CRN Site to rise above the HWEL at Watts Bar Dam. Sloshing of the reservoir from peaking operations at the Watts Bar, Melton Hill, and Fort Loudoun hydroelectric plants also can cause the opposite to occur, with the WSEL at the CRN Site falling below the HWEL at Watts Bar Dam. During these events, the current pattern in the Reservoir is reversed, with flow moving upstream rather than downstream.

Figure 3-8 shows the maximum, minimum, and average values of the daily midnight HWEL that are typical Watts Bar Dam as represented for the period of record from 2004 through 2021. As is evident in Figure 3-8, Watts Bar HWEL can spike above the target operating ranges due to storm runoff, flood operations to reduce flood impacts at Chattanooga, or both.

3.3.1.1.1.4 CRN Site and Associated Offsite Areas

TVA conducted field studies in 2021 to identify the surface water resources on the CRN Site and associated offsite areas (Table 3-4 and Figure 3-9). Identified surface water resources on or adjacent to the CRN Site include the Reservoir, 13 intermittent or perennial streams, 19 ephemeral streams and wet weather conveyances (WWCs), and four onsite ponds created during the CRBRP to serve as stormwater retention ponds. Chestnut Ridge is a prominent topographic feature that divides the drainages contributing to Grassy Creek north of the CRN Site and smaller drainage features in the northeastern portion of the CRN Site (Note: wetland resources and potential impacts to wetlands are discussed further in Section 3.4.2.1).

Notably, the central portion of Area 1 of the CRN Site generally lacks identified streams as this area was substantially disturbed by the prior CRBRP project. As noted in Figure 3-9, there are two ponds, one small (P07) and one large (P08), located on the southeast edge of the BTA. Several large wetlands are also located in three low areas near the shore of the Reservoir: in the BTA, south of Grassy Creek parallel to the CRN Site access road, and near the northeast edge of the CRN Site (associated with the cluster of streams) and along the TN 95 Access. Surface water features along the proposed offsite 161-kV transmission line consist of Grassy Creek in the vicinity of the transmission line crossing of Bear Creek Road. As indicated in Table 3-5, offsite surface water resources associated with the 500-kV line extending to the Bethel Valley Substation include four small intermittent and perennial streams. These streams include Ish Creek and several tributaries of White Oak Creek. Characteristics of these streams and their aquatic biota are described further in Section 3.6 (Aquatic Ecology).

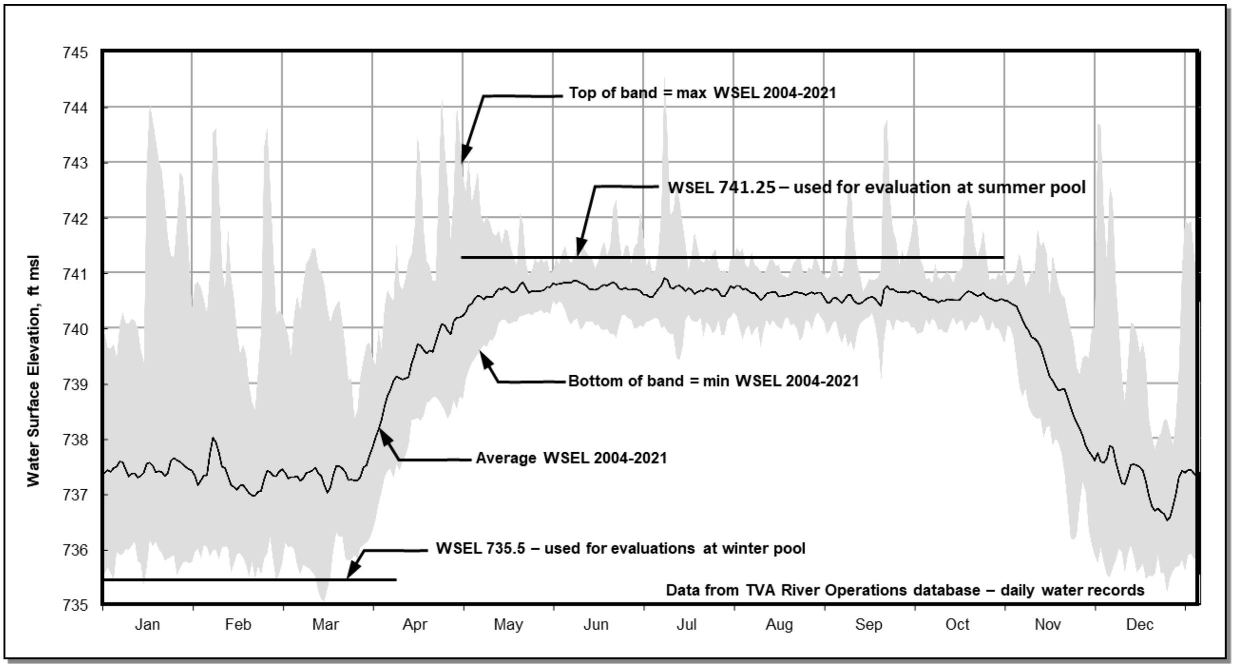


Figure 3-8. Headwater Elevation at Watts Bar Dam, Showing Max, Min, and Average Values of Daily Midnight Readings, 2004-2021

Table 3-4. Surface Water Resources (streams/ponds) on the CRN Site and Associated Offsite Areas

Location	Type	Identifier	Number	Length (Feet) / Area (Acres)
CRN Site				
	Ponds		**4**	**1.37**
		P01		0.28
		P02		0.18
		P03		0.75
		P04		0.16
	Perennial Streams		**3**	**2,525**
		STR07		681
		STR11		1,786
		STR12		58
	Intermittent Streams		**4**	**1,477**
		STR04		311
		STR05		286
		STR06		123
		STR10		757
	WWCs		**14**	**5,666**
		EPH03		144
		EPH04		55
		EPH05		113
		EPH06		118
		EPH07		115
		EPH08		124
		EPH09		614
		EPH10		673
		EPH11		1,052
		EPH12		919
		EPH13		540
		EPH14		322
		EPH18		83
		EPH19		794
Associated Offsite Areas				
Barge and Traffic Area				
	Ponds		**0**	**0**
	Perennial Streams		**1**	**117**
		STR03		117
	Intermittent Streams		**1**	**335**
		STR01		335
	WWCs		**2**	**812**
		EPH01		471

Location	Type	Identifier	Number	Length (Feet) / Area (Acres)
		EPH02		341
TN 95 Access				
	Ponds		**0**	**0**
	Perennial Streams		**3**	**594**
		STR13		305
		STR14		136
		STR15		153
	Intermittent Streams		**0**	**0**
	WWCs		**0**	**0**
161-kV Offsite Transmission Line				
	Ponds		**0**	**0**
	Perennial Streams		**0**	**0**
	Intermittent Streams		**1**	**1,271**
		STR08		1,271
	WWCs		**4**	**814**
		EPH15		101
		EPH16		294
		EPH17		161
		EPH18		258
500-kV Corridor to Bethel Valley Substation[1]				
	Ponds		0	-
	Streams		4	-
Project Area Total				
	Ponds		**4**	**0.62**
	Perennial Streams		**7**	**3,372**
	Intermittent Streams		**6**	**3,083**
	Undifferentiated Streams[1]		**4**	**-**
	WWCs		**19**	**7,292**

[1] based on desktop analysis within offsite 500-kV corridor, no site review conducted.
Note: WWC = wet weather conveyance

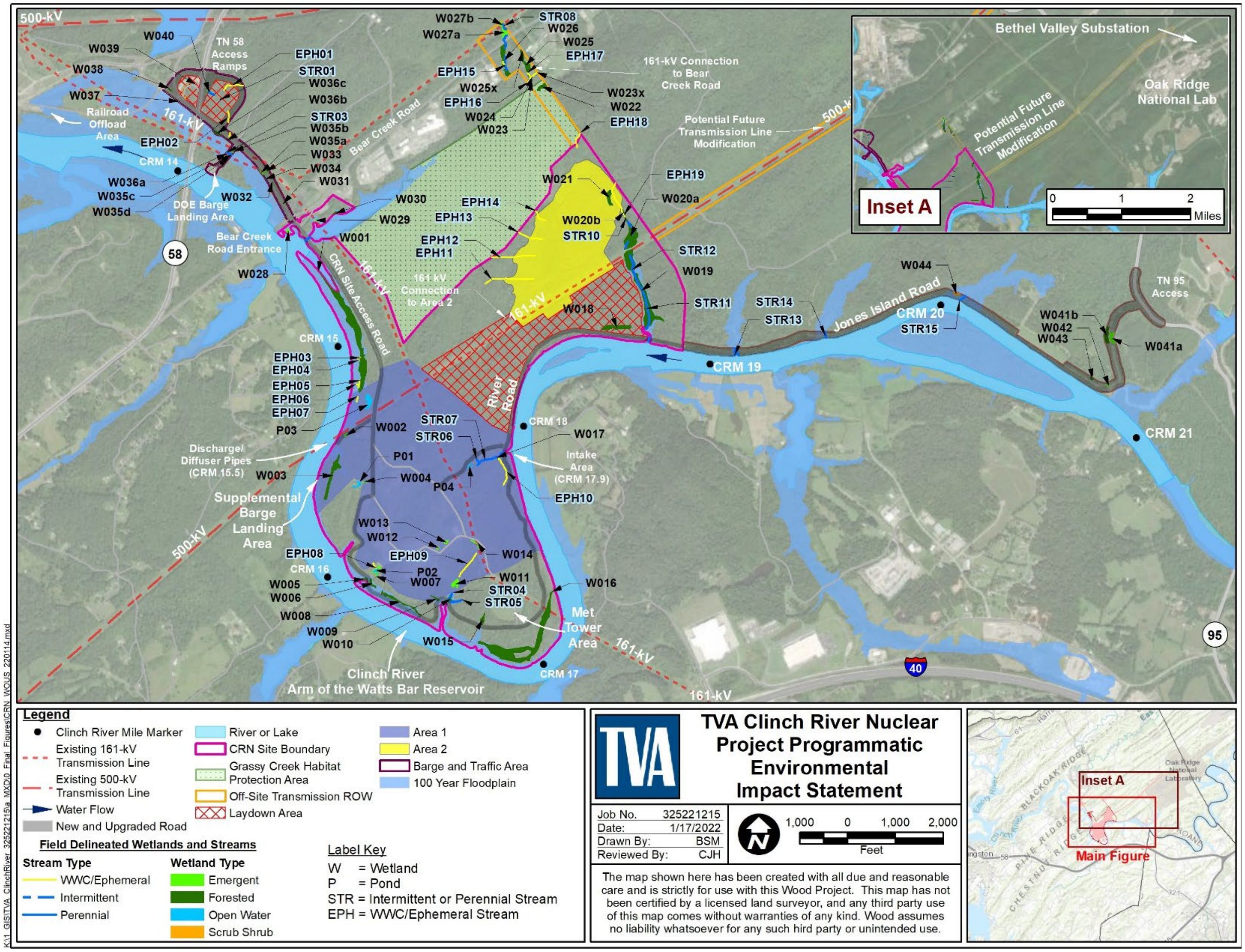


Figure 3-9. Identified Surface Water Resources on the CRN Site and Associated Offsite Areas

3.3.1.1.2 Water Use

USGS Categories of water use include thermoelectric power, industrial, public supply, and irrigation. Total water withdrawals from the Tennessee River watershed during 2015 were estimated to average 10,016 million gallons per day (MGD) for off-stream uses. In 2015, total withdrawal was about 16 percent lower than it was in 2010, which was primarily due to a reduction in thermoelectric withdrawal of about 18 percent as a result of lower energy generation in the watershed compared to 2010. Thermoelectric water use in the watershed was 82.1 percent of withdrawals, industrial use was 10.3 percent, and public supply was approximately 7 percent. Public supply use was the largest consumptive use in the Tennessee River basin, totaling 246 MGD in 2015 (Bowen and Springston 2018).

According to Bowen and Springston (2018), projected 2040 water withdrawals from the Tennessee River watershed are expected to decline relative to 2015 levels. Projected changes from 2015 levels are as follows: industrial will increase by 16 percent to 1,197 MGD, public supply will increase by 21 percent to 842 MGD, and irrigation will increase by 40 percent to 88 MGD. Thermoelectric water withdrawal is expected to decline by 27 percent to 5,981 MGD, reflecting changes in both generating and cooling technologies for TVA power plants. Although total withdrawals are expected to decrease, total net water demand will rise by 24 percent to 543 MGD. This is due to projected economic growth and continued population growth in the Tennessee Valley, as well as continued growth of irrigated agriculture (Section 3.15).

In the lower Clinch River watershed, water use levels reported by Bowen and Springston for 2015 are summarized in Table 3-5. Notably, the Bull Run Fossil Plant accounts for all surface water use within the Melton Hill Reservoir. As indicated by TVA, however, the Bull Run Fossil Plant located within the Melton Hill Reservoir is scheduled for retirement in 2023 (TVA 2021a).

Table 3-5. Water Use Characteristics within Melton Hill and Watts Bar Reservoirs in 2015

	Water Use by Source (MGD)				
	Surface Water	**Groundwater**	**Total Water Use**	**Total Return Flow**	**Net Water Demand**
Melton Hill	555.95	1.38	557.33	527.29	30.03
Watts Bar	1,127.41	2.23	1,129.64	984.06	145.58

	Water Use by Category (MGD)				
	Thermoelectric	**Industrial**	**Public Supply**	**Irrigation**	**Total Water Withdrawals**
Surface Water					
Melton Hill	528.62	0.32	26.35	0.65	555.95
Watts Bar	1,095.65	6.30	24.16	1.30	1,127.41
Groundwater					
Melton Hill	NA	0.00	1.36	0.02	1.38
Watts Bar	NA	0.00	2.19	0.04	2.23

Source: Bowen and Springston 2018

Water use may be either consumptive or non-consumptive. Consumptive use is that part of the water withdrawn that is evaporated, transported, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate environment (Bowen and

Springston 2018). Most of the surface water use in the lower Clinch River watershed is non-consumptive, meaning either no water is withdrawn, or that the volume withdrawn is returned to the source waterbody and is thus available to downstream users. Non-consumptive water uses in the lower Clinch River watershed include hydroelectric power generation at Melton Hill Dam, navigation, aquatic habitat, and recreational activities such as fishing, boating, and swimming.

Consumptive water use occurs when more water is withdrawn than is returned to the source waterbody, resulting in a decrease in supply downstream of the user. Thermoelectric power generation accounts for the greatest amount of consumptive use within the Tennessee Valley. Consumptive uses within Melton Hill and Watts Bar Reservoirs in 2015 were approximately 30 and 145 MGD, respectively (Bowen and Springston 2018).

3.3.1.1.3 Water Quality

3.3.1.1.3.1 Regional Water Quality

The water quality data in the Upper Tennessee River Basin from 1994 to 1998 were summarized by the USGS in 2000. The report evaluated concentrations and distribution of bacteria, nutrients, pesticides, and volatile organic compounds (VOCs) in surface water and sediment, the influence of industry and mining on water quality, and the effects of toxic spills and releases. The study was performed as part of the USGS National Water-Quality Assessment Program, which, as of 2000, had evaluated 36 study areas throughout the U.S. The report compared water quality data from the Upper Tennessee River to data from the other study areas, as well as to national water quality benchmarks, such as those for drinking water quality and protection of aquatic organisms.

In general, the report concluded that surface water in the Upper Tennessee River Basin usually meets existing guidelines for drinking water, recreation, and the protection of aquatic life. Specific findings included:

- Bacteria levels frequently exceeded state standards in agricultural and urban areas. In agricultural areas, this was attributed to runoff from pastureland. In urban areas, this was attributed to wastewater infrastructure.
- Nutrients, including nitrogen and phosphorus, were found at elevated levels in some streams.
- Herbicides were detected in 98 percent of the stream samples collected, and insecticides were detected in 12 percent of samples. Concentrations were within drinking water standards but exceeded aquatic life guidelines for some chemicals.
- Contamination from past industrial and mining activities was still present in many areas. Contamination had resulted in fish consumption advisories for polychlorinated biphenyls (PCBs), dioxin, and mercury. Semi-volatile organic compounds (SVOCs) were found in sediment at concentrations that exceeded aquatic life guidelines and were attributed to coal mining.
- Spills and releases had resulted in fish and mussel kills in many parts of the basin.

Fish consumption advisories are published by TDEC on a recurring basis and those issued for 2020 near the CRN Site include those on East Fork of Poplar Creek (including Poplar Creek embayment and Bear Creek) for mercury and PCBs (all fish), the entirety of the Melton Hill Reservoir for polychlorinated compounds (PCBs, catfish advisory), and the Reservoir for PCBs (striped bass, catfish and sauger). Bacteriological advisories are effective for the East Fork of

Poplar Creek due to City of Oak Ridge urban runoff and collection system issues (TDEC 2020b).

3.3.1.1.3.2 State Monitoring and 303(d) List
TDEC conducts monitoring of surface waters that includes biological, chemical, and bacteriological analyses in wetlands, rivers, streams, reservoirs, and lakes.

TDEC monitoring stations include those located on the Reservoir, including four monitoring stations between Melton Hill Dam and the CRN Site, and eight stations between the CRN Site and the confluence of the Clinch River arm with the Tennessee River arm of Watts Bar Reservoir. The closest station is located directly adjacent to the CRN Site, on the eastern side of the peninsula near CRM 18. Another station is located at Route 58, directly adjacent to the BTA.

Section 303(d) of the federal Clean Water Act requires that states develop a list of surface water bodies that are "water quality limited" or are expected to exceed water quality standards in the next two years. Streams that are water quality limited have one or more characteristics that violate water quality standards. These streams are impaired by pollution and cannot fully meet their designated uses.

In 2020, TDEC issued its updated 303(d) list. Table 3-6 lists the water bodies near the CRN Site that are listed as impaired.

Table 3-6. 303(d)-listed Waterbodies in the Vicinity of the CRN Site

Waterbody Name	Location	Waterbody Type	Cause	Potential Source
Poplar Creek Embayment	Roane County	Lake/ Reservoir/ Pond	PCBs, Mercury	Contaminated Sediments
Clinch River Arm of Watts Bar Reservoir	Roane County	Lake/ Reservoir/ Pond	PCBs, Mercury, Chlordane	Contaminated Sediments
Poplar Creek Embayment	Roane County	Lake/ Reservoir/ Pond	PCBs, Mercury	Contaminated Sediments
Poplar Creek	Roane County	River	Nitrate/Nitrite (Nitrite + Nitrate As N), Phosphorous-Total	Sanitary Sewer Overflows (Collection System Failures)
Bear Creek	Roane County	River	PCBs, Mercury, Nitrate/Nitrite, Cadmium	CERCLA NPL (Superfund) Sites
East Fork Poplar Creek	Roane County	River	Phosphorous-Total, Nitrate-Nitrite, Sedimentation, Mercury, *Escherichia*	Municipal (Urbanized High Density Area)

Waterbody Name	Location	Waterbody Type	Cause	Potential Source
			coli, Nutrients, PCBs	
Melton Branch	Roane County	River	Strontium	CERCLA NPL (Superfund) Sites
White Oak Creek	Roane County	River	Cesium	CERCLA NPL (Superfund) Sites
White Oak Creek	Roane County	River	Strontium	CERCLA NPL (Superfund) Sites

Source: TDEC 2020a,b

3.3.1.1.3.3 River and Reservoir Compliance Monitoring Program

TVA initiated a reservoir monitoring program, formerly called the Vital Signs Monitoring Program, in 1990 to provide information on the ecological health or integrity of major reservoirs in the Valley. Through the current Reservoir Ecological Health Program, TVA monitors ecological conditions at 69 sites on 31 reservoirs. Each site is sampled every other year unless a substantial change in the ecological health score occurs during a 2-year cycle. If that occurs, the site is sampled the next year to confirm that the change was not temporary. Roughly half the sites are sampled each year on an alternating basis. The program includes five ecological indicators (chlorophyll-a, dissolved oxygen (DO), sediment quality, benthic macroinvertebrates, and fish assemblage), which are monitored at up to four locations in each reservoir. To complete the ecological health scoring process, the 20 to 100 percent scoring range is divided into categories representing good, fair, and poor ecological health conditions relative to what is expected given the hydrogeomorphology of the reservoir.

Melton Hill Reservoir

TVA has monitored three locations on Melton Hill Reservoir: the deep, still water near the dam, called the forebay; the middle part of the reservoir; and the riverine area at the upper end of the reservoir, called the inflow. Monitoring is usually done on a two-year cycle. The overall ecological condition of Melton Hill rated fair in 2018. Melton Hill received a good rating in 2006, 2010, and 2016 but rated fair in all other years monitored. The higher ecological health scores were primarily due to two indicators (chlorophyll and bottom life) rating near the upper end of their historic ranges, as well as fish community scores in 2016.

Watts Bar Reservoir

TVA has monitored four locations on Watts Bar Reservoir: the forebay; the middle part of the reservoir; and the Tennessee and Clinch River inflow locations. Samples are usually collected on a two-year cycle. The overall ecological health condition for Watts Bar Reservoir rated at the upper end of fair in 2018. Ecological health scores for Watts Bar have fluctuated between a “high fair” and poor and have generally followed reservoir flow conditions. Flow conditions in 2012 were low during most of the summer months in response to the generally dry weather pattern. The indicator most responsive to flow is DO, which rated poor at the forebay in 2012. In addition, common problems are elevated chlorophyll concentrations, poor bottom life, and the presence of metals and/or organic contaminants in the sediments.

3.3.1.1.3.4 CRN Site Preapplication Monitoring Program

Water Quality Monitoring

To support the evaluation of the suitability of the CRN Site and BTA, TVA monitored the surface water on and in the immediate vicinity of these areas from July 2013 to June 2015. This program consisted of characterization of surface water in the Reservoir, as well as characterization of stormwater runoff on both the CRN Site and BTA. The resulting data provides information to determine existing conditions for surface water. The parameters measured or analyzed include temperature, total metals, nutrients, acids/base/neutral compounds, PCBs, gross alpha, gross beta, radium 228, radium 226, oil and grease, pH, cyanide, phenols, biochemical oxygen demand, chemical oxygen demand, total suspended solids (TSS), color, bromide, surfactants, total organic carbon (TOC), sulfide, sulfate, ammonia-N, fluoride, and hardness. Pesticide monitoring was included in the July 2013 sampling.

Nutrient and sediment chemistry data (as indicators of ecological health) were also collected at four mid-channel locations, including three upstream locations at CRM 18.5, 19.7, and 22.0, and one downstream location at CRM 15.5. Water samples were analyzed for nutrients (Kjeldahl nitrogen, nitrate plus nitrite-nitrogen, ammonia nitrogen, total phosphorus, and orthophosphate), TOC, alkalinity, hardness, water clarity (turbidity and TSS), total dissolved solids (TDS) and total and dissolved metals. In June 2011, sediment samples were collected at three of the locations, including CRM 15.5, 18.5, and 22.0. Sediment samples were analyzed for metals and organochloride pesticides and PCBs.

Results of water quality, nutrients, and sediment chemistry as compared with State of Tennessee water quality criteria are summarized in Table 3-7. The water quality criteria included in Table 3-7 are the most restrictive values for the applicable designated uses. Maximum measured values of reported water quality parameters satisfied available water quality standards, with the exceptions of lead, mercury, and thallium.

Table 3-7. Maximum Values for Water Quality Parameters Measured by TVA in the Clinch River Arm of Watts Bar Reservoir

			Clinch River Arm of Watts Bar Reservoir		Stormwater
Parameter	**Units**	**Water-Quality Criteria[(a)]**	**Biological Monitoring Stations CRM 15.5, 18.5, 19.7, and 22.0 (all dates)**	**Pre-Application Monitoring Stations CRS8, CRS9, CRS10, CRS12 (all dates)**	**Pre-Application Monitoring Stations CRS1, CRS2, CRS3, CRS6 (all dates)**
Temperature	°C	30.5	-	26.8	31.3
pH		6.5 to 9.0	-	6.1-7.7	6.7-81
Oil and Grease	mg/L		-	<5.0	<5.6
Cyanide	µg/L	5.2	-	<5	<5
Total Phenols	mg/L	10	-	0.14	0.083
Biochemical Oxygen Demand	mg/L		-	8.85	< 5
TSS	mg/L		-	13.4	114
Color	PCU		-	50.0	80.0
Bromide	mg/L		-	0.10	2.0
Surfactants	mg/L		-	0.20	0.16
Total Organic Carbon	mg/L		3.6	18.1	37.0
Sulfide	mg/L		-	<0.10	< 0.10
Ammonia-N	mg/L	1.24[(b)]	0.19	0.21	0.13
Nitrate/Nitrite	mg/L	10	0.7	1.5	0.95
Total Organic Nitrogen	mg/L		-	< 0.50	1.1
Total Kjeldahl Nitrogen	mg/L		0.79	< 0.50	1.1
Total Phosphorus	mg/L		0.048	< 0.10	0.23
Chemical Oxygen Demand	mg/L		-	< 25	6.2
Total Fluoride	mg/L		-	< 0.50	0.25
Sulfate	mg/L		-	24.3	130
Alkalinity	mg/L		130	-	-
Suspended Solids	mg/L		11	-	-
Dissolved Solids	mg/L	500	200	-	-
Hardness, Total (as $CACO_3$)	mg/L			143	324
Phosphate, Ortho	mg/L			-	-
Total Organic Carbon	mg/L			-	-
Turbidity	NTU		12	-	-
Metals					
Total Aluminum	µg/L		800	747	2,180
Aluminum, Dissolved	µg/L		150 DT[(c)]	-	-
Total Magnesium	µg/L		11,000	11,400	33,100
Magnesium, Dissolved	µg/L		12,000	-	-
Total Calcium	µg/L		38,000	39,100	87,300

Parameter	Units	Water-Quality Criteria[(a)]	Clinch River Arm of Watts Bar Reservoir: Biological Monitoring Stations CRM 15.5, 18.5, 19.7, and 22.0 (all dates)	Clinch River Arm of Watts Bar Reservoir: Pre-Application Monitoring Stations CRS8, CRS9, CRS10, CRS12 (all dates)	Stormwater: Pre-Application Monitoring Stations CRS1, CRS2, CRS3, CRS6 (all dates)
Total Iron	µg/L		610	232	2,880
Iron, Dissolved	µg/L		<100	-	-
Total Copper	µg/L	g[(d)]	<2.0	1.5	5
Copper, Dissolved	µg/L	g[(d)]	2.2 DT	-	-
Total Zinc	µg/L	120[(d)]	<10	10.0	25.0
Zinc, Dissolved	µg/L	120[(d)]	<10	-	-
Total Barium	µg/L	2,000	-	38.4	81.5
Total Boron	µg/L		-	50	50
Total Cobalt	µg/L		-	1.0	5
Total Manganese	µg/L		58	895	884
Manganese, Dissolved	µg/L		42 DT	-	-
Total Molybdenum	µg/L		-	1.0	1.2
Total Tin	µg/L		-	50	50
Total Titanium	µg/L		-	< 10	36.9
Total Antimony	µg/L	6	-	1.0	1.0
Total Arsenic	µg/L	10	1.1	0.0	5.0
Arsenic, Dissolved	µg/L	10	<1.0	-	-
Total Beryllium	µg/L	4	-	1.0	0.18
Total Cadmium	µg/L	5	<0.5	0.1	0.10
Cadmium, Dissolved	µg/L	0.25[(d)]	<0.5	-	-
Total Chromium	µg/L	11(Cr-VI)[(e)]	<2.0	1.4	5
Chromium, Dissolved	µg/L	11(Cr-VI)	<2.0	-	-
Total Lead	µg/L	2.5[(d)]	8.6	2.1	3
Lead, Dissolved	µg/L	2.5[(d)]	1.5 DT	-	-
Total Mercury	µg/L	0.05[(e)]	-	-	1,220
Low-Level Mercury	µg/L	50[(e)]	-	5.33	5.64
Total Nickel	µg/L	100	3.1	1.0	5.0
Nickel, Dissolved	µg/L	52[(d)]	2.5	-	-
Total Selenium	µg/L	5	<1.0	1.0	5.0
Selenium, Dissolved	µg/L	5	<1.0	-	+
Total Silver	µg/L	3.2[(d,f)]	-	< 0.5	0.5
Total Thallium	µg/L	0.24	-	1.0	1.0
Radioactivity			-		
Gross Alpha	pCi/L	15	-	<MCD[(f)]	2.39 ± 1.21
Gross Beta	pCi/L		-	2.85 ± 1.0	3.12 ± 1.41
Total Alpha Radium	pCi/L		-	<MDC	<MDC

			Clinch River Arm of Watts Bar Reservoir		Stormwater
Parameter	**Units**	**Water-Quality Criteria[a]**	**Biological Monitoring Stations CRM 15.5, 18.5, 19.7, and 22.0 (all dates)**	**Pre-Application Monitoring Stations CRS8, CRS9, CRS10, CRS12 (all dates)**	**Pre-Application Monitoring Stations CRS1, CRS2, CRS3, CRS6 (all dates)**
Radium 226	pCi/L	5 (Ra-226	-	0.719 ± 0.217	<MDC
Radium 228	pCi/L	+ Ra-228)	-	<MDC	<MDC

(a) Chapter 0400-40-03, General Water Quality Criteria, Rules of the Tennessee Department of Environment and Conservation. Values shown are the most restrictive for the applicable designated uses.
(b) For pH 8 and 25°C (Chapter 0400-40-03, General Water Quality Criteria, Rules of the Tennessee Department of Environment and Conservation gives formulas for calculating Criteria Maximum Concentration depending on presence/absence of salmonids and pH)
(c) DT=dissolved fraction exceeded the total recoverable metal concentration.
(d) Criteria concentrations are a function of total hardness; values correspond to total hardness of 100 mg/L.
(e) Criteria concentration expressed as dissolved.
(f) Fish and Aquatic Life Criteria Maximum Concentration for dissolved silver from Chapter 0400-40-03, General Water Quality Criteria, Rules of the Tennessee Department of Environment and Conservation. MDC – minimum detectable concentration

Temperature

The water temperature in the Reservoir varies with meteorological conditions and operation of the upstream Norris and Melton Hill Reservoirs. Cold water released from storage in Norris Reservoir flows down to Melton Hill Reservoir where it receives heat from Bull Run Fossil Plant cooling water discharge. This contributes to thermal stratification in Melton Hill Reservoir, which affects the temperature of water at the Melton Hill Dam hydroelectric intakes and therefore affects the temperature of the water released downstream to the Clinch River arm of the Watts Bar Reservoir. Figure 3-10 presents the average and range of hourly water temperature in the tailwater below Melton Hill Dam. During thermal monitoring in 2013, TVA found that hourly water temperature at the proposed discharge location approximately 7.7 miles downstream of Melton Hill Dam could range from up to 1°F colder to 3°F warmer than the Melton Hill Dam tailwater temperature. As a result, TVA estimated a seasonal water temperature range of 38°F in winter to 78°F in summer at the discharge location. While Melton Hill Dam operations are expected to continue in the same manner during building and operating activities at the CRN Site, the Bull Run Fossil Plant is scheduled for closure at the end of 2023 (TVA 2021a). As such, future water temperature fluctuations and seasonal variability are expected to exhibit a reduced range and degree of stratification relative to existing conditions.

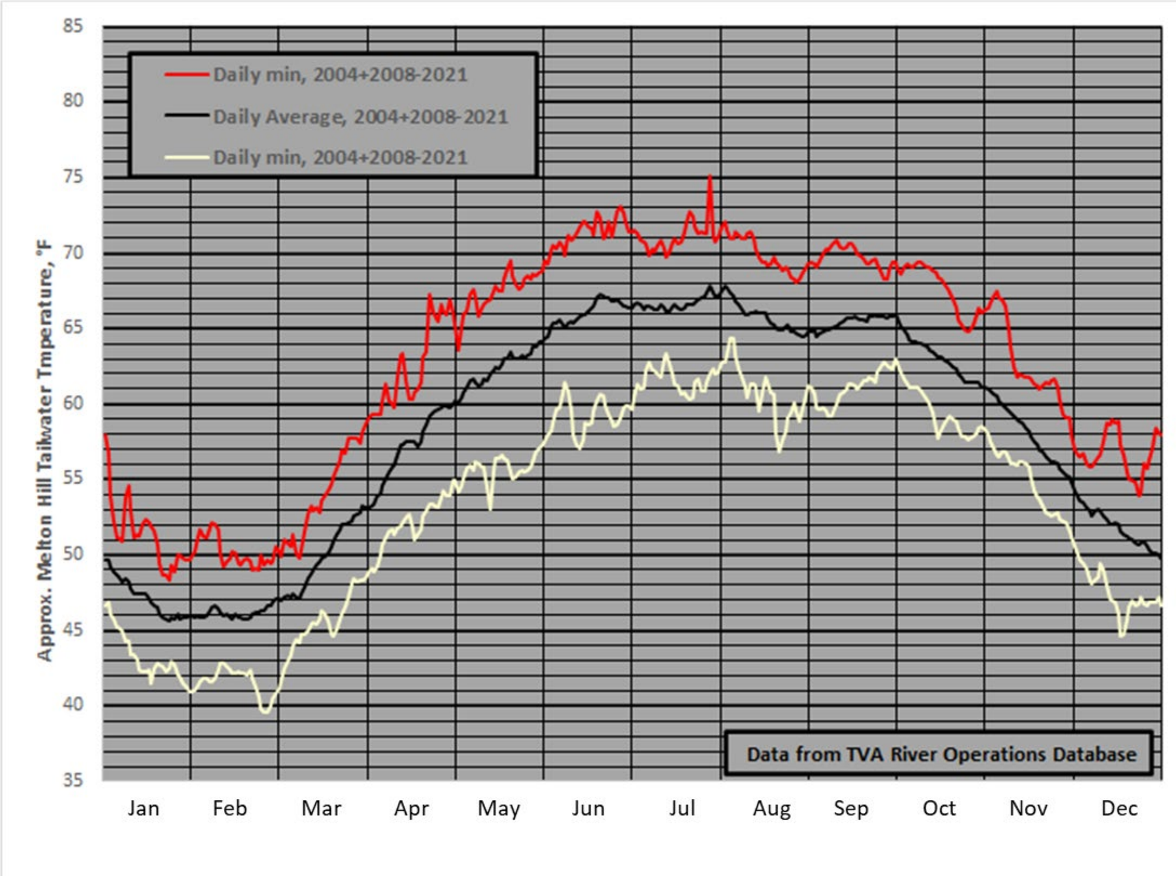


Figure 3-10. Average and Range of Hourly Water Temperature in the Tailwater below Melton Hill Dam by Date (data from 2004 and 2008–2021)

3.3.1.1.3.5 Sediments

Sediments present from CRM 0.0 to CRM 44 are a designated Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) site as the result of hazardous and radioactive contamination from past activities at ORR and other non-DOE municipal and industrial sources (EPA 1997). The current remedy includes maintenance of institutional controls on potential sediment-disturbing activities (i.e., the procedures of the Watts Bar Interagency Working Group), fish-consumption advisories, and monitoring to detect changes in contaminant levels or mobility. The 1991 Interagency Agreement (Watts Bar Interagency Agreement) was established in partnership with the USACE, DOE, TDEC, and the EPA, to coordinate review of permitting and other use authorization activities that 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. The CERCLA investigation concluded that metals and radionuclide contaminants occur in deep-water sediments, the highest concentrations are buried 20–60 centimeters deep, and little DOE-related contamination is in near-shore sediments (EPA 1997). Radionuclides detected in sediment during the CERCLA investigation included Cs-137, Co-60, uranium-238 (U-238), U-235, and Tc-99. DOE conducted annual sediment sampling at locations near the CRN Site through 2005, at which point the sampling frequency was reduced to once every five years; the closest monitoring location was at about CRM 14.5.

A number of metals and radionuclides have been present at greater than background concentrations (as measured at CRM 44.5-45). In 2015, sediment concentrations of aluminum, boron, lithium, potassium, and cesium-137 exceeded background levels. Cesium-137 concentration was very low, at 1.35 pCi/g sediment. PCBs were below detection levels in 2010 at CRM 14.5.

3.3.1.2 Groundwater

This section describes groundwater conditions associated with the CRN Site, including a description of regional aquifers and aquitards and those present at the CRN Site. The CRN Site is located within the Valley and Ridge Physiographic Province. The geologic units within the Valley and Ridge physiographic province are described in Section 3.2 and comprise the aquifers and aquitards found at the CRN Site.

3.3.1.2.1 Groundwater Hydrology

The principal aquifers in the Valley and Ridge Physiographic Province are found within the carbonate bedrock of Cambrian, Ordovician, and Mississippian age. The aquifers that underlie the Valley and Ridge Physiographic in Tennessee typically occur in the valleys and are rarely present on the broad dissected ridges. The carbonate-rock aquifers are often directly connected to surface-water features, such as rivers and lakes, that serve either as groundwater discharge points or as sources of recharge. The carbonate aquifers have little primary porosity, and permeability and groundwater movement in the Valley and Ridge aquifers is primarily a function of flow through apertures created along fractures, bedding planes, and solution openings which may be enlarged by dissolution (karst development). Groundwater flow also occurs within the primary pore spaces of alluvium occurring along stream courses, and residuum formed from the weathered rock that overlies bedrock.

Groundwater movement in the Valley and Ridge Physiographic Province in eastern Tennessee is localized due to the occurrence of thrust faults, which resulted in a repeated sequence of permeable and less permeable rocks. An example of this sequence can be seen in the cross-section shown in Figure 3-1. This repeated sequence together with the stream network, divides the area into a series of adjacent, isolated, shallow ground-water flow systems causing localized groundwater movement. Groundwater in the Valley and Ridge Physiographic Province generally moves from the ridges toward the valleys where it either discharges to streams running parallel to the valleys or flows along the geologic strike (down the valleys) toward more distant discharge points (springs or streams). Most of the groundwater flow occurs within 300 feet of the ground surface.

The principal aquifers of the Valley and Ridge Physiographic Province have well yields ranging from 1 to 2,500 gpm, with median yields ranging from 11 to 350 gpm. Spring discharges emanating from the principal aquifers range from 1 to 5,000 gpm, with median discharges of 20 to 175 gpm. Spring discharge during periods of abundant rainfall is significantly larger (as much as 10 times larger) than the discharge during extended dry periods which are associated with shallow groundwater flow. Well yields and spring discharge are highest in the carbonate-dominated sections of the aquifers due to dissolution along groundwater-flow pathways. As identified in Section 3.2, karst features (caves and surface depressions resulting from collapse of dissolution cavities) have been identified within the CRN Site and the vicinity.

Groundwater recharge rates are expected to be highest in areas that have a prevalence of carbonate-dominated rocks and karst development near the surface and occurs sporadically in response to precipitation events.

A sole source aquifer is defined by the EPA as the sole or principal source of drinking water that supplies 50 percent or more of drinking water for an area, with no reasonable available alternative sources should the aquifer become contaminated. Because surface water is abundant in the area of the CRN Site, the EPA's Sole Source Aquifer Program has not identified any sole source aquifers in east Tennessee (EPA 2021b). The identified sole-source aquifers in EPA Region 4 are beyond the boundaries of the local and regional hydrogeologic systems associated with the CRN Site. Therefore, the CRN Site would not impact any identified sole source aquifer.

Groundwater at the CRN Site is present in both the unconsolidated surface materials and bedrock. The weathered bedrock acts as a water table aquifer with depth to groundwater within the CRN Site ranging from near surface to 25 feet below ground surface. The presence and orientation of rock fractures and the extent of conduits and cavities resulting from dissolution controls the occurrence and movement of groundwater at the CRN Site. The Chickamauga Group is generally comprised of thinly bedded (0.5- to 4-inch) limestone and shale, which tends to reduce the occurrence of connected fractures and dissolution channels. The weathering and dissolution that allows for groundwater flow in the Chickamauga Group are more likely to occur in the more limestone-rich units, such as the Witten and Rockdell formations. While a few karst features (cavities) were observed at lower elevations, as low as 660 feet NAVD88, suggesting that groundwater circulation occurs at greater depths, most cavities were observed at elevations above the elevation of the Clinch River bed (approximately 720 feet NAVD88).

Groundwater monitoring wells were installed and screened in the Bowen, Benbolt, Rockdell, Fleanor, Eidson, and Blackford Chickamauga Group formations and in the upper portion of the Knox Group as clustered sets on Area 1 of the CRN Site as part of the ESPA process. Observation well data in combination with measured water-surface elevations in Watts Bar Reservoir indicate that the level of the Reservoir did not significantly affect the observed groundwater hydraulic head measurements. Additionally, the reported assessment of precipitation data with the observation well hydraulic head measurements indicated no strong seasonal variation in groundwater levels. However, some wells demonstrated seasonal fluctuations with higher levels in winter and early spring months. In groundwater wells that were continuously measured, water levels were observed to fluctuate by as much as 25 feet in response to precipitation events.

Generally, in the central portion of Area 1, the downward-vertical gradients between aquifer units are indicative of zones of groundwater recharge (e.g., Upper to Lower units, and in some cases Lower to Deeper units), whereas areas having upward-vertical gradients (e.g., deeper to lower to upper units) are zones of aquifer discharge. These discharge zones, where present in areas of shallow groundwater, may influence or contribute to the hydrology of associated wetlands and surface water features (springs, seeps, streams, ponds). In general, the vertical gradients tended to be downward in the center (upland areas) of the CRN Site and upward closer to the several wetlands and reaches of streams near the Reservoir, indicating groundwater recharge is likely occurring in the center of the site and groundwater is likely discharging to these surface water features and to the Reservoir, and to other incised drainage features (such as ephemeral streams).

Groundwater flow at the CRN Site generally occurs predominantly within the fractures and bedding planes of the bedrock and groundwater flow over significant distances and requires continuously connected fractures. The connectivity of the fracture network must be considered when interpreting hydraulic head measurements in wells. The available data indicates that bedrock fracturing decreases with depth, supporting that most groundwater flow occurs within the weathered rock and at shallow depths within the competent rock. The shallow groundwater is thought to discharge to the local streams and rivers, with the majority of groundwater recharged at the site, flowing through the uppermost aquifer units, and discharged to the Reservoir after a short time in the aquifer. However, it is noted that the Reservoir may not be a complete hydraulic barrier to deeper groundwater flow in the presence of significant hydraulic forcing and a connected fracture pathway. Such a pathway, however, is not known to exist at the CRN Site.

Groundwater flow at the CRN Site is characterized as occurring primarily within approximately 150 feet of the ground surface with little or no connection to groundwater at greater depths due to the observed decreasing fracture frequency with depth.

Groundwater primarily flows within the weathered rock and at shallow depths within the fractures of the competent rock primarily and discharges to the small streams and ponds onsite, or directly to the Reservoir based on vertical head gradients. Groundwater velocity was reported to be on the order of 3.9 feet/day based on an average horizontal hydraulic gradient (0.07 feet/feet), the maximum saturated hydraulic conductivity from the aquifer testing 2.6 feet/day), and an effective porosity of 0.0467.

3.3.1.2.2 Groundwater Use

The predominant source of water for all uses in the Tennessee Valley is surface water. As the primary source of water for drinking, agricultural, and industrial uses, this accounts for 98.1 percent of total withdrawals in 2015. Groundwater provided the balance at 1.9 percent, or about 189 MGD of withdrawals in the Tennessee Valley. Groundwater withdrawals within the Watts Bar arm of the Clinch River accounted for 2.23 MGD, whereas withdrawals from the Melton Hill arm of the Clinch River accounted for 1.38 MGD (Bowen and Springston 2018). EPA’s Safe Drinking Water Information System database was searched for water systems near the CRN Site with a primary water source of groundwater. The closest system was a transient non-community water system (a campground) located south of the Reservoir about 2.5 miles from the CRN Site boundary (EPA 2021a). All other water systems using groundwater as a primary water source were much farther from the CRN Site.

TDEC records were used to identify groundwater well users within about 1.5 miles of the CRN Site. A total of 32 residential wells, three commercial wells, and one agricultural well were reported in TDEC records (Figure 3-11). Of the identified wells, it is reported that well depths range from 42 to 900 feet below ground surface (bgs), with about 50 percent of the wells less than 300 feet deep. While the geologic formations were not provided for these wells, most of the wells were inferred to penetrate the Knox Group and upper Conasauga Group formations based on regional geologic information. Reported estimated well yields ranged from 0.5 to 75 gpm, and 50 percent of well yields were less than 7 gpm.

3.3.1.2.3 Groundwater Quality

Groundwater samples were obtained in support of the ESPA from wells on the CRN Site in Area 1 during monitoring in 2013 and 2014. Results indicate CRN Site groundwater is characterized as mostly calcium bicarbonate to magnesium-bicarbonate, with pH levels between approximately 7 and 8, and TDS concentrations ranging from 190 to 520 mg/L. A sample collected from the deepest well sampled is screened in the Fleanor Shale unit (at a depth of 160 feet bgs) and reported to have a sodium-bicarbonate chemistry with a pH level of 9.6 and TDS concentration of 1,100 mg/L. The results from the deepest well are reported as being a characteristic of deeper groundwater and may have been biased by sampling difficulties. The reported TDS result from the CRN Site well sampling is within the reported TDS concentrations for Valley and Ridge Physiographic Province aquifers which range between 15 to 1,700 mg/L, with a median concentration of 150 mg/L. Additionally, a well on the ORR and adjacent to the CRN Site at a depth of approximately 400 feet bgs was reported to have a sodium-chloride chemistry with high TDS.

Water quality parameters have been evaluated and compared to established Tennessee and EPA drinking water maximum contaminant levels for metals, gross alpha and beta radioactivity, selected radionuclides, organic compounds, PCBs, and pesticides. The only parameters reported to exceed maximum contaminant levels are fluoride in five samples from two wells and lead in one sample.

In consideration of legacy contamination at the ORR, which is adjacent to the CRN Site, quarterly groundwater quality monitoring results for the CRN Site were also evaluated for the presence of ORR legacy contaminants associated with long-term mission and adjacent-area operational activities. There are 10 legacy contaminants that were identified in CRN Site water samples at low concentrations (Table 3-8). The detection of these contaminants does not indicate a direct transport pathway from the adjacent ORR because of the regional geologic structures that create separation of the ORR contamination plumes from the CRN Site. The existing groundwater contamination in Bear Creek Valley and Bethel Valley on the ORR is more than 2 miles from the CRN Site.

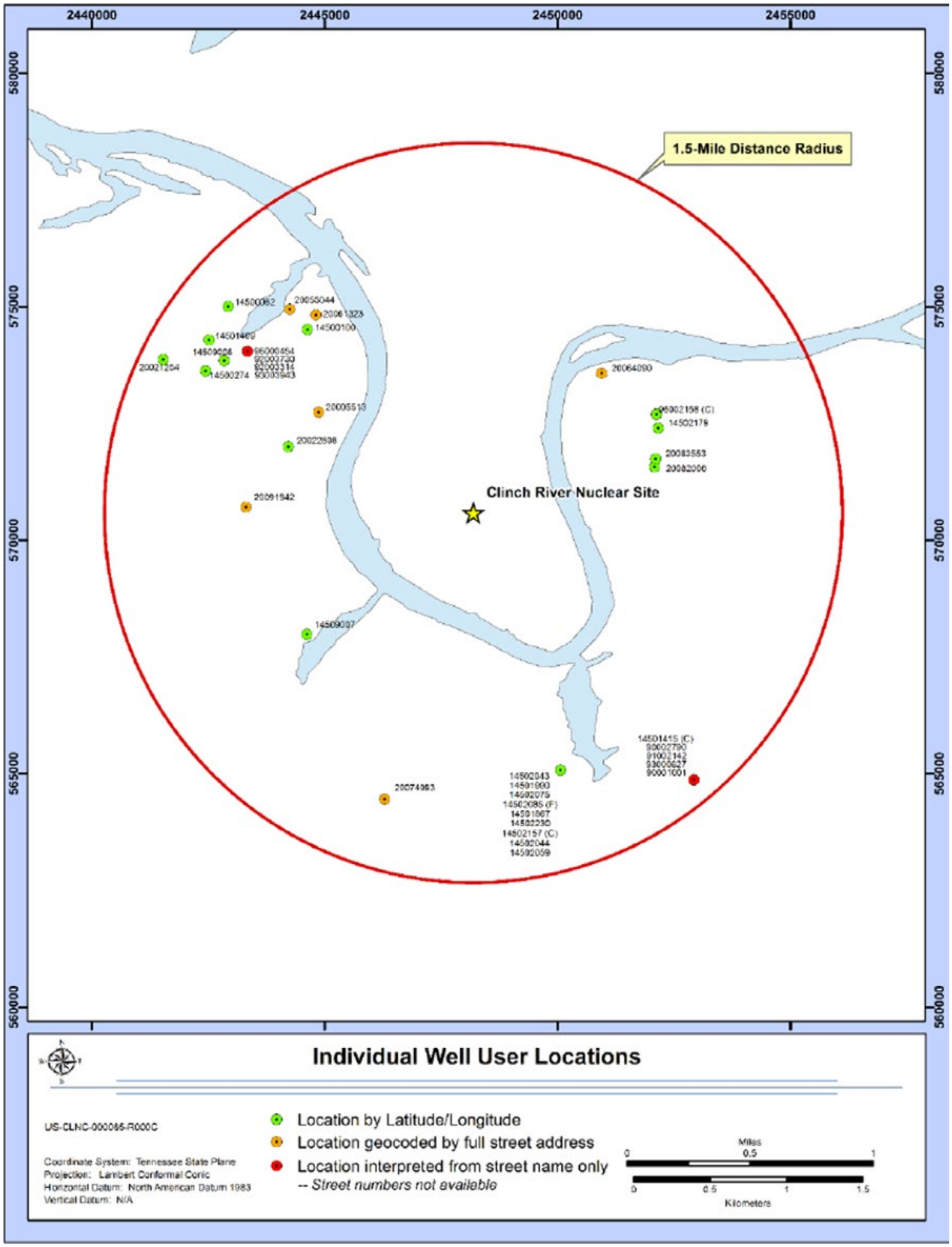


Figure 3-11. Wells Located within 1.5 Miles of the CRN Site

Table 3-8. ORR Legacy Contaminants Detected in CRN Site Groundwater Samples

Parameter	MCL	Maximum	# Detections
Nitrite + Nitrate, mg/L	NE[(a)]	2.62	54
Arsenic, µg/L	10	7	1
Barium, µg/L	2000	582	73
Cadmium, µg/L	5	1.2	2
Chromium, µg/L	100	11.6	5
Tritium, pCi/L	NE	847	4
Strontium-90, pCi/L	NE	0.428	5
Technitium-99, pCi/L	NE	8.16	3
Chloroform, µg/L	80	4.02	22
Tetrachloroethylene, µg/L	5	0.499	1

(a) Not established
MCL = maximum contaminant level.

Petroleum products were detected in a single well on the CRN Site during well completion activities in 2013, but the source of the contamination is reported to be localized around the well and no source was identified. The well cluster (upper, lower, and deep wells) is locked and not currently used for groundwater sampling.

3.3.1.3 Reasonably Foreseeable Future Actions in Proximity to the CRN Site

As noted in Section 3.1.3, TVA identified several reasonably foreseeable future actions in proximity to the CRN Site. The scope of these other proposed actions may entail the alteration of water resources within their respective project footprints. Depending on the local environmental setting and the design characteristics of these other proposed actions, direct alteration of surface water resources may occur. Furthermore, each of these projects entails land disturbance activities that have the potential to increase site runoff and contribute to pollutant loading and sedimentation within associated surface water resources. However, the specific details regarding the scope of these actions are lacking. Furthermore, none of the identified reasonably foreseeable future actions is overlapping geographically with the CRN Project Area and are not expected to directly impact the same resources as those potentially affected by activities at the CRN Site. Additionally, none of the identified projects are considered to have a causal relationship to the proposed development of the CRN Site. Further consideration of reasonably foreseeable future actions and their effects on water resources are included in the following section as appropriate.

3.3.2 Environmental Consequences

3.3.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, TVA would not develop the CRN Nuclear Technology Park. Additionally, there are no existing uses of groundwater on the CRN Site. As such under this alternative there would be no alteration of surface water or groundwater resources or their associated hydrology, use, or quality. Therefore, there would be no impacts to surface water and groundwater resources with Alternative A.

3.3.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced Non-LWRs

3.3.2.2.1 Surface Water Resources

In conjunction with Alternative B, TVA would develop the CRN Nuclear Technology Park only at Area 1. Actions that would impact water resources include site preparation within temporary and permanent use areas (Area 1 and laydown areas), development and improvement of roadways and associated barge access infrastructure, expansion of transmission systems, and construction and operation of structures associated with the cooling system, and potential flow alteration associated with the operation of the Melton Hill Dam. The proposed surface water intake is located at CRM 17.9, and the proposed discharge is located at approximately CRM 15.5.

3.3.2.2.1.1 Surface Water Hydrology

Construction

A number of activities would be conducted under Alternative B that could result in hydrologic alterations within the CRN Site and associated offsite areas. These include the following:

- General clearing and grading at the project areas and building infrastructure (e.g., roads, laydown areas, parking lots, and stormwater-conveyance and -retention systems)
- Construction and refurbishing of transportation corridors and features (roads, barge facilities)
- Construction of new structures at the site (e.g., power-block structures, cooling towers, switchyard, and subgrade piping and systems)
- Installation of a 5-mile-long transmission line from the CRN Site to the Bethel Valley Substation and various offsite transmission system uprates and upgrades
- Installation of pipelines and other utility infrastructure
- Excavation of the nearshore area of the Clinch River arm of the Watts Bar Reservoir in support of the construction of the cooling water intake structure, discharge structure (including associated diffuser) and supplemental onsite barge facility
- Excavation of a discharge holding pond and refurbishment of previously developed stormwater management ponds on the CRN Site
- Excavation and dewatering for construction of the nuclear island

Construction phase site preparation would entail general land disturbance and impacts to surface waterbodies on and near the CRN Site, including the Reservoir, Grassy Creek, and small unnamed streams and ponds on the CRN Site and associated offsite areas including the BTA, the TN 95 Access, and the 161-kV offsite transmission line (see Figures 2-1 through 2-3).

Following selection of a technology, final site design, and prior to site development and permitting, the USACE would conduct a site visit and make a jurisdictional determination of all surface water and wetland features identified by TVA that could be impacted by the proposed action. Such features are regulated as “waters of the U.S.” (WOTUS). TDEC would also make a Hydrologic Determination to identify the features within their jurisdiction and regulated as “waters of the state.” Table 3-9 summarizes impacts to surface water resources within the CRN

Site and associated offsite areas, and Table 3-10 identifies the potential effects to each identified surface water resource. A summary of total impacts for each alternative is provided in Table 3-11.

A total of 25 onsite streams would be affected under Alternative B (Table 3-11). Impacts include effects to seven perennial streams (1,775 linear feet), six intermittent streams (2,655 linear feet), and 13 ephemeral streams (3,931 linear feet). Alterations to existing streams would result in direct alteration and loss of stream channel and associated riparian zones coupled with the alteration of runoff rates from associated drainage areas and changes to hydrology of remaining adjacent stream habitats. Additionally, four streams would be crossed in conjunction with the potential offsite upgrades within the 500-kV corridor extending to the Bethel Valley substation.

Alterations to these streams are subject to USACE jurisdiction and permitting and/or the TDEC ARAP, and local ordinances as applicable. Unavoidable alterations and losses of regulated streams would be minimized in conjunction with design and mitigated as appropriate. Appropriately designed culverts would be installed as needed to manage runoff and conveyance under proposed access roads and other site improvements. Runoff from the affected areas including potential hydrologic modifications associated with increased runoff from impervious areas and areas with altered land cover would be managed as part of the CRN Site stormwater management requirements. A Tennessee Stream Quantification Tool is required per TDEC regulations to assess the quality of impacted streams in order to calculate mitigation credits. Prior to construction, the Stream Quantification Tool evaluation would be conducted for the stream impacts and would be used to determine the appropriate number of stream credits to be purchased by TVA. Details of the stream mitigation and credits to be purchased would be determined based on final design and subject to permitting requirements.

In addition, the ponds on the CRN Site originally constructed for stormwater management purposes would be reconstructed to manage stormwater and minimize impact to receiving water quality of the Reservoir. As indicated in Table 3-10. Impacts to Identified Surface Water Resources on the CRN Site and Associated Offsite Areas, two ponds would be impacted (P03 and P04) totaling 0.9 acre. Stormwater detention would be incorporated into detailed site design to ensure that runoff rates and discharge requirements are in compliance with all appropriate state and local requirements.

Table 3-9. Summary of Impacts to Surface Water Resources (streams/ponds)

Location	Type	Number	Area (Acres) / Length (Feet)
CRN Site			
	Ponds	2	0.9
	Streams	7	2,133
	WWCs	10	3,861
Associated Offsite Areas			
Barge and Traffic Area			
	Ponds	0	0
	Streams	2	452
	WWCs	2	812
TN 95 Access Area			
	Ponds	0	0
	Streams	3	594
	WWCs	0	0
161-kV Offsite Transmission Line			
	Ponds	0	0
	Streams	1	1,271
	WWCs	4	814
500-kV Corridor to Bethel Valley Substation[1]			
	Ponds	0	0
	Streams	4	-
Project Area Total			
	Ponds	2	0.9
	Streams	17	6,823
	WWCs	16	11,784

[1] Based on desktop analysis within offsite 500-kV corridor, no site review conducted.
Note: WWC = wet weather conveyance

Table 3-10. Impacts to Identified Surface Water Resources on the CRN Site and Associated Offsite Areas

Feature ID	Type	Alternative B	Alternative C	Alternative D	Waters of the State	WOTUS (Federal Status)
CRN Site						
Ponds						
P03	Pond	*0.75*		*0.75*		
P04	Pond	0.16		0.16	Yes	Yes
Total (acres)		*0.91*	*0*	*0.91*		
Streams						
STR03	Perennial	100	100	100	Yes	Yes
STR07	Perennial	681	318	681	Yes	Yes
STR11	Perennial	283	283	283	Yes	Yes
STR04	Intermittent	150	125	150	Yes	Yes
STR05	Intermittent	19	19	19	Yes	Yes
STR06	Intermittent	123	0	123	Yes	Yes
STR10	Intermittent	757	757	757	Yes	Yes
EPH07	Ephemeral/WWC	115	0	115	No	No
EPH08	Ephemeral/WWC	25	0	25	No	No
EPH09	Ephemeral/WWC	614	0	614	No	No
EPH10	Ephemeral/WWC	673	393	673	No	No
EPH11	Ephemeral/WWC	0	567	567	No	No
EPH12	Ephemeral/WWC	0	463	463	No	No
EPH13	Ephemeral/WWC	0	287	287	No	No
EPH14	Ephemeral/WWC	0	240	240	No	No
EPH18	Ephemeral/WWC	83	83	83	No	No
EPH19	Ephemeral/WWC	795	794	794	No	No
Total (feet)		*4,418*	*4,429*	*5,974*		

Feature ID	Type	Alternative B	Alternative C	Alternative D	Waters of the State	WOTUS (Federal Status)
Associated Offsite Areas						
Barge and Traffic Area						
Ponds						
Total (acres)		*0*	*0*	*0*		
Streams						
STR03	Perennial	117	117	117	Yes	Yes
STR01	Intermittent	335	335	335	Yes	Yes
EPH01	Ephemeral/WWC	471	471	471	No	No
EPH02	Ephemeral/WWC	341	341	341	No	No
Total (feet)		*1,264*	*1,264*	*1,264*	*452*	*1,264*
TN 95 Access Area						
Ponds						
Total (acres)		*0*	*0*	*0*	*0*	*0*
Streams						
STR13	Perennial	305	305	305	Yes	Yes
STR14	Perennial	136	136	136	Yes	Yes
STR15	Perennial	153	153	153	Yes	Yes
Total (feet)		*594*	*594*	*594*	*594*	*594*
161-kV Offsite Transmission Line						
Ponds						
Total (acres)		*0*	*0*	*0*	*0*	*0*
Streams						
STR08	Intermittent	1,271	1,271	1,271	Yes	Yes
EPH15	Ephemeral/WWC	101	101	101	No	No
EPH16	Ephemeral/WWC	294	294	294	No	No
EPH17	Ephemeral/WWC	161	161	161	No	No

Feature ID	Type	Alternative B	Alternative C	Alternative D	Waters of the State	WOTUS (Federal Status)
EPH18	Ephemeral/WWC	258	258	258	No	No
Total (feet)		*2,085*	*2,085*	*2,085*	*1,271*	*2,085*
500-kV Corridor to Bethel Valley Substation[1]						
Ponds		0	0	0	0	0
Streams	Undifferentiated[1]	4	4	4	-	-
Clinch River Arm of the Watts Bar Reservoir						
Instream						
Intake Structure		0.23	0.23	0.23	Yes	Yes
Discharge Structure		0.23	0.23	0.23	Yes	Yes
Supplemental Onsite Barge Landing Area		0.23	0.23	0.23	Yes	Yes
Total (acres)		*0.69*	*0.69*	*0.69*	*0.69*	*0.69*
Shoreline						
Shoreline Restoration		9,050	9,050	9,050	Yes	Yes
Total (feet)		*9,050*	*9,050*	*9,050*		

[1] Based on desktop analysis within offsite 500-kV corridor, no site review conducted
Source: TVA 2021d
Note: WWC = wet weather conveyance

Table 3-11. Summary of Impacts to Identified Stream Resources on the CRN Site and Associated Offsite Areas

Feature	Alternative B	Alternative C	Alternative D	Waters of the State	WOTUS (Federal Status)[3]
CRN Site and Associated Offsite Areas					
Ponds (acres)	0.91	0	0.91		
Total (acres)	*0.91*	*0*	*0.91*		
Streams (linear feet)					
Perennial Streams	1,775	1,412	1,775	Yes	Yes
Intermittent Streams	2,655	2,507	2,655	Yes	Yes
Ephemeral/WWC	3,931	4,453	5,487	No	No
Total (linear feet)	*8,361*	*8,372*	*9,917*		
Clinch River Arm of the Watts Bar Reservoir					
Clinch River Instream (acres)	0.69	0.69	0.69	Yes	Yes
Clinch River Shoreline (linear feet)	9,050	9,050	9,050	Yes	Yes

Note: WWC = wet weather conveyance

During building activities in the central portion of the CRN Site, the power block and other structures for a new plant would be located and designed to direct drainage away from the facilities. Modifications to the land surface made during building activities would alter the local hydrology and site drainage. The CRN Site land surface would be developed to include surface water drainage ditches and stormwater retention ponds to manage and control stormwater flows prior to being discharged to the Reservoir. These land-surface modifications would alter surface water runoff flow patterns and the infiltration properties of the land surface. Runoff would increase by replacing vegetated surfaces with buildings and relatively impervious ground surfaces. Details of the required stormwater management system would be developed during final site design, which would include a SWPPP that would be developed in accordance with TDEC stormwater NPDES permit discharge requirements for erosion protection and stormwater management. Stormwater runoff from the CRN Site would be controlled via engineered structures, collected in engineered retention ponds, and infiltrated to the ground, or released to the Reservoir in a controlled manner. The SWPPP would incorporate BMPs to minimize erosion and stabilize the land surface. BMPs would include methods described in the State of Tennessee Erosion and Sediment Control Handbook (TDEC 2012).

Construction activities would also be conducted along the shoreline of the Reservoir. Specific actions to be undertaken include the construction of a CWIS, discharge structure and associated diffuser, supplemental onsite barge facility, and shoreline restoration areas. Development of the CWIS, discharge structure, and supplemental onsite barge facility would require some localized nearshore underwater excavation. These activities would produce temporary and localized effects on patterns of river flows in the immediate area of the building activities. A total of 0.69 acres of nearshore underwater habitat is expected to be impacted by construction activities (Table 3-11). As summarized in Table 2-5, a minor amount of instream habitat alteration would be expected within the Reservoir.

TVA also proposes to implement shoreline restoration measures at selected locations along the Reservoir both within the CRN Site boundary and along the proposed TN 95 Access area. In total, up to 9,050 feet of shoreline between CRM 20.75 and CRM 17.9 would be restored (see Table 2-5 and Table 3-11). These areas are locations that were observed to be characterized as having a higher incidence of bank erosion and failure. Shoreline restoration activities would entail the placement of stabilizing structures along the bank line to minimize further bank erosion and restore previously eroded areas. Placement of shoreline stabilization structures would result in minor localized changes in river flow and current velocity but would provide long-term beneficial effects in shoreline stabilization and reduced erosion. Detailed restoration measures would be determined during final design and would be subject to permitting by the USACE under Section 404 of the CWA and Section 10 of the Rivers and Harbors Act and/or TDEC ARAP process, as applicable. Because the proposed measures would stabilize and restore the shoreline and would be sufficiently designed to reduce bank erosion and scour impacts associated with the construction activities, impacts on hydrology of the Reservoir would be beneficial.

In summary, TVA has determined that all construction impacts to surface waters related to the development of the CRN Site and associated offsite areas would have both direct and indirect impacts to surface water resulting in moderate permanent impacts associated with conversion and loss of onsite streams and shoreline alteration of the Reservoir. These impacts would be minimized to the extent practicable during design and appropriately mitigated in accordance with applicable permit requirements. Impacts to streams would be mitigated by purchase of credits in mitigation bank in accordance with permits, as appropriate. Shoreline restoration activities would provide long term beneficial effects in shoreline stabilization and reduced erosion. All discharges would comply with current or future NPDES permit limits and other state and federal regulations.

Operation

Under Alternative B development of a nuclear plant at the CRN Site could include the use of water from the Reservoir for the cooling-water system and other plant water systems. Localized alterations in river velocity and flow patterns are expected to occur in conjunction with the operation of the CWIS and the discharge. For water use, TVA defined the average (expected) temperature and chemical constituent operating conditions as four cycles of concentration and maximum operating conditions as two cycles of concentration. The estimated average and maximum total withdrawal are 18,423 and 30,708 gpm (41.0 cfs and 68.4 cfs), respectively (Section 2.4.7 and Appendix A). Evaporation and drift from the cooling towers would consumptively use the majority of the water withdrawn, and the remainder would be returned to the river as blowdown. Because the heat load would be the same under the average and maximum operating conditions defined by TVA, the estimated average and maximum total consumptive use by a plant for Area 1 would both be 12,800 gpm (28.5 cfs) (Appendix A, item 3.3.9). The primary hydrologic alteration from this water use would be the reduction of flow in the Reservoir, which could affect the availability of water for other uses (see Section 3.3.1.1.2).

The CWIS would be designed to meet current CWA 316(b) requirements for new facilities, with design through-screen intake velocities less than 0.5 ft/s at the screen. Potential impacts of the intake structure operation on aquatic life are evaluated in Section 3.6 (Aquatic Ecology). The NPDES permit would also encompass requirements pursuant to Section 316(b) of the Clean Water Act that ensures the protection of aquatic ecological communities by regulating CWISs. Cooling tower blowdown and plant process water would be discharged to the Reservoir after appropriate treatment and in accord with the requirements of the NPDES permit. The estimated average and maximum discharge rates are 4,270 gpm and 12,800 gpm (12.5 cfs and 39.9 cfs), respectively, including the contribution from the liquid radioactive waste system.

Physical impacts on hydrologic conditions could occur from increased water velocity or unanticipated maintenance dredging that could result in sediment erosion, suspension, and transport. The discharge diffuser would be designed to minimize scour; the diffuser ports would be designed to enhance mixing. No dredging is anticipated to maintain the intake or discharge structures during operation, because sediment accumulation is not anticipated. In the event dredging were to be needed, TVA would perform an environmental review and the activity would be properly authorized in conjunction with a CWA Section 10/404 permit issued by USACE and the ARAP issued by TDEC. Dredge spoils would be placed in a permitted disposal area with appropriate containment and stormwater controls. These activities would disturb sediment containing contaminants from historical practices or spills that occurred offsite at upstream locations. To mitigate and control activities involving the potential disturbance of contaminated sediments in the reservoir, TVA would invoke the 1991 Watts Bar Interagency Agreement, in partnership with the USACE, DOE, TDEC, and the 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.

In summary, because the associated river structures would be designed to minimize erosion and reduce scour the impacts of operation on hydrology associated with Alternative B would be minor.

3.3.2.2.1.2 Surface Water Use

Construction

Most of the water for building activities (e.g., concrete batch plant, potable, fire protection, and sanitary water systems) would be supplied by the City of Oak Ridge Public Works Department and as such are addressed in conjunction with effects on community facilities and services in Section 3.15.

During the construction phase, surface water use would be limited to relatively small volumes withdrawn from the Reservoir for dust suppression. As such, construction phase impacts associated with water availability and use would be minor and temporary.

Operation

Water-use and water-quality impacts involved with operating a nuclear power plant are similar to the impacts associated with any large thermoelectric power generation facility. Potable water would be supplied by the City of Oak Ridge Public Works Department. Impacts of water supply by the City of Oak Ridge are addressed in conjunction with effects on community facilities and services in Section 3.15.

Permits and certifications that TVA would be required to obtain in support of the operational phase under Alternative B would include the following:

- CWA (33 U.S.C. § 1251 et seq.) Section 401 Certification. This water quality certification would be issued by TDEC and would ensure that operation of a new nuclear power plant would not conflict with State water-quality management programs. This certification must be obtained before the NRC could issue a COL to TVA and before USACE would issue a CWA Section 404 permit.
- CWA (33 U.S.C. § 1251 et seq.) Section 402(p) NPDES Discharge Permit. This permit would be issued by TDEC and would regulate limits of pollutants in liquid discharges to surface water (stormwater and discharge system). A SWPPP would be required. The NPDES permit would also encompass requirements pursuant to Sections 316(a) and 316(b) of the CWA that provide protection to aquatic ecological communities by regulating thermal discharges and CWIS.
- CWA (33 U.S.C. § 1251 et seq.) Section 404 Permit. This permit would be issued by the USACE for the discharge of any dredged and/or fill material during operation into WOTUS. No dredging during operation is planned.
- Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. § 401 et seq.) Permit. This permit prohibits obstruction or alteration of navigable WOTUS and would be issued by the USACE for dredging activities that may be needed during operation. No dredging during operation is planned.
- Water Resources Information Act of 2002 (T.C.A. § 69-7-301 et seq.). State regulation requiring notification and water withdrawal registration for water withdrawals of 10,000 gpd or more. TDEC uses this information to identify water uses and resources that may require management during drought conditions.
- Water Quality Control Act (T.C.A. § 69-3-101 et seq.) ARAP. This permit is issued by TDEC to authorize physical alterations to waters of the state (stream, river, lake, or wetland), e.g., in the event maintenance dredging is needed.
- Spill Prevention, Control and Countermeasures rule (40 CFR Part 112) and EPA Facility Response Plan (40 CFR Part 9 and 40 CFR Part 112), and the EPA Hazardous Waste Contingency Plan. These regulations require pollution prevention and response plans for spills of oil and other hazardous materials. TVA would develop an IPPP to implement these regulations.
- City of Oak Ridge permits for use of City water and wastewater services.

Table 3-12 provides a comparison of the relative reduction to several Reservoir flow characteristics based on average and maximum withdrawal rates and for losses due to consumptive use. Average withdrawal and consumptive use would be less than 1 percent of the average annual discharge from Melton Hill Reservoir to the Reservoir. Therefore, operation of a plant at the CRN Site would have a minimal effect on average Reservoir flow at the CRN Site. Even the maximum withdrawal would be only 1.5 percent of the average annual flow. Withdrawal and consumptive use are a much larger fraction of the Reservoir flow during low-flow conditions.

For the minimum monthly river flow during the period 2004 to 2013, which occurred during the historically low-flow conditions of 2008, average withdrawal and consumptive use would result in 7.0 and 4.8 percent reductions, respectively, in Reservoir flow at the CRN Site.

Maximum withdrawal exceeds 11 percent of the minimum monthly river flow. For the base flow conditions, average and maximum withdrawals for a plant at the CRN Site would reduce Reservoir flow by 10.3 and 17.1 percent, respectively (see Table 3-12). Average consumptive use at the CRN Site would be 7.1 percent of the bypass flow. For evaluating water-use impacts, the effect of consumptive use is most relevant because the additional impacts on water resources from withdrawal would only occur between the intake and discharge locations, a region of the Reservoir where there are no active surface water withdrawals.

Table 3-12. Reduction in Clinch River Arm of Watts Bar Reservoir Flow from CRN Site Withdrawal and Consumptive Use

Flow Characteristic	Clinch River (cfs)	Flow Reduction from 41.0 cfs Withdrawal (%)	Flow Reduction from 68.4 cfs Withdrawal (%)	Flow Reduction from 28.5 cfs Consumptive (%)
Average Annual Flow[1]	4,670	0.9	1.5	0.6
Minimum Monthly Flow (November 2008)	589	7.0	11.6	4.8

[1]Flows are based 10-year period from 2004 to 2013

Because the minimum daily average discharge required at the Melton Hill Dam is not currently expected to change with operation of a plant at the CRN Site, operation of Melton Hill Reservoir is not expected to change from the current TVA policy for managing flows in the Clinch River arm of the Watts Bar Reservoir. As a result, water use for operation at the CRN Site would not have a noticeable effect on water users that obtain water from Melton Hill Reservoir. Consumptive use at Area 1 would reduce flows downstream of the site. Because the water below Melton Hill Dam is part of the Watts Bar Reservoir, the availability of water in the Reservoir depends not only on releases from Melton Hill Dam, but also on the much larger releases from Fort Loudoun Dam. The average release from Fort Loudon Dam during 2004 to 2013 was about four times larger than the average release from Melton Hill Dam. Additionally, as noted in Section 3.3.1.1.2, TVA plans to close the Bull Run Fossil Plant in 2023 (TVA 2021a), which would reduce both water use and water consumption within Melton Hill Reservoir from existing levels. Similarly, the operation of a plant at the CRN Site would consumptively use less than 1 percent of average flow in the Reservoir. During low-flow conditions (e.g., during drought periods), a plant at the CRN Site would consumptively use up to about 7 percent of the release from Melton Hill Reservoir under existing conditions (Table 3-12). Notably, the Clinch River at the CRN Site is an arm of the Watts Bar Reservoir, and existing water users on the Reservoir are located downstream near the confluence with the Tennessee River or upstream on Melton Hill Reservoir. As such, there are no other surface water users in proximity to the CRN Site that may potentially be affected by withdrawals from the cooling water intake structure.

In summary, the operational effects of Alternative B would not noticeably alter the availability of water supply for upstream or downstream users. Therefore, impacts associated with surface-water use from the operation of a plant at the CRN Site are minor and no additional mitigation would be required.

3.3.2.2.1.3 Surface Water Quality

Construction

Soil disturbances associated with construction activities within the CRN Site and associated offsite areas could potentially result in adverse water quality impacts. TVA expects to minimize potential impacts to streams through avoidance (if practical) and the implementation of erosion and sediment BMPs and a site-specific SWPPP developed for construction work in Tennessee, to reduce potential sediment-laden runoff into adjacent or downgradient streams. TVA plans to redesign and rebuild the existing site drainage and stormwater detention system on the CRN Site to accommodate the level of runoff expected from the new design(s). Soil erosion and sedimentation can accumulate in small streams and threaten aquatic life. During construction, TVA would comply with all appropriate state and federal permit requirements.

Discharges into jurisdictional streams would not occur unless authorized by the USACE through the CWA Section 404 permitting process and/or TDEC ARAP process, as applicable. In conjunction with permitting TVA would identify specific BMPs to address construction-related impacts. Appropriate BMPs would be followed, and all proposed project activities would be conducted in a manner to ensure that waste materials are contained, and the introduction of pollution materials to the receiving waters would be minimized. Temporary stream crossings and other construction and maintenance activities would comply with appropriate state permit requirements and TVA requirements as described in *A Guide for Environmental Protection and Best Management Practices for Tennessee Valley Authority* (TVA 2017). Areas where soil disturbance could occur would be stabilized and vegetated with native or non-native, non-invasive grasses and mulched. BMPs would be used to minimize impacts associated with clearing and site preparation. Mitigation measures would be incorporated into the final design of the project, if required through the permitting processes. As a result of implementing these measures, impacts to surface waters associated with the proposed offsite transmission line upgrades would be minor.

The construction of the supplemental onsite barge area, intake structure, discharge structure, and bank restoration areas would entail localized construction activities within the Reservoir. These activities would disturb sediment containing contaminants from historical practices or spills that occurred offsite at upstream locations. To mitigate and control activities involving the potential disturbance of contaminated sediments in the Reservoir, TVA would comply with the terms and practices of the Watts Bar Interagency Agreement described above (see Section 3.3.1.1.3.5).

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 that disturb sediments would be followed. Any sediment removed may also contain manmade radionuclides; therefore, coordination with DOE for the disposition of the sediment in an appropriately permitted location is also anticipated.

Because engineering controls (e.g., BMPs, silt fences/curtains, detention/retention basins, cofferdams) regulated by a combination of TDEC and USACE permitting, and the Watts Bar Interagency Agreement, would be in use during all construction activities, the impacts of construction on surface water resources would be controlled, localized, and temporary. Therefore, the impacts on surface water quality associated with Alternative B are minor.

Operation

Stormwater Runoff

Permanent land-surface alterations, as indicated in Section 2.4.1 would affect stormwater runoff from the CRN Site and associated offsite areas. Runoff would increase with the increased impervious surface area and alterations in land cover. A stormwater-management system would be built to manage runoff, and it would be operated in accordance with a stormwater NPDES permit. A SWPPP would be in place to manage stormwater runoff and prevent erosion, as well as prevent and manage accidental spills. After construction, stormwater BMPs would continue to be implemented so that surface water runoff from parking lots and industrially used areas of the site would be diverted to retention pond(s) and stormwater management impoundments with a controlled rate(s) of release. Because BMPs would be used as required by TDEC under the SWPPP, and because the CRN Site constitutes less than 0.1 percent of the drainage area contributing flow to the Clinch River near the CRN Site, operational phase impacts to the surface-water quality of the Reservoir near the CRN Site are considered to be minor.

Thermal Discharge Effects

During the operational phase, blowdown from the CWS cooling towers would be discharged to the Reservoir using a discharge pipeline and diffuser. Thermal discharge would be regulated as part of the NPDES permit administered by TDEC. The applicable temperature-related Tennessee water-quality criteria (TDEC 2019) for the CRN Site discharge are applicable at a depth of 5 feet and include the following:

(1) maximum water temperature change shall not exceed 5.4°F relative to an upstream control point

(2) temperature of the water shall not exceed 86.9°F and

(3) the maximum rate of change shall not exceed 3.6°F per hour

These criteria would be required to be met outside the mixing zone, which would be determined by TDEC and stipulated as part of the NPDES permit along with any monitoring requirements. Tennessee's water-quality criteria (TDEC 2019) specify that mixing zones be restricted in area and not prevent the free passage of fish or cause aquatic life mortality, among other requirements.

To evaluate the thermal effects of the discharge and the potential mixing zone requirements, TVA completed a detailed, three-dimensional modeling study. This study modeled flow in the river from CRM 13.5 to CRM 21.0 (i.e., from about 2 miles downstream of the CRN Site discharge to about 3 miles upstream of the intake). TVA evaluated thermal discharge effects using the maximum PPE values for the withdrawal (25,600 gpm), for the discharge (12,800 gpm), and for the discharge temperature (90°F).

Simulation conditions included a maximum temperature difference of 31°F for a winter scenario and 15°F for a summer scenario (extreme winter and summer conditions with the plant at full power). Simulations evaluated the "sloshing" in the Reservoir over a 48-hour period, with one hydropower unit operating at Melton Hill Dam for 1 hour on, 46 hours off, and 1 hour on. For the ESPA, TVA determined that a steady 400-cfs release from the

Melton Hill Dam bypass was needed to meet water-quality standards. With a river flow of 400 cfs in the downstream direction, TVA's simulation results showed that thermal water-quality criteria would be exceeded outside a 150-feet-diameter mixing zone centered at the discharge diffuser location (Figure 3-12, Hour 24, winter conditions). A 150-feet-diameter mixing zone is about 45 percent of the river width at the discharge location. TVA's simulation results also showed that the unsteady river flows ("sloshing") resulted in occasional local excursions of high-temperature water beyond a 150-feet-diameter mixing zone (Figure 3-12, Hour 24, winter conditions). These excursions exceeded water-quality criteria locally but were over a small area and temporary due to the unsteady flow. The simulation results showed that the discharge plume did not circulate upstream to interact with the intake. Depending on the technology selected for deployment at the CRN Site, it is possible that this flow could be managed with releases from the Melton Hill Dam. Such flow augmentation would be accomplished using the existing dam and would not substantially disturb the Clinch River sediments. Details regarding the need for augmentation of Melton Hill Dam Flow and its associated impacts would be evaluated further in a subsequent NEPA review when more technology-specific design and construction information is available.

Based on TVA's simulation results, these exceedances would be temporary and localized to the area immediately surrounding the mixing zone. However, the NPDES permit administered by TDEC would regulate the thermal discharge and encompass requirements pursuant to Sections 316(a) of the CWA to ensure protection to aquatic ecological communities. Implementation of the NPDES permit in conjunction with a steady, downstream 400 cfs flow from the Melton Hill Dam, would mitigate the thermal effects of the discharge and would meet the applicable water quality criteria with a mixing zone about 150 feet in diameter. As a result, the thermal effects of the operation of Alternative B on the water quality of the Clinch River are localized, seasonally limited to winter conditions, and minor.

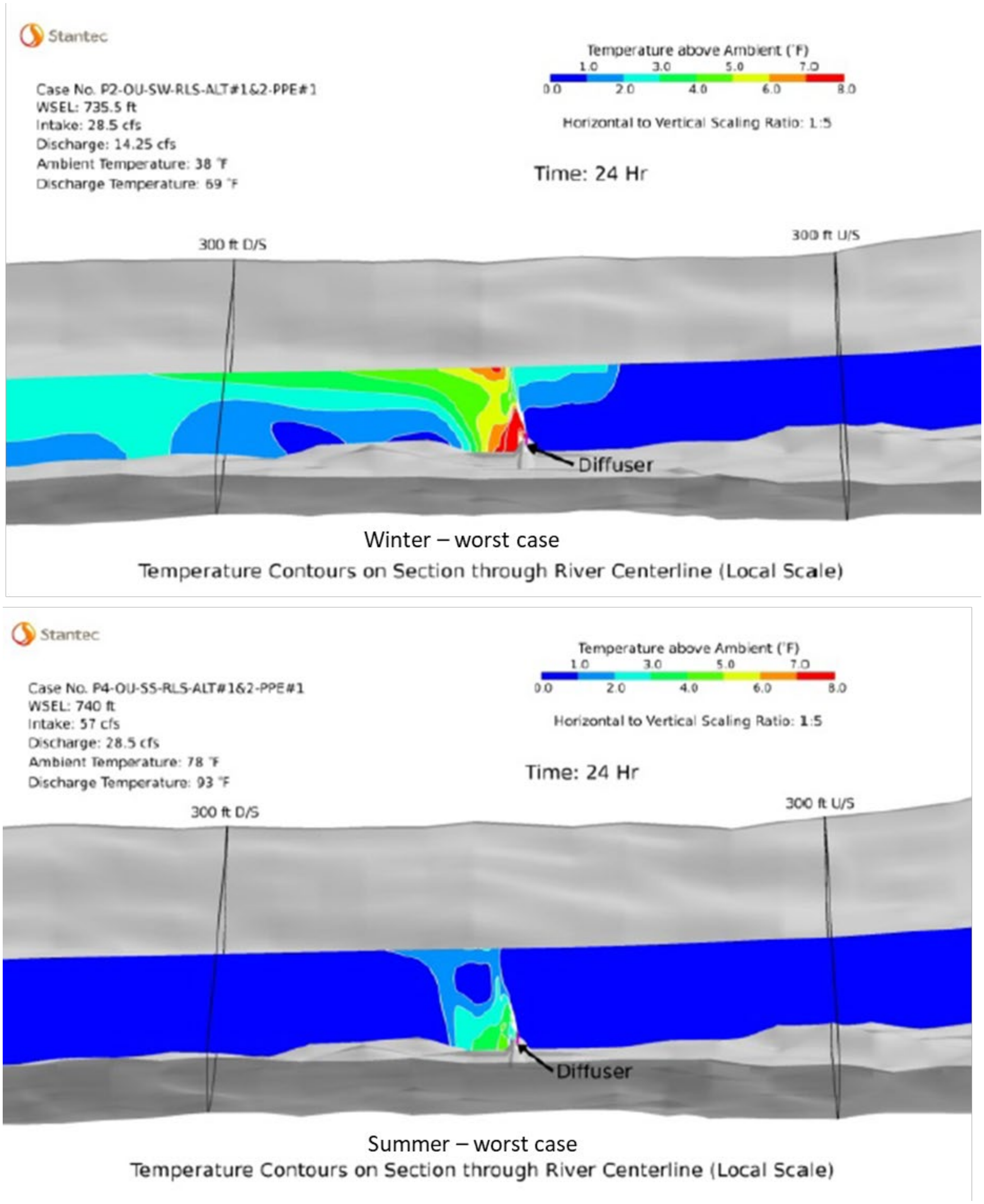


Figure 3-12. TVA Simulation Results of Thermal Discharge Effects under Bounding Conditions in Winter and Summer, 24 Hours from the Start of the Simulation Period

Concentrated Solutes and Residual Chemicals Discharge

Nonradioactive wastewater discharges during operation that may impact water quality include the following: cooling-tower blowdown; wastewater from the demineralized water system; wastewater from floor drains, sinks, and plant laboratories; and stormwater runoff.

Evaporation in the cooling towers would result in the concentration of solutes present in the makeup water that is withdrawn from the Reservoir. While some of these constituents (atmospheric mercury, sediment-associated polychlorinated biphenyl and chlordane) are presently causing water quality impairment in the Reservoir, these constituents would be diluted back to ambient concentrations within the Clinch River by discharge mixing. Therefore, the blowdown is not anticipated to contribute to water quality impairment in the Reservoir.

In addition to cooling-tower blowdown, liquid effluent from the CRN Site could contain residual water-treatment chemicals (e.g., scale inhibitors, pH adjusters, biocides, and coagulants) from treating water for various plant uses. Discharge from the cooling towers would contain anti-scaling compounds, corrosion inhibitors, and biocides to eliminate growth of bacteria and algae. The discharge could also contain concentrated minerals, salts, and organic compounds that enter the makeup water system. Pursuant to 40 CFR Part 423, discharge of these chemicals would be specifically regulated by the conditions of the NPDES permit administered by TDEC and would be subject to the numerical water-quality criteria and anti-degradation statement in the State of Tennessee’s general water-quality criteria). Based on the expectation that the CRN Site would comply with all applicable NPDES discharge limits, environmental effects associated with surface water usage are considered minor.

Regular monitoring would be required to ensure that liquid effluent discharges comply with the conditions of the NPDES permit for stormwater and plant wastewater. TVA would develop an operational monitoring program as part of its NPDES permit application. The specific requirements for hydrologic monitoring, water-quality parameters, number of stations, station locations, frequency and method of measurement, and equipment type would be specified in the program. Temperature and contaminant concentration limits would be established, as would any modeling efforts needed to demonstrate compliance. The Reservoir would also be monitored as part of the radiological environmental monitoring program described in Section 3.20.

Summary of Surface Water Quality Impacts During Operation

Impacts of operation activities on surface water in the area would be limited because (1) stormwater and plant wastewater discharges would be subject to NPDES permit requirements, (2) stormwater BMPs would be implemented, and the stormwater runoff from the site would be small compared to the flow of the Clinch River arm of the Watts Bar Reservoir, (3) thermal and chemical mixing zones would be established in the NPDES permit for plant wastewater discharges, and (4) maintenance dredging is not anticipated but, if needed, would meet the terms of applicable permits and the Watts Bar Interagency Agreement. Therefore, impacts to surface water under Alternative B resulting from the operation of a new nuclear plant at the CRN Site are minor.

3.3.2.2.2 Groundwater

3.3.2.2.2.1 Groundwater Hydrology

Construction

Land surface modifications would result in local alterations to groundwater recharge where previously vegetated surfaces are replaced by impervious or low permeability lands. These activities are expected to noticeably alter the spatial and temporal patterns of infiltration and recharge and influence groundwater flow directions in the uppermost aquifer. However, effects on infiltration, recharge, and groundwater flow would be localized within the CRN Site and minor.

Construction phase site preparation would entail general land disturbance and possible impacts to groundwater beneath the CRN Site. Constructing the main plant facilities would require excavation of overburden and weathered rock to reach competent bedrock on which to foundations can be placed. After construction is completed, groundwater hydrology is expected to be altered within the excavations by the placement of fill materials that have hydraulic properties different than native materials removed during excavation.

Depending on the reactor technology selected, excavation may extend to a depth of about 140 feet bgs, to an elevation of 683 feet NAVD88. At this depth, the bottom of the excavation would be approximately 40 feet below the channel bottom of the Reservoir. Because uppermost groundwater at the CRN Site is in communication with the Reservoir (as described in Section 3.3.1.2.1 Groundwater Hydrology), dewatering of the excavated area would likely be required. Dewatering would be accomplished using a gravity-type system(s): water that drains into the excavation under gravity would be collected at the bottom perimeter of the excavation, drained to sumps, and pumped out to a stormwater-retention basin for eventual infiltration or discharge to the Reservoir. Horizontal pressure-relief wells drilled into the excavation walls may be used to reduce hydrostatic pressure behind these walls to facilitate stabilizing the excavation. Thus, construction dewatering would lower groundwater levels in the areas surrounding excavation. To minimize this effect and reduce the need for dewatering, fractures and cavities transmitting large amounts of water—whether groundwater and/or storm flow water— would be appropriately blocked or grouted. This may also influence hydraulic gradients beyond the excavation. As appropriate, TVA would assess the effects of dewatering by monitoring groundwater levels surrounding the excavation and water levels in potentially affected surface waterbodies.

A qualitative evaluation of the effects of excavation dewatering was conducted on the surrounding groundwater levels and ponds, streams, and wetlands on the CRN Site. However, because identified surface water features are generally distant from the center of Area 1, such features are unlikely to be appreciably affected by dewatering based on the smaller radius of influence for the aquifer pumping test. Streams and wetland resources in proximity to excavation and construction areas (including laydown areas) may also be affected by groundwater flow disruptions where such resources have a hydrology that is dependent upon groundwater discharge (e.g., wetlands W019, W020a and W020b, see Figure 3-9). Subsequent to construction, the water table is expected to return to natural conditions.

Groundwater would be extracted as a consequence of dewatering for the power-block excavation. Effects of dewatering would be limited to the shallow groundwater of the CRN Site and not be noticeable at the locations of offsite groundwater users. Because groundwater flow alterations would be temporary and limited to the CRN Site, no impacts to groundwater availability to offsite users would be evident and no cumulative impacts would be anticipated.

In summary, impacts to groundwater hydrology at the CRN Site and associated offsite areas could occur from construction dewatering activities. Impacts would be temporary, limited to excavation and periods of subsurface construction and would have minimal potential for direct and indirect impacts to localized groundwater resources. As a result of engineering controls and final design measures, impacts associated with land disturbance on groundwater hydrology of the CRN Site are minor.

Operation

Land-surface modification in conjunction with the development of the CRN Site under Alternative B would alter the pattern and rate of groundwater infiltration because of the increased amount of impervious surface at the CRN Site. These alterations could affect groundwater flow in the shallow groundwater at the site, but the effects are expected to be localized and minor. The existing pattern of groundwater discharge to the Reservoir is not expected to be altered. No groundwater from onsite sources would be used during operation of the CRN Site.

In summary, impacts to groundwater hydrology at the CRN Site and associated offsite areas from operation are minor.

3.3.2.2.2.2 Groundwater Use

Most of the water for building activities (e.g., concrete batch plant, potable, fire protection, and sanitary water systems) would be supplied by the City of Oak Ridge Public Works Department and as such are addressed in conjunction with effects on community facilities and services in Section 3.15.

During the construction phase, groundwater would not be used for construction purposes and removal of groundwater by dewatering methods to maintain excavations in the dry during construction of foundations, substructure, and below grade infrastructure are relatively short term, i.e., limited to the period of construction. As such, construction phase impacts associated with groundwater resource availability and use are temporary and minor.

No groundwater would be used under Alternative B during operation and groundwater availability would not be affected.

3.3.2.2.2.3 Groundwater Quality

Construction

During construction, gasoline, diesel fuel, hydraulic lubricants, and other similar products would be used for construction equipment. Inadvertent spills of these fluids have the potential to contaminate groundwater. Pursuant to 40 CFR Part 112 and 40 CFR Part 9, TVA would implement an IPPP at the CRN Site, which would include the use of BMPs to minimize the occurrence of spills and limit their effects. These BMPs include actions such as proper vehicle and equipment maintenance, spill precautions such as use of absorbent pads under equipment, containment for fuel or oil storage tanks, and the maintenance of spill response equipment and materials. Four wells no longer in use were found to be present in Area 1. These wells had been used for groundwater characterization of the CRBRP. These would be properly abandoned and closed in accordance with TVA and TDEC requirements. With proper closure these wells would not provide potential pathways of preferential transport of contaminants to groundwater. Based on implementation of an IPPP, the use of BMPs, and closure of CRBRP wells, the effect on groundwater quality of an inadvertent chemical spill would be localized and temporary. As a result, the impacts on groundwater quality would be minor.

As noted previously (Section 3.2.2), a SWPPP would be developed in accordance with TDEC stormwater NPDES permit discharge requirements for erosion protection and stormwater management. Stormwater runoff from the CRN Site would be controlled via engineered structures, collected in engineered retention ponds, and infiltrated to the ground, or released to the Reservoir in a controlled manner. The SWPPP would incorporate BMPs to include not only guidance to minimize erosion and stabilize the land surface, but to also provide BMPs for dewatering methods as described in the State of Tennessee Erosion and Sediment Control Handbook (TDEC 2012).

Groundwater quality impacts identified above would be localized and temporary. Additionally, groundwater discharges would be regulated by NPDES permit and engineering controls and BMPs would be used to minimize and control inadvertent spills. Therefore, the impact on groundwater quality associated with Alternative B would be minor.

<u>Operation</u>

During plant operation(s), gasoline, diesel fuel, hydraulic lubricants, and other similar products would be used for operational equipment. Inadvertent spills of these fluids have the potential to contaminate groundwater. Pursuant to 40 CFR Part 112 and 40 CFR Part 9, TVA would implement an IPPP at the CRN Site, which would include the use of BMPs to minimize the occurrence of spills and limit their effects. These BMPs include actions such as proper vehicle and equipment maintenance, containment for fuel or oil storage tanks, and the maintenance of spill response equipment and materials. Based on implementation of an IPPP, and the use of BMPs, the effect on groundwater quality of an inadvertent chemical spill would be localized and temporary. As a result, the impacts on groundwater quality would be minor.

The stormwater drainage system would direct stormwater to retention basins designed to control the rate, volume, and water quality of runoff that would eventually reach the Reservoir. Stormwater discharge would be regulated under the NPDES permit. Retention basins and the discharge system holding pond may increase infiltration over the area of the basin and increase local recharge to groundwater, potentially affecting groundwater quality. Because stormwater pond design and effluent water quality would conform to the terms of the NPDES permit, infiltration from these basins would have a minor effect on shallow groundwater quality.

In conjunction with operation, a groundwater monitoring program would be defined that would include water level, radiological, and chemical monitoring as well as groundwater modelling to assess future changes from the baseline conditions. The monitoring would be conducted in accordance with TVA's Groundwater Protection Program which is focused on the prevention, early detection, and mitigation of impacts from potential subsurface or groundwater contamination. As part of the program, a monitoring plan would be developed to specify locations, sampling frequencies, protocols, and procedures for sampling and analysis.

In summary, impacts to groundwater quality at the CRN Site and associated offsite areas from operation are minor and mitigated with the implementation of an IPPP and adherence to NPDES permitting requirements. Site-specific potential effects of groundwater would be further studied under subsequent NEPA analysis once specific technologies are selected and proposed for deployment.

3.3.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced Non-LWRs

3.3.2.3.1 Surface Water Resources

In conjunction with Alternative C, TVA would develop the CRN Nuclear Technology Park only at Area 2. Actions include site preparation within permanent and temporary use areas (Area 2 and laydown areas), develop and improve roadways and associated infrastructure, expand transmission systems, and construct and operate structures associated with the cooling system. The proposed surface water intake and the proposed discharge would be the same as that proposed for Alternative B.

Notable differences in impacts to surface water relate to the effects of development within the proposed footprints of Area 1 under Alternative B versus Area 2 under Alternative C.

3.3.2.3.1.1 Surface Water Hydrology
Under Alternative C, construction phase site preparation activities would generally be similar to those described for Alternative B, but they would differ based on the degree of stream alteration within Area 1 verses that which would occur in Area 2. General land disturbance and impacts to surface waterbodies on and near the CRN Site would also include those effects to the Reservoir, Grassy Creek, and small unnamed streams and ponds on the CRN Site (Area 2 instead of Area 1) and associated offsite areas including the BTA, the TN 95 Access Area, and the 161-kV transmission line (see Figure 2-2).

Twenty-five streams would be affected under Alternative C within the CRN Site and associated offsite areas (Table 3-10 and Table 3-11). Impacts include effects to seven perennial streams (1,412 linear feet), five intermittent streams (2,507 linear feet), and 13 ephemeral streams (4,453 linear feet). Additionally, four streams would be crossed in conjunction with the potential offsite upgrades within the 500-kV corridor extending to the Bethel Valley substation. As described for Alternative B, alterations to existing streams under Alternative C would result in direct alteration and loss of aquatic habitat and associated riparian zones coupled with the alteration of runoff rates from associated drainage areas. However, unlike Alternative B, Alternative C would not result in impacts to ponds. Table 3-11 summarizes impacts to each of the identified stream resources in conjunction with actions on the CRN Site and associated offsite areas.

All other impacts to hydrology including minimization measures, permitting requirements, and mitigative measures are similar to those previously described for Alternative B. Therefore, because the number and length of streams (perennial and intermittent) altered under Alternative C would be less than those described for Alternative B, impacts to hydrology under Alternative C would be less than Alternative B but would still be moderate.

3.3.2.3.1.2 Surface Water Use
Impacts of water use under Alternative C are similar to those described for Alternative B. As such, impacts from water use under Alternative C would be minor.

3.3.2.3.1.3 Surface Water Quality
Impacts to water quality under Alternative C are similar to those described for Alternative B. Differences in water quality relate to the magnitude of impacts to surface water systems (streams). Impacts to water quality during construction are primarily related to construction stormwater runoff and sedimentation, which would be minimized through the use of BMPs under the CSWP/SWPPP. Operational impacts to water quality include potential increases to stormwater runoff due to increased area of hard surfaces, increases in thermal discharge in the Reservoir, and discharge of water-treatment associated chemicals. Under Alternative C, the impacts on perennial and intermittent streams, in terms of linear feet, is less than the overall impact of Alternative B. Therefore, impacts to water quality under Alternative C would be minor and would be mitigated through use of BMPs, monitoring and measurement programs, and adherence to NPDES permitting limits.

3.3.2.3.2 Groundwater

3.3.2.3.2.1 Groundwater Hydrology
In conjunction with Alternative C, impacts to groundwater hydrology are similar to those described for Alternative B; however, grading and excavation operations during construction are expected to encounter more varied conditions in Area 2 because of differing physical characteristics of the uppermost aquifer units (Knox Group). As such, the site may exhibit a broader range of groundwater flow conditions and require a range of dewatering approaches. Depending on proximity of construction and operation to the northeastern side of Area 2 where karst features may be present, there would likely be notable influences on groundwater flow, transient storage following precipitation events, and challenges associated with construction dewatering. This depends upon the interconnectivity of the epikarst (the thin zone near the karst surface) and its relative permeability, storage properties, and vertical gradients between aquifer units. Construction dewatering may be more irregular and varied depending on depths of excavation and means by which to control groundwater seepage through pit (and/or trench) walls and possible flow into the excavation. Therefore, impacts to groundwater hydrology under Alternative C would be minor because of potential for dewatering uncertainties, but impacts would be mitigated through use of BMPs, monitoring and measurement.

3.3.2.3.2.2 Groundwater Use
Impacts of groundwater use under Alternative C are similar to those described for Alternative B. Therefore, impacts to groundwater use under Alternative C would be minor during construction. No groundwater would be used under Alternative C during operation and groundwater availability would not be affected.

3.3.2.3.2.3 Groundwater Quality
Impacts of groundwater quality under Alternative C are similar to those described for Alternative B. However, grading and excavation operations during construction may encounter more varied conditions with a broader range of groundwater flow conditions and dewatering approaches. Depending on proximity of construction and operation to the northeastern side of Area 2 where karst features may be present in the Knox Group, Alternative C may influence water quality. This would depend upon the interconnectivity of the epikarst and its relative permeability, storage properties, and vertical gradients between

aquifer units. Construction dewatering may be more irregular and varied depending on depths of excavation and means by which to control groundwater seepage and possible flow into the excavation. Therefore, impacts to water quality under Alternative C may be considered moderate to minor, because of potential for dewatering uncertainties, but would be mitigated through use of BMPs, monitoring and measurement, a flexible dewatering program, and adherence to NPDES permitting limits.

3.3.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced Non-LWRs

3.3.2.4.1 Surface Water Resources

In conjunction with Alternative D, TVA would develop the CRN Nuclear Technology Park at both Areas 1 and 2. Actions include site preparation within temporary and all permanent use areas, develop and improve roadways and associated infrastructure, expand transmission systems, and construct and operate structures associated with the cooling system. The proposed surface water intake and the proposed discharge would be the same as that proposed for Alternative B.

Notable differences in impacts to surface water relate to the combined effects of development within the proposed footprints of both Area 1 and Area 2 under Alternative D as compared to more limited site disturbances associated with Alternative B and Alternative C.

3.3.2.4.1.1 Surface Water Hydrology

Under Alternative D, construction phase site preparation activities would generally be similar to those described for Alternative B and would include the additional stream alteration within Area 2 as described under Alternative C. General land disturbance and impacts to surface waterbodies on and near the CRN Site would also include those effects to the Reservoir, Grassy Creek, and small unnamed streams and ponds on the CRN Site (Area 2 coupled with those of Area 1) and associated offsite areas including the BTA, the TN95 Access Road, and the 161-kV transmission line (see Figure 2-3).

A total of 29 streams would be affected under Alternative D within the CRN Site and associated offsite areas. Impacts include effects to seven perennial streams (1,775 linear feet), six intermittent streams (2,655 linear feet) and 16 ephemeral streams (5,487 linear feet) (Table 3-10 and Table 3-11). Additionally, four streams would be crossed in conjunction with the potential offsite upgrades within the 500-kV corridor extending to the Bethel Valley substation. As described for Alternative B, alterations to existing streams under Alternative D would result in direct alteration and loss of aquatic habitat and associated riparian zones coupled with the alteration of runoff rates from associated drainage areas. Similar to Alternative B, Alternative D would impact two ponds totaling 0.9 acres. Table 3-10 summarizes impacts to each of the identified stream resources in conjunction with actions on the CRN Site and associated offsite areas.

All other impacts to hydrology including minimization measures, permitting requirements, and mitigative measures are similar to those previously described for Alternative B. Therefore, because the number and length of streams altered under Alternative D are greater than those previously described under both Alternative B and Alternative C, impacts to hydrology under Alternative D would be incrementally greater than those under Alternatives B and C but still would be moderate.

3.3.2.4.1.2 Surface Water Use

Impacts of water use under Alternative D are similar to those described for Alternatives B and C. As such, impacts from water use under Alternative D are minor.

3.3.2.4.1.3 Surface Water Quality

Impacts to water quality under Alternative D are similar to those described for Alternative B and Alternative C. Differences in water quality relate to the relative magnitude of impacts to surface water (streams). Impacts to water quality during construction are primarily related to disturbances from stormwater runoff and sedimentation, which would be minimized through the use of BMPs under the site CSWP/SWPPP. Operational impacts to water quality include potential increases to stormwater runoff from the increased area of hard surfaces, increases in thermal discharge in the Reservoir, and discharge of water-treatment-associated chemicals. Under Alternative D, impacts to water quality are expected to be similar to those under Alternative B and Alternative C, with the exception being an increase in the number of linear feet potentially impacted under Alternative D. Therefore, impacts to water quality under Alternative D would be greater than that for Alternatives B and C but still minor, and would be mitigated through use of BMPs, monitoring and measurement programs, and adherence to NPDES permitting limits.

3.3.2.4.2 Groundwater

3.3.2.4.2.1 Groundwater Hydrology

Impacts of groundwater hydrology under Alternative D are similar to those described for Alternative B and Alternative C, but greater due to the increased land disturbance area and increased areas for deep excavation of safety-related structures. Therefore, impacts to groundwater hydrology under Alternative D would be minor but greater than Alternatives B and C, and they would be mitigated through use of BMPs, SPPC Plans, monitoring and measurement.

3.3.2.4.2.2 Groundwater Use

Impacts of groundwater use under Alternative D are similar to those described for Alternatives B and C. Therefore, impacts to groundwater use under Alternative D are minor during construction. No groundwater would be used under Alternative D during operation and groundwater availability would not be affected.

3.3.2.4.2.3 Groundwater Quality

Impacts to groundwater quality under Alternative D are similar to those described for Alternative B and Alternative C. Therefore, impacts to groundwater quality under Alternative D may be considered moderate to minor, because of potential for dewatering uncertainties, but would be mitigated through use of BMPs, monitoring and measurement, flexible dewatering program, and adherence to NPDES permitting limits.

3.3.2.5 Potential Contributing Effects of Other Reasonably Foreseeable Future Actions

As described in Section 3.3.1.3, several reasonably foreseeable future actions were identified in proximity to the CRN Site. Depending on the local environmental setting and the design characteristics of these other proposed actions, direct alteration of surface water resources may occur. Furthermore, each of these projects entails land disturbance activities that have the potential to increase site runoff and contribute to pollutant loading and sedimentation within associated surface water resources. None of the identified actions by others geographically intersect with the same surface water resources affected by the proposed project. However, these other projects have the potential to increase demands on water use, wastewater treatment, and pollutant loading during both construction and operational phases. Example projects include the Kairos Hermes reactor project, proposed actions at ORNL, construction of the DOE Environmental Management Disposal Facility on ORR, development of the Horizon Center, and the development of the municipal airport near the ETTP. Because both the Kairos project and the proposed airport project are located adjacent to Poplar Creek near the Reservoir, they have the potential to result in increased pollutant loading to the same waterbody as that affected by the proposed project. However, it is also recognized that these and all other reasonably foreseeable actions are also subject to the same regulatory requirements for implementing a SWPPP and associated BMPs, and they would be required to comply with all relevant NPDES permitting requirements that would effectively minimize pollutant loading to the Reservoir. Construction and operation of other facilities, including the Kairos Hermes reactor, the proposed DOE disposal facility, and potential development of the Horizon Center, have the potential for increasing risk of contamination to groundwater resources. Each of these facilities is expected to include appropriate mitigative measures and design features to minimize potential contamination of groundwater. Additionally, because the impacts to groundwater quality at the CRN Site and associated offsite areas from operation are minor and mitigated with the implementation of an IPPP and adherence to NPDES permitting requirements, the potential effects of development of the CRN Site are minor. Furthermore, operation of the Advanced Nuclear Technology Park at the CRN Site would not utilize groundwater. As such, these actions would likely have minimal cumulative impacts on water resources in the area but could contribute to collectively increased demands on municipal water supply and wastewater treatment services (see Section 3.15.2.5).

3.3.2.6 Summary of Impacts to Surface Water and Groundwater Resources

As summarized in Table 3-13, TVA has determined that all impacts to surface waters and groundwater related to the development of the CRN Site and associated offsite areas would have both direct and indirect impacts. Overall, moderate permanent impacts would be associated with conversion and loss of onsite streams and shoreline alteration of the Reservoir. Water quality impacts expected from construction activities would be temporary and minor with adherence to the requirements of the SWPPP and implementation of proper BMPs. Direct effects to jurisdictional waters resulting in permanent impacts would be minimized through final design and mitigated as required by authorized permits. Operational Impacts associated with hydrology, water use (including consumptive use), and water quality from operation of each of the alternatives are similar and result from the effects of cooling water withdrawal and discharges to the Reservoir. Discharges to receiving waters would be minor when proper treatment and BMPs are implemented prior to discharge from the site.

Table 3-13. Summary of Impacts to Water Resources

Alternative	Project Phase	Impact	Severity
Alternatives B, C, D	Construction	Potential impacts to Project Area jurisdictional streams and riparian zones and near-shore instream areas of the Reservoir.	Moderate permanent impacts associated with conversion and loss of onsite streams and shoreline alteration of the Reservoir. Based on the length of stream alteration, the magnitude of impact is as follows: Alternative D, greater than Alternative B, which is greater than Alternative C. Impacts to streams mitigated by purchase of credits in mitigation bank in accordance with permits, as appropriate. Shoreline restoration activities to provide long term beneficial effects in shoreline stabilization and reduced erosion.
		Water use during construction for dust control measures.	Impacts associated with water use for dust control minor.
		Localized sedimentation and reduced water quality from stormwater during construction activities.	Temporary minor water quality impacts to surrounding surface waters with the implementation of SWPPP, redevelopment of stormwater management ponds, and appropriate BMPs. All impacts to surface water resources would be subject to Section 10/404 permitting under the CWA issued by the USACE and TDEC ARAP permit requirements. Discharges would comply with NPDES permit limits and other state and federal regulations. Unavoidable impacts to surface water features on site would be minimized during final design and mitigated as required by applicable permits.
		Potential impacts to groundwater hydrology during dewatering and land disturbance activities.	Impacts would be temporary, limited to excavation and periods of subsurface construction and would have minimal potential for direct and indirect impacts to localized groundwater resources. Impacts would be minor as a result of engineering controls and final design measures.

Alternative	Project Phase	Impact	Severity
		No groundwater would be used during construction and groundwater availability would not be affected.	No impact.
		Inadvertent spills of gasoline, diesel fuel, hydraulic lubricants, and other similar products have the potential to contaminate groundwater.	Minor and localized impacts as groundwater discharges would be regulated by NPDES permit and engineering controls and BMPs would be used to minimize and control inadvertent spills.
	Operation	Water diversion and use associated with CWIS operation. Potential for alteration of hydrology and scour.	Diversion and use of cooling water would result in minor localized alteration of hydrologic patterns and limited scour potential due to low intake velocity. Impacts of consumptive use of surface water would not noticeably alter the availability of water supply for upstream or downstream users. Impacts of consumptive use of surface water are therefore minor.
		Alteration of hydrology, flow patterns and water quality of the Reservoir due to discharge operation.	Effects on hydrology, flow patterns and water quality from discharge operation demonstrated to be localized and minor.
		Potential stormwater related pollutant loading from impervious surfaces.	Minor impact of stormwater runoff to water quality of receiving streams with use of stormwater ponds and proper treatment of runoff. Cooling water withdrawal, discharge of effluents (thermal, radiological and non-radiological constituents) subject to NDPES permit requirements and associated monitoring and mitigative measures. Therefore, impacts from runoff are minor.
		Alteration of the pattern and rate of groundwater infiltration due to increased impervious surface.	Effects on flow patterns would be localized and minor.
		No groundwater would be used during operation and groundwater availability would not be affected.	No impact.
		Inadvertent spills of gasoline, diesel fuel, hydraulic lubricants, and other similar products have	Minor impacts to groundwater quality, mitigated with the implementation of an IPPP and adherence to NPDES permitting

Alternative	Project Phase	Impact	Severity
		the potential to contaminate groundwater.	requirements. A groundwater monitoring program would be conducted in accordance with TVA's Groundwater Protection Program focused on the prevention, early detection, and mitigation of impacts from potential subsurface or groundwater contamination.

3.4 Floodplains and Flood Risk

3.4.1 Affected Environment

A floodplain is the relatively level land area along a stream or river that is subject to periodic flooding. The area subject to a one percent chance of flooding in any given year is normally called the 100-year floodplain. The area subject to a 0.2 percent chance of flooding in any given year is normally called the 500-year floodplain.

The CRN Site is situated between CRM 14.5 and 19, right descending bank, on the Reservoir, in Roane County, Tennessee. Based on Profile 08P in the 2009 Roane County, Tennessee, Flood Insurance Study, the 100- and 500-year flood elevations vary from 747.6 to 749.3 feet and 750.1 to 752.6 feet, respectively, referenced to NAVD 1988. The CRN Project Area would encompass portions of the floodplains of the Clinch River, Grassy Creek, Raccoon Creek, White Oak Creek, and several unnamed tributaries of the Clinch River. The Project Area is also encompassed by Roane County, Tennessee, Flood Insurance Rate Map (FIRM) Panel Numbers 47145C0120F, effective 9/28/2007, and 47145C0140G, effective 11/18/2009. Floodplain locations within the CRN Project Area are shown on Figure 3-9 in Section 3.3 Surface Waters. No FEMA 100-year floodplains are associated with the potential future offsite transmission upgrades within the 500-kV line extending to the Bethel Valley Substation.

A regulatory floodway is normally associated with the National Flood Insurance Program (NFIP). It refers to that portion of the channel of a river or other watercourse and the adjacent land areas that must be reserved to convey the 100-year flood without cumulatively increasing the water surface elevation more than a designated height. There is no floodway on this reach of the Reservoir.

Flood storage is the space available in a reservoir to store flood waters in order to reduce downstream flooding impacts. In TVA reservoirs, the Flood Storage Zone (FSZ) is the range of elevations used to store such flood water. The FSZ on the Reservoir extends from elevation 735.0 to elevation 750.1 at CRM 14.5 and 752.6 at CRM 19.0. TVA manages development within the FSZ in order to minimize the loss of flood storage space while still achieving project objectives using the TVA Flood Storage Loss Guideline (FSLG).

3.4.2 Reasonably Foreseeable Future Actions in Proximity to the CRN Site

As noted in Section 3.1.3, TVA identified several foreseeable future actions in proximity to the CRN Site. The scope of these other proposed actions may entail the alteration of floodplains within their respective project footprints. The specific details regarding the scope of these actions are unknown; however, any development within 100-year floodplains would be subject to City of Oak Ridge or Roane County floodplain regulations, as appropriate.

Floodplain regulations serve to both protect floodplains and the structures, activities, and facilities constructed within them. With adherence to local floodplain regulations, cumulative impacts due to construction within 100-year floodplains are expected to be minor and insignificant.

3.4.3 Environmental Consequences

As a federal agency, TVA adheres to the requirements of EO 11988, Floodplain Management. The objective of EO 11988 is "…to avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative" (EO 11988, Floodplain Management). The EO is not intended to prohibit floodplain development in all cases, but rather to create a consistent government policy against such development under most circumstances (U.S. Water Resources Council 1978). The EO requires that agencies avoid the 100-year floodplain unless there is no practicable alternative.

For certain "critical actions," the minimum floodplain of concern is the 500-year floodplain. The U.S. Water Resources Council defines "critical actions" as "any activity for which even a slight chance of flooding would be too great" (U.S. Water Resources Council 1978). Critical actions can include facilities producing hazardous materials (such as liquefied natural gas terminals), facilities whose occupants may be unable to evacuate quickly (such as schools and nursing homes), and facilities containing or providing essential and irreplaceable records, utilities, and/or emergency services (such as large power-generating facilities, data centers, hospitals, or emergency operations centers).

EO 13690, Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input was reinstated in May 2021. However, implementation of EO 13690 is still in development at the national level. TVA is working with other federal agencies to develop consistent implementing plans for these EO requirements. When those implementing plans are finalized, TVA would incorporate floodplain analysis with respect to EO 13690, in addition to EO 11988. Depending upon the results of these inter-agency efforts, TVA may update the floodplain implementing plan in subsequent NEPA analysis.

3.4.3.1 Alternative A – No Action Alternative

Under the No Action Alternative, there would be no development on the CRN Site, and thus no changes to conditions found within the local floodplains.

3.4.3.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced Non-LWRs

Impacts to floodplains under Alternative B are limited to the construction phase only. No impacts to floodplains are expected during the operation phase. Area 1 is located between CRM 15.1 and 17.9 and outside of the 100-year floodplain. With the exception of a small area near CRM 16.6, the proposed discharge diffuser pipes, and the proposed intake, proposed actions under Alternative B would be located outside 100- and 500-year floodplains. The exact location of structures and facilities that would be constructed in Area 1 are not known at this time. However, to minimize adverse impacts, flood-damageable structures and facilities would be located outside 100-year floodplains. If they cannot be located outside 100-year floodplains, additional floodplains review would be required.

The intakes and outfalls would be located within the 100-year floodplain and FSZ of the Reservoir. Consistent with EO 11988 and the TVA FSLG, intakes and outfalls are considered to be repetitive actions in the 100-year floodplain and FSZ that would likely result in only minor impacts. To minimize adverse impacts, these structures would be constructed using the least amount of fill practicable.

Areas of improvements to River Road on the CRN Site and the TN 95 Access may partially occur within 100-year floodplains. A detailed analysis of potential flood impacts would be undertaken during the design phase for these road facilities. However, to minimize adverse impacts, roads would be designed and constructed such that upstream flood elevations would not increase more than 1.0 foot and fill within the Reservoir would be minimized.

A portion of the laydown area on the CRN Site crosses the floodplain of an unnamed tributary to the Clinch River at CRM 18.8. At this location, the 100-year flood elevation would be 749.1 feet (NAVD 1988). Laydown areas are temporary uses of the floodplain; however, equipment and material could be damaged should a flood occur while the laydown area is in use. To minimize adverse impacts, flood-damageable material and equipment would be stored outside the floodplain and/or above elevation 749.1 feet.

The improvements within the BTA at TN 58 and Bear Creek Road and the new 161-kV transmission line connection from the existing 161-kV transmission line along Bear Creek Road southeast to the 500-kV transmission line near the northern CRN Site boundary, would be located outside 100-year floodplains, which would be consistent with EO 11988.

Improvements within the BTA at the existing DOE barge facility at CRM 14.1 and the supplemental barge facility being considered at approximately CRM 16.5 would involve construction within the 100-year floodplain. Improvements to or structures associated with these facilities would include retaining walls, mooring cells, bollards, riprap, engineered fill, sheet piles, or other structures to support the facility. Consistent with EO 11988, barge facilities are considered to be repetitive actions in the 100-year floodplain and TVA Flood FSZ that would likely result in only minor impacts. To minimize adverse impacts, only water-use or water-dependent facilities and structures would be located below the 100-year flood elevation at these locations.

If refurbishment of the existing rail spur offloading area is necessary, new construction would be limited to the north side of the rail spur, and thereby avoid the 100- and 500-year floodplains, which would be consistent with EO 11988.

Generally, water-use and water-dependent structures and facilities constructed under Alternative B would be located within 100-year floodplains, and flood-damageable equipment and facilities would be located at a minimum outside 100-year floodplains. Critical Actions would be located at a minimum outside 500-year floodplains, which would be consistent with pertinent EOs, associated guidance and the FSLG. Therefore, impacts to floodplains and flood risk under Alternative B would be minor.

3.4.3.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced Non-LWRs

Area 2 is located outside of the 100-year floodplain, which would be consistent with EO 11988. Potential impacts associated with the intake, outfall, laydown area on the CRN Site, and barge facilities, and mitigation measures are the same as in Alternative B. Therefore, impacts to floodplains would be minor for Alternative C.

3.4.3.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced Non-LWRs

As noted under Alternative B and Alternative C, Area 1 and Area 2 are located outside of 100- year floodplains, which would be consistent with EO 11988 and EO 13690. Potential impacts associated with the intake and outfall, laydown area on the CRN Site, and the BTA and mitigation measures are the same as in Alternative B. Therefore, impacts to floodplains would be minor for Alternative D.

3.4.3.5 Summary of Impacts to Floodplains and Flood Risk

As summarized in Table 3-14, TVA has determined that development of the CRN Site would have minor impacts to floodplains and flood risk. Construction of the intake, outfall, and barge facility improvements would be located within the 100-year floodplain. All other facilities associated with the nuclear technology park on the CRN Site would be constructed outside of the 100-year floodplain and, therefore, consistent with applicable EOs. Potential impacts associated with portions of the River Road and TN 95 Access improvements would be determined by TVA during project design and further environmental review would be conducted as appropriate. To minimize adverse impacts within floodplains, standard BMPs would be used during construction activities, and any new structures would adhere to the TVA subclass review criteria for location in floodplains. To minimize adverse impacts due to temporary use of the laydown area on the CRN Site, flood-damageable material and equipment would be stored outside the floodplain area.

Table 3-14. Summary of Impacts to Floodplains and Flood Risk

Alternative	Project Phase	Impact	Severity
Alternatives B, C, D	Construction	Potential impacts from intake, discharge, improvements to River Road and the TN 95 Access, and barge facility improvements are considered repetitive actions. No impact from site facilities which would be located outside of the 100- and 500-year floodplains, consistent with EO 11988 and FSLG.	Impacts are associated with repetitive actions or minimized in site design and, therefore, would be minor.

3.5 Wetlands

3.5.1 Affected Environment

3.5.1.1 Wetlands of the CRN Project Area

Waters of the United States (WOTUS) include lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, and other water resources. Activities resulting in the placement of fill within WOTUS are subject to USACE jurisdiction and require authorization under Section 404 of the CWA for planned fill activities. In conjunction with Section 404, a state-issued Section 401 Water Quality Certification may be required for impacts to WOTUS. In Tennessee, the TDEC Division of Water Resources administers Section 401 Water Quality Certifications through the ARAP [33 US Code § 1344]. Additionally, EO 11990 – Protection of Wetlands requires federal agencies to minimize the destruction, loss, or degradation of wetlands when carrying out their responsibilities, and to preserve and enhance the natural and beneficial values of wetlands. Before performing certain activities in wetlands, a Section 404 permit from the USACE may be required, depending on the size of the wetland or stream and its hydrologic connectivity to a navigable waterway. Section 401 of the CWA provides states with the ability to verify whether activities allowed under Section 404 are compliant with state water quality standards.

For the purposes of the CWA, wetlands are defined as those areas that are "inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" [33 CFR 328.3(b)]. Wetlands and wetland fringe areas can also be found along the edges of many watercourses and impounded waters (both natural and man-made). Wetlands provide valuable public benefits including improved water quality, erosion control, flood abatement, habitat enhancement, water supply, recreation, partnerships, education, and aesthetic appeal (TDEC 2021b).

The CRN Site and associated offsite areas are situated within the Ridge and Valley Level III ecoregion (Griffith et al. 1998), which is characterized by ridgelines and wide valley bottoms trending northeast to southwest. Hydrology in this ecoregion typically constitutes small upland drainage features intersecting lower gradient streams tributary to river bottoms meandering through wide valley flats. Wetland habitat across the region is most commonly associated with the floodplains of these stream and river systems, although springs and seepage wetlands are also known to occur. The study area is located in the Lower Clinch watershed basin (HUC-06010207). The National Wetlands Inventory (NWI) classifies wetland and deepwater habitats from aerial imagery. Within the Clinch River watershed, approximately 340 acres of wetland habitat have been mapped by NWI, which includes approximately one percent of the entire watershed.

The CRN Project Area comprises approximately 868 acres adjacent to the north side of the Reservoir, between CRM 14 and 21. The CRN Site includes the former CRBRP construction site, where construction ceased in the early 1980s after extensive grading and site preparation. These previously disturbed areas generally consist of leveled land over shallow soils or gravel substrate where vegetation is routinely mowed, and sporadic trees and shrubs persist. The remainder of the CRN Site is dominated by upland forest situated on gently sloped, rolling, or steep terrain, dissected by tributaries to the Reservoir. Bottomland riparian habitat is present along the Reservoir floodplain and tributary wetland flats. Existing gravel and unmaintained forestry roads are present throughout the CRN Site. Within the study area, two TVA transmission line ROWs cross perpendicular to each other. Vegetation with the ROWs is routinely maintained in accordance with conductor clearance requirements. No NWI wetlands are associated with the potential future offsite transmission upgrades within the 500-kV line extending to the Bethel Valley Substation. TVA would conduct additional surveys to assess these habitats based on future planning needs.

Field reconnaissance of the CRN Project Area was conducted by TVA between January and June 2021 to determine wetland presence, extent, and condition (TVA 2021d). The 2021 wetland assessment included a review of delineations conducted between 2011 and 2015 within the CRN Project Area, with previously mapped wetland features verified and their condition updated in addition to mapping wetlands not previously documented. Wetland determinations were conducted in accordance with USACE methods, which require documentation of hydrophytic vegetation, hydric soils, and wetland hydrology

(Environmental Laboratory 1987; USACE 2012; USACE 2018). Broader definitions of wetlands, such as those provided by EO 11990, the USFWS, and the TVA Environmental Review Procedures, also were considered in the wetland determinations for the Project Area.

Wetland condition was evaluated using the Tennessee Rapid Assessment Method (TRAM) wetlands, which quantifies wetland function and ranks wetlands into three categories, including low, moderate, or exceptional resource value based on six metrics coordinating to indicator functions (TDEC 2015). Low quality wetlands are degraded aquatic resources that may exhibit: low species diversity; minimal hydrologic input and connectivity; recent or on-going disturbance regimes; and/or predominance of non-native species. These wetlands provide low functionality and are considered low value. Moderate quality wetlands provide more functions than low quality wetlands due to less degradation and/or their habitat, landscape position, or hydrologic input. Moderate quality wetlands are considered healthy water resources of value. Disturbance to hydrology, substrate and/or vegetation may be present to a degree at which valuable functional capacity is sustained. Wetlands with exceptional resource value provide high quality functions and value and are considered Exceptional Tennessee Waters. Those wetlands would: exhibit little, if any, recent disturbance; provide essential and/or large-scale stormwater storage, sediment retention, and toxin absorption; contain mature vegetation communities; and/or offer habitat to rare species.

Within the CRN Project Area, 51 wetlands, totaling approximately 37.2 acres, were delineated and assessed during the field reconnaissance, as depicted on Figure 3-9 (Section 3.3.1.1.1). Identified wetlands include approximately 1.2 acres of emergent wetlands, 0.9 acres of emergent-scrub shrub wetlands, 0.7 acres of emergent-scrub shrub-forested wetlands, 0.2 acres of emergent wetland-open water complex, 0.2 acres of scrub-shrub wetlands, 0.2 acres of scrub shrub-forested wetlands, and 33.3 acres of forested wetlands (TVA 2021d). Identified wetlands cover approximately four percent of the study area, a greater percentage than mapped by the NWI at the watershed scale. Delineated wetlands are summarized in Table 3-15. Representative wetland descriptions are detailed below.

Table 3-15. Wetlands Delineated in the Project Area

Wetland ID	Wetland Type[1]	TRAM Category[2]	Location[3]	Total Wetland Acreage
CRN Site				
W001	PFO1E	Moderate	CRN Site	7.8
W002	PEM/PSS1E	Low	CRN Site	0.1
W003	PFO1E	Moderate	CRN Site	1.7
W004	PEM/PSS1E	Low	CRN Site	0.1
W005	PFO1E	Moderate	CRN Site Access Road	0.3
W006	PFO1E	Moderate	CRN Site Access Road	0.3
W007	PEM1Hx	Low	CRN Site Access Road	0.2
W008	PFO1E	Low	CRN Site Access Road	0.9
W009	PFO1E	Low	CRN Site Access Road	0.2
W010	PFO1E	Moderate	CRN Site Access Road	0.4
W011	PSS1Ex	Low	CRN Site	0.5

Wetland ID	Wetland Type[1]	TRAM Category[2]	Location[3]	Total Wetland Acreage
W012	PEM1E	Low	CRN Site	0.1
W013	PEM1E	Low	CRN Site	0.1
W014	PEM1E	Low	CRN Site	0.2
W015	PFO1E	Moderate	CRN Site Access Road	0.4
W016	PEM PFO1E	Moderate	CRN Site	1.4 6.5
W017	PFO1E	Low	CRN Site	0.2
W018	PFO1E	Moderate	CRN Site	1.2
W019	PFO1E	Exceptional	CRN Site	5.7
W028	PEM/SS/FO1E	Moderate	CRN Site	0.2
W020a W020b	PFO1E	Moderate	CRN Site & TL ROW	2.5 0.2
W021	PFO1E	Low	CRN Site & TL ROW	0.7
W029	PEM1E	Low	CRN Site	0.1
W030	PFO1E	Low	CRN Site	0.1
Total				*28.7*
Associated Offsite Areas				
Barge and Traffic Area				
W031	PEM1E	Low	Bear Creek Road	0.02
W032	PEM1E	Low	Bear Creek Road	0.02
W033	PEM1E	Low	Bear Creek Road	0.1
W034	PFO1E	Moderate	Bear Creek Road	0.03
W035a	PSS1E	Low	Bear Creek Road	0.1
W035b W035c W035d	PSS1E	Low	Barge Terminal Access	0.1 0.01 0.01
W036a	PSS1E	Moderate	Barge Terminal Access	0.1
W036b W036c	PSS1E PFO1E	Moderate	Bear Creek Road	0.01 0.3
W037	PEM1F	Low	Bear Creek Road	0.1
W038	PFO1E	Low	TN 58 Ramp	0.1
W039	PSS1E	Low	TN 58 Ramp	0.2
W040	PEM1F	Moderate	TN 58 Ramp	0.1
Total				*1.3*
TN 95 Access				
W041a W041b	PEM/SS/FO1H PFO1E	Moderate	Jones Island Road	0.549 0.7
W042	PEM1E	Moderate	Jones Island Road	0.1
W043	PFO1E	Moderate	Jones Island Road	0.1
W044	PSS/FO1F	Moderate	Jones Island Road	0.2
Total				*1.6*
161-kV Offsite Transmission Line				
W022	PFO1E	Low	CRN Site & TL ROW	0.5
W023	PFO1E	Low	CRN Site & TL ROW	0.02
W024	PFO1E	Low	CRN Site & TL ROW	0.1

Wetland ID	Wetland Type[1]	TRAM Category[2]	Location[3]	Total Wetland Acreage
W025	PEM/FO1E	Moderate	CRN Site & TL ROW	0.05/1.1
W026	PEM/FO1E	Moderate		0.01/1.4
W027a	PFO	Moderate	TL ROW	0.6
W027b	EM1E			0.2
Total				*7.4*

[1] Classification codes as defined in Cowardin et al. 1979: E = seasonally flooded/saturated; F = semi-permanently flooded; H = permanently flooded; P = Palustrine; EM1 = emergent, persistent vegetation; FO1= forested, broad-leaved deciduous vegetation,seasonally flooded/saturated; SS1= scrub-shrub, broad-leaved deciduous vegetation; UB = unconsolidated bottom; x = excavated.
[2] TRAM Category as defined by TDEC 2015: Low = low resource value; Moderate = moderate resource value; Exceptional = exceptional waters.
[3] TL = Transmission Line
Source: TVA 2021d

W001, W003, and W016 comprise forested bottomland wetland habitat within larger backwater depressions of the Reservoir floodplain. The central portions of these wetlands exhibited evidence of regular or seasonal inundation, and all wetlands contained soil coloration indicative of hydric conditions. These wetlands were dominated by common wetland trees, including sweetgum (*Liquidambar styraciflua*), American elm (*Ulmus americana*), silver maple (*Acer saccharinum*), red maple (*Acer rubrum*), and sycamore (*Platanus occidentalis*). Saplings of these species also persisted in the understory. Due to landscape position, buffer composition, hydrologic influence, disturbance history, and interspersion of habitat features, these wetlands are considered moderate quality, offering healthy and desirable wetland function to the surrounding landscape.

W002 and W004 are small emergent/scrub-shrub interspersed wetlands, both exhibiting low value due to their recent disturbance history, small size, and associated lack of influence on downstream waters. Fox sedge (*Carex vulpinodea*) dominated the ground layer of both of these wetlands. The shrub layer in W002 was dominated by Chinese privet (*Ligustrum sinense*) and W004 contained a shrub layer dominated by box elder (*Acer negundo*) saplings. W002 is a wetland swale located within an existing transmission line ROW at the east side of the site, where woody vegetation growth is deterred to ensure safe clearance for overhead conductors. W004 is located on a slope to a created sediment pond where woody vegetation clearing and seepage from an altered hydrologic source was evident.

W005, W006, W010, and W017 are forested wetland features dominated by sycamores and associated with onsite embayments of small inlets along the Reservoir. W005 and W006 are separated from each other by the perimeter road; similarly, W010 and W017 are separated from the Reservoir by the same perimeter road but at different locations. Regularly inundated soils have resulted in greyed and mottled soil coloration, indicative of hydric conditions. W005, W006, and W010 exhibit moderate value and healthy wetland function within the landscape. However, disturbance with W017 coupled with its small size and associated minimal hydrologic influence provides for low resource value.

W007 and W011 are isolated wetland features that have developed in retention basins created during previous site grading and preparation activities. W007 has developed emergent wetland vegetation along the periphery of the inundated basin, including soft path rush (*Juncus effusus*) and rice cut grass (*Leersia oryzoides*). The basin of W011 has become vegetated with wetland plants, including an interspersion of black willow (*Salix nigra*) and green ash (*Fraxinus pennsylvanica*) saplings and marsh seedbox (*Ludwigia palustrus*). Due to their recent development in constructed basins, these wetlands are considered low value.

W008 and W018 have developed in similar wide, linear backwater swales within the floodplain onsite; however, both of these wetlands are separated from the Reservoir by the perimeter road. These wetland features exhibit signs of inundation and associated soil coloration indicative of hydric conditions. W008 is dominated by box elder, an opportunistic wetland shrub. This wetland is considered low value due to its disturbance history within and adjacent to the wetland boundary. W018 is dominated by American elm, sweetgum, red maple, and silver maple trees, and is considered moderate value, with less indication of recent disturbance.

W009 and W015 receive hydrology from upgradient runoff and drain beneath the perimeter road directly to the Reservoir. These wetlands formed in a natural valley, but hydrology has increased to the wetlands from road construction and/or partially blocked culverts at their terminus. Evidence of sufficient wetland hydrology has resulted in hydric soil coloration. W009 is dominated by box elder, an opportunistic wetland shrub, and is considered low value due to evidence of more recent disturbance. W015 is dominated by sweetgum and sycamore and is considered moderate value due to less indication of recent disturbance.

W012, W013, and W014 are located within the large, previously graded footprint central to the Area 1 of the CRN Site. Site preparation resulted in a wide swale and associated flat where W012 has formed; a depression comprising W013; and another swale and associated flat where W014 was identified. These wetlands exhibited signs of inundation, such that hydric soil coloration has developed over gravel substrate. W012 was dominated by a wetland panic grass (*Coleataenia rigidula*). W013 is a cattail pond (*Typha latifolia*). W014 is dominated by soft path rush. All of these wetlands are maintained as emergent habitat, where woody vegetation is repressed by mowing or herbicide use. These wetlands have low resource value due to their historical and current disturbance regime coupled with their small size and lack of influence on downstream waters.

W019 is a relatively large, diverse forested wetland complex associated with an unnamed, perennial tributary near the eastern boundary of the site. Wetland hydrology has been affected by a beaver dam that impounds the southern end of the wetland. Hydrology in northern end of W019 is influenced by groundwater and fed by numerous seeps and springs. The wetland includes diverse habitats that transition from semi-permanently flooded scrub-shrub community in the southern end, to a seasonally flooded forested community in the south-central area, to a saturated forested wetland in the north-central area, and to a saturated emergent and scrub-shrub community maintained at the northern end of a transmission line corridor. Groundwater seeps and braided channels throughout this wetland provide sufficient hydrology for development of hydric soil coloration near the soil surface. Dominant vegetation includes green ash, sycamore, buttonbush, silky dogwood (*Cornus amomum*), black willow, *Aster* sp., blunt broom sedge (*Carex tribuloides*), fox sedge, and Frank’s sedge (*Carex frankii*). Due to its size, intact habitat, interspersion of plant communities, and hydrologic influence, this wetland scored as an exceptional water resource offering high value to the surrounding watershed.

W020a and W020b comprise the northern portion of the W019 wetland, separated by a culverted road within the existing ROW. This area has been more recently disturbed and exhibits less hydrology than its southern counterpart. W020a and W020b are separated by a berm and exhibit similar wetland features. Disturbance was apparent throughout this wetland. Hydrology is supported through seepage and groundwater influence was evident. Soils contained hydric color indicators near the surface. Vegetation was dominated by young forest comprised of sweetgum, red maple, and loblolly pine in the overstory and Nepalese browntop grass in the understory. This wetland offers moderate value and desirable retention and impediment of stormwater, regardless of disturbance history.

W021 is located immediately upstream and adjacent to the same drainage associated with W020 and W019. This wetland flat is seasonally saturated and has developed hydric soil coloration. Young sycamore and sweetgum were dominant and ground cover consisted extensively of Nepalese browntop grass, which are all hydrophytic species. W021 provides low wetland value due to the predominance of invasive species, and lack of hydrologic influence on downstream waters.

W023 and W024 consist of linear drains, where young, forested wetland has developed. Saturated soils with grey and mottled coloration indicate sufficient hydrology for wetland presence. Young box elder trees are dominant in both drains. These wetlands are of low value due to their small size and disturbance history.

W025 and W026 are forested wetlands containing sedge meadow habitats. These wetlands exhibit inundated and saturated soils that are grey and mottled in coloration, indicative of hydric conditions. Forest canopy is a mixture of young and mature trees dominated by American elm, sweetgum, and red maple. These wetlands provide habitat for state-listed plants, including pale green orchid (*Platanthera flava* var. *herbiola*) and rigid sedge (*Carex tetanica*) (see Section 3.8). This wetland offers moderate value and functions at a healthy capacity to retain and impede stormwater and support a diverse interspersed community that includes desirable botanical habitat.

W027a and W027b consist of the same wetland drainage north of Bear Creek Road from W026, and tributary to Grassy Creek. W027a is forested wetland habitat and W027b contains adjacent emergent wetland habitat maintained at low stature within a transmission line easement. W027 exhibited saturated soils with a grey and mottled coloration near the surface, indicative of hydric conditions. W027a was dominated by mature wetland trees, including American elm, sweetgum, and red maple. W027b was dominated by wetland forbs, including soft path rush, giant goldenrod (*Solidago gigantea*), and wetland sedges. This wetland offers moderate value and functions at a healthy capacity to retain and impede stormwater and support native wetland vegetation.

W028, W029, and W030 are wetlands associated with the Grassy Creek embayment at its confluence with the Reservoir along the northern boundary of the site. W028 is an island wetland, dominated by black willow and sycamore, and exhibiting moderate resource value. W029 is an emergent wetland maintained within a transmission line ROW where it meets the shoreline. W030 has formed in a small flat immediately upstream along the same shoreline as W029. Due to their small size and lack of influence on downstream waters, W029 and W030 are considered low value wetlands.

Both W031 and W032 are linear drainage features along Bear Creek Road that drain to W033. These wetland features have developed wetland vegetation, hydric soil, and exhibit indicators of wetland hydrology. W033 is located at the intersection of a valley flat on the east side of Bear Creek Road and drains through a culvert to an embayment of a Reservoir inlet bound by the wetland habitat identified as W034 and W035a. W031, W032, and W033 are considered low value due to small size and disturbance history. W034 is comprised of forested wetland habitat where the road easement transitions from upland to wetland. W035a is maintained as scrub-shrub vegetation beneath an existing ROW. W036b and W036c are part of a Clinch River floodplain wetland complex representing scrub-shrub and forested habitat, respectively. W034 and W036 are considered moderate in value; W035 is considered low value.

The offsite DOE barge landing abuts wetland habitat on either side of the existing road. However, wetlands are not present along the Reservoir shoreline where barge terminal infrastructure is proposed. W035 and W036 are wetlands that exist along the access road to the barge terminal across two separate wetland areas that enter the access easement four times and total 0.18 ac. These wetland areas are entirely scrub-shrub habitat and located within a maintained overhead transmission line ROW where it crosses floodplain wetland habitat of the Reservoir. W035 and W036 are separated by the barge terminal access, located on the south and north side, respectively. These wetlands contain saturated soils, hydric soil coloration, and a dominance of black willow saplings. They provide low to moderate value dependent on disturbance regime and hydrologic influence.

W037 comprises shoreline fringe dominated by cattails along a ponded area associated with the floodplain on the west side of Bear Creek Road. This shoreline is inundated, and soils exhibit hydric coloration. Due to its small size, this wetland scored a low value to the surrounding watershed. Similarly, W038 is located east of Bear Creek Road within a forested wetland flat tributary to the extended floodplain associated with W037. W038 contains inundation, hydric soils, and common wetland trees over an understory dominated by fowl manna grass (*Glyceria striata*), a hydrophyte. W038 is also considered low value.

W039 is located within the existing TN 58 entrance/exit ramp. This wetland is a linear drainage feature that appears associated with runoff from W040 east of TN 58 and drains through a culvert to the inundated floodplain flat associated with W037 west of TN 58. W038 is dominated by young black willow trees with wetland forbs, grasses, and rushes in the understory. Due to its disturbance history, this wetland exhibits low wetland value. W040, which is tributary to W038, represents a more intact form of a valley bottom wetland, although it is bound at its downstream side by the highway. This wetland was dominated by jewelweed (*Impatiens capensis*) and soft path rush under adjacent intact forest canopy and provides moderate wetland value.

W041a and W041b are hydrologically connected via a culvert under Jones Island Road. This wetland complex is associated with the floodplain of Melton Branch and regularly inundated. W041a exhibited a mixture of interspersed forest, shrub, and emergent habitat; whereas W041b exhibited similar forested wetland habitat to that identified in W041a. Dominant vegetation consisted of common wetland species including American elm, sycamore, red maple, silky dogwood, soft path rush, marsh seedbox, and redtop panic grass. W041 is considered a wetland of moderate value.

W042 is an emergent wetland depression that retains stormwater to provide adequate hydrology for wetland development and allow dominate emergent wetland vegetation. W043 is a forested wetland within and extending north outside of the road easement. Drift deposits and drainage patterns indicate sufficient presence of wetland hydrology, and established common wetland trees, including red maple, dominate over a depauperate ground layer. W044 is located in a flat associated with an embayment feeding the Clinch River via a culvert within the road easement. This wetland exhibited an interspersion of forest and scrub-shrub habitat, dominated by similar wetland trees in the overstory and tag alder below. Each of these wetlands is considered moderate value.

3.5.1.2 Reasonably Foreseeable Future Actions in Proximity to the CRN Site

As noted in Section 3.1.3, TVA identified several foreseeable future actions in proximity to the CRN Site. The scope of these other proposed actions may entail the alteration of wetlands within their respective project footprints. However, the specific details regarding the scope of these actions are unknown at this time. Should one or more of these projects result in unavoidable adverse effects to wetlands, they would be subject to permitting requirements pursuant to Section 404 of the Clean Water Act by TDEC and the USACE. As such, all unavoidable adverse effects would be appropriately minimized and mitigated by compensatory measures such that there would be no net loss of wetlands. Furthermore, none of the identified reasonably foreseeable future actions are overlapping geographically with the CRN Project Area nor are considered to have a causal relationship to the proposed development of the CRN Site. As such, no further consideration of reasonably foreseeable future actions and their effects on wetlands are included in TVA's analysis.

3.5.2 Environmental Consequences

Activities in wetlands are regulated by state and federal agencies to ensure long-term maintenance of wetland resources nationwide. The USACE regulates the discharge of dredged or fill material and associated secondary impacts to WOTUS, including wetlands, under the CWA Section 404 [33 USC § 1344]. CWA §401 mandates state water quality certification for projects requiring USACE approval. In Tennessee, an ARAP authorized by the TDEC provides water quality certification under CWA §401. An ARAP is required for any alteration to the physical, chemical, or biological properties of any waters of the state, including wetlands, pursuant to the Tennessee Water Quality Control Act (§69-3-108, 0400-40-07). TDEC's permit process ensures compliance with Tennessee's anti-degradation policy as well (§69-3-108, 0400-40-04). Tennessee's jurisdiction would apply to regulated activities affecting wetlands within the study area, including both isolated and hydrologically connected wetland features tributary to the Reservoir. This regulatory oversight ensures no more than minimal impacts to the aquatic environment and no net loss of wetland resources (EPA 1990). Similarly, EO 11990 – Protection of Wetlands requires federal agencies, such as TVA, to avoid wetland impacts to the extent practicable, minimize wetland destruction, net loss, or degradation, and preserve and enhance natural and beneficial wetland values, while carrying out agency responsibilities.

3.5.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, the proposed project would not proceed. As such, no project-related disturbance to wetlands within the Project Area would occur. The CRN Site and associated offsite areas would continue to be maintained in their current state, in accordance with existing transmission line vegetation management and the Watts Bar RLMP (TVA 2009; 2021k). Wherever vegetation management activities are not conducted, previously disturbed wetland habitat would naturally regenerate and mature. Therefore, no impacts to wetlands would occur in conjunction with Alternative A.

3.5.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced Non-LWRs

Within the Alternative B footprint of Area 1, laydown, and associated offsite areas, proposed impact would affect approximately 14 acres within 45 wetlands (Table 3-16). Approximately 7.8 acres of wetlands would be permanently altered by fill activities. These include the following wetland types or complexes: emergent (0.9 acre), emergent-scrub shrub (0.9 acre), emergent-scrub shrub-forest (0.5 acre), scrub-shrub (0.2 acre), scrub shrub-forest (0.2 acre), and forest (3.9 acres). Approximately 1.2 acres of forested wetland (W018) would be impacted by construction of the laydown area. Effects to wetlands adjacent to construction zones would be minor with the adherence to the requirements of the SWPPP and implementation of proper BMPs. Wetlands permanently impacted by fill activities would wholly or partly lose all wetland function and benefits. TVA would avoid and minimize impact to wetlands and other sensitive resources during the design phase when practicable. Impacts that are not avoidable would be subject to CWA permitting with the USACE and TDEC and associated compensatory mitigation, as appropriate. As such, all unavoidable adverse effects would be appropriately minimized and mitigated by compensatory measures such that there would be no net loss of wetlands. The permit process institutes an evaluation of wetland resources being impacted and imposes compensatory mitigation requirements to offset proposed loss of wetland. TVA would ensure applicable permitting and required mitigation is obtained such that wetland impacts would be compensated through the wetland mitigation process. Mitigation measures would be incorporated into the final design of the project for unavoidable impacts to wetlands, as required through the permitting processes.

Establishing a transmission line corridor requires tree removal and future maintenance of low stature vegetation to accommodate clearance and abate interference with overhead wires. Approximately 0.6 acre of an emergent-forested wetland complex and approximately 6.3 acres of forested wetlands that are present within the transmission line ROW would need to be cleared of tree species that could interfere with the transmission lines; therefore, these wetlands would be converted to emergent wetland habitat and maintained at that stature for the perpetuity of the transmission line ROW. Woody wetland vegetation, in general, have deeper root systems and contain greater biomass (quantity of living matter) per area than do emergent wetlands which do not grow as tall. As a result, forested wetlands tend to provide higher levels of wetland functions, such as sediment retention, carbon storage, and pollutant retention and transformation (detoxification), all of which support better water quality. Consequently, the clearing and conversion of forested wetlands to lower-growing wetlands reduces wetland functions that would otherwise support healthier and improved downstream water quality (Wilder and Roberts 2002; Ainslie et al. 1999; Scott et al. 1990). Although the 6.9 acres of converted emergent wetland habitat would provide the same combination of wetland functions as their previously forested counterpart, it would be at a reduced functional level due to the removal of the woody vegetation. Habitat conversion is considered a secondary impact of transmission line construction. Therefore, and because of the degradation to wetland function, the proposed wooded wetland conversion to emergent wetland habitat is subject to the regulation of the USACE Nashville District and TDEC and their associated mitigation requirements to ensure no net loss of wetland resources across the landscape. TVA would minimize impacts to wetlands and other sensitive resources within a 120-foot ROW within the 280-foot corridor during the design phase to the extent practicable.

Table 3-16. Wetland Impacts on the CRN Site and Associated Offsite Areas

Feature ID	Wetland Type[1]	Impact Type	Onsite Acreage	Impact Area (acres) Alternative B	Alternative C	Alternative D
CRN Site						
W001	PFO	Permanent	6.9	0.1	--	0.1
W002	PEM	Permanent	0.1	0.1	0.1	0.1
W003	PFO	Permanent	1.7	1.7	0.6	1.7
W004	PEM/PSS	Permanent	0.1	0.1	--	0.1
W005	PFO	Permanent	0.2	0.1	0.1	0.1
W006	PFO	Permanent	0.3	0.1	0.1	0.1
W008	PFO	Permanent	0.9	0.1	0.1	0.1
W009	PFO	Permanent	0.2	0.2	0.1	0.2
W010	PFO	Permanent	0.4	0.1	0.1	0.1
W011	PEM/PSS	Permanent	0.5	0.5	--	0.5
W012	PEM	Permanent	0.1	0.1	--	0.1
W013	PEM	Permanent	0.1	0.1	--	0.1
W014	PEM	Permanent	0.2	0.2	--	0.2
W015	PFO	Permanent	0.3	0.0	0.0	0.0
W016	PFO	Permanent	7.9	0.2	--	0.2
W017	PFO	Permanent	0.2	0.2	0.2	0.2
W018	PFO	Permanent	1.2	1.2	1.2	1.2
W020a	PFO	Conversion	2.5	2.5	2.5	2.5
W020b	PFO	Conversion	0.2	0.2	0.2	0.2
W021	PFO	Conversion	0.7	--	0.7	0.7
Associated Offsite Areas						
Barge and Traffic Area						
W031	PEM	Permanent	0.0	0.0	0.0	0.0
W032	PEM	Permanent	0.0	0.0	0.0	0.0
W033	PEM	Permanent	0.1	0.1	0.1	0.1
W034	PFO	Permanent	0.0	0.0	0.0	0.0
W035a	PEM/PSS	Permanent	0.1	0.1	0.1	0.1
W035b	PEM/PSS	Permanent	0.1	0.1	0.1	0.1
W035c	PEM/PSS	Permanent	0.0	0.0	0.0	0.0
W035d	PEM	Permanent	0.0	0.0	0.0	0.0
W036a	PEM/PSS	Permanent	0.1	0.1	0.1	0.1
W036b	PEM/PSS	Permanent	0.0	0.0	0.0	0.0
W036c	PFO	Permanent	0.3	0.3	0.3	0.3
W037	PEM	Permanent	0.1	0.1	0.1	0.1
W038	PFO	Permanent	0.1	0.1	0.1	0.1
W039	PSS	Permanent	0.2	0.2	0.2	0.2
W040	PEM	Permanent	0.1	0.1	0.1	0.1

Feature ID	Wetland Type[1]	Impact Type	Onsite Acreage	Impact Area (acres) Alternative B	Alternative C	Alternative D
TN 95 Access						
W041a	PEM/PSS/PFO	Permanent	0.5	0.5	0.5	0.5
W041b	PFO	Permanent	0.6	0.6	0.6	0.6
W042	PEM	Permanent	0.1	0.1	0.1	0.1
W043	PFO	Permanent	0.1	0.1	0.1	0.1
W044	PSS/PFO	Permanent	0.2	0.2	0.2	0.2
161-kV Offsite Transmission Line						
W022	PFO	Conversion	0.4	0.4	0.4	0.4
W023	PFO	Conversion	0.0	0.0	0.0	0.0
W024	PFO	Conversion	0.1	0.1	0.1	0.1
W025	PFO	Conversion	1.0	1.0	1.0	1.0
W026	PFO	Conversion	1.4	1.4	1.4	1.4
W027a	PEM/PFO	Conversion	0.6	0.6	0.6	0.6
Total Impacts by Wetland Type						
	PEM	Permanent		0.9	0.5	0.9
	PEM/PSS	Permanent		0.9	0.3	0.9
	PEM/PSS/PFO	Permanent		0.5	0.5	0.5
	PEM/PFO	Conversion		0.6	0.6	0.6
	PSS	Permanent		0.2	0.2	0.2
	PSS/PFO	Permanent		0.2	0.2	0.2
	PFO	Permanent		5.1	3.6	5.1
	PFO	Conversion		5.6	6.3	6.3
All Wetland Impacts						
		Permanent		7.8	5.3	7.8
		Conversion		6.2	6.9	6.9

[1] Classification codes as defined in Cowardin et al. 1979: PEM = emergent wetland, PSS = scrub-shrub wetland; PFO= forested.
Source: TVA 2021d

Wetland disturbance impacts to W025 and W026 would also impact the diverse meadow community persisting in the ground layer below the shaded canopy. These wetlands provide habitat for state-listed plant species. Impacts to these species from proposed wetland habitat conversion is addressed in Section 3.8 (Threatened and Endangered Species). Under Alternative B, a buffer has been established around a forested wetland (W019) that is rated with exceptional value; thus, it would not be impacted.

In summary, construction under Alternative B would result in direct and indirect impacts to 14 acres of wetlands in the Project Area. Fill activities would result in loss of wetlands, and partially filled wetlands would result in a loss, reduced quality, and benefit of the impacted wetlands. Temporarily filled wetlands would incur direct impact during construction and indirect impact post-construction until the wetlands are restored to pre-existing function. Forested wetlands converted to emergent wetlands within the proposed transmission line would incur indirect impact by quality reduction. Wetlands W025 and W026 would incur both direct and indirect impact due to the potential for permanent vegetation community alterations and potential degradation. The high-quality wetland, W019, would be avoided and not impacted by the project. Overall wetland impacts would be relatively small and not notable on a regional scale. Additionally, unavoidable impacts to wetlands would be mitigated in accordance with Section 404 of the CWA as required by both USACE and TDEC permitting requirements. Therefore, with restoration processes and mitigation requirements in place that ensure no net loss of wetland function, impacts to wetlands are considered minor.

3.5.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced Non-LWRs

Alternative C would impact approximately 12.2 acres within 39 wetlands located in Area 2, the laydown area, and associated offsite areas, as shown in Table 3-16.

Approximately 5.3 acres of wetlands would be permanently altered by fill activities. These include the following wetland types or complexes: emergent (0.5 acre), emergent-scrub shrub (0.3 acre), emergent-scrub shrub-forest (0.5 acre), scrub-shrub (0.2 acre), scrub shrub-forest (0.2), and forest (3.6 acres). As with Alternative B, approximately 1.2 acres of forested wetland, W018, would be impacted by construction of the laydown area for an unknown period of time and approximately 6.9 acres of forested wetlands will be converted to emergent wetlands within the proposed transmission lines.

Overall impacts to wetlands under Alternative C would be similar as those described for Alternative B but would result in fewer permanent impacts (5.3 acres) because there are less wetlands within Area 2. As such, wetland impacts would be relatively small and not notable on a regional scale. Additionally, unavoidable impacts to wetlands would be mitigated in accordance with Section 404 and 401 of the CWA as required by both USACE and TDEC permitting requirements. Therefore, with restoration processes and mitigation requirements in place that ensure no net loss of wetland function, impacts to wetlands are considered minor.

3.5.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced Non-LWRs

Alternative D would result in direct and indirect impacts to onsite wetlands that are the same as those previously described for Alternative B and Alternative C (14.7 acres within 46 wetlands), as shown in Table 3-16. Fill activities would result in loss of wetlands. A forested wetland within the laydown yard and partially filled wetlands abutting other construction areas would result in a loss of wetlands and reduced quality and benefit. Forested wetlands converted to emergent wetlands within the proposed transmission line would incur indirect impact by quality reduction.

As such, wetland impacts would be relatively small and not notable on a regional scale. Additionally, unavoidable impacts to wetlands would be mitigated in accordance with Section 404 of the CWA as required by both USACE and TDEC permitting requirements. Unavoidable adverse impacts would be subject to compensatory mitigative measures as appropriate. As such, impacts to wetlands are considered minor.

3.5.2.5 Summary of Impacts to Wetlands

As summarized in Table 3-17, TVA has determined that there would likely be direct and indirect impacts to wetlands related to the development of the CRN Site and associated offsite areas. Most impacts expected from construction activities would be minor with adherence to requirements of the SWPPP and implementation of proper BMPs. Direct effects to jurisdictional wetlands resulting in permanent impacts would be minimized through final design and mitigated as required by authorized permits. Forested wetlands within the proposed transmission line ROW may incur a conversion impact by a change of dominant vegetation; however, many wetland functions would still occur. Wetland impacts, permanent or conversion, would be avoided as feasible during final design. Unavoidable wetland impacts would be mitigated to compensate for the loss of wetland function. Therefore, with restoration processes and mitigation requirements in place that ensure no net loss of wetland function, impacts to wetlands are considered minor. Any site-specific impacts that are analyzed in the future that are expected to fall outside of the bounding analysis in this PEIS will be analyzed in subsequent NEPA analysis.

Table 3-17. Summary of Impacts to Wetlands

Alternative	Project Phase	Impact	Severity
Alternatives B, C, D	Construction	Potential permanent impacts to Project Area wetlands. Potential conversion impacts to Project Area wetlands within the proposed transmission line.	Permanent impact from fill activities would occur with each alternative with Alternative B and D resulting in the same amount of permanent impact and Alternative C resulting in slightly less. Temporary and conversion impacts would be the same for each proposed alternative.
		All impacts to wetland resources would be subject to CWA Section 10/404 (USACE) permitting and TDEC ARAP permit requirements. Discharges would comply with NPDES permit limits and other state and federal regulations. Functional loss associated with the conversion of forested wetlands to emergent wetlands.	Impacts associated with the offsite 161-kV transmission line would be minimized through design for all alternatives. Unavoidable impacts to wetlands on site would be minimized during final design and mitigated as required by applicable permits. With restoration processes and mitigation requirements in place that ensure no net loss of wetland function, impacts to wetlands are considered minor.

3.6 Aquatic Ecology

3.6.1 Affected Environment

Aquatic habitats present at the CRN Site and in the vicinity include those streams and ponds located within Area 1 and Area 2 of the CRN Site, the Reservoir and within associated offsite areas. The most recent aquatic ecological field surveys of the study area were conducted between May and June 2021. These efforts were focused on verifying streams documented on the CRN Site from past surveys and aquatic features in new areas added to the project footprint. Hydrologic determinations were made using the Tennessee Division of Water Pollution Control (Version 1.5) field forms by a Tennessee qualified hydrologic professional (Craig Phillips, #1036-TN11).

3.6.1.1 CRN Site and Associated Offsite Areas

The CRN Site and associated offsite areas currently contains 36 waterbodies that include perennial streams, intermittent streams, WWCs (ephemeral streams), and ponds. Notably, the central portion of Area 1 of the CRN Site generally lacks identified streams and their aquatic environments as this area was substantially disturbed by the prior CRBRP project. Four ponds are located within the CRN Site. All of the onsite ponds were created during the CRBRP to serve as stormwater retention ponds. More information on the characteristics of the ponds in the CRN Site can be found in Section 3.3 (Water Resources).

A total of seven perennial streams and six intermittent streams are documented to occur within the current project footprint. Three perennial streams are located within the CRN Site, one perennial stream in the BTA, and three perennial streams in the TN 95 Access. There are four intermittent streams on the CRN Site, one in the BTA, none in the TN 95 Access, and one within the associated 161-kV offsite transmission corridor. A total of 19 ephemeral streams or WWCs (see Section 3.3) are also located within the project footprint, but these features generally lack established aquatic ecological communities due to limited water permanence and are, therefore, not evaluated further in this section. Perennial streams are characterized by a well-defined channel and contain flowing water under normal weather conditions through the year. Perennial streams provide permanent habitat for aquatic organisms. Intermittent streams also have a well-defined channel, but only contain water during certain times in the year and may temporarily provide habitat for aquatic organisms when water is present (TDA 2003).

Additional offsite aquatic habitats associated with the 500-kV line extending beyond the CRN Site to the Bethel Valley Substation include four small streams that may include aquatic biota. These include Ish Creek and three tributaries of the White Oak Creek drainage. Aquatic biota including fish such as the Tennessee dace, a state listed species, has been observed in the vicinity of the Project Area on the ORR and potentially could occur in some streams within aquatic habitats associated with the potential future offsite transmission upgrades within the 500-kV transmission line. TVA would conduct additional surveys to assess these habitats as needed once the project design matures.

A 2015 biological assessment conducted by TVA evaluated four perennial streams and three intermittent streams that possessed habitat likely to contain aquatic biota. Surveys consisted of electrofishing and the use of seines. The only stream on the CRN Site where crayfish were observed was STR07. This stream contained small crayfish that were unable to be identified to species due to size. One fish, a banded sculpin (*Cottus carolinae*), and one unidentified crayfish (a crustacean) were found on the CRN Site in STR11. In the BTA, one stream exhibited aquatic organisms, with only one crayfish, *Cambarus dubius*. Grassy Creek, a stream located within the offsite transmission line corridor but not within the site, was also sampled as a control site. In total, 70 individual fish of nine species were identified in Grassy Creek. The most numerous species were logperch (*Percina caprodes*), largescale stoneroller (*Campostoma oligolepis*), and bluegill (*Lepomis macrochirus*) (Henderson and Phillips 2015).

Management of the areas in and around streams is facilitated through streamside management zones (SMZs). SMZs include the stream itself and additional adjacent areas (i.e., riparian areas). SMZs serve to provide protection to water quality and riparian habitat associated with the stream (TDA 2003). SMZs are developed along the border of perennial streams and intermittent streams that have a well-defined channel and flow occurs 40 to 90 percent of the time. TVA has defined a 50-foot SMZ for all ponds, intermittent streams, and all but two of the perennial streams across the CRN Site and in the BTA. The two perennial streams that do not have a 50-foot SMZ instead have a designated 100-foot SMZ. These are S06 on the east side of the CRN Site and S07 in the southeast corner of the BTA. Within a SMZ, BMPs are used to minimize negative impacts on the associated waterbodies.

3.6.1.2 Clinch River Arm of the Watts Bar Reservoir

The CRN Site is located between approximate CRM 14.5 and 19.0 on the Reservoir. Within the vicinity of the CRN Site, the Reservoir is both influenced by the impoundment by Watts Bar Dam below the CRN Site and by releases from Melton Hill Dam located upstream of the CRN Site (see Section 3.3.1.1.1 Surface Water Hydrology). Aquatic ecological communities in the Reservoir are described in the following sections.

3.6.1.2.1 Fish

Fish sampling within the Reservoir was conducted by TVA in 2011 at two locations downstream of the CRN Site (CRM 14 and 15) and two locations upstream of the TVA Site (CRM 18 and 19.8) in February, May, July, and October. Sampling methods included electrofishing and gillnetting. The survey found an average of 33 species downstream of the site and an average of 36 species upstream.

Common fish species within the reservoir in the vicinity of the CRN Site include bluegill (*Lepomis macrochirus*), Mississippi silverside (*Menidia audens*), gizzard shad (*Dorosoma cepedianum*), spotted sucker (*Minytrema melanops*), white bass (*Morone chrysops*), yellow bass (*Morone mississippiensis*), yellow perch (*Perca flavescens*), green sunfish (*Lepomis cyanellus*), redear sunfish (*Lepomis microlophus*), black redhorse (*Moxostoma duquesnii*), and sauger (*Sander canadensis*).

The fish community in the Reservoir was characterized using reservoir fish assemblage index (RFAI) methodology, which describes the fish community in the reservoir relative to similar reservoirs. TVA characterized the fish community for species richness and composition, trophic composition, abundance, and fish health. Overall, the ecological health rating for the fish community in the Reservoir ranged from Fair to Good. The downstream sampling location (CRM 15.0) was rated Fair across all sampling months (February, May, July, October). The upstream location was rated Fair for all sampling dates except May, which scored a Good ecological health rating. There are several thermally sensitive species documented in the Reservoir. These species include greenside darter (*Etheostoma blennioides*), logperch (*Percina caprodes*), spotted sucker (*Minytrema melanops*), and white sucker (*Catostomus commersoni*).

Sampling of ichthyoplankton in 2011-2012 within the Reservoir found that over the course of the one-year study, a total of 7,814 eggs were collected. Freshwater drum composed 53.6 percent of the total eggs collected, followed by clupeids (i.e., gizzard shad, threadfin shad, skipjack herring) at 23.4 percent of total, and moronids (i.e., white bass, yellow bass) at 14.3 percent of total catch. A total of 3,949 larval fish were collected as a part of this monitoring period. A higher volume of larval fish was captured at the downstream location than the upstream location. Clupeids (i.e., gizzard shad, threadfin shad, skipjack herring) were the dominant taxa and constituted 67.4 percent of total catch (TVA 2012).

The Reservoir provides an important recreational fishery. Species of interest for recreational fishing in the Reservoir include those species that are directly targeted by anglers, but also species that serve as important forage species for those game fish. The Tennessee Wildlife Resources Agency (TWRA) stocks certain species of recreational interest in the reservoir, including largemouth bass, striped bass, and walleye in the Watts Bar Reservoir. Stocking in the Melton Hill Reservoir consisted of the stocking of 500 muskellunge. Notably, as discussed in Section 3.3.1, fish consumption advisories have been issued by TDEC for 2020 near the CRN Site including those on the Reservoir and other adjacent waters for PCBs, mercury, and other constituents (TDEC 2020b). There is no commercial fishing activity in the Reservoir.

3.6.1.2.2 Other Aquatic Biota

Phytoplankton and zooplankton make up the lowest trophic levels within the aquatic ecosystem within the Reservoir and provide an important base of the aquatic trophic food web. Aquatic sampling conducted by TVA in 2011 included plankton community sampling effort at the CRN Site. Phytoplankton consisted of both drifting algae and photosynthesizing organisms. Bluegreen algae (Cyanophytes) comprised 90-99 percent of the samples regardless of location or season, whereas all other phytoplankton types comprised less than two percent of total catch during sampling events. Overall, the zooplankton community in the vicinity of the CRN Site was characterized by both low abundance and low diversity during the sampling period. Much of this is likely due to high turbulence within the sampling reach, limiting zooplankton populations and affecting their distribution. No notable differences in zooplankton communities were evident either spatially or temporally in the vicinity of the CRN Site. Rotifers were the dominant taxonomic group in May and Cladocera dominated during summer peak zooplankton abundance and biomass. This peak in abundance was associated with warmer water temperatures and generally low flow.

Aquatic macrophytes (i.e., aquatic plants) were also assessed by TVA in the vicinity of the CRN Site. However, no macrophytes were observed on either bank at any sampling location

Benthic macroinvertebrates are an important forage base for other aquatic organisms, including fish, and provide important indicators of overall system health. TVA assessed the benthic macroinvertebrate community using the Reservoir Benthic Index (RBI) at two locations, downstream (CRM 15.0) and upstream (CRM 18.8). RBI metrics are used to assess relative benthic community characteristics and is not an absolute measure of diversity or community health but is instead a measure of community metrics relative to similar reservoir-influenced sites within the TVA reservoir system. Overall, the ecological health rating for the benthic macroinvertebrate community was rated Good to Excellent across all sites. The ecological health rating for the downstream location was Good in spring and autumn and Excellent in summer. The ecological health rating for the upstream location was Good in spring and Excellent in summer and autumn.

A mollusk survey conducted by TVA in 2011 found a total of 74 living native mussels from six different species, as noted below:

- Pimpleback (Quadrula pustulosa)
- Fragile papershell (*Leptodea fragilis*)
- Purple wartyback (Cyclonaias *tuberculata*)
- Pink heelsplitter (*Potomilus alatus*)
- Giant floater (*Pyganodon grandis*)
- Elephant ear (*Elliptio crassidens*)

Zebra mussel (*Dreissena polymorpha*), an invasive species, was observed to be growing on native mussels. Overall, the 2011 survey concluded that the quality of the mussel community in the sampled sites was Poor and that the habitat in the Reservoir is generally inadequate for mussels.

3.6.1.2.3 Invasive Species

Invasive species that are present in the Reservoir include clams and mussels, fish, and aquatic plants. Non-native species present are the Asiatic clam (*Corbicula fluminea*), zebra mussel, Eurasian watermilfoil (*Myriophyllum spicatum L.*), hydrilla (*Hydrilla verticillate*), spiny-leaf naiad (*Najas minor*), curly-leaved pondweed (*Potamogeton crispus L.*), common carp (*Cyrpinius carpo*), Mississippi silverside, muskellunge, redbreast sunfish (*Lepomis auritus*), striped bass, yellow perch (*Perca flavescens*), and fathead minnow (*Pimephales promelas*). Some of these species, including striped bass and muskellunge, are stocked for recreational fishing activities.

Two of these species, Asiatic clam and zebra mussel, have already significantly altered the biota of the Reservoir. These species compete with native species for resources including food and habitat. They are also well known to have significant negative impacts regarding biofouling in power plant intakes and industrial water systems.

Details on protected aquatic species at the CRN Site and in the vicinity can be found in Section 3.8 (Threatened and Endangered Species).

3.6.1.3 Reasonably Foreseeable Future Actions in Proximity to the CRN Site

As noted in Section 3.1.3, TVA identified several foreseeable future actions in proximity to the CRN Site. The scope of these other proposed actions may entail the alteration of aquatic resources within their respective project footprints. However, the specific details regarding the scope of these actions are lacking. Furthermore, none of the identified reasonably foreseeable future actions is overlapping geographically with the CRN Project Area nor are considered to have a causal relationship to the proposed development of the CRN Site. As such, no further consideration of reasonably foreseeable future actions and their effects on aquatic ecology are included in TVA's analysis.

3.6.2 Environmental Consequences

3.6.2.1 Alternative A – No Action Alternative

Under Alternative A, a Nuclear Technology Park would not be constructed, operated, or maintained at the CRN Site. Under this alternative, no development of the CRN Site would occur, and the site would continue to be managed under provisions of the Watts Bar RLMP. Therefore, under Alternative A, there are no impacts to aquatic resources resulting from TVA's action.

3.6.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced Non-LWRs

3.6.2.2.1 CRN site and Associated Offsite Areas

3.6.2.2.1.1 Construction

Impacts from construction associated with Alternative B are primarily from direct, physical alteration to aquatic systems on the CRN Site, associated offsite areas, and aquatic habitats within the Reservoir. Such effects include in-filling of streams and ponds, associated alteration of adjacent riparian zones, placement of cofferdams, installation of new or replacement culverts, and localized dredging activities.

Aquatic resource impacts on the CRN Project Area include impacts to seven perennial streams (1,775 linear feet), six intermittent streams (2,655 linear feet) and two ponds (0.9 acre) (see Table 3-9). Impacts to streams would result in direct alteration and loss of aquatic habitat and associated riparian zones. Impacts under Alternative B would include alteration to three perennial streams (STR03, STR07, and STR11) located on the CRN Site, one (STR03) in the BTA, and three (STR13, STR14, STR15) located within the TN 95 Access. Additionally, one intermittent stream would be crossed by the offsite 161-kV transmission line. Aquatic biota were only observed within STR07 (near the proposed CWIS), on the CRN Site in STR11, within STR03 in the BTA, and within Grassy Creek located within the offsite transmission line corridor, and along the access to the BTA. Filling of these streams would result in the direct loss of resident aquatic biota and their associated habitats, and potential changes to hydrology of remaining adjacent stream habitats. The total linear footage of perennial and intermittent streams impacted within the Project Area of Alternative B is 4,430 feet (see Table 3-11). In contrast, the upper portion of Grassy Creek would be subject to some alteration of associated riparian zones but is expected to be spanned and not filled by transmission development activities. Impacts on streams from the construction of the 161-kV transmission line and other potential future transmission upgrades would be minimized through avoidance and the use of BMPs such as hand clearing of sensitive areas, silt fencing, and other erosion control methods.

Construction activities would also entail the installation or replacement of several culverts in association with improvements to roads. These include the replacement of a damaged culvert across the Grassy Creek embayment at the entrance to the CRN Site, and several culverts on River Road and the TN 95 Access/Jones Island Road, and new culverts along the Area 2 access road. Such culvert installations would be localized activities and would not result in substantial losses to aquatic habitats. BMPs would assist in minimizing any impacts related to construction or replacement of culverts.

There are four small, constructed stormwater retention ponds within Area 1 (see Figure 3-9). These ponds are shallow and generally have only intermittent connections to the Reservoir during precipitation events. These ponds provide a small amount of suitable habitat for aquatic communities. Under Alternative B, each of these ponds would require redevelopment for continued used as stormwater retention ponds during construction and operation. Because the ponds would continue in their intended use, the associated impacts of construction on aquatic communities within ponds on the CRN Site would be minor.

To minimize impacts to aquatic resources and habitats from erosion and stormwater runoff during and immediately following construction activities, established BMPs would be implemented. Further, a SWPPP would prescribe methods for collection and control of runoff from construction activities in accordance with state and federal regulations and permit requirements. Spill prevention BMPs would be used to prevent chemical contamination of surface waters during construction activities.

In summary, impacted streams on the CRN Site and associated offsite areas are small and do not support specialized or unique aquatic communities. Additionally, surface water ponds on the CRN Site are constructed and are expected to contain relatively common and unspecialized aquatic communities of relatively low quality. As such impacts to the aquatic communities of these streams and ponds would be minor.

3.6.2.2.1.2 Operation
The only impacts to ponds and streams during normal operation would be related to stormwater runoff at the CRN Site. To minimize stormwater runoff impacts, BMPs would be used. Further, a SWPPP would prescribe methods for collection and control of runoff from any future construction activities related to plant operations, for site disturbance greater than one acre, in accordance with state and federal regulations and permit requirements. Therefore, impacts to the aquatic ecological resources of streams and ponds on the CRN Site would be minor.

3.6.2.2.2 Clinch River Arm of the Watts Bar Reservoir

3.6.2.2.2.1 Construction
Construction activities that are likely to affect aquatic systems within the Reservoir include development of the CWIS, discharge structure, supplemental onsite barge facility, and alteration of nearshore habitats in conjunction with shoreline restoration and stabilization activities.

The Reservoir adjacent to the proposed SMR site (CRM 15.0 - 19.0) supports a fair to good fish assemblage and a poor mussel and snail community (see Section 3.6.1.2). A review of the 2011 mollusk and habitat survey, as well as surveys near the site in 1982 (Jenkinson), 1991 (Ahlstedt), and 1994 (TWRA and TDEC) found that habitat conditions to support mussels and snails is generally inadequate, despite reservoir release improvements to Melton Hill Dam and Watts Bar Dam that began in 1991. Although this reach of the Clinch River historically supported several federally listed aquatic mollusks, a lack of recent records for live endangered species in combination with a poor mussel and snail community indicates that developmental activities in or adjacent this reach of the Reservoir would not affect rare or listed aquatic animal species (See Section 3.8.2).

Construction of the intake and discharge structures, the supplemental onsite barge facility, and the shoreline restoration and stabilization activities have the greatest potential to impact aquatic habitat in the Reservoir. As described in Table 2-5, footprints of the intake, discharge and supplemental onsite barge facility are relatively small in comparison to the availability of similar habitats within the Reservoir. Construction of the intake and barge facilities is likely to impact 1.46 acres of instream benthic habitat in the Reservoir, while shoreline stabilization and the discharge structure are likely to impact 6,300 linear feet of shoreline along the Reservoir (Table 3-11). During construction, aquatic and benthic habitats within the construction zones would be disturbed or lost due to underwater excavation or dredging. However, these areas would be relatively small when compared to the extent of available aquatic habitat present in the Reservoir in the vicinity of the CRN Site. No habitats in the Reservoir are known to be unique or to provide essential habitat supporting rare aquatic species or important species. During construction, fish and other mobile aquatic species are likely to avoid the area, thereby minimizing impacts. Immobile benthic organisms would be directly impacted but would be expected to recolonize areas disturbed by construction.

Temporary and localized increases to turbidity in the immediate vicinity of intake and discharge structures may occur due to construction activities. Sedimentation could cause adverse effects on aquatic organisms adjacent to and downstream from construction activities if allowed to escape the immediate area. Additionally, as described in Section 3.3.2.2.1.1, the burial of diffusers and construction of intake, discharge, and onsite barge landing structures may disturb contaminated sediments in the Reservoir. Such disturbances may also affect aquatic biota. To mitigate and control activities involving the potential disturbance of contaminated sediments in the reservoir, TVA is party to the Watts Bar Interagency Agreement, along with the USACE, DOE, TDEC, and the EPA. Activities related to development of the Nuclear Technology Park which could result in the disturbance, re-suspension, removal, and/or disposal of contaminated sediments in the reservoir would be coordinated with these agencies through the agreement. Deposition would be minimized through the use of BMPs. While construction of intake and discharge structures are likely to have negative impacts on aquatic communities, the magnitude of impact would be minor with the application of Section 404 and 401 permits which would include the use of BMPs and with respect to the small area affected by construction activities as compared to the abundance of similar habitats within the Reservoir.

As a part of the construction of Alternative B, bank restoration and stabilization activities are expected to occur at several locations along the north bank of the Reservoir. In total, bank restoration and stabilization would be conducted at up to 9,050 feet of shoreline (Table 2-5). These measures include using riprap to stabilize and protect shoreline. Riprap would protrude into the river at a maximum of +/- 10 feet and would be installed from 2 feet below normal pool level to the top of the eroding bank. These activities can result in negative impacts to aquatic communities during the construction phase through disturbance to nearshore benthic habitats and increased sedimentation. There are no designated critical habitat areas in this nearshore zone. Additionally, given the abundance of similar available habitats in the reservoir, there is suitable area for mobile aquatic organisms to move from the disturbed area. Rapid recolonization of benthic habitats is also expected to occur within areas disturbed by construction. BMPs would be used to reduce runoff and sedimentation related to the construction of bank stabilization structures.

Throughout the duration of construction activities, BMPs would be used to minimize disturbance to the aquatic ecosystem in the Reservoir. This includes during the construction of intake and discharge structures, construction (i.e., pile driving) of barge facilities, and bank stabilization and culvert activities related to road improvements. Accordingly, construction activities on the CRN Site and in associated offsite areas along the Reservoir would not notably affect aquatic communities and the ecological impacts would be minor to moderate.

3.6.2.2.2.2 Operation

Plant operations on Area 1 would include the uptake of cooling water at the CWIS at CRM 17.9 through the dual-flow traveling screens at a velocity of less than 0.5 feet per second. Specific operational impacts to aquatic organisms related to operation of a CWIS are through entrainment and impingement of aquatic organisms at the intake. The term “entrainment” refers to the uptake of organisms such as eggs and ichthyoplankton in the intake water into the plant, whereas “impingement” refers to the entrapment of aquatic organisms (predominantly juvenile and adult fish) on the outer debris screens of the intake structure. Water intake at the CRN Site would be designed to be fully compliant with the rules in 316(b) of the CWA.

Entrainment typically affects those organisms that are small enough to pass through traveling screens located at the water intake structure. The most commonly entrained organisms include eggs, larval, and juvenile fish. Entrainment can vary drastically based on time of year, plant operation, and other factors. Mortality of entrained organisms is considered 100 percent. Preliminary entrainment studies in 2011-2012 indicated that percent entrainment ranged from 0.1 percent for one reactor with an intake flow of 5 cfs to 7.1 percent for four reactions and an average intake flow of 60 cfs (TVA 2012).

Impingement typically affects fish and shellfish, and the severity is variable and species dependent. Impingement mortality is the result of physical abrasion, asphyxiation, descaling, drowning or other physical harm. As a specific reactor technology has not been selected, the specific intake design and flow has not yet been finalized. Nonetheless, subject to technology selection TVA would design the CWIS such that the intake meets Best Technology Available criteria for both impingement and entrainment and is in compliance with all applicable Section 316(b) requirements. Therefore, impacts on aquatic resources from cooling water use would be minor.

During plant operations, blowdown from the cooling towers would be discharged in the Reservoir through a discharge pipeline and diffuser (Section 3.3.2.2.1.3). Thermal discharge from the plant at the discharge structure located at CRM 15.0 would potentially impact the aquatic organisms in the Reservoir. Low flow in the Reservoir could result in overall poor mixing of water. Thermal models have been described in Section 3.3.2.2.1.3 that show the extent of warming and mixing predicted for a plant located in Area 1 of the CRN Site. Thermal modeling shows that the largest area of high-temperature water could occur during the winter. This high-temperature water area would likely cover about 45 percent of the Reservoir width at CRM 15.0, in the vicinity of the discharge at a depth of about 5 feet. There are several thermally sensitive fish species in the Reservoir including greenside darter (*Etheostoma blennioides*), logperch (*Percina caprodes*), spotted sucker (*Minytrema melanops*), and white sucker (*Catostomus commersoni*). However, modeling indicates that the area of thermal discharge does not encompass the whole river, and there would be room for fish to avoid areas of high temperature to minimize thermal stress. Further, there are no nursery or critical habitat areas for fish located within the area potentially affected by increased temperatures; therefore, impacts of thermal discharge on aquatic ecology in the Reservoir would be minor.

Other impacts related to discharge include the potential chemical discharge and physical impacts from scouring of the river. Chemical discharge includes anti-scaling compounds, corrosion inhibitors, and biocides used to eliminate algal growth. The discharge could also contain minerals, salts, and organic compounds. These chemicals have the potential to have adverse effects on fish, invertebrate, and planktonic communities in the Reservoir. However, TDEC would approve of the use and quantities of chemicals for treatment of uptake water based on their future Biocide/Corrosion Treatment Plan. Biocides would likely be included specifically for the treatment of nuisance zebra mussels. Physical impacts from discharge are related to increased water velocity and unanticipated maintenance (e.g., dredging) at the discharge structure. These impacts could result in increased erosion, suspension, and deposition of sediments in the reservoir. To minimize impacts to aquatic habitats, the diffuser ports that are part of the discharge system would direct effluent upwards into the water column so that no physical alteration or scouring occurs, thereby minimizing impacts to benthic habitats. Therefore, impacts would be minor.

3.6.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced Non-LWRs

3.6.2.3.1 Construction

Stream impacts during construction in the associated offsite areas, such as the BTA and the transmission line ROWs, would be similar to those described for Alternative B. However, no ponds would be impacted under Alternative C. Under Alternative C, impacts to aquatic communities within streams and ponds are similar but slightly less than those described for Alternative B, with a total impact to seven perennial streams (1,412 lineal feet) and five intermittent streams (2,507 linear feet). Slightly reduced impacts would occur under Alternative C in conjunction with lesser impacts to STR07, STR06, and STR06. The total lineal footage of perennial and intermittent streams impacted within the Project Area of Alternative C is 3,919 feet (see Table 3-11). The impacts to streams would be minimized through the use of BMPs as practicable.

Under Alternative C, while the primary construction activities would take place in Area 2, construction along the Reservoir would be similar to those activities described in Alternative B. Specifically, the CWIS, the discharge structure, and the new barge facility would be constructed in the same location as in Alternative B. Bank restoration and stabilization activities are also the same as those described for Alternative B. Consequently, the impacts to aquatic organisms in the Reservoir for Alternative C are similar to impacts listed for Alternative B and would be minor to moderate.

3.6.2.3.2 Operation

The impacts of operation under Alternative C on aquatic ecology in streams and ponds that are not directly impacted by construction would be similar to those described for Alternative B. As remaining onsite streams and their riparian zones would be protected by 50- to 100-feet SMZs, the impacts to aquatic ecology during operational phase would be minor.

Under Alternative C, operation of the CWIS and discharge would be similar to operation under Alternative B. There are no additional operational impacts to the Reservoir outside of those listed under Alternative B. As such, the impacts of operation on the Reservoir would be minor.

3.6.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced Non-LWRs

3.6.2.4.1 Construction

Under Alternative D, the impacts to streams and ponds would reflect the additive of impacts associated with the addition of Area 2 to the effects described for Alternative B. However, because no additional effects to aquatic resources would occur within Area 2, the impacts from Alternative D are the same as those for Alternative B. Unavoidable impacts to aquatic resources would be mitigated in conjunction with stream mitigation commitments as described for Alternative B. Because the effects of the impacts to aquatic ecosystems under Alternative D are relatively small, and because these impacts would be mitigated, the impacts to aquatic ecosystems on the CRN Site and associated offsite areas would be minor.

For Alternative D, the CWIS, the discharge structure, and the new barge facility would be constructed in the same location as in Alternative B and C. Bank restoration and stabilization activities are also the same as those described for Alternative B. Consequently, the impacts on aquatic organisms in the Reservoir for Alternative D are similar to those for Alternative B and would be minor to moderate.

3.6.2.4.2 Operation

The impacts of operation under Alternative D on aquatic ecology in streams and ponds would be the same as those under Alternative B and Alternative C. As streams and their riparian zones would be protected by 50- to 100-feet SMZs, the impacts to aquatic ecology during operational phase would be minor.

Impacts of plant operation on the aquatic resource in the Reservoir under Alternative D are expected to be similar to those impacts under Alternative B and C. The main operation impacts to aquatic organisms include entrainment and impingement of fishes at the CWIS and warm water discharge at the discharge structure. Due to the changes to thermal profile of the river and the potential for entrainment and impingement, impacts to aquatic resources under Alternative D are expected to be moderate.

3.6.2.5 Summary of Impacts to Aquatic Ecology

In summary, potentially impacted streams on the CRN Site and associated offsite areas are small and do not support specialized or unique aquatic communities. Additionally, surface water ponds on the CRN Site were created during the CRBRP to serve as stormwater retention ponds and are expected to contain relatively common and unspecialized aquatic communities of relatively low quality. Impacts to aquatic systems could be mitigated through the use of BMPs during construction and operation.

Throughout the duration of construction activities, BMPs would be used to minimize disturbance to the aquatic ecosystem in the Reservoir. This includes during the construction of intake and discharge structures, construction (i.e., pile driving) of barge facilities, and bank stabilization and culvert activities related to road improvements. Accordingly, construction activities on the CRN Site and in associated offsite areas along the Reservoir would not notably affect aquatic communities and the ecological impacts would be minor to moderate.

A summary of impacts on aquatic ecology can be found in Table 3-18.

Table 3-18. Summary of Impacts to Aquatic Ecology

Alternative	Project Phase	Impact	Severity
Alternatives B, C, D	Construction	Potential loss of jurisdictional stream habitat related to construction.	In terms of impacts to aquatic habitats, impacts of Alternative C are greater than Alternative B and Alternative D.
		Construction of CWIS, discharge structure, and barge facilities within the Reservoir.	Loss of benthic habitat, sedimentation in the direct footprint of construction activities. Benthic habitat loss is expected to be temporary, and recolonization of much of the disturbed area would be expected to occur rapidly following the cessation of construction activities, therefore impacts would be minor.

Alternative	Project Phase	Impact	Severity
		Shoreline stabilization activities related to construction of the TN 95 Access Road would potentially result in the loss of nearshore aquatic habitat.	Shoreline restoration activities would result in the temporary loss of 2,000 feet of nearshore habitat for aquatic organisms in Reservoir. Further, construction activities would likely result in sedimentation in the water column. Impacts of stabilization on aquatic biota would be expected to be moderate. The severity of habitat loss would be mitigated through the use of BMPs. Following the cessation of construction, recolonization of nearshore areas by aquatic organisms would likely occur relatively quickly.
	Operation	Intake of water at the CWIS resulting in entrainment and impingement of aquatic species.	Intake design would be low velocity (less than 0.5 feet per second) to meet 316b standards for low impingement and entrainment. Though some level of impingement and entrainment is expected, impacts to aquatic organisms are expected to be minor.
		Thermal discharge during operation at the water discharge structure.	Thermal modeling shows that the largest area of high-temperature water would occur during the winter. This high-temperature water area would likely cover about 45 percent of the Reservoir width at a depth of about 5 feet. Fish and mobile aquatic organisms would be able to avoid these temporary increases in temperature, therefore impacts would be minor.
		Chemical discharge and physical scouring related to water discharges at the discharge structure.	Chemical inputs and physical scouring would likely have a minor adverse impact aquatic organisms in the Reservoir. Diffuser ports would be used to minimize the severity of physical scouring, reducing sedimentation and other negative impacts on aquatic habitats. Severity of impacts to aquatic organisms would be minor.

3.7 Terrestrial Ecology

3.7.1 Affected Environment

3.7.1.1 Plants

3.7.1.1.1 Plant Communities on the CRN Site and Vicinity

The CRN Site and associated offsite areas are located in the Southern Limestone/Dolomite Valleys and Rolling Hills and Southern Dissected Ridges and Knobs ecoregions, which are subdivisions of the Ridge and Valley. The Ridge and Valley, which occurs between the Blue Ridge Mountains on the east and the Cumberland Plateau on the west, is a relatively low-lying region made up of roughly parallel ridges and valleys that were formed through extreme folding and faulting events in past geologic time (Griffith et al. 1998). Over 95 percent of the CRN Site is found within the Southern Limestone/Dolomite Valleys and Rolling Hills, which is a heterogeneous region, composed predominantly of limestone and cherty dolomite. Landforms are mostly undulating valleys and rounded ridges with many caves and springs. Land cover in this ecoregion varies and includes forest, pasture, intensive agriculture, and areas of commercial, industrial, and residential development. The southern tip of the CRN Site, which comprises less than five percent of the site, is part of the Southern Dissected Ridges and Knobs ecoregion. This region contains more crenulated, broken, or hummocky ridges that support chestnut oak and pine forests in the higher elevations and stands of white oak, mixed mesophytic forest, and tulip poplar on the lower slopes (Griffith et al. 1998).

The CRN Site is situated in a rural area where forest and pasture/hayfields are dominant vegetation types (Figure 3-13). Based on the USGS land cover classification standards and the 2019 National Land Cover Database (NLCD), land cover in the CRN Site vicinity, which includes the CRN Site and the area within a six-mile radius, is categorized and shown in Figure 3-13 and Table 3-19. Forested land (deciduous, evergreen, or mixed forest) accounts for approximately 58 percent of the CRN Site vicinity. Wetlands (emergent herbaceous or woody wetlands) occupy approximately 2 percent of the CRN Site vicinity. Other vegetated undeveloped land (herbaceous or shrub/scrub) totals approximately 2 percent of the CRN Site vicinity. Land classified as cultivated crops and pasture/hay total approximately 21 percent of the CRN Site vicinity. Open water and barren land occupy approximately 3 percent of the CRN Site vicinity. The remaining approximately 14 percent of the CRN Site vicinity is classified as developed (high, medium, or low intensity, or open space).

Using the National Vegetation Classification System (Grossman et al. 1998), vegetation types within the CRN Site were classified as a combination of herbaceous vegetation and deciduous, evergreen, and mixed evergreen-deciduous forest. Based on interpretation of aerial photographs and the findings of past field surveys, TVA created a more refined map of dominant vegetation communities and other land cover types on the Project Area (Figure 3-14). Based on this map, over 75 percent of the CRN Site is covered by forest (including woody wetlands), approximately 22 percent is covered by herbaceous vegetation, and approximately one percent is covered by small ponds and emergent wetlands. The remaining two percent of the CRN Site is classified as roads and developed areas. Table 3-19 shows the percentage of the CRN Site and associated offsite areas covered by each type of vegetation community or land cover and the estimated acreage of each type.

Developed areas on the site have been heavily manipulated and have no appreciable vegetative cover. Previous environmental reviews state that much of the site was undergoing secondary succession due to previous disturbance associated with farming and logging and that plant communities present there were not unique because thousands of acres of comparable habitat occur on adjacent lands within the ORR (NRC 1977; NRC 1982). In addition, 240 forested acres on Area 1 of the CRN Site were cleared and heavily graded in preparation for construction of the prior CRBRP project.

The most recent field surveys of the CRN Site and associated offsite areas were conducted between September 2020 and June 2021. These efforts were focused on documenting plant communities and infestations of invasive plants and searching for possible threatened and endangered plant species on the CRN Site and associated offsite areas. Areas representative of each vegetation type present on the CRN Site were visited during the surveys. Characteristics of the vegetation communities on the CRN Site are described below, including examples of species generally representative of these community types.

Mixed evergreen-deciduous forest is defined as a forest stand where both evergreen and deciduous species contribute from 25 to 75 percent of total canopy cover. This is the most prevalent forest type on the CRN Site and accounts for approximately 41 percent of the vegetation cover on the site (TVA 2015; Table 3-19). It occurs as dry oak-hickory-pine stands along ridgelines and within disturbed tracts at other places on the landscape. The dry oak-hickory-pine forest is dominated by black oak (*Quercus velutina*), chestnut oak (*Q. montana*), northern red oak (*Q. rubra*), southern red oak (*Q. falcata*), and white oak (*Q. alba*). The dominant hickories include mockernut hickory (*Carya tomentosa*), pignut hickory (*C. glabra*), and shagbark hickory (*C. ovata*). Virginia pine (*Pinus virginiana*) is the dominant conifer along with scattered eastern red cedars (*Juniperus virginiana*). Black gum (*Nyssa sylvatica*), American hornbeam (*Carpinus caroliniana*), and sourwood (*Oxydendrum arboreum*) are common understory tress. Common herbaceous species include black snakeroot (*Sanicula odorata*), Christmas fern (*Polystichum acrostichoides*), little brown jug (*Hexastylis arifolia*), ebony spleenwort (*Asplenium platyneuron*), pennywort *(Obolaria virginica)*, running ground cedar (*Diphasiastrum digitatum*), spotted wintergreen (*Chimaphila maculata*), and wood sorrel (*Oxalis corniculata*) in the herb layer (TVA 2015).

Disturbed mixed evergreen-deciduous forest is similar to that found on dry ridgetops, but it generally occurs in more mesic situations. This relative abundance of soil moisture, mixed with historic disturbance, results in stands with a different assemblage of canopy species. Common hardwoods in these disturbed stands include sweetgum, yellow poplar (*Liriodendron tulipifera*), winged elm *(Ulmus alata),* sugarberry (*Celtis laevigata*), red maple, and sugar maple. The evergreen species loblolly pine (*P. taeda*) and white pine (*P. strobus*) are also frequent components of these sites.

Deciduous forest, the second most prevalent forest type, covers about 30 percent of the CRN Site and is characterized by trees with overlapping crowns and a canopy of more than 75 percent deciduous species (TVA 2015; Table 3-19). The deciduous forests on the CRN Site include three subtypes. The most extensive subtype of deciduous forest is mixed mesophytic forest, which has a rich herbaceous layer that includes species like bishop's cap (*Mitella diphylla*), blue cohosh (*Caulophyllum thalictroides*), bloodroot (*Sanguinaria canadensis*), dog-tooth violet (*Erythronium americanum*), doll's eyes (*Actaea pachypoda*), foam-flower (*Tiarella cordifolia*), Jack-in-the-pulpit (*Arisaema triphyllum*), maidenhair fern (*Adiantum pedatum*), Solomon's plume (*Maianthemum racemosum*), and Solomon's seal (*Polygonatum biflorum*). The forest canopy is dominated by yellow poplar with American beech (*Fagus grandifolia*), northern red oak, sugar maple, white oak, and yellow buckeye (*Aesculus flava*). The midstory is also diverse and includes American holly (*Ilex opaca*), Carolina buckthorn (*Rhamnus caroliniana*), flowering dogwood (*Cornus florida*), maple-leaf viburnum (*Viburnum acerifolium*), American cancer-root (*Conopholis americana*), muscadine (*Vitis rotundifolia*), poison ivy (*Toxicodendron radicans*), Virginia creeper (*Parthenocissus quinquefolia*), pawpaw (*Asimina triloba*), American hornbeam, and serviceberry (*Amelanchier* sp.) (TVA 2015, TVA 2021b).

The second subtype of deciduous forest, calcareous forest, occurs on portions of the CRN Site underlain by limestone. Woody plants present in the calcareous forest areas include bladdernut (*Staphylea trifolia*), eastern red cedar, eastern redbud (*Cercis canadensis*) along with the overstory tree species chinquapin oak (*Q. muehlenbergii*), which is characteristic in these limestone derived soils. Common herbaceous species include glade fern (*Diplazium pycnocarpon*), green violet (*Hybanthus concolor*), harbinger of spring (*Erigenia bulbosa*), Jacob's ladder (*Polemonium reptans*), twin-leaf (*Jeffersonia diphylla*), walking fern (*Asplenium rhizophyllum*), wild geranium (*Geranium maculatum*), and woodland phlox (*Phlox divaricata*). Most of the calcareous forest occurs within the Grassy Creek Habitat Protection Area and along a few mesic slopes adjacent to the river (TVA 2015).

The third subtype of deciduous forest present on the CRN Site is wetland forest. Wetland forest was found primarily near the edge of the Reservoir and within riparian areas of tributaries found on the site. These areas are dominated by American sycamore, black willow, buttonbush, silky dogwood, and tag alder (*Alnus serrulata*). In addition, persimmon (*Diospyros virginiana*) is common along the shoreline along with box elder, Chinese privet, false indigo (*Amorpha fruticosa*), multiflora rose (*Rosa multiflora*), and silver maple. Herbaceous species such as netted chain fern (*Woodwardia areolata*), jewelweed (*Impatiens capensis)*, lizard tail (*Saururus cernuus*), rose mallow (*Hibiscus* sp.), water willow (*Justicia americana*), and several species of grasses, rushes, and sedges are also present (TVA 2015).

The deciduous calcareous wetland forest just south of Bear Creek Road within the proposed offsite 161-kV transmission line ROW (see Figure 3-15 in Section 3.8 Threatened and Endangered Species) is fundamentally different from other wetland forests within the Project Area. This is likely because the geology and landscape position of this area differs from other forested wetlands onsite. Grass and sedge diversity is high here and includes fringed sedge (*Carex crinita*), sharpscale sedge (*C. oxylepis*), inflated narrow leaf sedge (*C. grisea*), squarrose sedge (*C. squarrosa*), lurid sedge (*C. lurida*), broom-like sedge (*C. bromoides*), nodding fescue (*Festuca subverticillata*), and slender spikerush (Eleocharis tenuis). Wetland forbs present include turtlehead (*Chelone* sp.), giant goldenrod, sweet flag iris (*Iris virginica*), groundnut (*Apios americana*), ironweed (*Vernonia gigantea*), and others. Notable species in this wetland include the state-listed pale green orchid (*Platanthera flava* var. *herbiola*) and rigid sedge (*Carex tetanica*).

Herbaceous vegetation has greater than 25 percent cover of grasses and forbs and occurs on about 22 percent of the CRN Site (Table 3-19). Approximately 240 acres on Area 1 of the site has been previously cleared and extensively graded for the prior CRBRP project and much of that land was revegetated with non-native species such as sericea lespedeza (*Lespedeza cuneata*) and tall fescue (*Lolium arundinaceum*). These cleared areas are in the process of undergoing succession and support a number of weedy species such as black-eyed Susan (*Rudbeckia hirta*), broom-sedge (*Andropogon virginicus*), tall goldenrod (*Solidago altissima*), poverty dropseed (*Sporobolus vaginiflorus*), Johnson grass (*Sorghum halepense*), Queen Anne's lace (*Daucus carota*), and various other common forbs. Young eastern redcedar is scattered throughout these heavily disturbed areas (TVA 2015; TVA 2021b).

Three areas of herbaceous vegetation resembling cedar glades, or barrens, were observed on the CRN Site and associated offsite areas (see Figure 3-15 in Section 3.8 Threatened and Endangered Species). These areas are characterized by shallow, drought prone soils and scattered eastern redcedar around canopy openings. Glade/barren habitat is notable for the region. These three separate habitat areas are: 1) disturbed glade on approximately 1.8 acres near the center of Area 1 within the existing 161-kV transmission line ROW; 2) approximately 5-acre glade on northeast portion of Area 1 near the proposed intake area; and 3) approximately 3.5-acre glade, known as the Raccoon Creek Barren, adjacent to the proposed offsite TN 95 Access improvements on the ORR near the Reservoir. The glade on Area 1 of the CRN Site that is adjacent to the existing 161-kV transmission line ROW is relatively disturbed compared to the other two areas. The most intact of the three sites is adjacent to the TN 95 Access on the ORR. It has sporadic tree cover with eastern redcedar, chinquapin oak, Shumard oak (*Q. shumardii*), and hophornbeam (*Ostrya virginiana*). No plant species that are considered rare and tracked by the state were observed, but many notable herbaceous species that are characteristic of cedar glades were present. These included grey headed coneflower (*Ratibida pinnata*), aromatic aster (*Symphyotrichum oblongifolium*), prickly pear (*Opuntia* sp.), glade St. Johnswort (*Hypericum dolabriforme*), spreading aster (*Symphyotrichum patens*), smooth aster (*S. laeve*), Indian grass (*Sorghastrum nutans*), Adam's needle (*Yucca filamentosa*), whorled milkweed (*Asclepias verticillata*), green comet milkweed (*A. viridiflora*), rough dropseed (*Sporobolus compositus*), false aloe (*Manfreda virginica*), and numerous others.

An herbaceous community is also maintained within the 500-kV transmission corridor extending to the Bethel Valley substation. The terrestrial habitats within this ROW are not known to include wetlands or occurrences of federally or state-listed species. The vegetation within the ROW is actively maintained by TVA as an herbaceous community with a composition flora and fauna that is similar to that of other transmission lines on the CRN Site.

Several small emergent wetlands occur on the CRN Site and associated offsite areas. See Section 3.4.2.1 (Wetlands) in this Draft PEIS for additional information on the structure and composition of vegetation in the wetlands.

Evergreen forest occurs on the CRN Site as remnants of planted loblolly and white pine plantations, and it comprises approximately three percent of the total land cover of the area.

3.7.1.1.2 Invasive Non-Native Plant Species

Executive Order (EO) 13112 directed TVA and other federal agencies to prevent the introduction of invasive species (both plants and animals), control their populations, restore invaded ecosystems, and take other related actions. EO 13751 amends EO 13112 and directs actions by federal agencies to continue coordinated federal prevention and control efforts related to invasive species. This order incorporates considerations of human and environmental health, climate change, technological innovation, and other emerging priorities into federal efforts to address invasive species.

Some invasive plants have been introduced accidentally, but most were brought to areas of the U.S. as ornamentals or for livestock forage. Because these robust plants arrived without their natural predators (insects and diseases) their populations spread quickly across the landscape displacing native species and degrading ecological communities and ecosystem processes (Miller 2010). According to Morse et al. (2004), invasive non-native species are the second leading threat to imperiled native species.

Large portions of the CRN Site were extensively altered during the CRBRP project, resulting in the introduction and spread of invasive non-native plants. No federal noxious weeds were observed during the most recent field surveys, but many non-native invasive plant species were observed throughout the study area. Common invasive plant species occurring on the CRN Site include autumn olive (*Elaeagnus umbellata*), Chinese privet, Japanese honeysuckle (*Lonicera japonica*), Japanese stilt grass (*Microstegium vimineum*), Johnson grass, mimosa (*Albizia julibrissin*), multiflora rose, Oriental bittersweet (*Celastrus orbiculatus*), sericea lespedeza, kudzu (*Pueraria montana* var. *lobata*), and tree-of-heaven (*Ailanthus altissima*) (TVA 2015; TVA 2021b). All of these species occur widely across the landscape and have the potential to adversely impact the native plant communities because of their potential to spread rapidly and displace native vegetation. All are considered a threat in Tennessee (Tennessee Invasive Plant Council 2021).

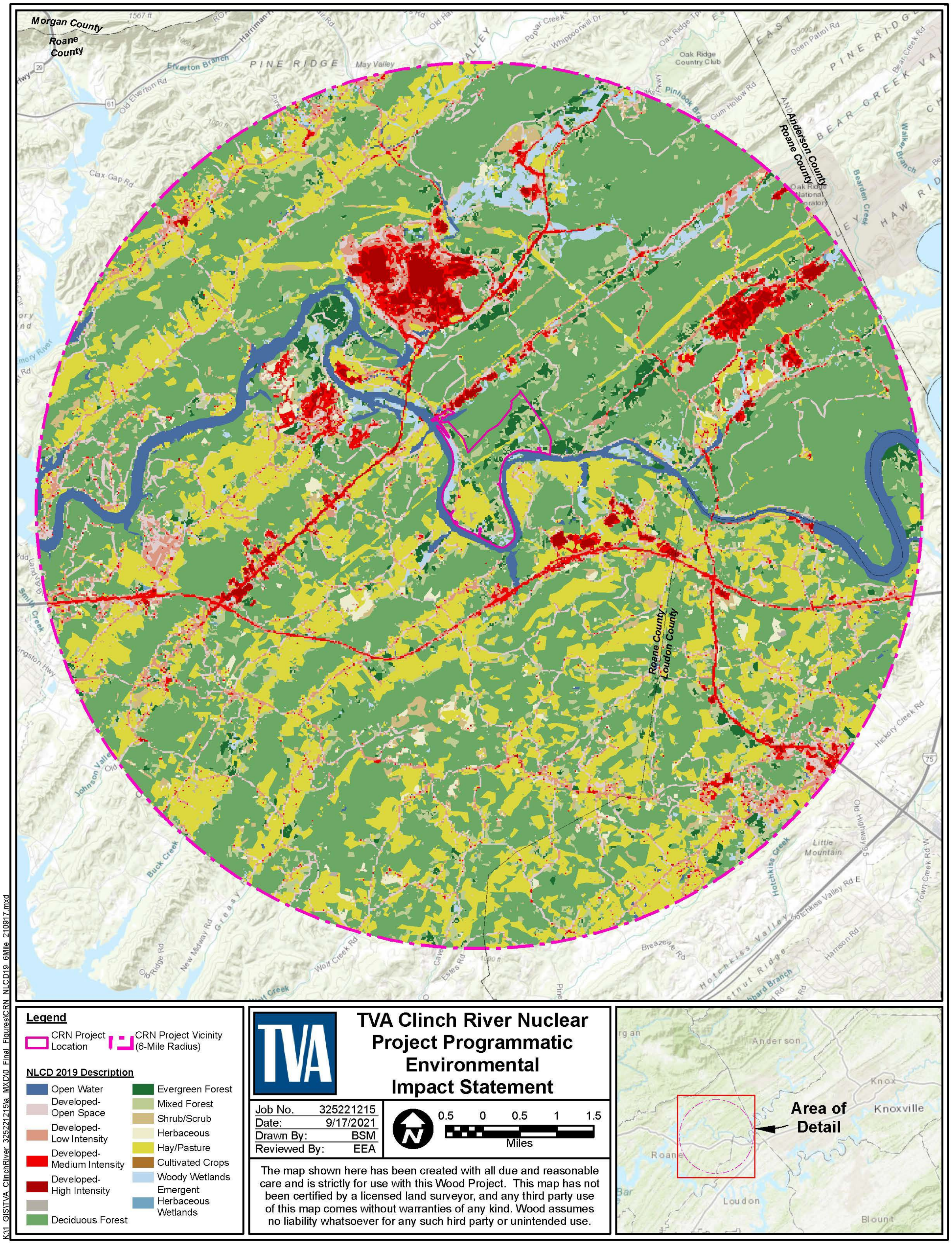


Figure 3-13. Land Cover within the 6-mile Vicinity of the CRN Site

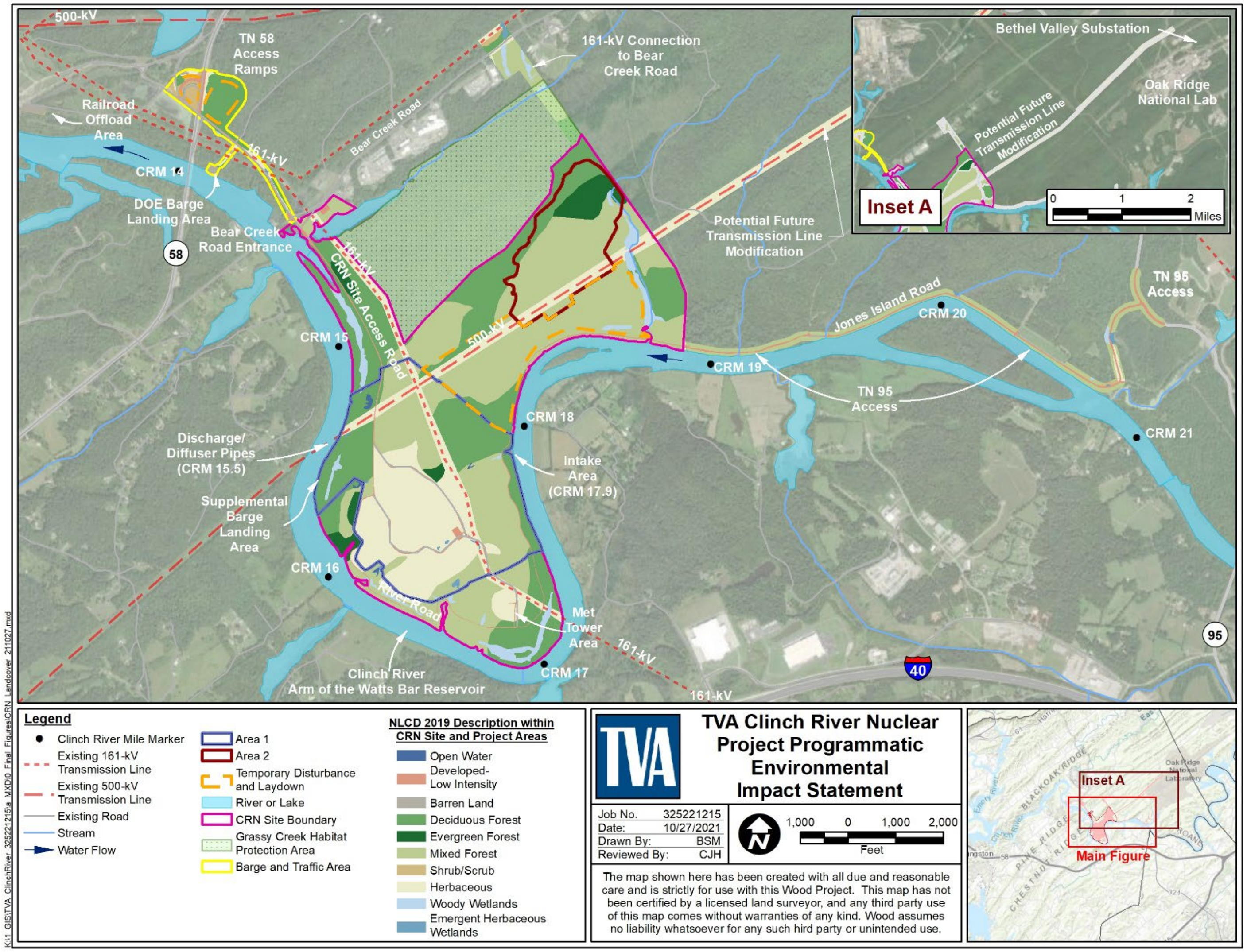


Figure 3-14. USGS Land Cover on the CRN Site and Associated Offsite Areas

Table 3-19. NCLD Land Cover Categories for the CRN Site and Vicinity

	CRN Site[1]		Barge and Traffic Area[1]		TN 95 Access[1]		Offsite 161-kV Transmission Corridor[1]		6-Mile Radius[2]	
NCLD Description	**CRN Site (ac)**	**Percent of Land Cover (%)**	**Barge/ Traffic Area (ac)**	**Percent of Land Cover (%)**	**Jones Island Road (ac)**	**Percent of Land Cover (%)**	**Offsite 161-kV Corridor**	**Percent of Land Cover (%)**	**Vicinity (ac)**	**Percent of Land Cover (%)**
Barren Land	0	0	1.1	3	0	0	0	0	90	<1
Cultivated Crops	0	0	0	0	0	0	0	0	0	0
Deciduous Forest	270.7	29	22.9	52	0	0	5.5	20	36,414	50
Developed, High Intensity	0	0	0	0	9.8	19	0	0	947	1
Developed, Medium Intensity	0	0	0	0	0	0	0	0	1,968	3
Developed, Low Intensity	14.2	2	7.5	17	0	0	0.4	1	3,316	5
Developed, Open Space	0	0	0	0	0	0	0	0	3,923	5
Emergent Herbaceous Wetlands	1.5	<1	0.9	2	0.8	2	0.7	3	43	<1
Evergreen Forest	32.0	3	0	0	0	0	0	0	1,476	2
Herbaceous	201.4	22	5.1	12	1.4	3	2.3	8	907	1
Mixed Forest	383.9	41	0.02	<1	38.2	74	14.8	53	4,086	6
Open Water	1.4	<1	0	0	0	0	0	0	2,159	3
Hay/Pasture	0	0	0	0	0	0	0	0	14,956	21
Shrub/Scrub	0	0	5.8	13	0.5	1	1.2	4	865	1
Woody Wetlands	29.3	3	0.4	1	0.7	1	2.9	10	1,232	2
Total	**934.4**	100	**43.7**	100	**51.4**	100	**27.8**	100	**72,382**	100

[1]Land cover for the CRN Site and associated offsite areas presents a more refined representation of vegetation/land cover types than the NLCD data presented for the 6-mile vicinity. Dominant vegetation communities and other land cover types on the CRN Site and associated offsite areas were drawn in GIS based on aerial photographs and information from TVA field surveys.
[2]Source: NLCD Land Cover (Dewitz 2019)

3.7.1.2 Wildlife

The CRN Site offers a wide array of wildlife habitats that support species common to the region. As described in Section 3.7.1.1, over half of Area 1, approximately 240 acres, has been previously cleared and extensively graded for the CRBRP and is now herbaceous fields with sporadic cedar trees, gravel roads, parking lots, and periodically mowed transmission line ROWs. The northern section of Area 1, as well as Area 2, are mostly forested. In addition, the proposed offsite 161-kV transmission line ROW would be sited across and down a ridge of forest habitat into forested bottomland. The proposed BTA is primarily located along existing roads (paved and gravel) with mowed or forested edges. However, a new section of road would be constructed in the BTA area through forest habitat. In addition, the areas that would be affected by the proposed TN 95 Access improvements consist of forest and mowed areas, as well as a barren known as the Raccoon Creek Barren. Extensive field surveys were performed across the CRN Site in 2011, 2013, and 2021 (TVA 2021c). Additional surveys were performed at the BTA in 2015 and along Jones Island Road in 2021 (TVA 2021c). Over 200 wildlife species have been observed on the CRN Site during these surveys.

Although some of the species observed on the CRN Site prefer specific habitat types, many are generalists and may occur in habitats throughout the site. Regionally abundant mammals that have been observed on the CRN Site include the white-tailed deer (*Odocoileus virginianus*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), eastern gray squirrel (*Sciurus carolinensis*), eastern chipmunk (*Tamias striatus*), eastern cottontail (*Sylvilagus floridanus*), raccoon (*Procyon lotor*), Virginia opossum (*Didelphis virginiana*), and short-tailed shrew (*Blarina brevicauda*).

Breeding birds that have been observed during field surveys include the American crow (*Corvus brachyrhynchos*), blue jay (*Cyanocitta cristata*), Carolina chickadee (*Poecile carolinensis*), Carolina wren (*Thryothorus ludovicianus*), tufted titmouse (*Baeolophus bicolor*), pileated woodpecker (*Dryocopus pileatus*), red-bellied woodpecker (*Melanerpes carolinus*), hairy woodpecker (*Picoides villosus*), wild turkey (*Meleagris gallopavo*), barred owl (*Strix varia*), red shouldered hawk (*Buteo lineatus*), Cooper's hawk (*Accipiter cooperii*), ruby-throated hummingbird (*Archilochus colubris*), yellow-billed cuckoo (*Coccyzus americanus*), red-eyed vireo (*Vireo olivaceus*), yellow-throated vireo (*Vireo flavifrons*), white-eyed vireo (*Vireo griseus*), scarlet tanager (*Piranga olivacea*), chuck-wills-widow (*Caprimulgus carolinensis*), and whip-poor-will (*Caprimulgus vociferus*). Birds observed in riverine habitat and along the riparian zone include the belted kingfisher (*Megaceryle alcyon*), great blue heron (*Ardea herodias*), tree swallow (*Tachycineta bicolor*), osprey (*Pandion haliaetus*), black-crowned night heron (*Nycticorax nycticorax*), bald eagle (*Haliaeetus leucocephalus*), wood duck (*Aix sponsa*), Canada goose (*Branta canadensis*), and double-crested cormorant (*Phalacrocorax auritus*).

Amphibians observed on the CRN Site include the gray treefrog (*Hyla versicolor*), American toad (*Bufo americanus*), green frog (*Rana clamitans*), and eastern narrow-mouthed toad (*Gastrophryne carolinensis*). Reptiles observed include the black rat snake (*Elaphe obsoleta obsoleta*), corn snake (*Elaphe guttata guttata*), and aquatic turtles, including the common snapping turtle (*Chelydra serpentina*), painted turtle (*Chrysemys picta*), river cooter (*Pseudemys concinna*), and Cumberland slider (*Trachemys scripta troostii*).

Three caves and one rock shelter exist on the HPA. One additional cave exists across the Reservoir immediately adjacent to the CRN Site. Review of the TVA Regional Natural Heritage database in July 2021 indicated that 11 additional cave records exist within five miles of the CRN Site. State- and federally listed species associated with these caves are discussed in Section 3.8 (Threatened and Endangered Species). Three wading bird colonies have been reported within 5 miles of the CRN Site, the closest of which is approximately 0.6 miles away. Thirteen osprey nests were observed on or adjacent to the CRN Site in January-May 2021 (TVA 2021c) (see Figure 3-15 in Section 3.8, Threatened and Endangered Species). Eight of these nests are on large transmission structures, four are on small utility poles, and one is on a nesting platform. These nests were active in spring/summer of 2021.

Review of the USFWS's Information for Planning and Consultation (IPaC) website in July 2021 resulted in seven migratory bird species of conservation concern identified as having the potential to occur near the CRN Site (bald eagle, cerulean warbler [*Setophaga cerulea*], prairie warbler [*S. discolor*], red-headed woodpecker [*Melanerpes erythrocephalus*], rusty blackbird [*Euphagus carolinus*], wood thrush [*Hylocichla mustelina*], and yellow-bellied sapsucker [*Sphyrapicus varius*]) (USFWS 2021). Suitable habitat exists for these species in the Project Area. Juvenile bald eagles have been observed flying along the Reservoir near the CRN Site. Prairie warbler, red-headed woodpecker, wood thrush, and yellow-bellied sapsucker have been observed on the CRN Site. While not observed onsite, suitable habitat exists for cerulean warbler within forested habitats and for rusty blackbird within forested wetlands.

3.7.1.3 Reasonably Foreseeable Future Actions in Proximity to the CRN Site

As noted in Section 3.1.3, TVA identified several foreseeable future actions in proximity to the CRN Site. The scope of these other proposed actions may entail the alteration of terrestrial resources within their respective project areas. While the specific details regarding the scope of many of these actions are lacking it is expected that each would entail the alteration of land cover and associated terrestrial habitats. Furthermore, none of the identified reasonably foreseeable future actions is overlapping geographically with the CRN Project Area nor is considered to have a causal relationship to the proposed development of the CRN Site. However, because each of these projects has the potential to alter terrestrial ecosystems, further consideration of reasonably foreseeable future actions and their effects on terrestrial resources are included in the following section as appropriate.

3.7.2 Environmental Consequences

3.7.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, the CRN Site would remain relatively unused, and vegetation and wildlife would be maintained and managed as they have been in recent years in accordance with the Watts Bar RLMP (TVA 2009, 2021k). TVA would continue routine maintenance and clearing associated with the transmission lines that traverse the CRN Site. Limited disturbance related to periodic mowing of developed areas and road margins would continue, but there would be no appreciable change to plant communities found in those areas. Forested areas within the site would continue to change over time, but any shift in forest composition would be related to natural ecological processes and not adoption of Alternative A. In addition, the TWRA permit for use of TVA land for controlled hunting could be continued. Thirteen active osprey nests were documented on or immediately adjacent to the CRN Site during field surveys in spring/summer 2021 (TVA 2021c). If the timing of routine maintenance actions within 660 feet of these nests cannot be modified to avoid nesting seasons, coordination with USDA Wildlife Services would be required for guidance to ensure compliance under the EO 13186 [Responsibilities of

Federal Agencies to Protect Migratory Birds]. With the use of avoidance and mitigation measures near osprey nests no notable impacts would occur to these terrestrial wildlife species. Therefore, there would be no impacts to terrestrial plants and wildlife under the No Action Alternative.

3.7.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced Non-LWRs

3.7.2.2.1 Plants

3.7.2.2.1.1 Construction

In conjunction with Alternative B, TVA would develop the CRN Nuclear Technology Park only at Area 1. Construction activities would start with site preparation work (clearing and grading) on the CRN Site and improvements to the offsite barge facility and haul road in the BTA. Activities such as land clearing, grading, excavation, and filling have the greatest potential to result in substantial effects on ecosystems. Subsequent construction-phase impacts would include installation of components that make up the facility's power block (reactor, turbine, cooling tower, transmission lines, transformers, switchyard, admin/control building, and associated parking).

As depicted in Table 3-20, up to approximately 550 acres of the CRN Site would be affected by construction activities under this alternative, including approximately 469 acres that would be permanently covered by the facility or otherwise developed and approximately 83 acres that would be used temporarily as laydown during construction. In addition to the areas on the CRN Site that would be affected by construction, additional areas that would be affected are located off the CRN Site within the BTA (43.7 acres), the TN 95 Access area (51.4 acres), and offsite transmission line ROW (27.8 acres). Impacts by land cover type within the BTA, TN 95 Access, and offsite transmission areas are provided in Table 3-20.

Adoption of Alternative B would have permanent, minor impacts on the vegetation of the region. However, much of Area 1 has been heavily disturbed by previous work on the CRN Site (NRC 1977; NRC 1982). The most disturbed areas within Area 1 are currently a patchwork of herbaceous vegetation and scattered trees. Because these areas have been previously cleared and graded and are dominated by non-native species, they do not resemble natural plant communities and possess little conservation value. Other portions of Area 1 support forest stands that range from early successional to mature. Some of these forest stands are dominated by planted pines that are not native to the region, while other stands are populated by larger hardwood trees and have many native plants in the herbaceous layer. Thus, forested stands that would be affected on Area 1 are a mix of habitats that range from lower quality sites to more intact, less disturbed plant communities.

The plant communities on the CRN Site and associated offsite areas most affected by construction-related activities under Alternative B would be, in order of decreasing acreage affected, mixed evergreen/deciduous forest, herbaceous (including all three native cedar glade areas), and deciduous forest. Table 3-20 shows the estimated acreage of each type of vegetation community or land use potentially disturbed by development on the CRN Site and associated offsite areas and the approximate percentage of each type that would be disturbed temporarily and permanently.

Construction activities would comply with federal and state regulations, permit requirements, established BMPs, and TVA procedures and guidelines. 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 would prevent any unnecessary damage to the remaining natural vegetation, would protect wetlands and streams, and would prevent soil erosion. 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 3.2, BMPs for erosion control and stormwater management would be employed during 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 terrestrial plant communities that would be permanently disturbed by the construction of facilities on the CRN Site under Alternative B comprise predominantly mixed evergreen-deciduous, deciduous, evergreen forest, and woody wetlands (273.6 acres) and herbaceous (180.6 acres) vegetation (Table 3-20). These acreages are a modest component of the expanse of such communities within the vicinity, as shown in Table 3-19.

Native cedar glade/barrens habitat occurs on about 1.8 acres in the center of Area 1, approximately 5 acres near the northeastern boundary of Area 1, and on approximately 3.5 acres on the offsite DOE ORR near the TN 95 Access within the Raccoon Creek Barren, that would be permanently impacted under Alternative B. These grasslands, particularly the grassland on the proposed offsite TN 95 Access area, are intact native habitats that are notable for the Ridge and Valley ecoregion. TVA would coordinate with DOE as appropriate to minimize and avoid impacts in these native cedar glade areas during design, construction, and operation of a future facility.

Some of the areas disturbed under Alternative B (approximately 83.2 acres or 15 percent of the total onsite disturbed area) would be for temporary use comprising construction-related facilities and material laydown areas (Table 3-20). Temporary use areas would be cleared and graded as appropriate to support construction activities. The areas cleared for temporary uses may be revegetated or otherwise restored after construction completion using native or non-invasive species to avoid the introduction or spread of invasive species.

Terrestrial vegetation communities and other land cover types on the offsite areas, including the BTA, TN 95 Access, and 161-kV transmission corridor, are described in Subsection 3.7.1.1 and in Table 3-19. Approximately 23 acres, 39 acres, and 23 acres of forest land in the BTA, TN 95 Access, and 161-kV transmission line ROW, respectively, would be permanently disturbed and/or converted by the planned improvements. These areas of mixed and deciduous forest are a negligible component of the expanse of these common plant communities within the vicinity of the CRN Site. It should be noted that offsite 161-kV transmission corridor impacts in Table 3-20 are for the entire proposed 280-foot corridor, as the final placement of the 120-foot ROW to be developed within this corridor is not yet known. Acreages of actual land cover impacts within the 120-foot ROW would be notably lower.

Much of Area 1 currently has a substantial component of invasive terrestrial plant species and adoption of Alternative B would not significantly affect the extent or abundance of these species at the county, regional, or state level. Implementation of Alternative B would result in conversion of most of Area 1 from natural vegetation to developed areas and regularly maintained habitats, such as mowed lawn. While developed areas would contain no vegetation and regularly mowed areas would be much less diverse than natural habitats, the conversion would likely result in fewer invasive plant populations on the landscape. All areas disturbed during the construction, operation, and management of the Technology Park in Area 1 would be revegetated with native and/or non-invasive plant species.

Table 3-20. Land Cover Types Potentially Disturbed by Development on the CRN Site and Associated Offsite Areas

Land Cover Types	Alternative B – Approximate Acreage Affected	Approximate Percentage of Affected Areas (%)	Alternative C – Approximate Acreage Affected	Approximate Percentage of Affected Areas (%)	Alternative D – Approximate Acreage Affected	Approximate Percentage of Affected Areas (%)
		CRN Site				
Permanently Disturbed Areas						
Deciduous forest	102.9	19	50.8	15	116.5	19
Developed, low intensity	12.5	2	8.4	3	12.5	2
Emergent herbaceous wetlands	1.0	0	0.1	0	1.0	0
Evergreen forest	8.5	2	20.0	6	22.1	3
Herbaceous	180.6	33	32.6	10	180.6	29
Mixed forest	155.1	28	109.9	33	212.9	34
Open water	1.0	0	0	0	1.0	0
Woody wetlands	7.1	1	5.9	2	7.4	1
Total forest (including woody wetlands)	***273.6***	***50***	***186.6***	***57***	***358.9***	***57***
Subtotal Permanent	***468.6***	***85***	***227.7***	***69***	***553.9***	***88***
Temporarily Disturbed Areas (Laydown)						
Deciduous forest	10.8	2	15.2	5	10.7	2
Herbaceous	0	0	7.8	2	0	0
Mixed forest	71.3	13	77.1	23	67.2	11
Woody wetlands	1.2	0	1.2	0	1.2	0
Total forest (including woody wetlands)	***83.2***	***15***	***93.5***	***28***	***79.0***	***12***
Subtotal Temporary	***83.2***	***15***	***101.2***	***31***	***79.0***	***12***
Subtotal All Affected Areas	**551.8**	**100**	**328.9**	**100**	**633.0**	**100**

Land Cover Types	Alternative B – Approximate Acreage Affected	Approximate Percentage of Affected Areas (%)	Alternative C – Approximate Acreage Affected	Approximate Percentage of Affected Areas (%)	Alternative D – Approximate Acreage Affected	Approximate Percentage of Affected Areas (%)
Associated Offsite Areas						
Offsite Barge and Traffic Area						
Permanently Disturbed Areas						
Barren land	1.1	3	1.1	3	1.1	3
Deciduous forest	22.9	52	22.9	52	22.9	52
Developed, low intensity	7.5	17	7.5	17	7.5	17
Emergent herbaceous wetlands	0.9	2	0.9	2	0.9	2
Herbaceous	5.1	12	5.1	12	5.1	12
Mixed forest	0.02	0	0.02	0	0.02	0
Shrub/scrub	5.8	13	5.8	13	5.8	13
Woody wetlands	0.4	1	0.4	1	0.4	1
Total forest (including woody wetlands	***23.3***	***53***	***23.3***	***53***	***23.3***	***53***
Subtotal	**43.7**	**100**	**43.7**	**100**	**43.7**	**100**
TN 95 Access						
Permanently Disturbed Areas						
Developed, low intensity	9.8	19	9.8	19	9.8	19
Emergent herbaceous wetlands	0.8	1	0.8	1	0.8	1
Herbaceous	1.4	3	1.4	3	1.4	3
Mixed forest	38.2	74	38.2	74	38.2	74
Shrub/scrub	0.5	1	0.5	1	0.5	1
Woody wetlands	0.7	1	0.7	1	0.7	1
Total forest (including woody wetlands)	***38.9***	***76***	***38.9***	***76***	***38.9***	***76***
Subtotal	**51.4**	**100**	**51.4**	**100**	**51.4**	**100**

Land Cover Types	Alternative B – Approximate Acreage Affected	Approximate Percentage of Affected Areas (%)	Alternative C – Approximate Acreage Affected	Approximate Percentage of Affected Areas (%)	Alternative D – Approximate Acreage Affected	Approximate Percentage of Affected Areas (%)
161-kV Offsite Transmission Line						
Permanently Disturbed/Converted Areas						
Deciduous forest	5.5	20	5.5	20	5.5	20
Developed, low intensity	0.4	2	0.4	2	0.4	2
Emergent herbaceous wetlands	0.7	3	0.7	3	0.7	3
Herbaceous	2.3	8	2.3	8	2.3	8
Mixed forest	14.8	53	14.8	53	14.8	53
Shrub/scrub	1.2	4	1.2	4	1.2	4
Woody wetlands	2.9	10	2.9	10	2.9	10
Total forest (including woody wetlands)	***23.2***	***83***	***23.2***	***83***	***23.2***	***83***
Subtotal	**27.8**	**100**	**27.8**	**100**	**27.8**	**100**
Total (All Areas)	**674.7**		**451.8**		**755.9**	

[1]Offsite 161-kV Transmission Corridor land cover impacts noted here are for a 280-foot corridor, as final placement of the 120-foot ROW to be developed within this corridor is not yet known. Acreages of actual land cover impacts for the 120-foot ROW would be notably lower.

3.7.2.2.1.2 Operation
Impacts on vegetation related to operation of the proposed facilities may result from cooling-system operations and routine transmission line ROW maintenance. Operation of the cooling system can result in local deposition of dissolved solids (commonly referred to as salt deposition); increased local fogging, precipitation, or icing. As described in Chapter 2 of this Draft PEIS, the cooling systems at the CRN Site would use mechanical draft cooling towers for heat dissipation. TVA modeled salt drift deposition using the Electric Power Research Institute's SACTI (Seasonal and Annual Cooling Tower Impact) model for the ESPA. Results demonstrated that due to the relatively small size of the cooling towers (in comparison to cooling towers servicing a large power plant), and the temperature and climate of the area, there would be no hours of fogging or icing. Therefore, the potential impacts of fogging or icing on vegetation in the surrounding area would be negligible.

Potential impacts on vegetation from the operation and maintenance of the transmission system include maintenance of vegetation within transmission line ROW consistent with TVA's Transmission System Vegetation Management Final Programmatic EIS (TVA 2019c). Methods such as hand clearing, selective spraying, and conducting field surveys prior to vegetation management are used to protect wetlands and other sensitive biological resources as directed by TVA BMPs (TVA 2019c). Thus, potential impacts on terrestrial resources and native plant communities due to ROW maintenance would be negligible.

3.7.2.2.2 Wildlife

3.7.2.2.2.1 Construction
In conjunction with Alternative B, TVA would develop the CRN Nuclear Technology Park only at Area 1. Actions that would potentially affect wildlife habitats include site preparation within permanent and temporary use areas (Area 1 and laydown areas), development and improvement of barge access infrastructure and roadways, and expansion of transmission systems.

Construction activities would start with site preparation work (clearing and grading) on the CRN Site and improvements to the barge facility and haul road in the BTA. Activities such as land clearing, grading, excavation, and filling have the greatest potential to result in effects on terrestrial habitat. Subsequent construction-phase impacts would include installation of components that make up the facility's power block (reactor, turbine, cooling tower, transmission lines, transformers, switchyard, admin/control building, and associated parking).

Under Alternative B, habitat in Area 1 that could support common wildlife and migratory birds of conservation concern would be removed. These species include bald eagle, prairie warbler, cerulean warbler, wood thrush, yellow-bellied sapsucker, and rusty blackbird. Potential impacts to bald eagles are addressed in Section 3.8, Threatened and Endangered Species. Prairie warblers were present in Area 1 near sparsely growing cedar trees. They were also noted along the existing 500-kV transmission line, near Grassy Creek, and along the Reservoir. Cerulean warbler, wood thrush, and yellow-bellied sapsucker habitat exists in the forested areas in the northern portion of Area 1. Wood thrush and yellow-bellied sapsucker have been found in several forested areas across the CRN Site. Rusty blackbird habitat exists near retention ponds and intermittent streams along the perimeter of Area 1.

Thirteen active osprey nests were documented on or immediately adjacent to the CRN Site during field surveys in spring/summer 2021 (TVA 2021c). All but two are within 660 feet of the Alternative B Project Area. If the timing of proposed actions within 660 feet of these nests cannot be modified to avoid nesting seasons, then coordination with USDA Wildlife Services would be required for guidance to ensure compliance under the EO 13186 [Responsibilities of Federal Agencies to Protect Migratory Birds].

The terrestrial wildlife species identified on the CRN Site and associated offsite areas are characteristic of the region and the habitats described in Sections 3.7.1.1 and 3.7.1.2. Construction activities on the CRN Site and offsite areas would have both short-term and long-term effects on these wildlife species. The removal of upland plant communities would eliminate wildlife habitat permanently in the areas where permanent facilities are constructed and temporarily in the laydown area to be used only during the construction period and later revegetated.

As shown in Table 3-20, within the Alternative B footprint the areas and associated offsite areas to be directly affected by disturbance currently contain some terrestrial forest and herbaceous habitats. None of these habitats are unique in the region, and the permanent loss of approximately 273.6 acres of forest onsite (85.4 acres of forest offsite) and 180.6 acres of herbaceous vegetation onsite (8.8 acres offsite) to the building of facilities under Alternative B would not noticeably reduce the local abundance and diversity of wildlife in the surrounding vicinity. Removal of forest from the Project Area would not affect forest fragmentation any further than it already has been affected by previous work on the CRBRP project. Proposed clearing on the BTA would be small and would not permanently preclude species access and movement to suitable adjacent habitat.

A forested riparian zone would be likely 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. Because similar riparian habitat for wildlife is extensively available along reservoirs and other water bodies in the vicinity (see Figure 3-13), the loss of small segments at the intake and discharge structures would have a minor effect on populations of wildlife that utilize riparian habitats.

During construction, 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, or eggs or nestlings, are likely to be at 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 offsite areas, including the BTA, TN 95 Access, and the 161-kV transmission ROW.

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. Therefore, avian collisions with structures during construction are predicted to have a negligible effect on avian mortality and populations.

Section 3.14 describes noise that can result from construction and operation of a Nuclear Technology Park and factors that influence noise effects, such as frequency, intensity, duration, location, and timing. As discussed in that section, noise is attenuated by natural factors such as vegetation, topography, and temperature, and it quickly decreases over relatively short distances. The majority of the noise 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 decibels (dB) at a distance of 100 feet from the equipment.

Noise can affect wildlife by inducing physiological changes, nest or habitat abandonment, or behavioral modifications, or it may disrupt communications required for breeding or defense. It is also not unusual for wildlife to habituate to noise. Prediction of noise effects on wildlife is limited by the lack of information linking sound levels to effects on individual species. Some wildlife may experience effects similar to those noted for construction noise in Section 3.8.2.2.3.1, and the risk of such effects would be much higher within the site boundary, especially in close proximity to the cooling towers, than beyond. Based on the predicted lack of noise exceeding 80 to 85 dB in habitat areas on adjacent lands, 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 onsite, impacts of noise on wildlife are expected to be minor.

The loss of habitat at the CRN Site and associated offsite areas would result in mortality or temporary displacement of wildlife in those areas; however, these areas 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 minor impact on wildlife populations in the vicinity.

BMPs would be followed to minimize impacts to streams, ponds, and wetlands. In an effort to minimize impacts, when feasible, tree removal across the Project Area would occur in winter when most species of migratory birds would not be nesting and/or would be away from the region. When considering the heavily disturbed nature of a large portion of Area 1, the potential avoidance of breeding/nesting seasons, the avoidance and minimization measures used near active osprey nests, and the amount of similar suitable habitat in areas immediately adjacent to or near the Project Area, impacts of the proposed actions to populations of common wildlife species and populations of migratory birds of conservation concern under Alternative B are expected to be minor.

Construction worker vehicles, delivery trucks, and other traffic needed to build the proposed new facilities on the CRN Site would increase traffic on the local roadway network, particularly Bear Creek Road and the Jones Island Access Road. The additional commuting workforce and truck traffic would likely increase traffic-related wildlife mortalities. Local wildlife populations could suffer declines if roadkill rates were to exceed the rates of reproduction and immigration. However, while roadkill is an obvious source of wildlife mortality and would likely increase during the construction period, traffic mortality rates rarely limit population size (Forman and Alexander 1998). Consequently, overall impact on local wildlife populations from increased vehicular traffic during the construction period is expected to be minor.

3.7.2.2.2.2 Operation

Impacts on terrestrial wildlife and habitats related to operation of the proposed facilities may result from cooling-system operations, routine vegetation management of transmission line ROW, and traffic. Operation of the cooling system can result in local deposition of dissolved solids (commonly referred to as salt deposition); increased local fogging, precipitation, or icing; increased local noise levels; risk of avian mortality caused by collision with tall structures; and shoreline alteration. As described below, these effects would all be minimal and localized.

As discussed in Section 3.7.2.2.1.2, the cooling systems on SMRs to be constructed at Area 1 are expected to use mechanical draft cooling towers for heat dissipation. Modeling for the ESPA predicted that salt drift impacts resulting from the cooling towers would be limited to non-forested early successional habitats and thus would be minor. In addition, due to the relatively small size of these cooling towers (in comparison to cooling towers servicing a 1,000 MW power plant), and the temperature and climate of the area, there would be no hours of fogging or icing (see Section 3.7.2.2.1.2). Therefore, the potential impacts of fogging or icing on wildlife habitats in the surrounding area would be negligible.

The maximum expected sound level produced by the operation of cooling towers, measured at 1,000 feet from the source would be less than 70 dBA. Noise can affect wildlife by inducing physiological changes, nest or habitat abandonment, or behavioral modifications, or it may disrupt communications required for breeding or defense. Some wildlife may experience effects similar to those noted for construction noise described above, and the risk of such effects would be much higher within the site boundary, especially in close proximity to the cooling towers, than beyond. However, because trees and other potential roosting or foraging habitat in proximity to the proposed cooling towers within Area 1 would be substantially removed and the area would be developed, noise impacts on wildlife would be minor. Based on the predicted lack of noise exceeding 70 dBA in habitat areas on lands adjacent to Area 1, the similarity to highway noise levels, the rapid attenuation of noise expected, and the habituation and limited sensitivity of many wildlife species to the noise levels likely to occur in habitat areas, impacts of cooling tower noise on wildlife populations are expected to be minor. Additionally, because mechanical draft colling towers are low in height relative to tall natural draft cooling towers, they pose no appreciable collision risk.

Potential impacts on terrestrial wildlife and habitats from the operation and maintenance of the offsite transmission system upgrades include vegetation maintenance, avian collision mortality and electrocution, and effects from electromagnetic fields. These effects would also be minimal and localized. Routine vegetation management of transmission line ROWs would have periodic effects on habitats within the ROW over the long term. Maintenance methods may vary by location but would be consistent with TVA's Transmission System Vegetation Management Final Programmatic EIS (TVA 2019c), resulting in minor and local impacts to wildlife.

Implementation of BMPs should facilitate avoidance and reduction of impacts to the extent practicable. If necessary, further environmental review would be conducted when more definitive information is available about the locations and areal extent of habitat disturbance in relation to terrestrial resources within the transmission line ROWs. In addition, the CRN Site is not within a major waterbird migratory flyway, and, based on previous experience with existing transmission lines, TVA staff do not expect avian species to collide with transmission lines often enough to effect local populations. Thus, offsite transmission line construction and upgrades near the Reservoir are not expected to result in additional mortality or injury to local avian populations.

Transmission lines generate coupled electric and magnetic fields, referred to together as electromagnetic fields (EMF). The strength of the magnetic field that surrounds the conductor decreases rapidly with distance. Studies have found that magnetic and electric fields from transmission lines do not cause adverse behavioral, health, or reproductive effects in wildlife or other animals (NRC 2013). Thus, EMF effects on terrestrial wildlife from operation of offsite transmission line ROW would be negligible.

Increases in traffic generated by the operation workforce would be less than those experienced during the construction period. As noted in Section 3.12, during operation, traffic would increase on the local roadway network around the CRN Site, particularly Bear Creek Road and the site access road during plant personnel shift changes. The additional workforce traffic would likely increase traffic-related wildlife mortalities, but the overall impact on local wildlife populations from increased vehicular traffic during the operation period would be less than during the construction phase and is expected to be minor.

3.7.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced Non-LWRs

3.7.2.3.1 Plants

Clearing of all or part of the vegetation in Area 2 on the CRN Site would have similar impacts to those of clearing Area 1, described under Alternative B. As summarized in Table 3-20, removal of up to 186.6 acres of forest vegetation on the CRN Site would be moderate, although all the forested habitats onsite are common throughout the region and represent a negligible percentage (0.4 percent) of forest cover in the vicinity. Temporary impacts and impacts to vegetation communities on associated offsite areas would be similar to those described for Alternative B.

Alternative C would not impact the cedar glade areas on Area 1 of the CRN Site, but impacts to the glade on the DOE ORR along the TN 95 Access could occur under this alternative. TVA would work to minimize and avoid impacts in this area during design, construction, and operation of a future facility and would revegetate all disturbed areas with native and non-invasive plant species.

Operational impacts to vegetation under Alternative C would be similar to those described under Alternative B. Overall, there would be moderate impacts to terrestrial vegetation under Alternative C.

3.7.2.3.2 Wildlife

Under Alternative C, a Nuclear Technology Park would be constructed on Area 2 of the CRN Site. Effects of Alternative C on terrestrial wildlife species would be similar to those discussed for Alternative B because wildlife species found in Area 2 are similar to those found in forested areas and open herbaceous areas of Area 1. As shown in Table 3-20, there would be 186.6 acres of forest and 32.6 acres of herbaceous habitats on the CRN Site converted to developed land under Alternative C as compared to 273.6 and 180.6 acres, respectively, under Alternative B. Impacts to habitats in associated offsite areas would be the same as those for Alternative B. Due to implementation of BMPs, including potential avoidance of breeding/nesting seasons, avoidance and minimization measures used near active osprey nests, and the amount of similarly suitable habitat in areas immediately adjacent to or in the vicinity of the Project Area, impacts to populations of common wildlife species and populations of migratory birds of conservation concern under Alternative C are expected to be moderate.

3.7.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced Non-LWRs

3.7.2.4.1 Plants

Clearing of all or part of the vegetation in both Area 1 and Area 2 under Alternative D would have greater impacts than clearing either of the areas alone (Alternatives B or C). The impacts of the permanent removal of up to 358.9 acres of forest on the CRN Site under this alternative would be moderate, although all the forested habitats onsite are common throughout the region and represent a negligible percentage (0.9 percent) of forest cover in the vicinity. Temporary impacts and impacts to vegetation communities on associated offsite areas would be similar to those described for Alternative B.

The cedar glade areas near the northeast boundary of Area 1 and along Jones Island Road on the DOE ORR could be impacted by adoption of Alternative D. These sites, particularly the glade on the ORR, are intact native habitats that are notable for the Ridge and Valley ecoregion. TVA would work to minimize and avoid impacts in these areas during design, construction, and operation of a future facility and would revegetate all disturbed areas with native and noninvasive plant species.

Operational impacts to vegetation under Alternative D would be similar to those described under Alternative B. Overall, there would be moderate impacts to terrestrial vegetation under Alternative D.

3.7.2.4.2 Wildlife

Under Alternative D, impacts would be greater than those under Alternatives B or C because the Nuclear Technology Park would be constructed on a greater area of the CRN Site (Areas 1 and 2). As shown in Table 3-20, there would be 358.9 acres of forest and 29 acres of herbaceous habitats on the CRN Site converted to developed land under Alternative D as compared to 273.6 acres of forest and 180.6 acres of herbaceous habitats under Alternative B and 186.6 acres of forest and 32.6 acres of herbaceous habitats under Alternative C. BMPs, including potential avoidance of breeding/nesting seasons, avoidance and minimization measures used near active osprey nests would be implemented to avoid and minimize impacts to upland plant and animal communities to the extent possible. Due to the amount of similarly suitable habitat in areas immediately adjacent to or in the vicinity of the Project Area and the implementation of BMPs, impacts to populations of common wildlife species and populations of migratory birds of conservation concern under Alternative D are expected to be moderate.

3.7.2.5 Potential Contributing Effects of Other Reasonably Foreseeable Future Actions

As described in Section 3.1.3, several reasonably foreseeable future actions were identified in proximity to the CRN Site. Depending on the local environmental setting and the design characteristics of these other proposed actions, direct alteration of terrestrial ecological resources may occur. Furthermore, each of these projects entails land disturbance activities that have the potential to change land cover, and impact both vegetation and faunal populations. None of the identified actions by others geographically intersect with the same terrestrial resources affected by the proposed project. However, it is expected that many of the proposed projects are located adjacent to existing developed facilities (ORNL, Kairos Hermes project, Oak Ridge airport, Roane Regional Business and Technology Park, TDOT roadway improvements) and are located within predominantly disturbed, developed, or artificially vegetated herbaceous habitats. As such, these actions would likely have minimal cumulative impacts on terrestrial ecological resources in the area.

3.7.2.6 Summary of Impacts to Terrestrial Ecology

The environmental effects to upland plant and animal communities from construction activities on the CRN Site and associated offsite areas would be moderate. However, affected communities in the areas to be developed are generally not high quality or unique habitats and there is an expanse of quality, undeveloped habitats in the vicinity. There is potential for impacts to three native cedar glade habitats, and TVA would work to minimize and avoid impacts in these areas during design, construction, and operation of a future facility.

The potential impacts of operating activities at the CRN Site and the associated cooling system (mechanical draft cooling towers) on terrestrial resources would be minor. The potential impacts of transmission line operation, including those from EMFs and routine ROW maintenance, on habitats are considered minor and would be consistent with TVA's Transmission System Vegetation Management Final Programmatic EIS (TVA 2019c). Impacts from operation of the proposed new facilities on terrestrial resources would be minor.

As summarized in Table 3-21, TVA has determined that impacts to terrestrial ecology related to development of the CRN Site and associated offsite areas are minor to moderate.

Table 3-21. Summary of Impacts to Terrestrial Resources

Alternative	Project Phase	Impact	Severity
Alternative B	Construction	Loss of mostly low-quality forest (approximately 274 acres) and herbaceous (approximately 181 acres) habitats associated with construction on the CRN Site, displacement of common wildlife. Loss of approximately 85 acres of forest and 9 acres of herbaceous habitat associated with construction of facilities in offsite areas. Temporary impacts to approximately 83 acres of forest habitat in laydown area. Impacts to active osprey nests would be avoided with seasonal restrictions. Permanent impacts to three small areas of native cedar glade including approximately 1.8 acres in the center of Area 1, approximately 5 acres near the northeastern boundary of Area 1, and approximately 3.5 acres near the offsite TN 95 Access.	Moderate due to construction phase losses to existing low quality habitats within Project Area and abundance of other similar habitats in surrounding landscape. Moderate impacts to common wildlife populations. BMPs such as winter tree removal would reduce impacts to roosting and nesting wildlife. Other suitable habitat readily available in vicinity for migratory birds of conservation concern. TVA would work to minimize and avoid impacts in the native cedar glade areas during design, construction, and operation of a future facility.
Alternatives B, C, and D	Operation	Operation of the cooling system and towers can result in local deposition of dissolved solids, increased local fogging, precipitation, or icing, noise, and wildlife collisions. Potential impacts on vegetation and wildlife from the operation and maintenance of the transmission system include maintenance of vegetation within transmission ROW and potential EMFs.	Due to the relatively small size of the cooling towers and the temperature and climate of the area, cooling system effects would be minor and localized. In addition, due to vegetation clearing around the proposed facility and a lack of migration corridors in the area, potential noise and collision impacts to wildlife would be minor. Due to use of BMPs for vegetation maintenance in the transmission ROW, effects would be minor and localized.

Alternative	Project Phase	Impact	Severity
Alternative C	Construction	Impacts similar to those of Alternative B. Loss of mostly low-quality forest (approximately 186.6 acres) and herbaceous (approximately 32.6 acres) habitats associated with construction on the CRN Site, displacement of common wildlife species. Loss of habitats in associated offsite areas would be the same as for Alternatives B and D. Temporary impacts to approximately 93.5 acres of forest habitat in laydown area. Impacts to active osprey nests would be avoided with seasonal restrictions. Permanent impacts to one 3.5-acre native cedar glade near the offsite TN 95 Access. No impacts to native glade on Area 1 of the CRN Site.	Moderate due to construction phase losses to existing low quality habitats within Project Area and abundance of other similar habitats in surrounding landscape. Moderate impacts to common wildlife populations. BMPs such as winter tree removal would reduce impacts to roosting and nesting wildlife. TVA would work to minimize and avoid impacts in the native cedar glade area during design, construction, and operation of a future facility.
Alternative D	Construction	Impacts similar to those of Alternatives B and C. Loss of mostly low-quality forest (approximately 358.9 acres) and herbaceous (approximately 180.6 acres) habitats associated with construction on the CRN Site, displacement of common wildlife species. Loss of habitats in associated offsite areas would be the same as for Alternatives B and C. Temporary impacts to approximately 79 acres of forest habitat in laydown area. Impacts to active osprey nests would be avoided with seasonal restrictions. Permanent impacts to three native cedar glade areas would be the same as described for Alternative B.	Moderate due to construction phase losses to existing low quality habitats within Project Area and abundance of other similar habitats in surrounding landscape. Moderate impacts to common wildlife populations. BMPs such as winter tree removal would reduce impacts to roosting and nesting wildlife. TVA would work to minimize and avoid impacts in the native cedar glade areas during design, construction, and operation of a future facility.

3.8 Threatened and Endangered Species

3.8.1 Affected Environment

TVA reviewed the TVA Natural Heritage Database (TVA 2021f) to produce records of state and federally listed or protected aquatic and terrestrial plant and animal species and other sensitive species tracked by the state of Tennessee that have been documented within the ten-digit HUC, within Roane County, and/or within certain radii of the Project Area. According to the database, records of federally and state-listed and tracked species include 19 aquatic animal species (six fish, 11 mussels, and two snails), 22 plants, and 14 terrestrial animals (two amphibians, five birds, and seven mammals). Appendix G includes the complete list and descriptions of these species.

In addition to the review of TVA's Natural Heritage Database, TVA also conducted comprehensive field surveys for aquatic and terrestrial plant and animal species on the CRN Site and associated offsite areas in 2011, 2012, 2013, and 2015 for the ESPA process and in 2021 as part of the Draft PEIS.

3.8.1.1 Aquatic Animals

A review of the TVA Natural Heritage Database (TVA 2021f) indicated records of 19 state and/or federally listed aquatic animal species (six fish, 11 mussels, and two snails) within Roane County and/or within the ten-digit HUC (0601020704) Clinch River watershed of the CRN Site (Table 3-22). No federally designated critical habitat for aquatic species exists within 10 miles of the Project Area. Species descriptions can be found in Appendix G.

Table 3-22. Records of Federally and State-Listed Aquatic Animal Species Known from Roane County and/or within Ten-digit HUC (0601020704) Clinch River Watershed of the CRN Site (Clinch River Miles 14 - 19)[1]

Common Name	Scientific Name	Element Rank[2]	Federal Status[3]	State Status[3]	State Rank[4]
FISHES					
Blue sucker	*Cycleptus elongatus*	E		T	S2
Highfin carpsucker	*Carpiodes velifer*	E		D	S2S3
Snail darter	*Percina tanasi*	E	T	T	S2S3
Spotfin chub	*Erimonax monachus*	E	T	T	S2
Tangerine darter	*Percina aurantiaca*	E		D	S3
Tennessee dace	*Phoxinus tennesseensis*	E		D	S3
MUSSELS					
Alabama lampmussel	*Lampsilis virescens*	H	E	E	S1
Fanshell	*Cyprogenia stegaria*	H	E, XN	E	S1
Fine-rayed pigtoe	*Fusconaia cuneolus*	H	E, XN	E	S1
Orangefoot pimpleback	*Plethobasus cooperianus*	H	E, XN	E	S1
Pink mucket	*Lampsilis abrupta*	E	E	E	S2
Purple bean	*Villosa perpurpurea*	H	E	E	S1
Pyramid pigtoe	*Pleurobema rubrum*	E			S2S3

Common Name	Scientific Name	Element Rank[2]	Federal Status[3]	State Status[3]	State Rank[4]
Ring pink	*Obovaria retusa*	H	E, XN	E	S1
Sheepnose	*Plethobasus cyphyus*	E	E	E	S2S3
Spectaclecase	*Cumberlandia monodonta*	H	E	E	S2S3
Tennessee clubshell	*Pleurobema oviforme*	H			S2S3
SNAILS					
Ornate rocksnail	*Lithasia geniculata*	H			S3
Spiny riversnail	*Io fluvialis*	E			S2

[1] Source: TVA Natural Heritage Database queried on 07/19/2021 (TVA 2021f)
[2] Heritage Element Occurrence Rank; E = extant record ≤25 years old; H = historical record >25 years old
[3] Status Codes: E = Endangered; T = Threatened; E, XN = Experimental, non-essential population; D = Deemed In Need of Management
[4] State Ranks: S1 = Critically Imperiled; S2 = Imperiled; S3 = Vulnerable

Of these aquatic animal species, five are federally listed as endangered, two are federally listed as threatened, and four are listed as endangered, experimental non-essential populations (Table 3-22). Nine of the 19 aquatic species records are considered historical (records >25 years old). Therefore, because these species have not been detected in many decades (including no detection during the 2011 survey) and due to apparent continuation of unsuitable habitat conditions for mollusks, TVA has determined that nine of the mollusk and snail species (Alabama lampmussel, fanshell, fine-rayed pigtoe, orangefoot pimpleback, purple bean, ring pink, spectaclecase, Tennessee clubshell, and ornate rocksnail) either do not occur or occur at extremely low (undetectable) levels near the CRN Site. Therefore, these species will not be addressed further in this analysis.

As discussed in Appendix G, none of the threatened and endangered species listed in Table 3-22 are likely to occur within the Project Area due to unsuitable, impounded habitat conditions present in the Reservoir. In addition, the tangerine darter and the Tennessee dace potentially could occur in some sections of Grassy Creek or streams potentially affected by offsite transmission line upgrades; however, habitat conditions in these streams are likely not suitable and these species were not found in surveys of streams on the CRN Site or the BTA.

3.8.1.2 Plants

A review of the TVA Regional Natural Heritage database (TVA 2021f) and the USFWS IPaC report (USFWS 2021) indicated that no federally listed plants have been previously reported from within 5 miles of the CRN Site, but three federally listed plants have been previously reported within Roane County, Tennessee: American hart's-tongue fern (*Asplenium scolopendrium* var. *americanum*), white fringeless orchid (*Platanthera integrilabia*), and Virginia spiraea (*Spiraea virginiana*) (Table 3-23). These three federally listed plants have not been observed in TVA field surveys of the CRN Site (TVA 2021b), and their preferred habitats were not found to be present. Federally designated critical habitat for plants also does not occur on the CRN Site or associated offsite areas. Therefore, federally listed plant species do not occur on the Project Area.

The TVA Regional Natural Heritage database indicates that 19 species tracked by the state of Tennessee have been reported from within 5 miles of the CRN Site (Crabtree 2016). Of these species, two (spreading false-foxglove [*Aureolaria patula*] and pale green orchid) were observed during 2021 field surveys within the Project Area. One additional state endangered plant that has not been previously observed near the CRN Site (rigid sedge) was also documented during the 2021 field surveys. Spreading false-foxglove was observed within Area 1 of the CRN Site, in steep floodplain forest associated with bluffs along the Reservoir (Figure 3-15). Rigid sedge and pale green orchid were observed in a calcareous wetland within the proposed offsite transmission line ROW just south of Bear Creek Road (Figure 3-15). Species descriptions are included in Appendix G.

Table 3-23. Plant Species of Conservation Concern Previously Reported from within 5 Miles of the CRN Site and Federally Listed Plants Known from Roane County, Tennessee[1]

Common Name	Scientific Name	Federal Status[2]	State Status[2]	State Rank[3]
Earleaf foxglove	*Agalinis auriculata*		E	S2
American hart's-tongue fern[4]	*Asplenium scolopendrium* var. *americanum*	T	E	S1
Spreading false-foxglove[5]	*Aureolaria patula*		S	S3
River bulrush	*Bolboschoenus fluviatilis*		S	S1
Rigid sedge[5]	*Carex tetanica*		E	S1
Tall larkspur	*Delphinium exaltatum*		E	S2
Northern bush-honeysuckle	*Diervilla lonicera*		T	S2
Branching whitlow-wort	*Draba ramosissima*		S	S2
Waterweed	*Elodea nuttallii*		S	S2
Godfrey's thoroughwort	*Eupatorium godfreyanum*		S	S1
Naked-stem sunflower	*Helianthus occidentalis*		S	S2
Butternut	*Juglans cinerea*		T	S3
Short-head rush	*Juncus brachycephalus*		S	SH
Slender blazing-star	*Liatris cylindracea*		T	S2
Loesel's twayblade	*Liparis loeselii*		T	S1
Pale green orchid[5]	*Platanthera flava* var. *herbiola*		T	S2
White fringeless orchid[4]	*Platanthera integrilabia*	T	E	S2S3
Heller's catfoot	*Pseudognaphalium helleri*		S	S2
Prairie goldenrod	*Solidago ptarmicoides*		E	S1S2
Virginia spiraea[4]	*Spiraea virginiana*	T	E	S2
Shining ladies'-tresses	*Spiranthes lucida*		T	S1S2
Ozark bunchflower	*Veratrum woodii*		E	S1

[1] Source: TVA Natural Heritage Database (TVA 2021f) and USFWS IPaC (USFWS 2021), queried July 2021
[2] Status Codes: E = Listed Endangered; S = Listed Special Concern; T = Listed Threatened
[3] State Ranks: S1 = Critically Imperiled; S2 = Imperiled; S3 = Vulnerable; S4 = Apparently Secure; SH = Possibly Extirpated (Historical); S#S# = Denotes a range of ranks because the exact rarity of the element is uncertain (e.g., S1S2)
[4] Federally listed species occurring within the county where work would occur, but not within 5 miles of the Project Area
[5]State-tracked plant species observed during 2021 field surveys of the CRN Site

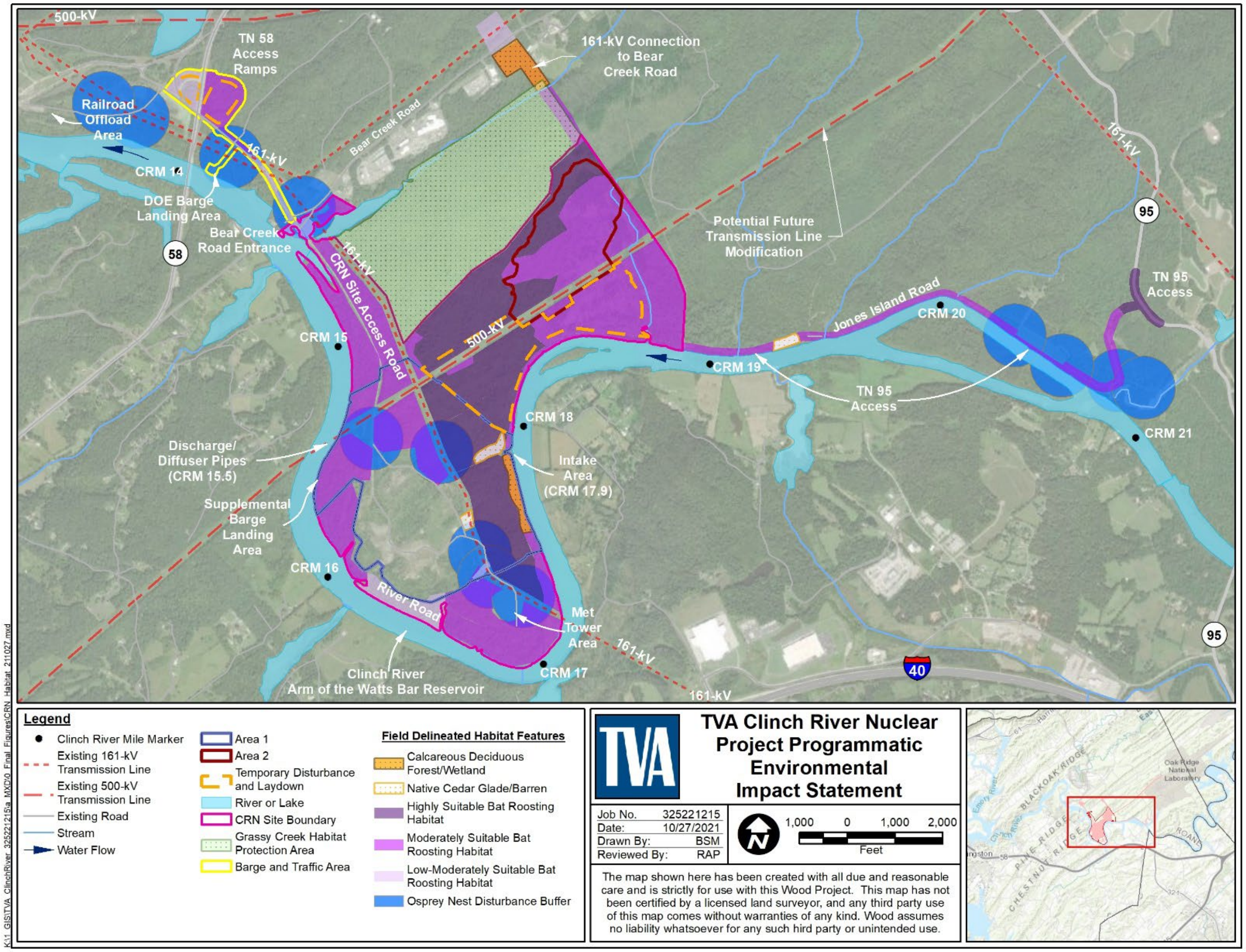


Figure 3-15. Sensitive Habitat Features for Species of Special Concern at the CRN Site and Associated Offsite Areas

3.8.1.3 Wildlife

Review of TVA's Regional Natural Heritage Database for terrestrial wildlife (TVA 2021f) indicated that there are records of 10 state-listed or tracked terrestrial wildlife species and two federally listed species within 5 miles of the CRN Site and associated offsite areas (Table 3-24.). One additional federally protected species (bald eagle) is known from Roane County. The USFWS also has determined that the CRN Site and associated offsite areas are in the range of the federally endangered Indiana bat (USFWS 2021). No records of this species are currently known from Roane County. No federally designated critical habitat exists within 5 miles of the Project Area. Species descriptions are included in Appendix G.

Table 3-24. Federally and State-listed Terrestrial Animal Species Documented Within Roane County, and Within 5 Miles of the CRN Site and Associated Offsite Areas[1]

Common Name	Scientific Name	Federal Status[2]	State Status[2]	State Rank[3]
Amphibians				
Four-toed salamander	*Hemidactylium scutatum*	-	D	S3
Hellbender	*Cryptobranchus alleganiensis*	PS[4]	E	S3
Birds				
Bachman's sparrow	*Aimophila aestivalis*	-	E	S1B
Bald eagle	*Haliaeetus leucocephalus*	DM	D	S3
Cerulean warbler	*Setophaga cerulea*	-	D	S3B
Sharp-shinned hawk	*Accipiter striatus*	PS		S3B,S4N
Swainson's warbler	*Limnothlypis swainsonii*	-	D	S3
Mammals				
Gray bat	*Myotis griscesens*	E	E	S2
Northern long-eared bat	*Myotis septentrionalis*	T	T	S1S2
Indiana bat	*Myotis sodalis*	E	E	S1
Little brown bat	*Myotis lucifugus*	-	T	S3
Meadow jumping mouse	*Zapus hudsonius*	PS	-	S4
Southeastern shrew	*Sorex longirostris*	-	-	S4
Tricolored bat	*Perimyotis subflavus*	-	T	S2S3

[1] Source: TVA Natural Heritage Database (TVA 2021f), queried 07/19/2021, USFWS 2021.
[2] Status abbreviations: D = Deemed in Need of Management; DM = Recovered, delisted, and being monitored, E = Endangered, T = Threatened; PS = Partial Status.
[3] State Rank Definitions: S1 - critically imperiled; S2 - imperiled; S3 - rare or uncommon; S4 - widespread, abundant and apparently secure, but with cause for long-term concern; S#B = Status of Breeding population; S#N = Status of non-breeding population.
[4] Species in this table with Partial Status are federally listed elsewhere in the U.S. but are not federally listed in Roane County, Tennessee.

3.8.1.4 Reasonably Foreseeable Future Actions in Proximity to the CRN Site

As noted in Section 3.1.3, TVA identified several foreseeable future actions in proximity to the CRN Site. The scope of these other proposed actions may entail the alteration of habitats potentially supporting threatened or endangered species within their respective project footprints. However, the specific details regarding the scope of these actions are lacking. None of the identified actions by others geographically intersect with the same terrestrial resources affected by the proposed project. However, it is expected that while many of the proposed projects are located adjacent to existing developed facilities (ORNL, Kairos Hermes project, Oak Ridge airport, Roane Regional Business and Technology Park, TDOT roadway improvements) are located within predominantly disturbed, developed, or artificially vegetated herbaceous habitats, some may contribute to further habitat disturbance. Because each of these actions has the potential to affect forested habitats, further consideration of reasonably foreseeable future actions and their effects on habitat for listed bat species are included in the following section as appropriate.

3.8.2 Environmental Consequences

3.8.2.1 Alternative A – No Action Alternative

Under Alternative A, a Nuclear Technology Park would not be constructed, operated, or maintained at the CRN Site. Under this alternative, no development of the CRN Site would occur, and the site would continue to be managed under provisions of the Watts Bar RLMP. Therefore, under Alternative A, there are no impacts to threatened or endangered species resulting from TVA's action.

3.8.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced Non-LWRs

In conjunction with Alternative B, TVA would develop the CRN Nuclear Technology Park only at Area 1. Actions that would potentially affect threatened and endangered species include site preparation within temporary and permanent use areas (Area 1 and laydown areas), development and improvement of barge access infrastructure and roadways, including bank stabilization, expansion of transmission systems, and construction and operation of structures associated with the cooling system, including intake and discharge structures.

3.8.2.2.1 Aquatic Animals

3.8.2.2.1.1 Construction

Construction phase site preparation would entail general land disturbance and subsequent impacts to aquatic habitats and organisms within waterbodies on and near the CRN Site, including the Reservoir, Grassy Creek, and small unnamed streams and ponds on the CRN Site and associated offsite areas (Figure 3-9). These activities would affect only small instream areas of the reservoir, and TVA would use BMPs to prevent erosion and sediment transport. In addition, these activities would require a Department of the Army permit from the USACE, and TVA would need to conduct activities in accordance with the requirements of the permit.

The Reservoir adjacent the CRN Site (CRM 14.0 - 19.0) supports a fair to good fish assemblage and a poor mussel and snail community. While suitable habitat for state- and federally threatened and endangered fishes may exist within the Reservoir adjacent the CRN Site, high quality spawning habitat is not present, the area of instream impact would be small, and these species would be capable of swimming away from the construction footprint while work is ongoing. Therefore, no direct impacts to these fish species are anticipated.

A review of the 2011 mollusk and habitat survey, as well as the surveys near the site in 1982 (Jenkinson), 1991 (Ahlstedt), and 1994 (TWRA and TDEC) indicated that habitat conditions to support mussels and snails are generally inadequate, despite reservoir release improvements to Melton Hill Dam and Watts Bar Dam that began in 1991. Although this reach of the Clinch River historically supported several federally listed aquatic mollusks, a lack of recent records for live endangered species in combination with a depauperate mussel and snail community indicates that construction activities in or adjacent to this reach of the Clinch River under Alternative B would not affect rare or listed aquatic mussel or snail species. Additionally, no suitable habitats for threatened or endangered mussels and snails occur within the aquatic features (small streams and wetlands; see Figure 3-9) identified within the Project Area associated with the construction of a Nuclear Technology Park.

Ground disturbance would be minimized and appropriate BMPs (TVA 2017) would be followed to reduce sedimentation and other impacts, and all proposed project activities would be conducted in a manner to ensure that waste materials are contained and the introduction of pollution materials to the receiving waters would be minimized. TVA also will follow a SWPPP that sets controls to manage runoff during clearing and construction activities, and TVA would subsequently restore temporarily disturbed areas in accordance with the SWPPP and other associated permits.

For installation of offsite transmission line ROW, TVA would implement BMPs during construction and vegetation removal to minimize erosion and transport of sediments in the streams along the ROW. Therefore, there would be little potential for adverse effects on state-listed species that may inhabit streams along the ROW, such as the Tennessee dace or tangerine darter. Because these fish species are motile, most individuals can be expected to evade disturbance activity. It is assumed that the anticipated transmission line upgrades would not involve any physical disturbance of rivers, streams, ponds, or other aquatic features. Although riparian zone shrubs and trees may be cut for transmission line installation, impacts to aquatic species are not anticipated due to restoration of the riparian zone and lack of in-stream work. Considering also that the upgrade work would be brief and temporary, it is unlikely that aquatic species of conservation concern would be adversely affected by the upgrades.

Therefore, no impacts are expected to aquatic or riparian threatened and endangered species with the implementation of BMPs in accordance with site-specific erosion control plans. Activities would be designed to minimize impacts to the Reservoir and other surface waters and meet the terms and conditions of applicable USACE, NPDES, and TDEC permits.

3.8.2.2.1.2 Operation and Maintenance

Operational activities that could have a potential to affect aquatic species and habitats include the operation of the intake, discharge, and the barge facility, and maintenance of the offsite transmission line ROW. Potential effects from intake operation include water withdrawal and consumption, as well as entrainment and impingement of aquatic biota. Potential effects of the discharge operation on the aquatic habitats in the reservoir include thermal discharges, for cold shock, and physical changes resulting from scouring and chemical discharges. Impacts involved with operating a nuclear power plant are similar to the impacts associated with any large thermoelectric power generation facility, and TVA would be required to obtain all permits and certifications designed to protect aquatic life. In addition, because it is unlikely that threatened and endangered aquatic species are present in the Reservoir in the area of the CRN Site, impacts from cooling water intake and thermal discharge are not anticipated for these species.

Potential impacts on aquatic threatened and endangered species from the operation and maintenance of the transmission system include maintenance of vegetation within transmission line ROW consistent with TVA's Transmission System Vegetation Management Final Programmatic EIS (TVA 2019c). TVA would use BMPs specifically directed toward avoiding or minimizing adverse impacts on streamside management zones (SMZs) and the waterbodies to minimize erosion and transport of sediments in the streams along the transmission line ROW. TVA guidance for environmental protection and BMPs limit the broadcast application of fertilizers and herbicides within the SMZs, including the spraying of herbicides other than those labeled for aquatic use (TVA 2019c).

As discussed in Section 3.8.1.1 and in Appendix G, it is unlikely that threatened and endangered aquatic species are present in the Reservoir in the area of the CRN Site or in the streams and ponds on the site and in associated offsite areas. Because there is a lack of quality habitat for threatened and endangered species in the Project Area and TVA would obtain all required operational permits, operation of the CRN facilities including the water intake and discharge facilities situated on the Reservoir is not expected to affect populations of species of conservation concern. In addition, no impacts to listed aquatic species are expected from maintenance of proposed transmission line ROW because potential stream habitat would be protected by use of the BMPs discussed previously.

3.8.2.2.2 Plants

3.8.2.2.2.1 Construction

Alternative B would have no impact on federally listed plants or designated critical habitat because no suitable habitat for federally protected plant species occurs within the CRN Site or associated offsite areas. However, Alternative B does have the potential to impact two locations that contain known populations of state-listed plants. Development of Area 1 on the CRN Site has the potential to impact a calcareous forest that contains individuals of the state-listed spreading false-foxglove. This species was observed along the eastern edge of Area 1 within a calcareous forest situated between a steep slope and the Reservoir (Figure 3-15). Given the steepness of the adjacent terrain, it is not likely that development would occur at that location and directly impact spreading false-foxglove. If the population was directly impacted, impacts to the species would not be significant because spreading false-foxglove has been observed from at least 70 locations in Tennessee (TVA 2021f) and eliminating a single occurrence would not jeopardize the status of the species in the state.

Rigid sedge and pale green orchid occur just south of Bear Creek Road within an area of calcareous wetland potentially affected by the proposed offsite transmission line interconnection (Figure 3-15). No route has been designed, but a future transmission line alignment could impact one or both species. While the pale green orchid is known from about 20 locations within Tennessee, rigid sedge has only been documented from one other location in the state. Therefore, elimination or substantial degradation of this habitat would substantially impact rigid sedge in Tennessee. TVA would ensure that rigid sedge and pale green orchid are not significantly impacted under Alternative B by designing the proposed offsite transmission line to avoid the species and their habitat to the greatest extent possible. TVA transmission engineers would consult with the TVA botanist during design to ensure the location of the habitat is considered early in the process. TVA would consider additional avoidance measures to ensure impacts are not significant once a final transmission route is determined. With implementation of environmental commitments, adoption of Alternative B is not expected to impact populations of rigid sedge or pale green orchid. Furthermore, TVA is pursuing expansion of the Grassy Creek

HPA by approximately 14 acres to include the area where these species occur to provide additional protection.

3.8.2.2.2.2 Operation

Impacts on rare plants related to operation of the proposed facilities may result from cooling-system operations and routine transmission line vegetation maintenance. Operation of the cooling system can result in local deposition of dissolved solids (commonly referred to as salt deposition); increased local fogging, precipitation, or icing; and shoreline alteration. As described below, these effects would all be minimal and localized.

As discussed in Section 3.7.2.2.1.2, the cooling systems on SMRs to be constructed at Area 1 are expected to use mechanical draft cooling towers for heat dissipation. Modeling for the ESPA predicted that salt drift impacts resulting from the cooling towers would be limited to non-forested early successional habitats and thus would be minor. In addition, due to the relatively small size of these cooling towers (in comparison to cooling towers servicing a 1,000 MW power plant), and the temperature and climate of the area, there would be no hours of fogging or icing (see Section 3.7.2.2.1.2). Therefore, the potential impacts of fogging or icing on potential threatened and endangered species habitats in the surrounding area would be minor.

Potential impacts on threatened and endangered species from the operation and maintenance of the transmission system include maintenance of vegetation within transmission line ROW consistent with TVA's Transmission System Vegetation Management Final Programmatic EIS (TVA 2019c). Methods such as hand clearing, selective spraying, and conducting field surveys prior to vegetation management are used to protect sensitive plant communities as directed by TVA BMPs (TVA 2019c). Thus, potential impacts on native plant communities from routine transmission line ROW maintenance would be negligible.

3.8.2.2.3 Wildlife

3.8.2.2.3.1 Construction

Under Alternative B, approximately 359.0 acres of forest and 189.4 acres of herbaceous habitats would be permanently removed, as compared to 272.0 and 41.4 acres, respectively, under Alternative C and 444.3 and 189.4 acres, respectively, under Alternative D.

Fourteen species were addressed in this review based on records within 5 miles of the CRN Site and associated offsite areas. All of these species either have some potential to occur on portions of the Project Area or their occurrence was documented within the Project Area.

Suitable habitat for four-toed salamanders was identified along potentially affected streams on the CRN Site and the BTA. Field reviews were performed there during winter months when four-toed salamanders would be nesting. However, no four-toed salamander nests were observed. ORNL staff conduct ongoing periodic surveys along Jones Island Road near wet areas. While suitable habitat for this species was identified in these areas as well, no individuals have been documented on the CRN Site or associated offsite areas. Therefore, impacts to four-toed salamanders are expected to be minor.

Hellbenders have historically occurred in the Clinch River, but the most recent records of this species are over 30 years old. Shoreline impacts would occur at the barge terminal and may occur at the junction with Grassy Creek or along the TN 95 Access where road improvements are proposed. Areas of this riverine habitat directly impacted by proposed actions under Alternative B would be discrete, small, and scattered along the Project Area. With the use of BMPs in these areas, impacts to populations of this species are expected to be minor.

Bachman's sparrows, cerulean warblers, and Swainson's warblers were not observed on the Project Area during any of the field surveys that were conducted in 2011, 2013, 2015, and 2021. Additionally, there have been bird point count surveys conducted since 1995 at a survey station along Jones Island Road, and none of these species have been documented at this station. Although there is potentially suitable habitat for these species within the Project Area and there would be adverse impacts to these species if there was vegetation removal where active nests occur, surveys did not result in observations of these species. Therefore, impacts to populations of Bachman's sparrow, cerulean warbler, and Swainson's warbler are expected to be minor.

Sharp-shinned hawk was hawks have been observed on the CRN Site during winter boat surveys along the Reservoir, and they have been documented on the ORR, but they have not been observed onsite during the breeding season. Suitable habitat for this species does occur across the Project Area, and there would be adverse impacts to individuals if there was tree removal where active nests occur. However, due to lack of presence documented during the breeding season, impacts to populations of sharp-shinned hawk are expected to be minor.

No bald eagle nests have been documented within 1 mile of the Project Area. The closest nesting record of this species is approximately 7.8 miles away. Therefore, proposed actions are in compliance with the National Bald Eagle Management Guidelines (USFWS 2007), and impacts to the bald eagle are expected to be minor.

Meadow jumping mice and southeastern shrews have not been observed on the Project Area during any of the field surveys, including during small mammal trapping in 2013 and 2015. Only one record of meadow jumping mouse is known from the ORR, which is 3.4 miles from the CRN Site. In contrast, nine records of southeastern shrew are known within 5 miles of the site, including one historical record only 283 feet away from the proposed TN 95 Access road upgrades. Suitable habitat for both species occurs near water throughout the Project Area. Impacts could occur to individuals if nesting in areas of proposed vegetation removal at the time of proposed actions. However, impacts to jumping meadow mouse are unlikely because of its rarity in the area. The potential for impacts to individuals of the southeastern shrew is more likely, due to their documented presence nearby, though recent records do not exist within areas of potential impact. Because suitable habitat for these species is concentrated near bodies of water, site design would minimize and avoid impacts to streams and wetlands where feasible. Therefore, impacts to suitable habitat would only occur at discrete locations on the Project Area. With these minimization and avoidance measures, impacts to meadow jumping mouse and southeastern shrew are expected to be minor.

Gray bats inhabit caves in the vicinity and forage across the CRN Site and associated offsite areas, as documented in mist nest and acoustic surveys. Gray bats were captured along upland forest roads as well as near lowland wetlands. They were detected at all acoustic survey locations during 2013 and 2015 acoustic surveys and at all but one in 2021. A transitional roosting cave was identified across the Reservoir from the CRN Site in March 2021, approximately 966 feet from the Area 1 boundary. One gray bat was identified using the site at that time as well. A high proportion of the gray bats captured on the CRN Site were pregnant, which indicates presence of nearby maternity caves. While no caves onsite provide suitable summer or winter roosting habitat for gray bats, suitable foraging habitat is present throughout the Project Area. Because detailed project designs have not been selected, specific impacts, if any, to gray bats roosting in the cave across the river cannot yet be determined. Consultation with the USFWS under Section 7 of the ESA would occur when specific designs have been selected and scope of the project has been refined. Additional survey efforts may be needed closer to the time of potential impacts to determine when bats are using this cave and how best to avoid potential impacts.

One northern long-eared bat was captured during a mist net survey on the CRN Site in 2011 and this species was detected during acoustic surveys in 2013 and 2015. Indiana bat was detected acoustically in 2011. Neither of these species was detected acoustically or captured during mist net surveys in 2021. No occupied roost trees have been documented onsite. No suitable winter roosting habitat exists onsite for either species; however, suitable summer roosting habitat and foraging habitat does occur in forested habitat throughout the CRN Site and associated offsite areas. Because detailed project designs have not been selected, a specific estimate of the amount of potentially suitable summer roosting habitat that would be removed under Alternative B cannot yet be determined. Depending on the duration between previous bat surveys and site-specific design selection, additional presence/absence surveys may be required. Where feasible, tree removal would occur in winter (October 15 – March 31) to avoid nesting and roosting wildlife and to minimize impacts. Consultation under Section 7 of the ESA would occur when specific designs have been selected and scope of the project has been refined. By implementing minimization measures such as winter tree removal and any additional conservation measures that may result from the Section 7 consultation, impacts to Indiana bat and northern long-eared bat under Alternative B are expected to be minor.

While not yet federally protected as of August 2021, tricolored bats and little brown bats are being considered for listing under the ESA. Both species were detected acoustically on the CRN Site in 2021 and tricolored bats were captured during mist net surveys in 2011 and 2021. These species have both experienced significant recent declines due to white-nose syndrome. The tricolored bat captured in 2021 was a post-lactating female, indicating there is a maternity site in the vicinity of the CRN Site. Suitable summer roosting habitat for these species also occurs in forested habitat throughout the CRN Site and associated offsite areas. No winter hibernacula for either species occurs within the Project Area and therefore no winter hibernacula would be impacted by proposed actions. By implementing minimization measures such as winter tree removal, protective buffers around caves, and other conservation measures, adverse effects to little brown bat and tricolored bat are not anticipated under Alternative B.

Potential impacts to federally listed tree-roosting bats alongside existing ROWs were addressed in TVA's programmatic consultation with the USFWS on routine actions and federally listed bats in accordance with ESA Section 7(a)(2) and completed in April 2018 (USFWS 2018). For those activities with potential to affect federally listed bats, TVA committed to implementing specific conservation measures. With the use of avoidance, minimization, and conservation measures, there would likely be no adverse effects to threatened and endangered species under this alternative.

3.8.2.2.3.2 Operation

Impacts on threatened and endangered wildlife species related to operation of the proposed facilities may result from routine maintenance of proposed new transmission line ROW, collision with cooling towers, and cooling tower noise. For new onsite and offsite transmission line ROW, any proposed danger tree (i.e., any tree on or off the ROW that could contact electric supply lines) removal would be reviewed to determine if impacts to suitable Indiana bat and northern long-eared bat roosting habitat may occur. As described above under construction impacts, for those activities with potential to affect gray bats, Indiana bats, and northern long-eared bats, TVA has committed to implementing specific conservation measures. These activities and associated conservation measures would be identified on site-specific TVA Bat Strategy Project Screening Forms and would be implemented as part of the site-specific proposed actions. There would be no risk of potential impacts for gray bats from danger tree removal along new transmission line ROW, because they do not roost in trees. With the application of minimization measures such as winter tree removal and other conservation measures and BMPs, substantial impacts to threatened and endangered bats are not anticipated from transmission line ROW maintenance activities under Alternative B.

Other potential operational effects on listed bat species include the potential for collisions with elevated structures and the potential exposure to operational noise from cooling towers. However, the low height (maximum of 65 feet) of the proposed mechanical draft cooling towers makes the risk of bat collisions unlikely. Additionally, because trees and other potential roosting or foraging habitat in proximity to the proposed cooling towers within Area 1 would be substantially removed and the area would be developed, noise impacts on sensitive bat species would be minor.

3.8.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced Non-LWRs

Under Alternative C potential impacts to aquatic animals are the same as those previously described for Alternative B. Alternative C would have no impact on federally listed plants or designated critical habitat because no suitable habitat for federally protected plant species occurs within the CRN Site or associated offsite areas. In contrast to Alternative B, Alternative C would not impact spreading false-foxglove, but, similar to Alternative B, could potentially impact rigid sedge and pale green orchid. With implementation of the environmental commitment described under Alternative B, adoption of Alternative C is not expected to impact populations of rigid sedge or pale green orchid.

Effects of Alternative C on threatened and endangered terrestrial animal species would be generally similar to those discussed under Alternative B. However, as shown in Table 3-20 in Section 3.7, up to approximately 272.0 acres of forest and 41.4 acres of herbaceous vegetation that may offer some suitable summer roosting and/or foraging habitat to state and federally listed bats would be removed, as compared to 359.0 acres and 189.4 acres, respectively, under Alternative B and 444.3 and 189.4 acres, respectively, under Alternative D. As such, the effects of potential habitat alteration on listed bat species are incrementally less than those previously described for Alternative B. In addition, proposed actions at Area 2 would occur approximately 0.38 miles from a transitional roosting cave used by federally listed gray bats. Depending on the duration between previous bat surveys and site-specific design selection, additional presence/absence surveys may be required prior to construction activities. When feasible, tree removal would occur in winter (October 15 – March 31) to minimize impacts to tree-roosting bats. Consultation under Section 7 of the ESA would occur when specific designs have been selected and scope of the project has been refined. By implementing minimization measures such as winter tree removal and any additional conservation measures that may result from the Section 7 consultation, substantial impacts to state and federally listed bats are not anticipated. Therefore, in consideration of minimization measures and any additional conservation measures, potential impacts to listed bat species are generally similar to those previously described for Alternative B and minor.

3.8.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced Non-LWRs

Under Alternative D potential impacts to threatened and endangered animals and sensitive plants are the same as those previously described for Alternative B.

Effects of Alternative D on threatened and endangered terrestrial animal species would be generally similar to those discussed under Alternative B. However, because Alternative D would result in impacts to approximately 444.3 acres of forest and 189.4 acres of herbaceous vegetation that may offer some suitable summer roosting and/or foraging habitat to state and federally listed bats, the potential effects of potential habitat alteration on listed bat species is incrementally greater than that previously described for Alternative B. In addition, proposed actions at Area 2 previously described under Alternative C would occur approximately 0.38 miles from a transitional roosting cave used by federally listed gray bats. Depending on the duration between previous bat surveys and site-specific design selection, additional presence/absence surveys may be required prior to construction activities. Where feasible, tree removal would occur in winter (October 15-March 31) to minimize impacts to roosting bats. Consultation under Section 7 of the ESA would occur when specific designs have been selected and scope of the project has been refined. By implementing minimization measures such as winter tree removal and any additional conservation measures that may result from the Section 7 consultation, substantial impacts to state and federally listed bats are not anticipated. Therefore, in consideration of minimization measures and any additional conservation measures, potential impacts to listed bat species are incrementally greater than to those previously described for Alternative B and minor.

3.8.2.5 Potential Contributing Effects of Other Reasonably Foreseeable Future Actions

As described in Section 3.8.1.4, several reasonably foreseeable future actions were identified in proximity to the CRN Site. Depending on the local environmental setting and the design characteristics of these other proposed actions, direct alteration of aquatic and terrestrial resources may occur. Furthermore, each of these projects entails land disturbance activities that have the potential to contribute to habitat loss due to land clearing. None of the identified actions by others geographically intersect with the same habitat affected by the proposed project. However, these other projects have the potential to increase demands on water and land use during both construction and operational phases. Example projects include continued development in the Roane Regional Business and Technology Park and the Heritage Center Industrial Site, the Kairos Hermes reactor project, proposed actions at ORNL, development of the Horizon Center, and the development of the municipal airport near the ETTP. Project activities at the CRN Site would be within the bounds of impacts analyzed in TVA's Bat Strategy Programmatic Section 7 ESA consultation. With the implementation of identified conservation measures and BMPs and the abundance of available habitat surrounding the project area, the proposed actions are not expected to significantly impact listed bat species. Other reasonably foreseeable future actions may also have the potential to result in the removal of forested lands that may contain suitable bat foraging habitat or potentially suitable bat roost trees. Because many of the identified foreseeable future projects are also expected to be federally funded, each of these projects would have similar requirements for avoidance and minimization of potential impacts to federally listed bat species. As such, these actions would likely have minimal cumulative impacts on threatened and endangered species in the area but could contribute to collectively increased demands on existing habitats.

3.8.2.6 Summary of Impacts to Threatened and Endangered Species

For most of the federally and state-listed terrestrial and aquatic animal species that may have suitable habitat in the Project Area, there are no confirmed records that indicate that these species have historically occurred within the Project Area and there were no sightings of these species during recent field surveys.

While there may be minor impacts to discrete locations of potential habitat for some state listed species, impacts are not expected to affect populations of the species. Forest and herbaceous vegetation that may offer some suitable summer roosting and/or foraging habitat to state and federally listed bats would be removed under the action alternatives. In addition, proposed actions would occur in the vicinity of a transitional roosting cave used by federally listed gray bats. Depending on the duration between previous bat surveys and site-specific design, additional presence/absence surveys may be required prior to construction activities. Where feasible, tree removal would occur in winter to minimize impacts to roosting bats. Consultation with the USFWS under Section 7 of the ESA would occur when specific designs have been selected and scope of the project has been refined. By implementing minimization measures such as winter tree removal and any additional conservation measures that may result from the Section 7 consultation, substantial impacts to state- and federally listed bats are not anticipated.

Direct impacts to a population of the state-listed spreading false-foxglove located on the edge of Area 1 under Alternatives B and D are not likely due to topographical limitations on development of the calcareous forest where it is located. Potential impacts to the state-listed rigid sedge and green orchid from proposed development of the offsite transmission line ROW would be the same for all action alternatives. TVA would ensure that rigid sedge and pale green orchid are not significantly impacted under all action alternatives by consulting with the TVA botanist during design of the proposed offsite transmission line to avoid the plants and their associated calcareous wetland habitat to the greatest extent possible. With implementation of this environmental commitment, adoption of Alternatives B, C, and D are not expected to impact populations of rigid sedge or pale green orchid.

As summarized in Table 3-25, TVA has determined that impacts to threatened and endangered species and their associated habitats related to the proposed actions under Alternatives B, C, and D are minor.

Table 3-25. Summary of Impacts to Threatened and Endangered Species

Alternative	Project Phase	Impact	Severity
Alternatives B, C, and D	Construction	Loss of potential summer roosting and foraging habitat for Indiana bat, northern long-eared bat, little brown bat, and tricolored bat and loss of potential summer foraging habitat for gray bat.	Consultation with the USFWS under Section 7 of the ESA would occur when specific designs have been selected and scope of the project has been refined. By implementing minimization measures such as winter tree removal and any additional conservation measures that may result from the Section 7 consultation, large impacts to gray bat, Indiana bat, northern long-eared bat, little brown bat, and tricolored bat are not expected. No impact to other threatened and endangered species.
		Possible loss of habitats potentially used by four-toed salamander, hellbender, Bachman's sparrow, bald eagle, cerulean warbler, sharp-shinned hawk, Swainson's	Impact minor. There are no confirmed records for most of these species within the Project Area during the breeding season. TVA to use BMPs and conduct

Alternative	Project Phase	Impact	Severity
		warbler, meadow jumping mouse, and southeastern shrew.	further avoidance and minimization measures during design, as appropriate.
		Potential impacts to Project Area jurisdictional streams and riparian zones and near-shore instream areas of the Reservoir.	No impacts expected to aquatic threatened and endangered species due to lack of species observed in Project Area, and because BMPs would be implemented in accordance with site-specific erosion control plans. Activities would be designed to minimize impacts to the Clinch River arm of the Watts Barr Reservoir and other surface waters and meet the terms and conditions of applicable USACE, NPDES, and TDEC permits.
Alternatives B and D	Construction	Potential direct impacts to state-listed spreading false-foxglove, rigid sedge, and pale green orchid from development of Area 1 and offsite transmission line ROW.	Location of spreading false-foxglove in Area 1 not likely to be affected by development due to steep topography. TVA would ensure that rigid sedge and pale green orchid are not significantly impacted under all action alternatives by consulting with the TVA botanist during design of the proposed actions to avoid the plants and their associated habitats to the greatest extent possible.
Alternative C	Construction	Potential direct impacts to state-listed rigid sedge and pale green orchid from development of offsite transmission line ROW.	Potential impacts to state-listed rigid sedge and pale green orchid would be the same as Alternatives B and D.
Alternatives B, C, D	Operation	Potential for alteration of hydrology, flow patterns, and water quality of Clinch River arm of Watts Bar Reservoir from stormwater and water intake and discharge facilities.	Because there is a lack of quality habitat for threatened and endangered species in the Project Area and TVA would obtain all required operational permits, operation of the CRN facilities including the water

Alternative	Project Phase	Impact	Severity
			intake and discharge facilities situated on the Clinch River arm of Watts Bar Reservoir is not expected to affect populations of species of conservation concern.
		Routine maintenance of transmission line ROW.	No impacts to listed species are expected from maintenance of proposed transmission line ROW because potential stream and other sensitive habitats would be protected by BMPs and conservation measures such as winter tree removal would be implemented.
		Potential collisions and noise associated with cooling towers.	Impacts would be minor to negligible due to low tower height (<65 feet) and distance from noise source to suitable bat roosting and foraging habitat after development of the CRN Site.

3.9 Managed and Natural Areas

3.9.1 Affected Environment

Managed and natural areas include TVA and non-TVA managed areas, ecologically significant sites and Nationwide Rivers Inventory (NRI) streams, State Natural Areas (SNA), and HPAs. Managed areas include lands held in public ownership that are managed by an entity (e.g., TVA, DOE, State of Tennessee) to protect and maintain certain ecological and/or recreational features. Ecologically significant sites are either tracts of privately owned land that are recognized by resource biologists as having significant environmental resources or identified tracts on TVA lands that are ecologically significant but not specifically managed by TVA's Natural Areas program. NRI streams are free-flowing segments of rivers recognized by the National Park Service (NPS) as possessing remarkable natural or cultural values. SNAs are designated and protected under the Natural Areas Preservation Act as intact ecosystems which serve as reference areas for how natural ecological processes function and are designated and protected under the Natural Areas Preservation Act (TDEC 2021a). HPAs are TVA managed natural areas that are managed to protect populations of species identified as threatened or endangered by the USFWS, state-listed species, and any unusual or exemplary biological communities/geological features (TVA 2021g).

There are no natural areas present within the CRN Site boundary. There are numerous managed and natural areas within the surrounding geographic area of interest (Anderson, Knox, Loudon, and Roane Counties). A review of the TVA Natural Heritage database and the TDEC State Natural Area Boundaries indicated that five managed/natural areas, two designated

SNAs, and four proposed SNAs are located within the 6-mile vicinity of the CRN site (TVA 2021f; Tennessee State Parks 2021).

The natural areas adjacent or in proximity to the CRN Site are:

- **Grassy Creek HPA.** The Grassy Creek HPA is a 271-acre natural area located on Grassy Creek, abutting the northern end of the proposed CRN Site boundary. The HPA provides habitat for the state-listed plant species shining ladies-tresses (*Spiranthes lucida*). The northern portion of the HPA borders Grassy Creek and the southern portion is a buffer area for the sensitive habitats (TVA 2021h). Appalachian bugbane (*Cimicifuga rubifolia*), formerly listed as a state-listed species, has been reported on this site and was confirmed to be present during field surveys in 2011.
- **Oak Ridge Reservation**. The ORR is located adjacent to the northern and eastern portion of the CRN Site. The DOE manages this 32,900-acre area, which is used for manufacturing, laboratory, managed forest, and ecosystem process research. An analysis was conducted by ORNL in 2009 to document all the ecologically significant areas on ORR lands including natural areas, aquatic natural areas, reference areas, aquatic reference areas, special management zones, conservation easement areas, cooperative management areas, habitat areas, and potential habitat areas which are described in Table 3-26 and illustrated in Figure 3-16 (Baranski 2009). Also located in the ORR, the New Zion Boggy Area comprises 376 acres in the western portion of the ORR and is adjacent to the east of the CRN Site. It features portions of the Haw Ridge uplands, including rock outcrops, Raccoon Creek Barrens, Raccoon Creek Embayment as well as wetlands. Several rare and uncommon plant species occur here.
- **Oak Ridge State WMA.** This WMA is located adjacent to the proposed CRN Site, is a 37,000-acre area managed by the TWRA for small and large game hunting, and is located at CRM 18.8 to 14.5 on the right descending shoreline of Clinch River arm of the Watts Bar Reservoir) primarily on USDOE ORR.
- **ORNL National Environmental Research Park (and Biosphere Reserve).** This area is adjacent to the proposed site and contains approximately 20,000 acres and is within the boundaries of the ORR. The park is used as an outdoor laboratory for studying present and future environmental consequences from energy related issues. It provides protected land for the use of education and research in environmental sciences. Managed by the ORNL for USDOE, it is located on the Clinch River at (CRMs 21.0 to 18.9) and on Melton Hill Reservoir at (CRMs 33.2 to 23.0) on the right descending shoreline.

Two officially designated SNAs located outside the ORR are within a 3-mile radius of the proposed CRN Site. These are:

- **Campbell Bend Barrens—Designated SNA.** This SNA is approximately (1.7 miles) northwest of and across the Reservoir from the CRN Site. This 35-acre area, managed by TDEC, consists of small barrens that are a rare community type in a region where much of the land base has been developed or converted to agriculture. Eastern red cedar, white pine, post oak, dwarf chinquapin oak (uncommon in Tennessee), and other hardwoods are scattered throughout the open grassland community. The dominant grasses include little and big bluestem and side-oats gramma. The barrens community within the nature area is approximately four to six acres.

- **Crowder Cemetery Barrens—Designated SNA.** This SNA is approximately (1.8 miles) west of and across the Reservoir from the CRN Site. This 15-acre area, managed by TDEC, has grasslands in a matrix of mixed oak-pine with eastern red cedar and other hardwoods that are scattered throughout the barrens. Grasses include little bluestem and side-oats gramma and rare plants include slender blazing star and prairie dock. Dwarf chinquapin oak, uncommon in Tennessee, also is found here.

In 2001, four areas within the boundaries of the ORR were proposed for future designation as a designated state natural area (DSNA) and protection under the Natural Areas Preservation Act. These four areas are considered ecological core areas and contain multiple smaller natural areas within their boundaries. The four proposed DSNAs are within 3.0 miles of the CRN Site.

- **Copper Ridge Unit—Proposed DSNA.** This proposed DSNA comprises 3,908 acres located in the southern portion of the ORR, 2.3 miles southeast of the CRN Site. Prominent features include Copper Ridge, extensive river bluffs on the perimeter of Melton Hill Reservoir, a variety of forest community types, several caves and sink holes, ravines, springs, seeps, and forested wetlands. This area has been nominated but not yet been designated as a SNA.
- **Black Oak Ridge Unit—Proposed DSNA.** This proposed DSNA comprises 2,929 acres in the western part of the ORR (1.7 mile) north east of the CRN Site. This natural area includes two sections: East Black Oak Ridge and West Black Oak Ridge separated by the Poplar Creek water gap and Blair Road. Prominent features are the East Fork Poplar Creek floodplain, Black Oak Ridge, McKinney Ridge hemlocks, Leatherwood bluff, mixed hardwood-native pine forest, and a large forested wetland. This area has been nominated but not yet been designated as a SNA.
- **Pine Ridge-Bear Creek Valley Unit—Proposed DSNA.** This proposed SNA comprises 4, 584 acres adjacent to the northern boundary of the DOE Reservation (2.5 mile) north east of the CRN Site. Topographic features include Pine Ridge and the western portion of East Fork Ridge. There are extensive unfragmented forest and a variety of wetland habitat types, including headwater wetlands, seeps, marshes, and forested wetlands and sandstone outcrops. This area has been nominated but not yet been designated as a SNA.
- **Walker Branch-Three Bend Unit—Proposed DSNA.** This proposed DSNA comprises 6,059 acres located (2.6 mile) east of the CRN Site in the eastern corner of the ORR, including the entire Three Bend Scenic and Wildlife Area. The area includes one of the world's largest populations of the rare wildflower species, tall larkspur. This area has been nominated but not yet been designated as a DSNA.

Table 3-26. Natural Areas and Sensitive Areas within the ORR

Label ID	Area Name	Acreage	Label ID	Area Name	Acreage
NA2	East Fork Ridge Mesic Forest	282.8	PH1	Black Oak Ridge Mixed Pine and Hardwood Forest	83.8
NA4	Rein-orchid Swamp	421.4	PH2	Water Tank Road Forest	171.7
NA6	West Haw Ridge	444.9	PH6	Chestnut Ridge Forest	350.0
NA13	Pine Ridge Wetlands	158.7	CMA1	Fingerless Orchid Wetlands	50.6
NA20	Poplar Creek Cliffs	471.3	CMA5	White Oak Lake	152.5
NA25	Clinch Floodplain Swamp	30.7	RA6	Pink Lady Slipper Community	6.1
NA29	Northwest Pine Ridge Fringeless Orchid Site	20.4	RA19	Sweet Flag Marsh	6.3
NA31	Environmental Sciences Division Lily Site	237.9	RA22	Grassy Creek Security Site	43.2
NA33	The ETTP Filtration Plant Wetland	6.5	RA23	Upper Poplar Creek Rookery	17.5
NA37	Duct Island Road Bluffs	12.2	RA28	Spring Pond	2.9
NA41	Leatherwood Bluffs	103.5	RA30	Lower Poplar Creek Rookery	6.5
NA42	New Zion Boggy Area	376.0	RA31	Copper Ridge Cave Area	377.8
NA45	McKinney Ridge Hemlocks	52.1	HA1	Holland Road Forest	434.0
NA48	Sleepy Salamander Forest	233.1	HA2	East Pine Ridge Forest	1233.2
NA49	K-25 Beaver Pond Complex	16.9	HA5	Melton Valley Drive Forest	24.3
NA50	Bear Creek Tributary 4	88.6	HA7	McNew Hollow and Ridge Forests	610.2
NA51	Dry River Bluffs and Caves	431.9	HA8	New Zion Road Barrens	158.0
NA52	Bear Creek Springs	124.5			
NA53	Flashlight Heaven Area	102.0			
NA55	Chestnut Ridge Springs Area	291.1			

Source: Baranski 2009

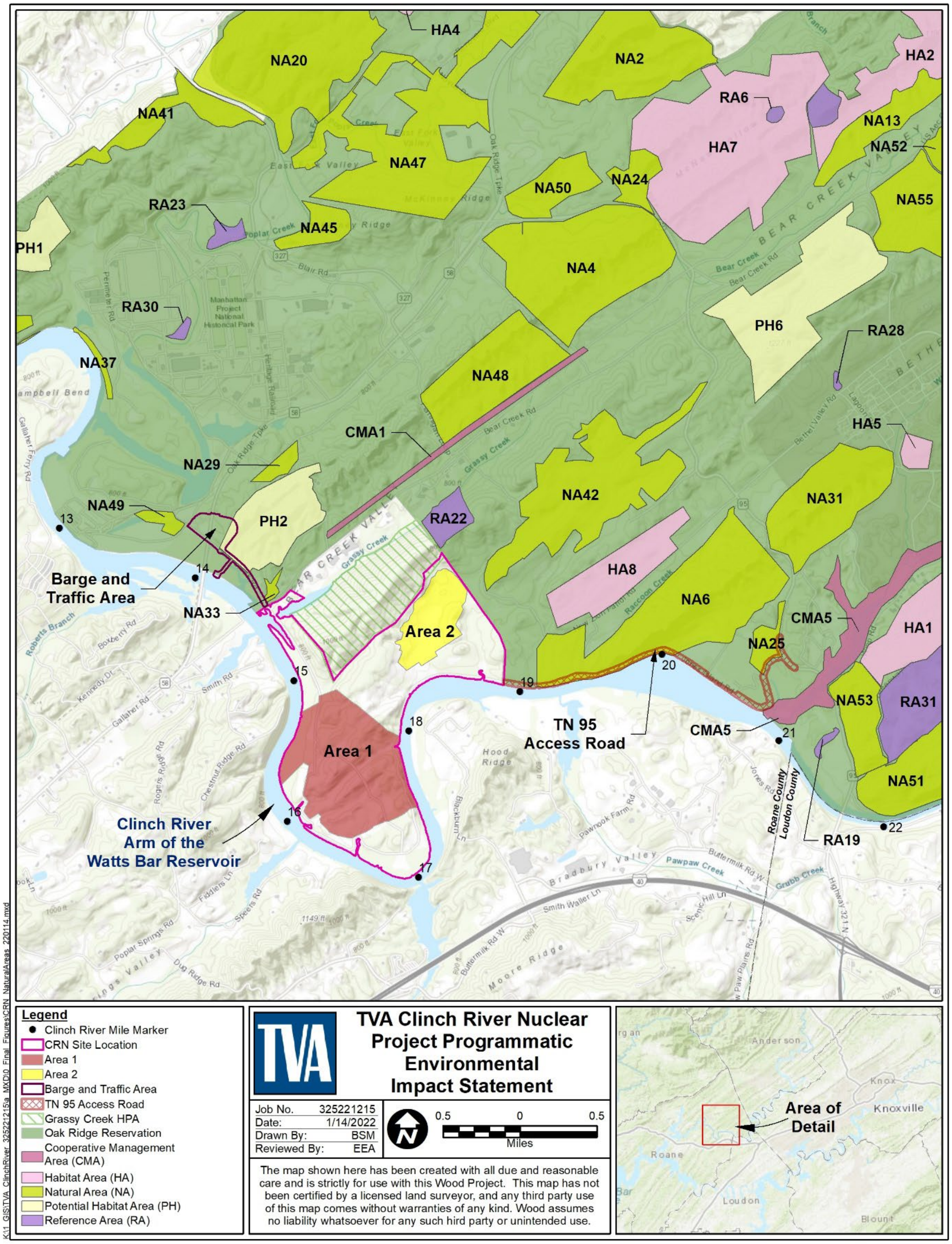


Figure 3-16. Managed and Natural Areas Within the ORR in the Vicinity of the CRN Site

3.9.1.1 Reasonably Foreseeable Future Actions in Proximity to the CRN Site

As noted in Section 3.1.3, TVA identified several foreseeable future actions in proximity to the CRN Site. The scopes of these other proposed actions are generally lacking. However, it is expected that they would not likely affect natural and managed areas. Furthermore, none of the identified reasonably foreseeable future actions is overlapping geographically with the CRN Project Area nor is considered to have a causal relationship to the proposed development of the CRN Site. As such, no further consideration of reasonably foreseeable future actions and their effects on managed and natural areas are included in TVA's analysis.

3.9.2 Environmental Consequences

3.9.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, a Nuclear Technology Park would not be developed at the CRN Site; therefore, there would be no impact to managed or natural areas.

3.9.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced Non-LWRs

Under Alternative B a Nuclear Technology Park would be constructed and operated in Area 1 of the CRN Site. There are no managed or natural areas within Area 1; therefore, construction activities at this site would not directly impact natural or managed areas.

Several natural areas would be affected under Alternative B in conjunction with the proposed associated offsite areas:

- **Grassy Creek HPA.** The proposed 161-kV transmission line would intersect the eastern edge of the Grassy Creek HPA (Figures 2-1 through 2-3). Construction of the proposed 161-kV transmission line would include establishment of a maintained 120-foot ROW within a 280-foot corridor and would involve removal of trees and shrubs within the ROW. TVA would develop a mitigation plan to mitigate impacts associated with the loss of habitat in the Grassy Creek HPA. Under Alternative B, potential indirect effects on the Grassy Creek HPA include the development of a transmission line "edge" habitat that would potentially introduce associated plant and animal species that are characteristic of such habitats. Additionally, such edge habitats also represent the potential for increased introduction of invasive plant species into the interior of the HPA. However, TVA would manage the vegetation within the transmission line ROW in accordance with TVA's Transmission System Vegetation Management Final Programmatic EIS (TVA 2019c). Potential impacts to threatened, endangered, and sensitive species and their mitigative measures are discussed further in Section 3.8 (Threatened and Endangered species). As described in Section 3.8, TVA is pursuing expansion of the Grassy Creek HPA by approximately 14 acres to provide additional protection for these species. Based on the avoidance of sensitive species during transmission line design, and the commitment to additional mitigative measures, impacts to the Grassy Creek HPA are minor.
- **New Zion Boggy Area.** The TN 95 Access would cross several of the elements within the ORR boundary contained within the New Zion Boggy Area including the Haw Ridge uplands, Raccoon Creek Barrens, Raccoon Creek Embayment and Haw Ridge and the Clinch Floodplain Swamp. However, location of the TN 95 Access has been developed to coincide with the alignment of the existing Jones Island Road immediately adjacent to the Reservoir throughout much of its length. Widening of the existing Jones Island Road would be required. Potential encroachment on these natural area elements would be minimized when applicable; however, TVA would conduct extensive shoreline stabilization and restoration measures within this reach of the river and would therefore,

stabilize the eroding shorelines associated with these natural areas. Further avoidance and minimization measures would be undertaken in consultation with DOE during the detailed design phase. As such, impacts to these natural areas is moderate.

Managed and natural areas located within the adjacent 0.5-mile radius of the CRN Site may be indirectly impacted due to increases in noise, fugitive dust, and visual impacts associated with construction activities. However, the impacts would be intermittent and would only occur during construction periods and as such would be minor.

The construction and operation workforce and their families who relocate to the area of geographic interest would utilize natural areas in the vicinity of the CRN Site. The anticipated in-migrating construction and operation workforce would result in an 0.5 percentage population increase (Section 3.15.2) within the four-county geographic area of interest. Given the small increase in population, and diverse array of developed and dispersed recreation opportunities in the vicinity of the CRN Site, the impact associated with increased visitation to natural areas would be minor.

3.9.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced Non-LWRs

There would be no direct impacts associated with construction at Area 2 as no managed or natural areas are present. Potential impacts to managed and natural areas would be similar to those described under Alternative B.

Area 2 is located 0.38 miles northeast of Area 1 and is, therefore, closer to the Grassy Creek HPA. Accordingly, during construction indirect impacts from increases in noise, fugitive dust, and potential visual impairments associated with construction activities and operations would be slightly higher than Alternative B; however, these impacts would be intermittent. Other indirect impacts associated with the development of a transmission line “edge” habitat are similar to those described under Alternative B, but greater in proportion to the increase in edge habitat created. However, as stated for Alternative B, TVA would manage the vegetation within the transmission line ROW in accordance with TVA’s Transmission System Vegetation Management Final Programmatic EIS (TVA 2019c). Indirect impacts due to noise and visual intrusions during plant operation from plant facilities and systems are anticipated to be moderate.

3.9.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced Non-LWRs

Under Alternative D, a nuclear technology park would be constructed and operated in Areas 1 and 2. There would be no direct impacts associated with construction at Area 1 and 2 as there are no managed or natural areas present.

Indirect impacts would be similar to those described under Alternative C. Although activities associated with construction at Area 1 and Area 2 would be spread over a larger footprint, the maximum number of vehicles and staff would be the same under all alternatives.

Impacts associated with operation of the Nuclear Technology Park at Area 1 and 2 would be similar to those described for Alternative C. Therefore, impacts to managed and natural areas resulting from the actions undertaken by TVA under Alternative D would be minor to moderate.

3.9.2.5 Summary of Impacts to Managed and Natural Areas

Table 3-27 summarizes impacts to managed and natural areas from the development of a Nuclear Technology Park at the CRN Site. Overall, impacts would be minor. Users of these areas could be indirectly impacted during construction; however, the impacts would be minor and intermittent. Operational impacts could occur due to the creation of additional edge habitat, and noise and visual impairments.

Table 3-27. Summary of Impacts to Managed and Natural Areas

Alternative	Project Phase	Impact	Severity
Alternatives B, C, D	Construction	Improvements to BTA and TN 95 Access in the ORR on existing road corridors.	Minor impacts that would be the same for all alternatives.
		Loss of habitat for sensitive species due to 161-kV transmission line (associated 120-foot ROW) through Grassy Creek HPA.	Minor impacts managed with TVA mitigation plan for sensitive species.
		Encroachment in several of the elements within the ORR boundary contained within the New Zion Boggy Area including the Haw Ridge uplands, Raccoon Creek Barrens, Raccoon Creek Embayment and Haw Ridge and the Clinch Floodplain Swamp.	Impacts minimized by avoidance. Extensive shoreline stabilization and restoration measures within this reach of the river and would stabilize the eroding shorelines. Further avoidance and minimization through consultation with DOE during the detailed design phase. Impacts are moderate.
		Increases in noise and fugitive dust, and visual impacts associated with construction activities.	Minor impacts based on area of disturbance and proximity to ORR and the Grassy Creek HPA. The magnitude of impact would be the same for Alternatives C and D, and incrementally less for Alternative B due to distance of Area 1 from the ORR and HPA.
	Operation	Potential increased indirect impacts to Grassy Creek HPA due to visual/noise intrusion and increased edge effect with Alternatives C and D.	Minor impacts for Alternative B and minor to moderate impacts for Alternatives C and D.

3.10 Recreation

3.10.1 Affected Environment

Developed recreation includes campgrounds, lodges, marinas, boat-launching ramps, parks, swimming pools and beaches, visitor buildings and other day use facilities, and golf courses. Dispersed recreation consists of passive informal activities such as hunting, hiking, nature observation, primitive camping, and bank fishing.

Parks and recreation facilities that are on, immediately adjacent to (within 0.5 miles), or within the vicinity (within a 6-mile radius) of the CRN Site are shown in Table 3-28 and illustrated on Figure 3-17.

Table 3-28. Parks and Recreation Facilities in the Vicinity of the CRN Site

Facility Name	Managing Entity	Distance from CRN Site
Black Oak Ridge Conservation Easement	TDEC, TWA, DOE	2.6 miles
Crosseyed Cricket Campground	Private Company	2.5 miles
ETTP Overlook	DOE	1 mile
Gallaher Recreation Area	City of Oak Ridge	0.1 mile
K-25 Gaseous Diffusion Plant (Manhattan Project Nation Historic Park)	DOE	1.25 miles
K-25 History Center (Manhattan Project National Historic Park)	DOE	1.6 miles
Melton Hill Dam	TVA	3.7 miles
Melton Hill Dam Recreation Area	TVA	3.9 miles
Soaring Eagle Campground and RV Park	Private	0.5 miles
Southern Appalachia Railway Museum	Private	0.8 miles
Wheat Community African Burial Ground	DOE	0.8 miles
X-10 Graphite Reactor (Manhattan Project National Historic Park)	DOE	3.1 miles
The Clinch River arm of the Watts Bar Reservoir	TVA	Adjacent

Source: Crosseyed Cricket 2021, Tennessee Landforms 2019, TVA 2021j, NPS 2021 and DOE 2020

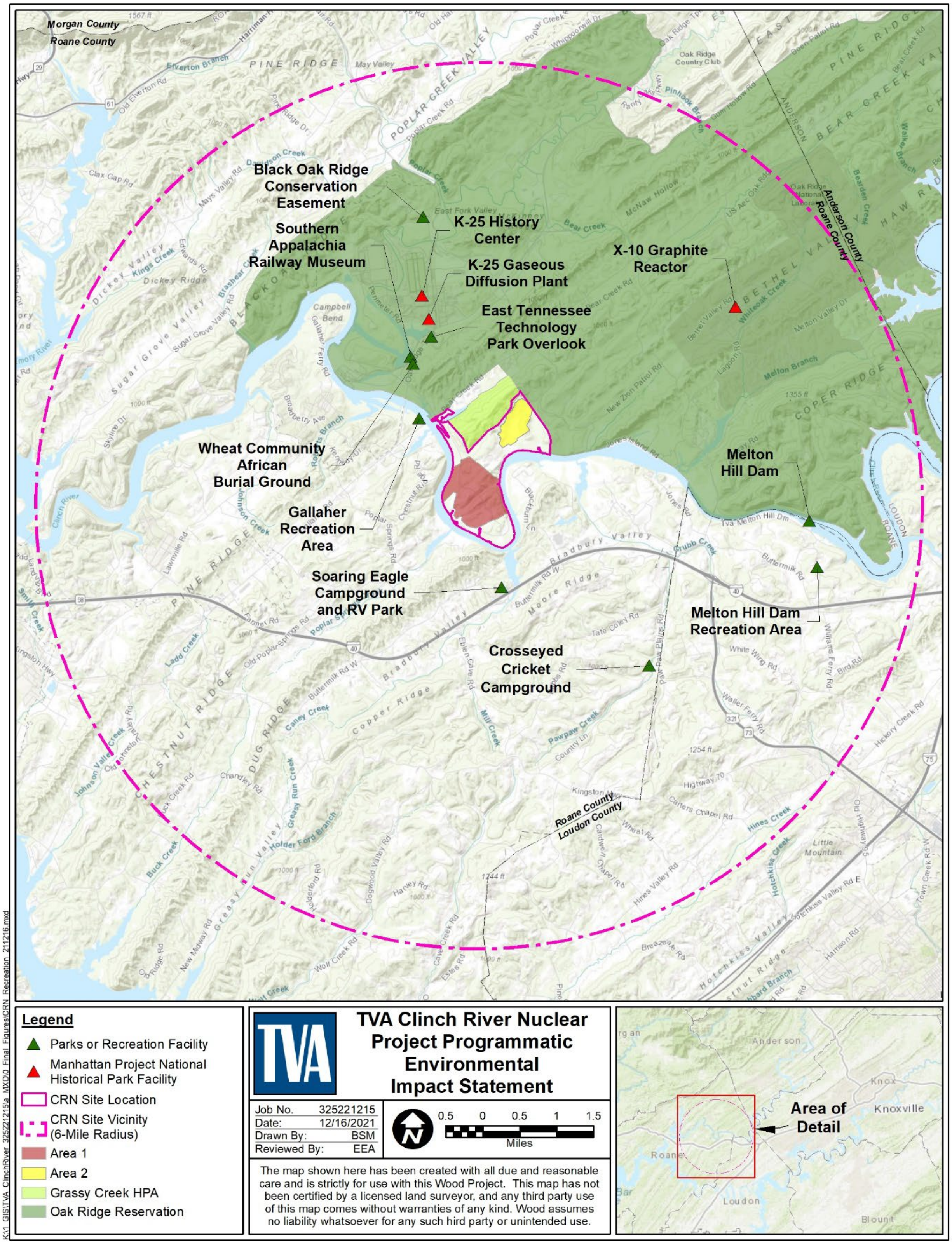


Figure 3-17. Parks and Recreation Facilities Within the Vicinity of the CRN Site

There are no parks and recreation facilities located on the CRN Site. Eleven parks and recreation facilities are located within the vicinity of the site, three are located adjacent to (within 0.5 miles) the CRN Site, which include the Gallaher Recreation Area, Soaring Eagle Campground, and the Reservoir. This section focuses on the recreation facilities adjacent to the CRN site, as there would be no direct impacts on parks or recreation facilities outside of this radius due to distance between the site and these facilities.

The Gallaher Recreation Area, located across the Reservoir from the CNR Site, spans over 45 acres and includes a boat ramp at CRM 14.5 and a beach area for swimming and fishing. The recreation area is managed by the City of Oak Ridge, and approximately 30-50 people visit the recreation area daily.

The Soaring Eagle Campground and RV Park includes 90 campsites for tents and RVs located 0.5 miles from the CRN site, on the opposite side of the Reservoir. The campground includes picnic pavilions, boat ramp and dock, a swimming pool, playground, bathhouses and laundry facilities. Approximately 13,000 patrons visit this area each year.

The Reservoir, which wraps around the western, southern, and eastern borders of the CRN Site, provides opportunities for various dispersed recreation activities including fishing, boating, and hiking (TVA 2021j). There are several boat ramps along the Reservoir, including privately owned boat ramps and public boat ramps associated with existing parks and recreation facilities. These boat ramps support activities such as power boating, canoeing, kayaking and dock fishing.

3.10.1.1 Reasonably Foreseeable Future Actions in Proximity to the CRN Site

As noted in Section 3.1.3, TVA identified several foreseeable future actions in proximity to the CRN Site. While the specific details regarding the scope of these actions are generally lacking, it is expected that these other proposed actions would not likely affect parks and recreation facilities. Furthermore, none of the identified reasonably foreseeable future actions is overlapping geographically with the CRN Project Area nor is considered to have a causal relationship to the proposed development of the CRN Site. As such, no further consideration of reasonably foreseeable future actions and their effects on parks and recreation are included in TVA's analysis.

3.10.2 Environmental Consequences

3.10.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, the CRN Site would remain unused and managed in accordance with the Watts Bar RLMP (TVA 2009; TVA 2021k). Therefore, there would be no impacts to parks or recreation.

3.10.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced Non-LWRs

There are no parks or recreational facilities within the CRN Site boundaries or within the associated offsite areas (BTA, TN 95 Access, and 161-kV offsite transmission line). Therefore, there would be no direct impacts to parks or recreational facilities from construction or operation of the Nuclear Technology Park at Area 1. The three parks and recreation facilities that are adjacent to the CRN Site would not be directly impacted; however, construction-related impacts associated with construction activities could have some disruptive effect on dispersed recreation use and on developed recreation areas adjacent to the CRN Site.

Erosion and sedimentation from site stormwater runoff could impact recreators on the Reservoir, including those accessing the river from the Gallaher Recreation Area. However, erosion and sedimentation would be minimized with implementation of BMPs and, therefore, this impact would be minor. In addition, construction noise may indirectly impact fishing, boating, and hiking in the areas immediately adjacent to the Reservoir. However, due to the intermittent nature of these activities and the availability of additional areas for recreation upstream and downstream of the CRN Site, impacts would be minor.

Recreators at the Soaring Eagle Campground and RV Park may experience indirect impacts associated with increased traffic generated by the construction workforce and equipment transport. However, primary access to this campground is from I-40, and most construction traffic would access the CRN Site from TN 58 and Bear Creek Road, thereby not affecting traffic to the campground. As such, impacts would be minimal.

During operation of the Nuclear Technology Park at Area 1, users of parks and recreation facilities adjacent to the CRN Site may be indirectly impacted due to delays in traffic and operational noise. However due to the small size of the operational workforce traffic, noise impacts would be minor and mainly confined to normal working hours. As described in Section 3.13, development of the undisturbed CRN Site may reduce scenic integrity. However, while the major buildings of the facility would be visible to recreationists on the Reservoir, views would be somewhat screened by topography. As such, operation of the facility would result in minor impacts to recreational activities along the Reservoir.

Transient construction and temporary fuel outage workforces may utilize recreation facilities for short-term temporary housing. Within the vicinity of the CRN Site there are three campgrounds and RV sites that can provide temporary housing, in addition to other temporary housing as described in Section 3.15.1.2. Therefore, impacts associated with competition for transient housing would be minor. In-migrating operation workforces and their families would utilize parks and recreation areas within the vicinity of the CRN Site. As described in Section 3.9.2.2, the operation workforce would account for a small increase in the population. Therefore, impacts associated with increased visitation to recreation facilities would be minor.

3.10.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced Non-LWRs

Impacts to parks and recreation areas would be similar to those described under Alternative B. Area 2 is located adjacent to the ORR, approximately 0.4 miles northeast of Area 1, and is further set back from the Reservoir. Therefore, the magnitude of potential impacts to parks and recreation facilities would be minor to moderate yet incrementally less than those described for Alternative B.

3.10.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced Non-LWRs

Development of Areas 1 and 2 would create a greater visual impairment from the undisturbed landscape. However, the transformation of the undeveloped nature of the site to industrial development is not anticipated to destabilize users of parks and recreation areas, resulting in a moderate impact to recreationist along the Reservoir. Indirect impacts to parks and recreation facilities located adjacent to the CRN Site are bounded by the analysis in Alternative B, as the maximum number of vehicles and staff would be the same under all alternatives. Therefore, impacts to parks and recreation areas resulting from implementation of Alternative D would be minor to moderate.

3.10.2.5 Summary of Impacts to Recreation

Table 3-29 summarizes impacts to parks and recreation resources from the development of a Nuclear Technology Park at the CRN Site. Overall, impacts to parks and recreation would be minor to moderate. Recreators could be indirectly impacted during construction, but these impacts would be minor and minimized through the use of BMPs designed to reduce erosion, noise, and fugitive dust emissions. Operational impacts would be minor and would not impact the use or enjoyment of surrounding parks and recreational facilities.

Table 3-29. Summary of Impacts to Parks and Recreation Resources

Alternative	Project Phase	Impact	Severity
Alternatives B, C, D	Construction	No direct impacts to parks or recreational facilities. Indirect impacts associated with erosion and sedimentation due to land disturbances and temporary increase in noise, fugitive dust, and traffic during construction activities. Limited to users of parks and recreation facilities adjacent to CRN Site.	Minor impact. The magnitude of impact would be the same for Alternatives B and D, and incrementally less for Alternative C due to distance of Area 2 from the Reservoir.
	Operation	Introduction of industrial features into the existing natural landscape, reducing scenic integrity, traffic and noise increases from standard operation.	Impacts to parks and recreation would be minor based on the small operational workforce and somewhat screened views of the CRN Site. The magnitude of impact would be the same for Alternatives B and D, and incrementally less for Alternative C due to distance of Area 2 from the Reservoir.

3.11 Air Quality and Climate Change

3.11.1 Affected Environment

3.11.1.1 Air Quality

The discussion of air quality includes the six air pollutants for which the EPA has set NAAQS: ozone (O_3), particulate matter with a mean aerodynamic diameter of less than or equal to 10 µm and 2.5 µm (PM_{10} and $PM_{2.5}$, respectively), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and lead (Pb). These six pollutants are called criteria pollutants. This discussion also includes greenhouse gases (GHGs), primarily carbon dioxide (CO_2).

Areas with pollutant concentrations that are greater than the acceptable levels for criteria pollutants established by the NAAQS are nonattainment areas. Anderson, Blount, Knox, and Loudon Counties and a portion of Roane County were nonattainment areas for 1997 annual $PM_{2.5}$ and for 2006 24-hour $PM_{2.5}$ but have been re-designated as attainment areas effective August 29, 2017, and September 27, 2017, respectively (82 FR 40718; 82 FR 40953). Emissions from new major sources in attainment areas are evaluated by the State of Tennessee through the Prevention of Significant Deterioration (PSD) program.

Federal Class I areas are afforded additional protection for air quality under Section 169A of the CAA. The closest mandatory Class I Federal areas to the CRN Site are the Great Smoky Mountains National Park near Gatlinburg, Tennessee, approximately 31 miles east-southeast of the CRN Site (40 CFR 81.428) and the Joyce Kilmer-Slickrock Wilderness Area, in Monroe County, Tennessee, and Graham County, North Carolina, approximately 36 miles southeast of the CRN Site (40 CFR 81.428).

3.11.1.2 Climate Change and Greenhouse Gases

The CRN Site is located in a region of eastern Tennessee that is commonly referred to as “The Great Valley,” an area of ridges and valleys, which influences the climate of the site. Terrain elevations range from 700 feet AMSL to 1,500 feet AMSL. The climate of the CRN Site is humid and subtropical, with seasonal variations driven by the position of the jet stream. The jet stream is generally situated north of the CRN Site during warmer months, which allows maritime tropical air masses from the Gulf of Mexico, or, to a lesser extent, the Atlantic Ocean, to influence the region. During the winter months, the jet stream shifts toward the south, but with a west-to-east orientation, and conditions remain moderate. When the jet stream dips farther south into the southern states, the CRN Site experiences colder temperatures due to the intrusion of polar continental air masses. However, the region’s topography often blocks the coldest portions of the polar air masses, limiting temperature extremes at the CRN Site.

The winds at the CRN Site are influenced by the local topography of “The Great Valley”, as the topography channels winds into southwesterly or northeasterly directions. As a result, the prevailing wind direction at the nearby Oak Ridge National Weather Service (NWS) Station (located 12 miles to the northeast in the City of Oak Ridge) is from the northeast. Surface wind speeds are typically low due to the terrain as well, so that the mean annual wind speed at the Oak Ridge NWS Station is 2.9 mph.

The CRN Site typically experiences warm summers and mild winters. The annual average temperature at Oak Ridge was approximately 59°F. The highest normal daily maximum temperature at Oak Ridge was 88.4°F in July, while the lowest normal daily minimum temperature was 28.9°F in January. Average annual precipitation at the Oak Ridge NWS Station (located 25 miles to the east-northeast of the CRN Site) is approximately 51 inches. Droughts are relatively uncommon because precipitation is typically well distributed during the year. Annual average snowfall amounts are 11.1 inches at the Oak Ridge NWS Station and 6.5 inches at the Knoxville NWS Station. Snowfall usually occurs during November through March, with normal amounts per snowfall event that are typically between 0.1 and 4 inches at the Oak Ridge NWS Station. Thunderstorms are commonly reported at the surrounding NWS stations; approximately 40 to 55 days with thunderstorm activity are recorded annually at nearby NWS stations (Chattanooga, Bristol/Johnson City/Kingsport, Knoxville, and Nashville). The majority (approximately 60 to 75 percent) of thunderstorms occur between May and August.

3.11.1.2.1 Greenhouse Gases

GHGs are transparent to incoming short-wave radiation from the sun but are opaque to outgoing long-wave (infrared) radiation from Earth’s surface. The net effect over time is a trapping of absorbed radiation and corollary warming of Earth’s atmosphere, which together constitute the “greenhouse effect.” Since the onset of the Industrial Revolution in the mid-1700s, human activities have contributed to the production of GHGs, primarily through the combustion of fossil fuels (such as coal, oil, and natural gas) and deforestation. The principal GHGs that enter the atmosphere because of human activities include carbon dioxide CO_2, methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. Some

GHGs, such as CO_2, CH_4, and N_2O, are also emitted to the atmosphere through natural processes.

Climate-related changes are under way in the U.S. and globally, and their scope and extent are projected to continue to grow during the next several decades. Potential climate-related changes include rising temperatures and sea levels; increased frequency and intensity of extreme weather (e.g., heavy downpours, floods, and droughts); earlier snowmelts; more frequent wildfires; and reduced snow cover, glaciers, permafrost, and sea ice. Climate-related changes are closely linked to increases in GHGs.

Though global climate change, in both its magnitude effects, is uncertain, projected trends are discussed in relationship to current conditions. The CRN Site is located in the southeast region of the U.S. During the preceding 100 years, the southeast has experienced alternating periods of generally warmer, or cooler temperatures. Warmer temperatures have occurred from the 1970s until present (with an average increase of 2°F). Further, there have been an increasing number of days that exceed 95°F, nights that exceed 75°F, and a decrease in the number of “extremely cold” days since the 1970s.

Regarding precipitation patterns, the southeast is located in a “transition zone” between the southwestern U.S., which is generally dryer and the Northern U.S., which is overall wetter. As such, precipitation trends in the southeast show less pronounced trends. Though precipitation patterns are more uncertain, reduced water availability is expected from increased evaporation due to higher air temperatures in the southeast.

Based on current understanding of the impacts of climate change, the greatest potential effects of climate change for the CRN Site and its surroundings are increased temperatures and reduced water availability. These projections are inherently uncertain, however. As part of a future licensing action of advanced nuclear reactors at the CRN Site, TVA would continuously monitor meteorological and environmental conditions throughout the life cycle of any reactors proposed for deployment, to ensure their operation would occur within authorized and licensed limits of operation.

3.11.1.2.2 Regulatory Requirements

Although there have been a series of recent administrative changes, no binding GHG emission reduction requirements are currently in force at the federal level for fossil-fired power plants. The national emissions reduction requirements established in the EPA’s Clean Power Plan (CPP) rule were repealed on July 8, 2019 (84 Federal Register 32250) and the targets in the Paris Climate Accord were withdrawn in November of 2020. The emission reduction requirements established by EPA in the Affordable Clean Energy (ACE) rule, which replaced the CPP rule, were vacated by the D.C. Circuit Court of Appeals on January 19, 2021. On January 20, 2021, President Biden issued EO 13990 (Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis) and on January 27, 2021, President Biden issued the EO 14008 (Tackling the Climate Crisis at Home and Abroad). Amongst other objectives, the EOs set an aspirational target to achieve a net-zero emission economy by 2050 and a carbon-free electricity sector by 2035. In addition, on January 20, 2021, President Biden announced that the U.S. would rejoin the Paris Climate Agreement, and the U.S. became a party to the Agreement on February 19, 2021. The Agreement is a binding international agreement to reduce GHG emissions and impacts due to climate change that was signed by 196 parties on December 12, 2015 and entered into force on November 4, 2016. The Agreement aims to limit global warming to well below 2°C, and preferably to 1.5°C, compared to pre-industrial levels. Prior to the U.S. withdrawal from the Agreement in November 2020, the

U.S. had proposed a 26 to 28 percent domestic reduction in GHG emissions by 2025 compared to 2005 levels. It is likely that the U.S. would retain or modify these goals upon rejoining the Agreement. On April 22, 2021, the U.S. submitted its nationally determined contribution (NDC) in line with Article 3 of the Paris Agreement. In the NDC, the U.S. is setting an economy-wide target of reducing GHG emissions by 50 to 52 percent below 2005 levels in 2030. Additionally, at the United Nations Climate Change Conference, COP 26, in November 2021, the United States and China, the world's top emitters of GHGs, agreed to boost cooperation on combating climate change over the next decade. *Both countries* said they will work together on increasing the use of renewable energy, developing regulatory frameworks, and deploying technologies such as carbon capture.

On December 8, 2021, President Biden signed EO 14057 detailing the administration's policy to take a whole of government approach to lead by example to achieve a carbon pollution-free electricity sector by 2035 and net-zero emissions economy-wide by no later than 2050. EO 14057 instructs virtually all elements of the federal government to demonstrate how innovation and environmental stewardship can protect our planet, safeguard federal investments, respond to the needs of American communities, and expand American technologies, industries, and jobs. EO 14057 highlights include:

Section 102. Government-wide Goals.

> (i) 100 percent carbon pollution-free electricity, defined as electricity produced from resources that generate no carbon emissions, on a net annual basis by 2030, including 50 percent 24/7 carbon pollution-free electricity, defined as carbon-pollution free electricity purchased to match actual electricity consumption that is produced within TVA's regional grid; and
> (iv) a 65 percent reduction in greenhouse gas emissions, defined as GHG emissions from operations/property that agencies owns or controls, by 2030 from 2008 levels.

Section 301. Federal Supply Chain Sustainability. Federal supply chains should support a government and economy that serves all Americans by creating and sustaining well-paying union jobs, protecting public health, advancing environmental justice, reducing greenhouse gas emissions, and building resilience to climate change. Consistent with applicable law, agencies shall pursue procurement strategies to reduce contractor emissions and embodied emissions in products acquired or used in federal projects.

While not binding on TVA specifically, EO 14057 creates binding requirements on federal agencies that TVA serves, including DOE's ORR.

3.11.1.2.3 TVA Carbon Trajectory and Strategic Intent

At its May 6, 2021, meeting, the TVA Board adopted the TVA Strategic Intent and Guiding Principles, which focus on energy supply and decarbonization initiatives (TVA 2021i). These guiding principles commit TVA to delivering safe, low-cost, reliable power while providing responsible stewardship by caring for the region's natural resources. The guiding principles are based on the 2019 IRP Recommendations and reiterate TVA's plan for 70 percent carbon reduction over 2005 levels by 2030, 80 percent carbon reduction by 2035, and aspirations for net-zero carbon emissions by 2050. Additional details regarding TVA's carbon trajectory can be found in the Fiscal Year 2020 Sustainability Report (TVA 2021e).

3.11.1.3 Reasonably Foreseeable Future Actions in Proximity to the CRN Site

As noted in Section 3.1.3, TVA identified several foreseeable future actions in proximity to the CRN Site. The scope of these other proposed actions may entail the alteration of local and regional air quality and may contribute to GHG emissions. Specific foreseeable future actions that may contribute to local and regional air emissions include the potential development of the Kairos Hermes Reactor Project, the development of the new airport by the City of Oak Ridge (both at the ETTP), the proposed construction of new production facilities at the Y-12 complex, and potential development at the Horizon Center Industrial Park. Specific details regarding air emissions associated with these actions and their respective timing (construction duration, start of operation) are lacking. However, construction phase activities would increase particulates and other pollutants in conjunction with land disturbance and vehicular emissions. Such effects would generally be localized, temporary and not impactful to regional air quality. Operational phase activities would also increase emissions from vehicles and in conjunction with facility operations. Because each of these actions has the potential to contribute to impacts to regional air quality, further consideration of reasonably foreseeable future actions and their effects on the local air quality are included in the following section as appropriate.

3.11.2 Environmental Consequences

3.11.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, TVA would not develop the CRN Nuclear Technology Park. Therefore, there would be no GHG emissions and no impacts to air quality from construction and operation of the advanced nuclear reactors.

3.11.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced Non-LWRs

3.11.2.2.1 Air Quality

3.11.2.2.1.1 Construction

Under Alternative B, advanced nuclear reactors would be manufactured in factories, with large, fabricated components shipped to the construction site. Therefore, less onsite construction would be required for installation than for a typical commercial reactor. Construction activities at the Area 1 could result in temporary impacts to local air quality from the following activities:

- land clearing and grading; and material processing, handling, and removal
- material replacement (e.g., subsurface preparation and concrete pouring and paving)
- driving piles and erecting structures
- machinery operation and maintenance
- truck deliveries of supplies and materials
- soil and rock transport and temporary stockpiling
- workforce commute

The equipment required to support the digging, grading and construction of this project is expected to be both gasoline and diesel powered. As such, this equipment would emit the air pollutants normally associated with mobile fossil fuel powered equipment. Equipment and vehicle emissions from these activities would contain CO, oxides of nitrogen (NO_X), VOCs, and sulfur oxides (SO_X) to a lesser extent. Per air quality regulations, all diesel equipment would use low-sulfur fuel and are expected to be equipped with all required pollution controls. The increase in emissions from the equipment would be temporary and would be within the normal daily variation of mobile emissions from a construction site. It is expected that fugitive dust particles (such as PM_{10} and $PM_{2.5}$) generated during demolition would be controlled using standard construction BMPs. A small amount of emissions would also be generated from the one-time burning of the trees and stumps to be cleared. Air emissions from construction are expected to be temporary and minor. The air quality impacts are also expected to be limited to the area within 5 miles of the CRN Site. As discussed above, Roane County, where the CRN Site is located, is in attainment for all criteria pollutants.

During construction activities, additional commuter vehicles, trucks, and other construction vehicles would pass daily through routes leading to the CRN Site, primarily TN 58, Bear Creek Road, and TN 95. This traffic would include the passenger cars and light-duty trucks of the construction workforce and truck traffic for delivery of construction materials and heavy equipment used to support development (e.g., excavators, bulldozers, heavy-haul trucks, cranes). Additionally, traffic delays and congestion may be expected to occur at key intersections surrounding the CRN Site during peak hours. Such increased traffic volumes and increased delays would result in result in locally increased emissions during construction. Mitigation measures that may be considered include staggering work shifts to avoid localized delays at key intersections, thereby reducing the effects of additional emissions from vehicle idling. The increases in emission levels are expected to be minimal and temporary and would have a minimal impact on air quality from criteria pollutants. Possible mitigation measures during onsite construction may include stabilizing construction roads and spoils piles, covering haul trucks, watering unpaved construction roads to control dust, and conducting routine inspections and maintenance on construction vehicles and equipment.

The overall impact caused by increased traffic volume and congestion would be localized and temporary and minor. TVA would identify specific mitigation measures that would be developed before building activities begin to reduce the impact of increased traffic on air quality.

3.11.2.2.1.2 Operation

Based on the CRN Site PPE (Appendix A), sources of air emissions would include stationary combustion sources (auxiliary boilers, emergency diesel generators, and/or standby power gas turbines), mechanical draft cooling towers, and mobile sources (worker vehicles, onsite heavy equipment and support vehicles, and delivery of materials and disposal of wastes). Emergency diesel generators, and/or standby power gas turbines would operate only for limited periods, including periodic maintenance testing.

The principal air emission sources associated with operating nuclear reactors at the CRN Site would be cooling towers, auxiliary boilers for heating and startup, engine-driven emergency equipment, and emergency power supply system diesel generators and/or gas turbines. Estimates of the annual auxiliary boiler, diesel generator, and gas turbine air emissions, which include NO_X, CO, SO_X, hydrocarbons in the form of VOCs, and PM_{10}, are shown in Table 3-30.

Table 3-30. Annual Estimated Emissions from Cooling Towers, Auxiliary Boilers, Diesel Generators, and Gas Turbines at the CRN Site

Emission Effluent	Cooling Towers (lb/yr)[1]	Auxiliary Boilers (lb/yr)[2]	Diesel Generators (lb/yr)[3]	Gas Turbines (lb/yr)[4]	Total (lb/yr)	Emissions (lb/yr)
Nitrogen Oxides	NA[5]	33,900	39,000	2,300	75,200	37.6
Carbon Monoxide	NA	5,900	3,100	600	9,600	4.8
Sulfur Oxides	NA	41,600	NA	25	41,625	20.8
Volatile Organic Compounds[6]	NA	500	700	15	1,215	0.6
Particulate Matter (PM_{10})	6,700	7,700	300	NA	14,700	7.4

[1]Based on 8,760 hours of operation at 0.76 lb/hr, using Reisman and Frisbie 2002
[2]Based on 36 days of operation, one auxiliary boiler
[3]Based on 4 hours operation per month
[4]Based on 4 hours of operation per month
[5]NA = not applicable
[6]As total hydrocarbon

Since no specific reactor technologies and associated supporting equipment have been selected, detailed emission data are not available at this time. Equipment associated with which are defined in the PPE (Appendix A), would contribute gaseous and particulate emissions to the air. The auxiliary boilers would be used for heating buildings associated with the new plant, primarily during the winter months, and for process steam during site startups. The diesel generators/gas turbines and engine-driven emergency equipment would be used intermittently and for brief durations.

For the purposes of the PPE, it is expected that one or more mechanical draft cooling towers would be used to provide reactor process water cooling primarily for the SMRs. However, the non-LWR reactors may not use water for cooling or require external cooling systems. The exact locations of the cooling towers would depend upon where the reactors are constructed. The proposed cooling towers remove excess heat by evaporating water. Upon exiting the tower, water vapor mixes with the surrounding air, and this process generally leads to condensation and formation of a visible plume, which would have aesthetic impacts. Other potential impacts include ground-level fogging/icing, plume shadowing, drift deposition from dissolved salts and chemicals found in the cooling water, and ground-level temperature and humidity increases. In addition, plumes from the cooling towers could interact with emissions from other sources. However, TVA performed a SACTI analysis that demonstrated that due to the relatively small size of the cooling towers (in comparison to cooling towers servicing a large power plant), and the temperature and climate of the area, there would be no hours of fogging or icing. Any mechanical draft cooling towers used onsite would be equipped with efficient drift eliminators to reduce PM emissions and the effects of drift around the CRN Site.

Predicted potential impacts of plumes from cooling towers would be limited primarily to the immediate onsite area and just beyond the site boundary. The area around the CRN Site is relatively sparsely populated and is therefore less sensitive to the potential impacts from cooling-tower operations. Therefore, atmospheric impacts of cooling-tower operation at the CRN Site would not be noticeable and no further mitigation is required.

Combustion sources that would be associated with new reactors at the CRN Site would operate for only limited periods. With the exception of particulates, these combustion sources emit criteria air pollutants (such as NO_X, SO_2, and CO) that are different from those produced by the cooling towers (i.e., small amounts of PM as drift). Interaction among pollutants emitted from these sources and the cooling-tower plumes would be for only limited periods and would not have a significant impact on air quality.

Small amounts of O_3 and even smaller amounts of NO_X are produced by transmission lines. The production of these gases was found to be insignificant for 745-kV transmission lines (the largest lines in operation) and for a prototype 1,200-kV transmission line (NRC 2013). Transmission line upgrades described in Section 2.4.2 may be necessary to support the added generation capacity. Given the sizes of the existing transmission line sizes and additions, air quality impacts from transmission lines would not be noticeable and mitigation would not be warranted.

Air emission sources associated with new reactors would be managed in accordance with federal, state, and local air quality control laws and regulations. New reactors at the CRN Site would comply with all regulatory requirements of the CAA, as well as the TDEC requirements to minimize impacts on state and regional air quality. As reactor designs are selected for placement in the Nuclear Technology Park, detailed air quality modeling would be conducted as required to demonstrate that project-related emissions would not result in exceedances of the NAAQS. Because the CRN Site is currently located in an attainment area for all criteria pollutants, the proposed project would not be subject to a Nonattainment New Source Review.

It is anticipated that up to 500 operational staff would be present once the park achieved 800 MW build-out. Nominal localized increases in emissions would occur due to the increased numbers of cars, trucks, and delivery vehicles that would travel to and from the CRN Site. Most of the increased traffic would be associated with employees driving to and from work and routine deliveries by truck to the site. Additionally, traffic delays and congestion may be expected to occur at key intersections surrounding the CRN Site during peak hours that may increase localized emissions, particularly during periods where there could be an overlap between construction and operational activities as it is likely portions of the CRN Site could be developed at different times. However, during operation alone, such increased traffic volumes and increased delays would be less than that for construction. Therefore, mitigation measures implemented for construction such as staggering of work shifts to avoid localized delays at key intersections and planned road improvement (see Section 3.12 Transportation) should be more than adequate to prevent congestion during operations. With the proposed mitigation, impacts on local and regional air quality from operation-related traffic would minor. Mitigation measures should also include instances when multiple plants are constructed following staggered schedules, so that traffic related to construction and operation overlap.

As described in Section 3.11.1.1, the closest mandatory Class I Federal area where visibility is an important value is the Great Smoky Mountains National Park near Gatlinburg, Tennessee (40 CFR 81.428), approximately 31 miles east-southeast of the CRN Site. Another Class I Federal area, the Joyce- Kilmer Slickrock Wilderness Area, in Graham County, North Carolina (40 CFR 81.428), is approximately 36 miles to the southeast. These Class I areas are located crosswind to the prevailing southwesterly and northeasterly winds around the CRN Site, so direct transport from the CRN Site to these Class I areas is unlikely. Given the minor air emissions from the CRN Site, there is little likelihood that activities at the CRN Site could adversely affect air quality, including visibility or acid deposition, in these Class I areas.

3.11.2.2.2 Climate Change and Greenhouse Gases

3.11.2.2.2.1 Construction

Construction activities, such as operation of construction vehicles, commuter vehicles, construction equipment, and marine engines, would result in GHG emissions, principally CO_2. The NRC ESP FEIS provides an estimate of the GHG footprint for a reference 1,000-MWe light water reactor. The GHG emission estimates include direct emissions from the nuclear facility and indirect emissions from workforce transportation and the uranium fuel cycle. The reference reactor assumes a 7-year construction period. Specifically, the GHG footprint includes estimated emissions of 39,000 MT CO_2 equivalent (CO_2e)[1] for construction. This value would not significantly differ for any reactor technology considered because TVA used an 80 percent capacity factor for a 1,000-MWe reference nuclear power plant and a 90 to 98 percent capacity factor for the 800-MWe CRN Site. The estimated GHG emissions translates to an emission rate of about 5,570 MT CO_2e annually, averaged over a 7-year period of construction. To put this into perspective, this emission rate corresponds to approximately 0.006 percent of the total estimated GHG emissions in Tennessee (100,000,000 MT of gross[2] CO_2e) in 2015. This also equates to about 0.00008 percent of the total U.S. annual emission rate of 6.6 billion MT CO_2e in 2015.

Workforce transportation would also result in GHG emissions, principally CO_2. Assuming a 7-year period for construction activities and a typical workforce size contained in the estimated GHG footprint, the total workforce GHG emission footprint for building the 1,000-MWe reference reactor would be on the order of 43,000 MT CO_2e. This total emission quantity translates to a rate of about 6,100 MT CO_2e annually, averaged over the 7-year period of construction. This amounts to approximately 0.006 percent of the total estimated GHG emissions in Tennessee (100,000,000 MT of gross[3] CO_2e) in 2015 and 0.00009 percent of the total U.S. annual emission rate of 6.6 billion MT CO_2e in 2015.

In general, air emissions from construction activities, including GHG emissions, would vary based on the level and duration of a specific activity, but the overall impact is expected to be temporary and limited in magnitude. TVA would develop and implement emission-specific strategies to ensure compliance with applicable air quality standards such as:

- Scheduling 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

Based on the projected size of the construction workforce and the GHG footprint compared to the Tennessee and U.S. annual GHG emissions, the atmospheric impacts of GHGs from workforce transportation would not be noticeable and additional mitigation would not be

[1] A measure to compare the emissions from various greenhouse gases (GHGs) on the basis of their global warming potential, defined as the ratio of heat trapped by one unit mass of the GHG to that of one unit mass of CO_2 over a specific time period.
[2] Total GHG emissions estimate is based on twice the reported emissions from large emitting facilities.
[3] Total GHG emissions estimate is based on twice the reported emissions from large emitting facilities.

warranted. Based on the limited increase in local vehicle traffic and TVA's plans to implement the mitigation measures above, the impact on the air quality from construction activities, including effects of GHG emissions, would be short term and minor.

3.11.2.2.2.2 Operation

The emission of some GHGs, primarily CO_2, along with CH_4 and N_2O, are to be expected in the Nuclear Technology Park. Based on the GHG emission estimates in the NRC ESP FEIS for the reference 1,000-MWe reactor, the total GHG footprint for operating a new nuclear power plant for 40 years is on the order of 317,000 MT of CO_2e. The value of 317,000 MT CO_2e includes the emissions from a nuclear power plant operating (181,000 MT CO_2e) and the associated emissions from the operation workforce (136,000 MT CO_2e). The CO_2e emission rate 317,000 MT corresponds to an emission rate of about 7,925 MT CO_2e annually, averaged over the 40-year period of operation. This amounts to approximately 0.008 percent of the total projected GHG emissions estimate in Tennessee of 100,000,000 MT of gross CO_2e in 2015. This also equates to about 0.0001 percent of the total U.S. annual emission rate of 6.6 billion MT CO_2e in 2015.

GHG emissions are also subject to PSD review as of January 2, 2011. A new major stationary source is subject to PSD permitting for GHGs if the source is major for a regulated NSR pollutant that is not GHGs and also has the potential to emit 75,000 tons per year CO_2e. Based on an estimate of 7,925 MT CO_2e emitted annually from operation of a new nuclear power plant at Area 1, the CRN project would not be classified as a major source for GHGs. TVA would obtain the required air emissions permits under Tennessee and Federal laws.

Based on its assessment of the GHG footprint of plant operation as compared to the annual GHG emissions for Tennessee and the U.S., the atmospheric impacts of GHGs from operation of advanced nuclear reactors would be minor, and additional mitigation would not be warranted.

3.11.2.2.2.3 Fuel Cycle and Fossil Fuel Consumption

The largest source of GHG emissions associated with nuclear power is from the nuclear fuel cycle, not operation of the nuclear power plant. The largest source of GHGs in the nuclear fuel cycle is production of necessary electric energy and process heat from combustion of fossil fuel in conventional power plants. This energy is used to provide power for components of the fuel cycle such as enrichment. Further consideration of the GHG emissions and other effects of the uranium fuel cycle are provided in Section 3.21.

3.11.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced Non-LWRs

The impacts on air quality and from GHG emissions for Alternative C would be similar to those for Alternative B.

3.11.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced Non-LWRs

Under Alternative D, the impacts on air quality and from GHG emissions would be greater in physical extent because activities would occur over different parts of Area 1 and also Area 2 but ultimately are similar to those discussed under Alternative B.

3.11.2.5 Potential Contributing Effects of Other Reasonably Foreseeable Future Actions

As described in Section 3.11.1.3, several reasonably foreseeable future actions were identified in proximity to the CRN Site. Depending on the local environmental setting and the design characteristics of these other proposed actions, direct increases or changes in air emissions would be expected. These identified foreseeable future actions by others would result in air emissions that would potentially affect the same region as that of the CRN Site and, as such, may have the potential to affect air quality during both construction and operational phases. Example projects include the Kairos Hermes reactor project, proposed actions at ORNL, development of the Horizon Center, and the development of the municipal airport at the ETTP. Construction activities would increase particulates and other pollutants in conjunction with land disturbance and vehicular emissions. Because increased traffic generation by the CRN project (and others) during construction is typically greater than that of operational phases, these reasonably foreseeable future projects have the potential to be more pronounced during the construction phase of the CRN Nuclear Technology Park. However, potential impacts to air quality from construction activities from each of these projects are expected to be minor, localized, and short term. Consequently, even for projects that have construction schedules that overlap with that of the CRN Site, no notable cumulative effects to air quality are expected. Operational phase activities would also increase emissions in conjunction with facility operations. Similar to the CRN Nuclear Technology Park, reasonably foreseeable future projects would be subject to operational phase air permits processed through TDEC, as applicable. Permitting reviews performed by TDEC are conducted to ensure that new permits do not result in regional air quality degradation. Therefore, the cumulative effects on regional air quality are minor.

3.11.2.6 Summary of Impacts on Air Quality and Climate Change

As summarized in Table 3-31, TVA has determined that impacts on local and regional air quality during construction are minor and temporary. During operation of advanced nuclear reactors, emissions from vehicles and mobile equipment, auxiliary systems and cooling towers have limited impacts on local and regional air quality. Regarding GHG emissions, atmospheric impacts of GHG emissions during construction are temporary and minor. Likewise, atmospheric impacts of GHG emissions during operation of advanced nuclear reactors are also relatively minor and not noticeable.

Table 3-31. Summary of Impacts on Air Quality and GHG Emissions

Alternative	Project Phase	Impact	Severity
Alternatives B, C, D	Construction	Particulate and gaseous emissions from land clearing, earthmoving, other construction-related activities, and work force commute.	Temporary and localized impacts on air quality, the locations of which depend upon the exact location of the construction sites. Air quality impacts mitigated by dust control measures applied in accordance with air permit requirements.
		GHG emissions from vehicles and equipment supporting construction activity.	Atmospheric impacts of GHG emissions are temporary and minor. Emissions reduced by minimizing idling time and staggering workforce shifts.

Alternative	Project Phase	Impact	Severity
Alternatives B, C, D	Operation	Particulate and gaseous emissions from mobile sources (worker vehicles, onsite heavy equipment, and support vehicles; material delivery and waste removal vehicles).	Minor impacts.
		Particulate and gaseous emissions from auxiliary boilers for heating and startup.	Minor impacts mitigated by limited building heating requirements (primarily during winter months) and limited startup operations.
		Emissions from engine-driven emergency equipment, diesel generators and gas turbines.	Minor impacts mitigated by limiting operations to periodic testing and emergency use.
		Particulate emissions and visible plumes from cooling towers.	Impacts are reduced by installation of efficient particulate drift eliminators. Potential minor impacts limited to the immediate onsite area and site boundary. The area around the CRN Site is sparsely populated and thus relatively less sensitive to impacts.
		Small amounts of O_3 and NOx produced by transmission lines.	Production of O_3 and NOx was found to be insignificant for 745-kV transmission lines and a prototype 1,200-kV line. Impacts are minor.
		GHG emissions from plant operation, vehicles, and equipment.	Atmospheric impacts of GHG emissions from operations are relatively minor and not noticeable.

3.12 Transportation

3.12.1 Affected Environment

The transportation network in the area around the CRN Site consists of a network of federal and state highways; three freight rail lines; one major navigable river; one commercial passenger airport, McGhee Tyson Airport; and the Knoxville Downtown Island Airport (see Figure 1-1).

3.12.1.1 Roads

The eight federal highways provide access to the geographic area of interest include I-40, I-75, US 11, US 27, US 70, US 129, US 321, and US 441. The closest interstate highway to the CRN Site is I-40, which runs east to west approximately 0.6 miles southeast of the CRN Site. Tennessee State Highways in the vicinity of the CRN Site include TN 58, TN 95, US 321/TN 73, TN 326, TN 327, and TN 1/US 70. TN 58 and TN 95 are the primary roadways near the CRN Site. TN 95 runs north to south approximately 2.6 miles east of the CRN Site and connects to the City of Oak Ridge business district approximately 10 miles to the northeast.TN 58 runs northeast to southwest approximately 0.9 miles northwest of the CRN Site and terminates at TN 95 approximately 3.2 miles north-northeast of the CRN Site (see Figure 1-1).

TN 58 is a five-lane northeast/southwest principal arterial north and west of the CRN Site that connects I-40 to TN 95 via an interchange. Posted speed limits along TN 58 vary between 45 and 55 mph. Bear Creek Road is a two-lane roadway that provides the only existing access to the CRN Site. Bear Creek Road is accessed shortly after crossing the Gallaher Bridge by a left turn from northbound TN 58 onto a loop ramp. From this location Bear Creek Road extends to the southeast under TN 58 to the entrance to the CRN Site. Bear Creek Road then makes a left turn to head northeast to an intersection with TN 95 (Figure 1-1). Posted speed limits along Bear Creek Road are primarily 45 mph.

TN 95 is a two-lane north/south principal arterial approximately 2.6 miles east of the CRN Site that connects I-40 to TN 58 (eventually to the City of Oak Ridge). TN 58 terminates at TN 95 north of the CRN Site via an interchange. TN 95 has a traffic volume of 6,057 vehicles per day with three percent heavy vehicles. Posted speed limits along TN 95 are primarily 55 mph. Several locations along TN 95 contain 35 mph advisory speed limit signs due to the horizontal (corners/bends) and vertical (hills/valleys) curvature of the roadway.

TN 327 is a two-lane north/south major collector that connects TN 58 to TN 61 carrying approximately 3,000 vehicles per day with two percent heavy vehicles. TN 61 connects the towns of Oliver Springs and Harriman, Tennessee to Oak Ridge and Clinton, Tennessee where it intersects I-75. Posted speed limits along TN 327 are primarily 35 mph.

In addition to the federal highways near the CRN Site, Jones Island Road is an existing private road that runs along the shoreline of the Reservoir on DOE property east of the CRN Site boundary. Access to Jones Island Road is provided at the gated entrance to the DOE property on TN 95. The road is a partially developed gravel roadway which can experience flooding in some areas during prolonged wet weather. Access and use of the road are restricted by DOE.

3.12.1.2 Traffic Conditions

3.12.1.2.1 Level of Service (LOS)

The traffic carrying ability of a roadway is described by level of service (LOS). LOS is a quality measure describing operational conditions within a traffic stream, generally in terms of such service measures as speed and travel time, freedom to maneuver, traffic interruptions, and comfort and convenience. Table 3-32 lists traffic conditions associated with LOS as described by the Florida Department of Transportation (FDOT 2020).

Table 3-32. Traffic Conditions Associated with Level of Service

Level of Service	Traffic Condition
A	free flow traffic conditions
B	free flow conditions although presence of other vehicles begins to be noticeable
C	increases in traffic density become noticeable but remain tolerable to the motorist
D	borders on unstable traffic flow; the ability to maneuver becomes restricted; delays are experienced
E	traffic operations are at capacity, travel speeds are reduced, ability to maneuver is not possible; travel delays are expected
F	designates traffic flow breakdown where the traffic demand exceeds the capacity of the roadway; traffic can be at a standstill

Vehicle volume on roads is provided by TDOT in the form of estimated annual average daily traffic (AADT) counts. The 2020/2021 AADT counts for the primary roadways that would serve the CRN Site, presented in Table 3-33, are measured in vehicles per day (veh/day). LOS on these roadways was calculated for the most recent daily traffic volumes and ranged from LOS A to LOS B.

Table 3-33. Average Annual Daily Traffic Counts of Affected Roadways

Roadway Segment	2020/2021 Average Daily Vehicle Use (veh/day)[1]	Functional Classification	Number of Lanes	Existing Level of Service[2]
Bear Creek Road (TN 58 to TN 95)	383	Local	2	B
TN 58 (Clinch River to TN 95)	11,121	Principal Arterial	4	B
TN 95 (TN 58 to Clinch River)	6,047	Principal Arterial	2	B
TN 95 (Clinch River to I- 40)	5,599	Principal Arterial	2	B
TN 327 (TN 61 to TN 58)	2,569	Major Collector	2	B
I-40 (at TN 95)	39,707	Interstate	4	A

[1] Source: TDOT 2021a. Value shown is average of all available AADT data for area roadway segments.
[2] Source: based on criteria in FDOT 2020.

Capacity analyses were performed for the 10 intersections most likely to be affected by construction and operation of the Nuclear Technology Park at the CRN Site for 2021 AM and PM peak hours. These intersections and results of the capacity analysis for each are described below and in Table 3-34. The existing LOS for each intersection is depicted in Figure 3-18.

TN 58 at Bear Creek Road Ramp

This unsignalized intersection currently operates at an LOS B in the AM peak hour and an LOS B during the PM peak hour. No significant queuing is present at this intersection.

TN 58 at TN 327

This signalized intersection currently operates at an LOS B in the AM and PM peak hours. No significant queuing is present at this intersection.

Bear Creek Road at TN 58 Southbound Ramp

This unsignalized intersection currently operates at an LOS A in the AM and PM peak hours. In the AM peak hour, the major turning movement is the southbound left-turn from Bear Creek Road ramp onto Bear Creek Road. This movement is stop-controlled; however, low volumes on Bear Creek Road allow this stop-controlled intersection to operate with minimal delay. In the afternoon, most of the vehicles turn right onto Bear Creek Road ramp from Bear Creek Road. This movement operates under yield control with minimal delay. The west leg (Bear Creek Road) of this intersection carries minimal traffic because it is restricted to personnel entering the DOE's ORR as indicated on a sign. No significant queuing is present at this intersection.

TN 95 at TN 58 Northbound and Southbound Off-Ramps

This is a freeway interchange with free-flowing ramps for all movements. The ramp merging and diverging movements operate at LOS A at all times.

TN 95 at Bear Creek Road One Way Ramp

This unsignalized intersection is a one-way ramp from Bear Creek Road to TN 95 and operates at LOS B in the AM peak hour and LOS F in the PM peak hour. This serves as an exit option from Bear Creek Road to TN 95 northbound for traffic generated from the ORNL and the Y-12 National Security Complex. The intersection is over capacity (LOS F) in the PM peak hour due to the large volume of right turning westbound vehicles. There is also some queuing during that period within the westbound right turn.

TN 95 at Bear Creek Road

This unsignalized intersection currently operates at an LOS B in the AM peak hour (eastbound approach) and a LOS C during the PM peak hour (westbound approach). In the PM peak hour, the major turning movement is the westbound left-turn from Bear Creek Road onto TN 95 for traffic generated from the ORNL and the Y-12 National Security Complex. In the afternoon, most of the vehicles leaving the facilities use the one-way ramp described above located approximately 1,000 feet north of this intersection. Traffic volumes on movements to and from Bear Creek Road are very low and traffic is minimal along TN 95. This intersection is over capacity (LOS F) in the PM peak hour and there is some queuing during that period of the westbound left turn.

TN 95 at Bethel Valley Road

This signalized intersection currently operates at an LOS B in the AM and PM peak hours. No significant queuing is present at this intersection.

TN 95 at Buttermilk Road

This unsignalized intersection currently operates at LOS B in the AM peak hour and LOS C in the PM peak hour.

TN 95 at I-40 Westbound and Eastbound Ramps

This signalized diamond interchange consists of two signalized intersections that operate in coordination. The westbound ramp intersection (northern intersection) operates at LOS C in the AM peak hour and LOS B in the PM peak hour. The eastbound ramp intersection (southern intersection) operates at LOS B in the AM and PM peak hours.

Table 3-34. CRN Site Area Intersections Existing Conditions

Intersection	Description	Turning Movement	LOS
TN 58			
TN 58 at Bear Creek Road Ramp	Unsignalized T - Intersection (One-Way Stop)	Eastbound Left (Ramp to Northbound TN 58)	B
Bear Creek Road at TN 58 Southbound Ramp	Unsignalized T-Intersection (One-Way Stop)	Southbound Left (Ramp to Eastbound Bear Creek)	A
TN 95			
TN 58 Northbound and Southbound Off-Ramps to TN 95 Southbound	Freeway to Freeway Interchange	Merge	A
TN 95 Northbound to TN 58 Northbound and Southbound On-Ramps	Freeway to Freeway Interchange	Diverge	A
Bear Creek Road One Way Ramp at TN 95 Northbound	Unsignalized T -Intersection (One Way Stop)	Westbound Right	F
Bear Creek Road at TN 95 Northbound and Southbound	Unsignalized Four Leg Intersection (Two-Way Stop)	Westbound Left	F
TN 95 at Bethel Valley Road	Signalized 3-Leg Intersection	Various	B
Buttermilk Road at TN 95 Northbound and Southbound	Unsignalized T - Intersection (One Way Stop)	Eastbound Left from Buttermilk Road onto TN 95 North	C
TN 95 at I-40 Westbound Ramps	Signalized Freeway Ramp	Various	B
TN 95 at I-40 Eastbound Ramps	Signalized Freeway Ramp	Various	B

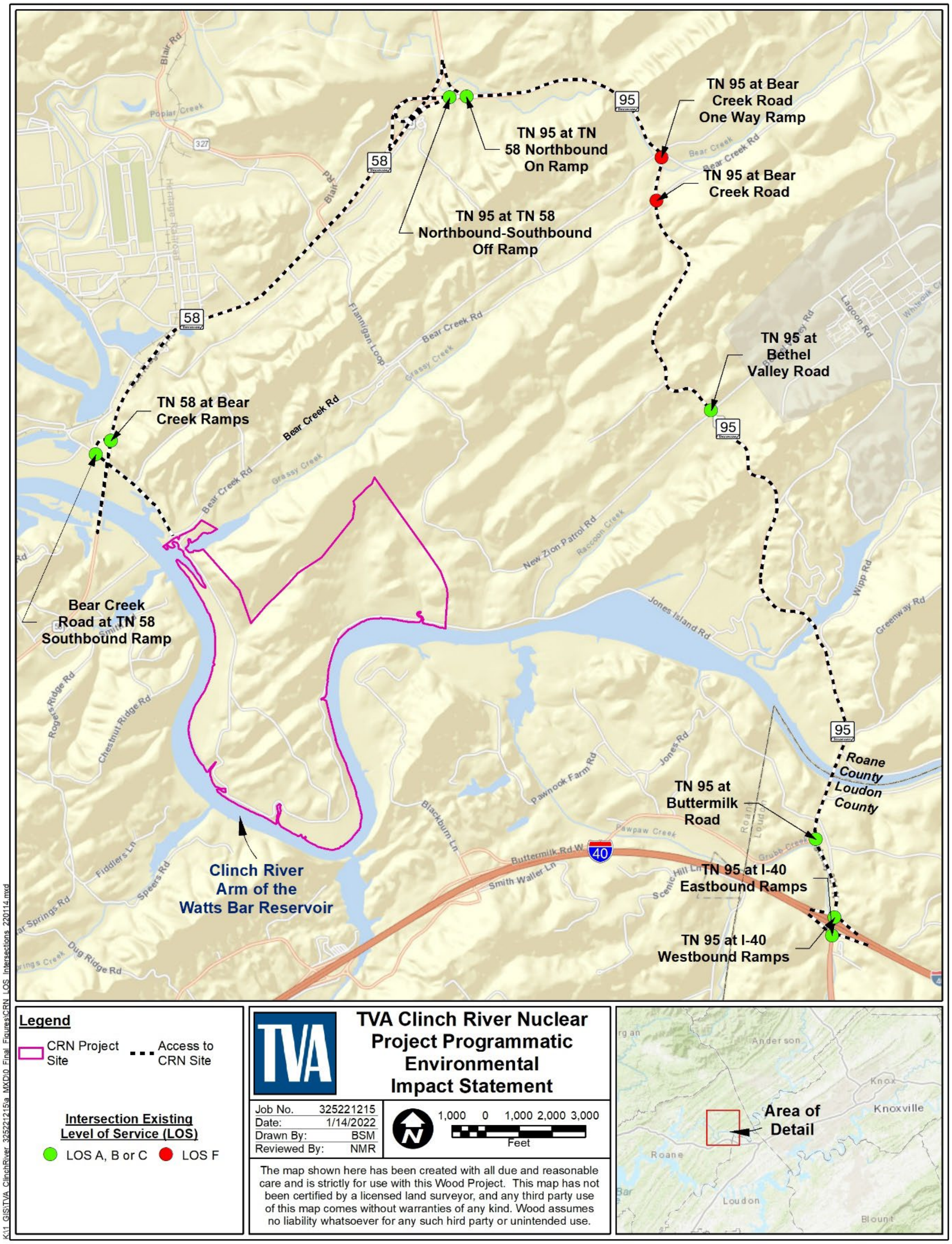


Figure 3-18. LOS at Existing Intersections Near the CRN Site

3.12.1.2.2 Traffic Crashes

The three primary roadways providing access to the CRN Site via Bear Creek Road are TN 58, TN 95, and TN 327. Crash data (from January 2019 through September 2021) were analyzed for segments of these three roadways to determine rates of traffic crashes for injury crashes, fatality crashes, and total crashes. Traffic crash data for the primary CRN Site roadways are presented in Table 3-35. Of the three roadways, TN 327 has the highest overall crash rate in annual crashes per million vehicle miles travelled (MVM) because the crashes occurred over a shorter and lower volume road. TN 95 has the lowest overall crash rate among the roadways near the CRN Site.

Table 3-35. Traffic Incident Rates in the Vicinity of the CRN Site (January 2019 to September 2021)

Incident Type	TN 58 (LM 17.60 to LM 20.18)	TN 95 (LM 0.00 to LM 6.70)	TN 327 (LM 0.00 to LM 2.20)
2021 Average Daily Traffic	11,121	6,047	2,569
Length (miles)	2.58	6.7	2.2
No. of Crashes (2019 to 2021)	29	36	14
No. of Injury Crashes (2019 to 2021)	6	11	3
No. of Fatality Crashes (2019 to 2021)	0	2	0
Overall Crash Rate per Year per 100 MVM	100.7	88.5	247.8
Injury Crash Rate per Year per 100 MVM	20.8	27.1	52.9
Fatality Crash Rate per Year per 100 MVM	0.0	4.9	0.0

LM = Log Mile, MVM = Million Vehicle Miles
Source: TDOT 2021b

3.12.1.3 Railroads

Figure 1-1 shows railways within the area surrounding the CRN Site. In Oak Ridge, Energy Solutions, LLC operates the 11.5-mile Heritage Railroad shortline serving the ETTP. This rail spur terminates at the rail offloading area to the northwest of the BTA, approximately 2.5 miles north-northwest of the CRN Site. A second shortline, operated by Knoxville and Holston River Railroad, extends 18 miles from Knoxville through Knox County. Both of these lines connect with rail lines operated by Norfolk Southern Railway Company. Norfolk Southern rail lines are located approximately 7.5 miles northwest and 9 miles southeast of the CRN Site. The line to the southeast runs through Knoxville, connecting Chattanooga with Johnson City and Kingsport, Tennessee.

3.12.1.4 Navigable Waterways

The CRN Site is immediately adjacent to the Reservoir between approximately CRMs 14.5 and 19. The Clinch River is a major tributary of the Tennessee River. The Tennessee River has a main navigable channel 652 miles long that begins at Knoxville and merges with the Ohio River in Paducah, Kentucky. This channel is controlled by a series of nine mainstream dams and locks that are part of TVA's integrated river control system consisting of a total of 49 dams and 15 navigation locks. Commercial navigation occurs on the Clinch River for 61 miles. The commercially navigable portion of the Clinch River extends from its mouth near Kingston, Tennessee upstream to Clinton, Tennessee. The navigable portion of the Clinch River includes a navigation lock at the Melton Hill Dam, 5 river miles north of the CRN Site.

3.12.1.5 Airports

The closest commercial airport to the CRN Site is the McGhee Tyson Airport in Alcoa, Tennessee. This airport is approximately 22.0 miles east-southeast of the CRN Site. Another smaller airport, the Knoxville Downtown Island Airport, is located in Knoxville. It is a reliever airport, designed to provide additional capacity for the McGhee Tyson Airport. Additionally, the Rockwood Municipal Airport is a public use airport in Roane County, located approximately 25 miles west of the CRN Site. As described in Section 3.1.3, the City of Oak Ridge, Tennessee is planning the development of a general aviation airport on the site of a large industrial complex, the ETTP, located approximately 3.5 miles north of the CRN Site. Although the final plans have not yet been completed, the airport conceptual layout includes a 5,000-foot runway which could be used by corporate jets, private airplanes, and Emergency Medical Service aircraft.

3.12.1.6 Reasonably Foreseeable Future Actions in Proximity to the CRN Site

As noted in Section 3.1.3, TVA identified several foreseeable future actions in proximity to the CRN Site. The scope of these other proposed actions is expected to result in both construction phase and operational phase traffic generation that would increase traffic volumes on associated roadways. Specific foreseeable future actions that may contribute traffic to the roadways served by the CRN Project include the potential development of the Kairos Hermes Reactor Project, the development of the new airport by the City of Oak Ridge (both at the ETTP), the proposed construction of new production facilities at the Y-12 complex, and potential development at the Horizon Center Industrial Park. While the specific details regarding the scope of many of these actions is generally not available, each of these projects would potentially contribute both construction and operational phase traffic to the same regional roadway network surrounding the CRN Site. Because each of these actions has the potential to affect the same roadway network, further consideration of reasonably foreseeable future actions and their effects on the local transportation system are included in the following section as appropriate.

3.12.2 Environmental Consequences

3.12.2.1 Alternative A – No Action Alternative

Under the No Action alternative, TVA would not develop a Nuclear Technology Park at the CRN Site. As such under this alternative there would be no alteration of transportation facilities associated with the project. Therefore, there would be no impacts to transportation under Alternative A.

3.12.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced Non-LWRs

Existing transportation routes would be affected by the transportation of equipment, materials, supplies, and the construction workforce to the CRN Site. As stated above, the CRN Site can be accessed via roads, rail, and the Reservoir, and all transportation modes likely would be used during building activities. Large components and equipment could be transported by barge via the Tennessee and Clinch Rivers or by rail. TVA plans to refurbish the existing DOE barge facility in the BTA as described in Section 2.4.4.1 or may choose to construct an onsite barge landing area.

Under Alternative B, several roadway projects would be developed to accommodate workforce construction and operational traffic at the Nuclear Technology Park. These improvements are described in Section 2.4.1.2 and include the following as illustrated on Figure 3-19 and Figure 3-20:

- *Construction of New Ramps to Facilitate Access of Bear Creek Road and TN 58*. An additional northbound loop ramp between TN 58 and Bear Creek Road would be constructed to provide added capacity for the peak construction and operation traffic (Figure 3-19). This would allow traffic to/from the primary CRN Site entrance at Bear Creek Road to be distributed between two ramps rather than the existing configuration that includes one ramp.
- *Bear Creek Road Intersection with CRN Site Access*. The connection from the CRN Site access road onto Bear Creek Road would be improved to include a traffic signal with two receiving lanes onto Bear Creek Road (Figure 3-19). Bear Creek Road would also be realigned to a T-intersection, eliminating the existing curve at the CRN Site entrance, and would also be widened and upgraded to create a heavy haul road from the CRN Site entrance to the rail delivery area.
- *Improvements to the CRN Site Access Road*. These improvements would entail the upgrading of the existing roadway to a permanent heavy-haul road from the site entrance to the plant area (Figure 3-19). Eighty percent of construction and operation traffic at the CRN Site would use the upgraded highway interchange and primary access at Bear Creek Road to enter and exit the site.
- *New TN 95 Access*. In addition to improvements at the primary CRN Site entrance, a secondary entrance, the TN 95 Access, would be developed to accommodate approximately 20 percent of construction and operation traffic (Figure 3-20). The TN 95 Access would originate at the intersection of TN 95 and an existing gated entrance road to DOE property (See Section 2.4.1.2). The access road would then connect to Jones Island Road and River Road and traverse through DOE property along the shoreline of the Reservoir for a distance of approximately 2.3 miles to the CRN Site boundary. As shown in Figure 3-20, the intersection at Route 95 would be signalized and consist of left and right turning lanes.

Traffic capacity analysis modeling was used to determine the ability of roadways accessing the CRN Site to accommodate the influx of traffic associated with construction and operation at the Nuclear Technology Park. The capacity analysis was conducted using Synchro 10 software, which follows Transportation Research Board Highway Capacity Manual (HCM 2016) practices that are considered the national standard. The capacity analysis is based on a combination of peak construction employment, operation workforce, and baseline background traffic. The analysis considers 13 intersections shown in Figure 3-21, which include both existing and proposed intersections that are most likely to be affected by the CRN Nuclear Technology Park construction and operation traffic. Among the 13 intersections analyzed, ten are existing and three would be added as part of the project. The new intersections include the TN 58 northbound loop ramp at Bear Creek Road, a roundabout at the northbound ramp and Bear Creek Road, and a “T” intersection at Bear Creek Road and the CRN Site entrance.

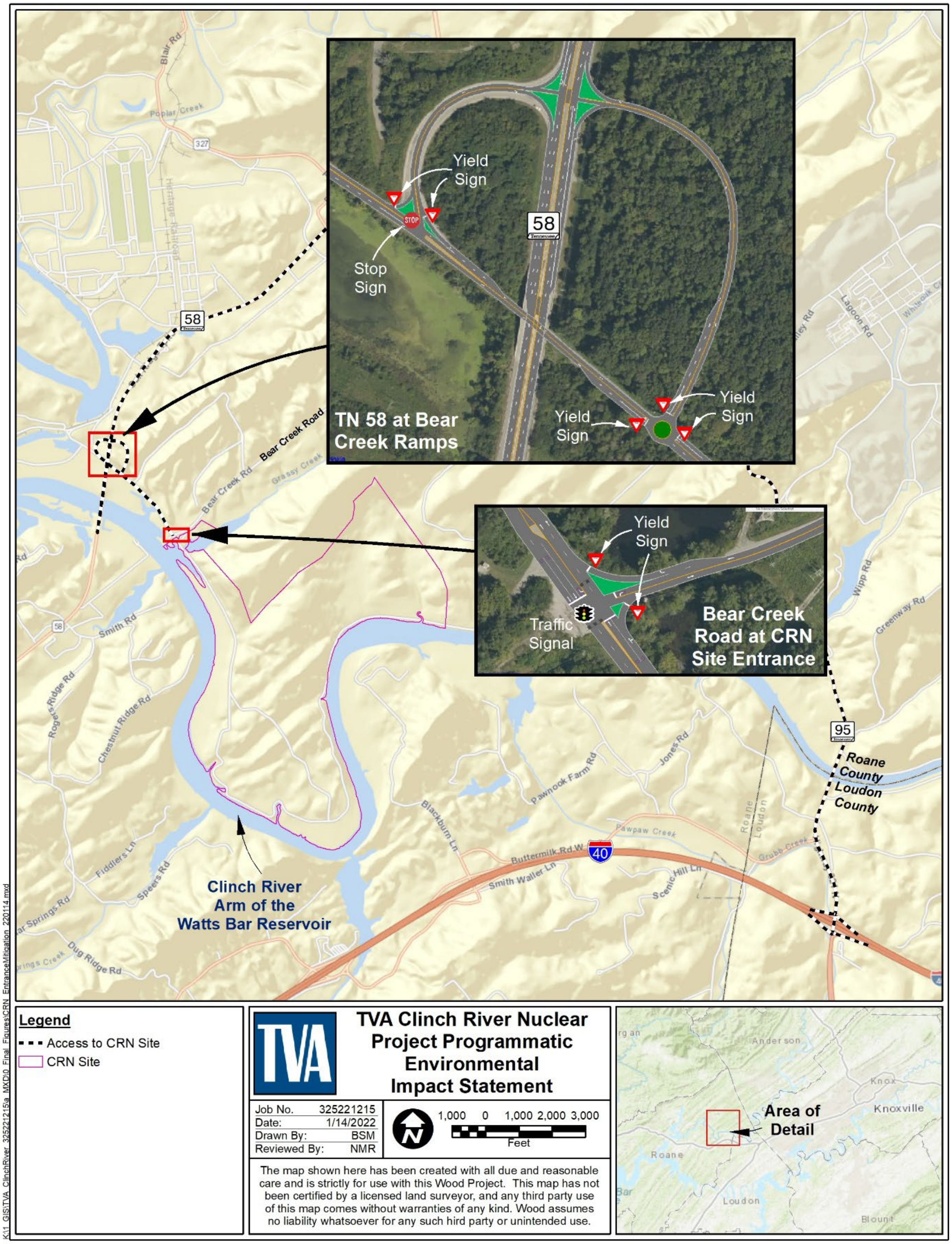


Figure 3-19. Proposed TN 58 and Bear Creek Road Improvements

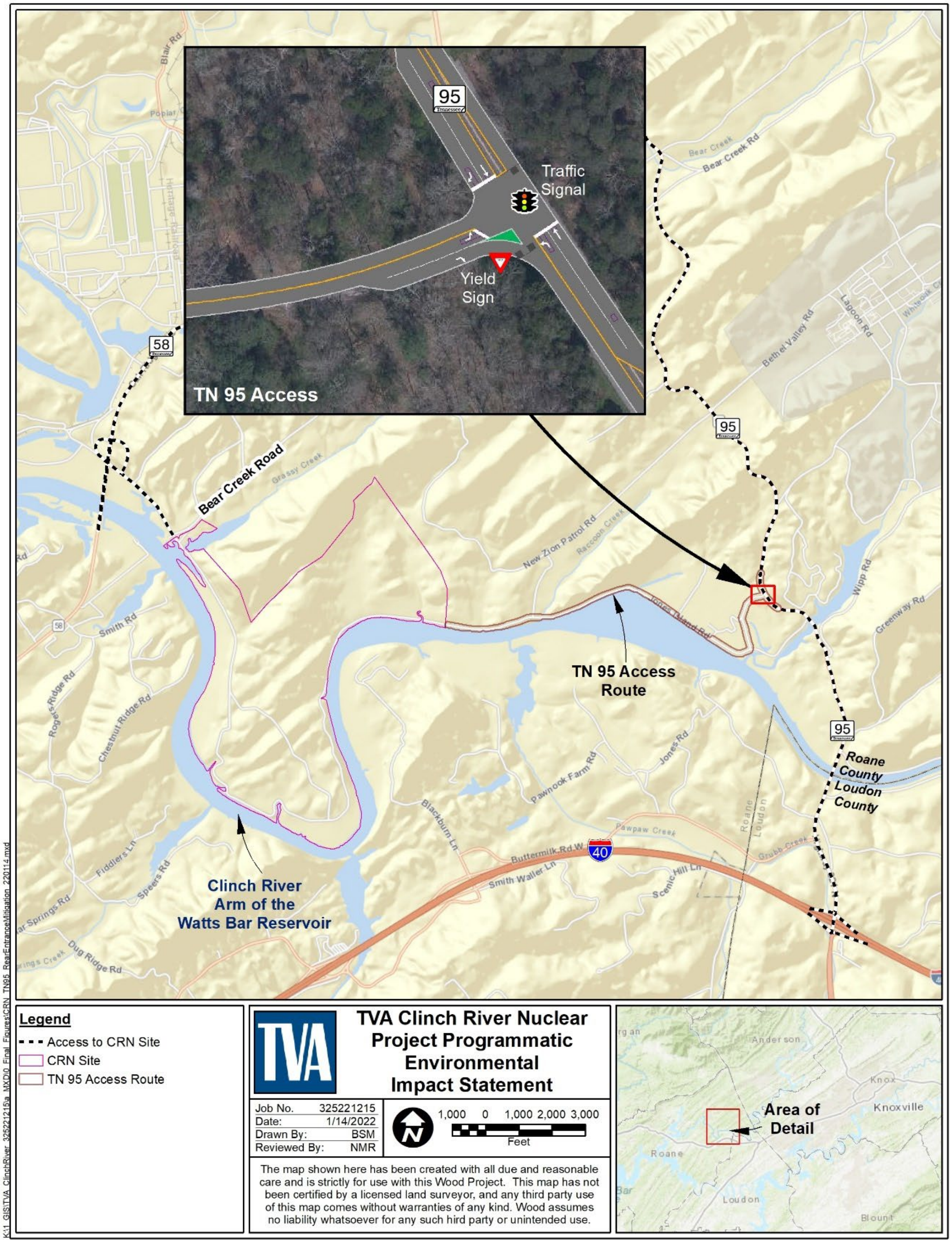


Figure 3-20. Proposed TN 95 Access Intersection

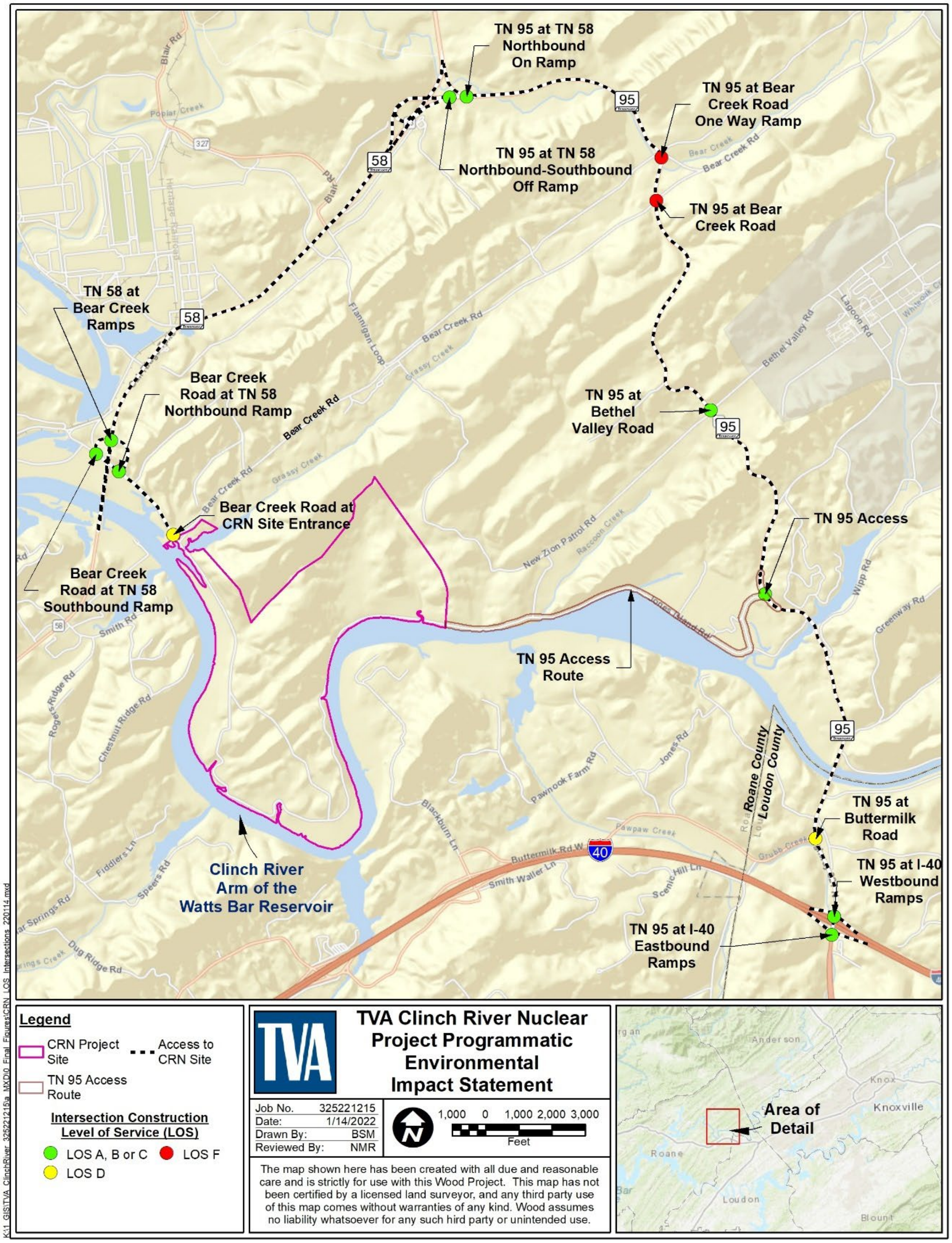


Figure 3-21. Construction Phase LOS at Key Intersections Near the CRN Site

Other assumptions used in the capacity analysis include the estimated daily workforce generated during CRN construction of 3,666 workers during the peak month of construction, which consists of 3,300 workers plus an additional 366 workers. It is also assumed that carpooling during construction would create an average of 1.3 persons per vehicle. In addition to workforce traffic, other construction-related trucking would include an estimated 30 trucks per hour during the ten-hour day shift workday. The day shift represents the worst-case scenario for construction traffic as 67 percent of the workforce would work this shift. Peak hourly traffic is estimated at 1,878 total workers arriving during the AM peak hour and departing during the PM peak hour in addition to the 30 trucks per hour of construction trucking. Based on these assumptions, 1,502 workers and 24 trucks per hour would use the Bear Creek entrance and 376 workers and 6 trucks per hour would use the TN 95 Access. These traffic levels were used to calculate the added traffic on the road network near the CRN Site and the associated impact on intersection capacity. Using the assumptions outlined above, the LOS at the intersections evaluated were determined for the peak construction traffic at the CRN Site. The analysis results are summarized in Table 3-36. The relative effects of Alternative B on the intersections evaluated is described below.

- *Bear Creek Road at TN 58*. Improvements at the connection of Bear Creek Road and TN 58 were proposed as a potential mitigative measure to offset potential impacts as part of the ESPA process. As discussed in Section 2.4.1.2 and above in this section, these improvements have been integrated into the proposed project plan and are therefore integrated into the impact assessment process (see Figure 3-19). As summarized in Table 3-36, the proposed action includes both intersection improvements and the construction of a new access ramp to provide an effective connection from Bear Creek Road to northbound TN 58. Each of these proposed improvements would either maintain or improve the existing LOS from A or B (indicative of a freeflow traffic condition). As such impacts associated with these improvements would be minor during construction and operation.
- *Bear Creek Road at CRN Site Entrance*. Improvements at the entrance of the CRN Site Access Road and the entrance to the CRN Site would be conducted to accommodate project staffing and deliveries of materials and equipment during construction. Improvements would facilitate traffic movements to/from Bear Creek Road north, but elevated traffic levels and delays would be evident during construction that would result in a LOS of D during the construction phase and a LOS of B during operation. Because 80 percent of the workforce is expected to use the primary entrance from Bear Creek Road, extensive delays and backups on Bear Creek Road entering the CRN Site would be evident, particularly during the peak hours associated with workforce shift changes. Impacts are therefore expected to be moderate during construction and minor during operation due to the reduced volume of workers and associated traffic.
- *TN 58 and TN 95 Interconnection*. Additional traffic associated with both construction and operational phases would utilize the existing interchange that serves the TN 58 and TN 95 interconnection. This interchange has an existing LOS of A and would continue to function in a free flow condition during both construction and operation. Impacts to this intersection are therefore minor.

Table 3-36. Project-Related Traffic Impacts at CRN Site Area Intersections

Intersection	Description	Turning Movement Evaluated	Existing LOS	Construction		Operation	
				Projected LOS	Impact	Projected LOS	Impact
TN 58							
TN 58 at Bear Creek Road Ramps	Unsignalized T-Intersection (One Way Stop)	Eastbound Left (Ramp to Northbound Rt 58)	B	A	Minor	A	Minor
Bear Creek Road at TN 58 Southbound Ramp	Unsignalized T Intersection (One Way Stop)	Southbound Left (Ramp to Eastbound Bear Creek)	A	A	Minor	A	Minor
Bear Creek Road at TN 58 Northbound Ramp	Roundabout	Southbound Left (Ramp to Eastbound Bear Creek)	NA (not developed under existing condition)	B	Minor	A	Minor
Access to CRN Site							
Bear Creek Road at CRN Site Entrance	Unsignalized T-Intersection (One-Way Stop)	Various	NA (access to CRN Site currently closed)	D	Moderate	B	Minor
TN 58 and TN 95 Interconnection							
TN 95 at TN 58 Northbound and Southbound Off-Ramps	Freeway to Freeway Interchange	Merge	A	A	Minor	A	Minor

Intersection	Description	Turning Movement Evaluated	Existing LOS	Construction		Operation	
				Projected LOS	Impact	Projected LOS	Impact
TN 95 at TN 58 Northbound On-Ramp	Freeway to Freeway Interchange	Diverge	A	A	Minor	A	Minor
TN 95 Access							
TN 95 at CRN Site TN 95 Access	Unsignalized T Intersection (One Way Stop)		NA (not developed under existing condition)	B	Minor	A	Minor
Local Road Access onto TN 95							
TN 95 at Bear Creek Road One Way Ramp	Unsignalized T Intersection (One Way Stop)	Westbound Right	F	F	Moderate	F	Minor
TN 95 at Bear Creek Road	Unsignalized Four Leg Intersection (Two Way Stop)	Westbound Left	F	F	Moderate	F	Minor
TN 95 at Bethel Valley Road	Signalized 3-Leg Intersection	Various	B	B	Minor	B	Minor
TN 95 at Buttermilk Road	Unsignalized T Intersection (One Way Stop)	Eastbound Left onto TN 95 North	C	D	Minor	C	Minor
I-40 Interchange							
TN 95 at I-40 Westbound Ramps	Signalized Freeway Ramp	Various	B	C	Minor	B	Minor
TN 95 at I-40 Eastbound Ramps	Signalized Freeway Ramp	Various	B	C	Minor	B	Minor

- *TN 95 Access*. The proposed TN 95 Access would allow for approximately 20 percent of both construction phase and operational phase traffic to exit the CRN Site onto local roadways. A signalized intersection and associated turning lanes would be installed at the proposed intersection to facilitate safe ingress/egress to/from the CRN Site (see Figure 3-20). Intersection LOS would be B during construction and A during operation. However, project related traffic on TN 95 would increase the volume of traffic on TN 95 that has the potential to increase delays on intersecting roadways as described below.
- *Local Road Access onto TN 95*. Several local roads that intersect with TN 95 would be affected by both construction phase and operational phase traffic. These include those at Bear Creek Road, Bethel Valley Road, and Buttermilk Road.
- Intersections associated with Bear Creek Road are currently rated as having an LOS of F (primarily due to high traffic volumes associated with ORR) that are associated with substantial delays for motorists accessing TN 95 from Bear Creek Road. These motorists would experience a reduced (worsened) condition during construction due to the increased traffic on TN 95. As such impacts of construction would exacerbate the existing LOS of F and result in additional delays. Impacts during construction at this location are therefore considered to be moderate. During operation, increased traffic on TN 95 is substantially less than that during construction, which would result in only a minor increase in delays. As such, impacts at this location during operation are minor.
- Increased project related traffic on TN 95 would also result in delays in access associated with Bethel Valley Road and Buttermilk Road. Impacts at these intersections during construction would typically be less than 10 seconds and are considered minor. Delays are less during operation and impacts are correspondingly reduced and minor.
- *I-40 Interchange*. Project related traffic using TN 95 is also expected to increase traffic on ramps associated with I-40. Although the LOS at TN 95 at the I-40 westbound and eastbound ramps would change from a LOS B to LOS C during construction, the increase in average vehicle delay at these signalized intersections is only five seconds and two seconds, respectively. Based on a lower level of CRN-related traffic during operation, the LOS of these ramps is expected to improve to LOS B. Therefore, impacts at this intersection are considered minor.

During construction, vehicular traffic volumes in the area would increase due to construction workers and delivery trucks driving to and from the CRN Site each day. Given the size of the increases in traffic volumes, construction activities at the CRN Site would increase the rate of degradation on some roads in the area, particularly TN 58 and Bear Creek Road in Roane County. These impacts could also result in localized roadway degradation and warrant increased maintenance that may also cause additional traffic congestion in some areas. Most road degradation would occur in Roane County. The physical impacts on roads would be noticeable where pavement is degraded, but it is not expected to occur on a widespread basis. TVA's payments to the state as a result of construction would increase to help compensate for road degradation. As such, these impacts are considered to be minor.

Additional increases in traffic and intersection delays may also occur during both the construction and operational phases for the CRN Project in conjunction with the reasonably foreseeable future actions described in Section 3.1.3. Depending on the timing of these projects and the intensity of traffic they generate, impact magnitude categories may increase relative to those included in Table 3-36.

3.12.2.2.1 Navigation Impacts

Transport of bulk materials or some components during construction may be expected to occur by barge that would use either the existing DOE offsite barge facility or the proposed supplemental onsite barge facility. However, barge traffic and access to the CRN Site would be spread out over time and appropriately conducted to minimize interference with existing navigation and boating operations on the Reservoir. Barge transport during the operational phase is expected to be infrequent. As such, impacts associated with navigation are minor.

3.12.2.2.2 Other Transportation Systems

Neither construction nor operational activities at the CRN Site would impact the operation of air or rail facilities in the vicinity of the CRN Site.

3.12.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced Non-LWRs

The impacts to transportation for Alternative C would be the same as those for Alternative B.

3.12.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced Non-LWRs

The impacts to transportation for Alternative D would be the same as those for Alternative B.

3.12.2.5 Potential Contributing Effects of Other Reasonably Foreseeable Future Actions

As described in Section 3.12.1.6, several reasonably foreseeable future actions were identified in proximity to the CRN Site. Depending on the local environmental setting and the design characteristics of these other proposed actions, direct increases or changes in traffic patterns would be expected. Several of the identified actions by others geographically intersect with the roadways affected by the proposed project and these other projects have the potential to increase demands on local roadways during both construction and operational phases. Example projects include the Kairos Hermes reactor project, proposed actions at ORNL, development of the Horizon Center, and the development of the municipal airport at the ETTP. As such, depending upon their specific timing, location and access to the primary arterial roadway system (e.g., TN 58, TN 95, I-40), these actions may result in notable increases in congestion and a reduced LOS at key intersections. Because increased traffic generation by the CRN project (and others) during construction is typically greater than that of operational phases, these reasonably foreseeable future projects have the potential to be more pronounced during the construction phase of the CRN Nuclear Technology Park. Regarding the potential development of the municipal airport at the ETTP, the NRC would require TVA to perform a design-specific assessment of the effects on the facility of the impact of a large commercial aircraft. TVA would ensure that each of the designs for the reactor technologies being considered for the CRN Site (SMRs and advanced non-LWRs) would follow the applicable requirements of 10 CFR 50.150 for Aircraft Impact Assessment (AIA). Additionally, 10 CFR 100.20(b) requires TVA to evaluate the nature and proximity of human-related hazards to establish site parameters for use in determining whether a plant design can accommodate commonly occurring hazards and whether the risk of other hazards is very low. The acceptability of a site depends on establishing that (1) an accident at a nearby facility will not result in radiological consequences that exceed the dose guideline in 10 CFR 50.34; (2) the accident poses no undue risk because it is sufficiently unlikely to occur; or (3) the nuclear power station can be designed so its safety will not be affected by the accident. As such the cumulative impacts of these projects is moderate during construction and potentially moderate during operation. Any site-specific impacts that are analyzed in the future that are expected to fall outside of the bounding analysis in this PEIS will be analyzed in subsequent NEPA analysis.

3.12.2.6 Summary of Impacts to Transportation

As summarized in Table 3-37, TVA has determined that impacts to transportation resulting from the alternatives would be minor with moderate impacts limited to localized intersections during construction.

Table 3-37. Summary of Impacts to Transportation

Alternative	Project Phase	Impact	Severity
B, C, D	Construction	Increased traffic due to workforce and associated construction activities. Improvements to key roadway intersections included in project design.	Impact generally minor with proposed improvements. Impacts moderate at Bear Creek Road and TN 95 due to increased traffic on TN 95. Impacts moderate at primary CRN Site access at Bear Creek Road intersection and on Bear Creek Road due to delays entering CRN Site during peak hours
		Transport of bulk materials or some components during construction would use either the existing DOE offsite barge facility or the proposed supplemental onsite barge facility.	Barge traffic and access to the CRN Site would be properly managed to reduce impacts on navigation. Impacts are minor. Moderate cumulative impacts.
B, C, D	Operation	Increased traffic due to workforce and associated operational activities, but substantially less than that during construction. Improvements to key roadway intersections included in project design.	Impact minor with proposed improvements at all locations. Increased traffic on TN 95, but notably less than that observed during construction. Therefore, impacts of delays at Bear Creek Road and TN 95 are minor. Impacts minor at primary CRN Site access at Bear Creek Road intersection and on Bear Creek Road. Moderate cumulative impacts.
		Barge operations infrequent.	Impacts minor.

3.13 Visual Resources

3.13.1 Affected Environment

This assessment provides a review and classification of the visual attributes of existing scenery, along with the anticipated attributes resulting from the proposed action. The classification criteria used in this analysis are adapted from a scenic management system developed by the U.S. Forest Service (USFS) and integrated with planning methods used by TVA (USFS 1995). Potential visual impacts to cultural and historic resources are not included in this analysis as they are assessed separately in Section 3.17.

The visual landscape of an area is formed by physical, biological, and man-made features that combine to influence both landscape identifiability and uniqueness. The scenic value of a particular landscape is evaluated based on several factors that include scenic attractiveness, scenic integrity, and visibility. Scenic attractiveness is a measure of scenic quality based on human perceptions of intrinsic beauty as expressed in the forms, colors, textures, and visual composition of each landscape. Scenic attractiveness is expressed as one of the following three categories: distinctive, common, or minimal. Scenic integrity is a measure of scenic importance based on the degree of visual unity and wholeness of the natural landscape character. The scenic integrity of a site is classified as high, moderate, low, or very low. The subjective perceptions of a landscape's aesthetic quality and sense of place are dependent on where and how it is viewed.

Views of the landscape are described in terms of what is seen in the foreground, middleground, and background distances. In the foreground, an area within 0.5 miles of the observer, details of objects are easily distinguished. In the middleground, from 0.5 miles to 4 miles from the observer, objects may be distinguishable, but their details are weak and tend to merge into larger patterns. In the distant part of the landscape, the background, details and colors of objects are not normally discernible unless they are especially large, standing alone, or have a substantial color contrast. In this assessment, the background is measured as 4 to 10 miles from the observer. Visual and aesthetic impacts associated with an action may occur as a result of the introduction of a feature that is not consistent with the existing viewshed. Consequently, the visual character of an existing site is an important factor in evaluating potential visual impacts.

For this analysis, the affected environment includes the areas within the CRN Site that encompass both permanent and temporary impact areas, as well as associated offsite improvement areas. The CRN Site is bounded on three sides (south, east, and west) by the Reservoir and bounded to the northeast by ORR. The topography in the vicinity of the CRN Site is characterized by parallel elongated ridges and valleys that run from northeast to southwest. The difference in height between the valleys and ridges is generally about 300 to 350 feet, and the ridges have steep profiles, often steeper than 45 degrees. The topography of the CRN Site was previously altered during construction related to the CRBRP, as shown in the grading and excavation photos in Figure 3-22. Approximately 240 acres of the CRN Site were extensively disturbed by the CRBRP, including the removal of approximately 3 million cubic yards of earth and rock. This excavation area was partially backfilled following project termination and has become sparsely revegetated over the intervening years, currently covered by open areas of herbaceous vegetation and scattered eastern red cedars. However, the excavation area remains a prominent feature in the landscape due to the notable topographic contrast. The remainder of the CRN Site topography includes both steep wooded hills and flat meadows, with elevations that range

Figure 3-22. CRBRP Grading and Excavation

from approximately 745 feet AMSL at the shoreline of the Reservoir to approximately 940 feet AMSL in the northern portion of the CRN Site. Vegetation covering the CRN Site outside of the previously disturbed areas is dense and consists of a mixture of mature hardwood forest, stands of evergreen trees, and shrubs.

Views of the CRN Site from surrounding areas beyond the river valley to the east, south, and west are characterized by the waters within the winding channel of the Reservoir; forested shorelines, bluffs, and ridges; and areas of old fields in the south-central portion of the CRN Site affected by the earlier CRBRP. Views of the CRN Site from the north are blocked by Chestnut Ridge. The areas across the river, to the east, south, and west of the CRN Site, are rural and sparsely populated. The principal aesthetic disturbances on the CRN Site when viewed from the areas across the river are the two TVA transmission lines that cross the CRN Site. The transmission lines are minor visual intrusions that can be seen from most locations in the foreground and middleground distances. Smaller structures currently present on the CRN Site, such as the construction trailers, are also minor intrusions on the landscape as they are relatively unobtrusive and small in comparison to the overall landscape. Views of the CRN Site from the adjacent portion of the Reservoir are dominated by the forested riparian zone, which is only interrupted in the two locations where the transmission line ROW corridors cross the river. The view of the CRN Site from higher surrounding areas also includes the Reservoir and agricultural fields associated with the floodplain in the foreground to middleground, and forested hills in the background.

In a visual impact assessment, sensitive receptors generally include any scenic vistas, scenic highways, residential viewers, and public facilities such as churches, cemeteries, schools, parks, and recreational areas that are located in the project’s viewshed. However, because the areas immediately surrounding the CRN Site are bounded by water features, forests, and ridge lines, direct views of the CRN Site are generally limited to onsite workers and visitors, recreators using the Reservoir, and residents living in close proximity across the Reservoir to the east, south, and west. The closest residences to the CRN Site are located on Blackburn Lane, approximately 850 feet east-northeast of Area 1 and 1,500 feet south of Area 2. The proposed project would also be in the foreground of visitors to the Hensley Cemetery, which is located on the CRN Site. However, the cemetery is on lower ground than Area 1, and is surrounded by trees and vegetation which provide visual screening that would be retained during site development. Overall, scenic visibility of the CRN Site from surrounding areas is considered moderate.

Land uses in the areas surrounding the CRN Site generally are rural, agricultural, or undeveloped. The ORR adjoining the CRN Site to the northeast is predominantly undeveloped. The ORR was acquired by the federal government in the 1940s and since then, the majority of the reservation has reverted from agricultural fields to forest. However, there are several notable industrial developments located in the immediate vicinity of the CRN Site, including:

- Clinch River Industrial Park, located north adjacent to the CRN Site and Grassy Creek HPA, on Bear Creek Road;
- ETTP/Heritage Center Industrial Park, approximately 1 mile to the north;
- ORNL, approximately 2.5 miles to the east; and
- Roane Regional Business and Technology Park, approximately 0.5 miles to the southeast.

Scenic views are common in the area surrounding the CRN Site and typically include contrasts between features such as forested ridges and relatively flat valleys, including agricultural fields and reservoirs. The aesthetic appeal of the scenery in the area derives predominantly from a natural landscape that provides ample opportunities for visual appreciation, with relatively limited visual interruptions due to industrial and other highly developed areas. The thickly forested slopes and valleys help to obscure and soften the appearance of the industrial areas.

Based on the above characteristics, the scenic attractiveness of the affected environment at the CRN Site is considered to be common, whereas the scenic integrity is considered to be moderate. The rating for scenic attractiveness is based on the ordinary or common visual quality of the landscape, with generally positive but typical attributes and a basic variety of forms, colors, and textures that are commonly seen in the surrounding landscape and are not considered to have distinctive visual quality. The scenic integrity of the site is moderate; while minor human alterations can be seen in the foreground, the deviations are subordinate to the overall landscape and largely natural in appearance. The scenic class of a landscape is determined by combining the levels of scenic attractiveness, scenic integrity, and visibility and can be excellent, good, fair, or poor. Based on the criteria used for this analysis, the overall scenic class for the affected environment at the CRN Site is considered to be good.

3.13.1.1 Reasonably Foreseeable Future Actions in Proximity to the CRN Site

As noted in Section 3.1.3, TVA identified several foreseeable future actions in proximity to the CRN Site. The scope of these other proposed actions may entail the alteration of the visual attributes of the landscape surrounding their respective project areas. However, the specific details regarding the scope of these actions are generally lacking. Furthermore, none of the identified reasonably foreseeable future actions is overlapping geographically with the CRN Project Area nor is considered to have a causal relationship to the proposed development of the CRN Site. As such, no further consideration of reasonably foreseeable future actions and their effects on visual resources are included in TVA's analysis.

3.13.2 Environmental Consequences

The potential impacts to the visual environment from a given action are assessed by evaluating the potential for changes in the scenic value class ratings based upon landscape scenic attractiveness, integrity, and visibility. Sensitivity of viewing points available to the general public, their viewing distances, and visibility of the proposed action are also considered during the analysis. These measures help identify changes in visual character based on commonly held perceptions of landscape beauty and the aesthetic sense of place. The extent and magnitude of visual changes that could result from the proposed alternatives were evaluated based on the process and criteria outlined in the scenic management system as part of the environmental review required under NEPA.

3.13.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, a Nuclear Technology Park would not be constructed or operated at the CRN Site and landscape character and integrity would remain in its current state. Therefore, there would be no impact to visual resources.

3.13.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced Non-LWRs

3.13.2.2.1 Construction

Implementation of Alternative B would result in both permanent and temporary visual impacts associated with construction activities in Area 1, designated laydown areas, and associated onsite and offsite areas for development and improvement of infrastructure for barge access, roadways, and transmission systems (see Figure 2-1). During the construction period, there would be increased visual discord from existing conditions due to an increase in personnel and equipment coupled with disturbances from land clearing, grading, cut and fill activities, and facility construction. As these activities would generally be limited to the immediate vicinity of the project footprint, and because the areas immediately surrounding the CRN Site are bound by water features, forests, and ridge lines, most construction activities would not be visible to the general public. However, construction of advanced nuclear reactors would entail the use of large cranes, the largest of which is expected to be a heavy lift crane with a height of 638 feet. This would generally be visible over the tree line from local roadways near the CRN Site. Additional activities such as use of large earth-moving equipment; the transportation of large materials onto the CRN Site; transmission line modifications and switchyard construction; and intersection improvements at the BTA and TN 95 access, would likely be visible to members of the public on surrounding roadways and/or to residents located across the Reservoir to the east, south, and west. Additionally, nighttime lighting could be used during construction if work is to take place at night and for security purposes, which may be within the viewshed of residents in the surrounding area.

Project-related construction activities would also be visible to recreational users of the Reservoir and the Gallaher Recreation Area. Construction activities would be most noticeable to these groups during bank stabilization activities and while the intake and discharge structures are being built. Additionally, in conjunction with Alternative B, a portion of the existing 161-kV transmission line located on the CRN Site may be re-routed to the east, closer to the Reservoir. This would entail removing most of the vegetative buffer from the east side of the peninsula. The new transmission towers and cleared corridor would be visible from the Reservoir and a small group of residences across from the CRN Site. Given the presence of the existing transmission lines in the area and on Area 1, the effect of the project-related construction on nearby residents and recreational users would be noticeable but would not significantly alter the character of the landscape.

Overall, given that visibility of the CRN Site is limited by topography and that impacts of construction activities on visual resources would be localized, visual impacts to the general public would be minor. For nearby residents and recreational users of the Reservoir, which would have more direct views of the CRN Site, visual impacts of construction would be moderate.

3.13.2.2.2 Operation

Long-term visual impacts resulting from the development and operation of the CRN Nuclear Technology Park at Area 1 would include visible alterations to the existing landscape associated with one or more reactors, as well as supporting infrastructure including cooling towers and maintenance of cleared transmission line ROW corridors. Per the ESPA PPE (Appendix A), the minimum site grade in the power block area would be 821 feet AMSL, with the tallest power block structure up to 160 feet above grade and the mechanical draft cooling towers up to 65 feet above grade.

Renderings were completed for the ESPA ER, using baseline photographs from various observation points and plant design parameters from the PPE to estimate potential visual impacts associated with operation of the CRN Nuclear Technology Park at Area 1. The renderings depict the tallest facility structure visible from specific locations. Overall, the renderings show that the CRN facility would be well screened by the riparian trees from most locations. While the major buildings of the facility would be visible from some sensitive receptors in the foreground of the CRN Site, including recreationists on the Reservoir and a small number of residents living along the Reservoir, views from residences would be somewhat screened by trees. The surrounding hills would also help to soften the industrial aspects of the view because they are larger than the facility and make it seem smaller and less imposing. From a distance of approximately 2 miles, the CRN Nuclear Technology Park structures would not be visible from most viewpoints.

Apart from the facility structures themselves, a dominant visual feature resulting from the operation of the CRN Nuclear Technology Park would be the cooling tower plume. Plume height depends on weather conditions and wind; longer plumes generally occur with colder temperatures and when the atmosphere is more saturated. Based on SACTI modeling predictions, visible cooling tower plumes at the CRN Site would not go beyond 300 meters (984 feet) from the towers more than three percent of the time for any wind direction. So, while the facility buildings would generally not be visible from distances greater than 2 miles, cooling tower plumes, when present, may draw the observer’s attention to the facility from greater distances, inserting an industrial aspect to a mostly natural landscape. The plume impacts would be larger on a clear, cloudless day than on an overcast day. Therefore, the visual intrusion due to operation of the CRN Nuclear Technology Park would range from minor to moderate, depending on the location of the observer and the atmospheric conditions.

Additionally, views of the proposed project from the Hensley Cemetery, located on Area 1 of the CRN Site, are expected to be minimal because the cemetery is surrounded by vegetation and trees which provide visual screening. TVA intends to maintain the grounds and would avoid the cemetery during operation and maintenance activities. The cemetery would remain accessible to those individuals that have family members buried at Hensley Cemetery.

The meandering river channel and forested hills in the vicinity of the CRN Site contribute to the landscape’s ability to absorb negative visual change. Therefore, while the forms, colors, and textures of the landscape that make up the scenic attractiveness would be notably altered by the construction of the CRN Nuclear Technology Park and associated components, it would remain common or ordinary. Scenic integrity would be reduced from moderate to low, as visually disruptive human alterations such as the power block structures, cooling towers, vapor plume, and transmission systems would become prominent elements of the landscape. Based on the criteria used for this analysis, the scenic value class for the affected environment after the proposed modifications would be reduced from good to fair. While Alternative B would contribute to a decrease in visual integrity of the landscape at foreground and middleground distances, impacts would be minimal at background distances. The existing scenic class would not be reduced by two or more levels, which is the threshold of significance of impact to the visual environment.

Therefore, overall visual impacts resulting from the implementation of the Alternative B would be minor to moderate depending on location of the observer.

3.13.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced Non-LWRs

Under Alternative C, a Nuclear Technology Park would be constructed on Area 2 of the CRN Site (see Figure 2-2). Impacts to visual resources would be similar to those discussed under Alternative B because construction activities, the offsite area improvements, and the reactor and cooling tower specifications and design parameters would be consistent with that described above. The site grade in the power block area (821 feet AMSL) and the maximum structure heights would be the same as those noted under Alternative B, resulting in a similar profile and visibility. Because Area 2 is located northeast of Area 1 and is set back further from the Reservoir, it would be less visible to sensitive receptors to the south and west of the CRN Site. However, for recreators and a small number of residences located southeast of the CRN Site, the clearing, grading, and development of the currently forested Area 2 would result in notable viewshed changes. Additionally, under Alternative C, the 161-kV transmission line would not be re-routed, so there would be no construction-related impacts associated with the establishment of a new transmission line along the eastern edge of the CRN Site, nor long-term intrusion associated with the maintenance of a cleared ROW corridor. Additional impact analyses for construction and operations at Area 2 would be further analyzed in future, supplementary NEPA analyses. Thus, while the impacts of Alternative C are anticipated to be somewhat less than that of Alternative B, the scenic value class of the affected environment would still be reduced from good to fair, resulting in minor to moderate impacts to visual resources depending upon the location of the observer.

3.13.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced Non-LWRs

Under Alternative D, impacts would be greater than those under Alternatives B and C because the Nuclear Technology Park would be spread over both Areas 1 and 2 (see Figure 2-3), creating visual discord over a larger portion of the CRN Site. Although the facilities would have the same bounding design parameters, impacts would be somewhat greater than those of Alternatives B and C due to the larger area of disturbance. However, the scenic value class of the affected environment would still be reduced to fair based on the ability of the landscape topography to absorb the negative change, resulting in minor to moderate impacts to visual resources depending upon the location of the observer.

3.13.2.5 Summary of Impacts to Visual Resources

As summarized in Table 3-38, visual resource impacts related to the construction and operation of a Nuclear Technology Park at the CRN Site would be minor to moderate.

Table 3-38. Summary of Impacts to Visual Resources

Alternative	Project Phase	Impact	Severity
Alternatives B, C, D	Construction	Temporary visual discord onsite and in associated offsite areas due to land disturbances and an increase in personnel and equipment. Limited visibility to general public due to rural location and terrain.	Impacts to visual resources would be minor for the general public and moderate for a small number of adjacent residents and recreators. Based on visibility and area of disturbance, the magnitude of impact is as follows: Alternative D greater than Alternative B, which is greater than Alternative C.
	Operation	Introduction of industrial features, including a cooling tower plume, into the existing natural landscape, reducing scenic integrity. Visibility limited by forested, hilly terrain and low number of nearby visual receptors.	Impacts to visual resources would be minor to moderate based on atmospheric conditions and the location of the observer. Based on visibility and area of disturbance, the magnitude of impact is as follows: Alternative D, greater than Alternative B, which is greater than Alternative C.

3.14 Noise

3.14.1 Affected Environment

Noise is unwanted or unwelcome sound usually caused by human activity and added to the natural acoustic setting of a locale. It is further defined as sound that disrupts normal activities or diminishes the quality of the environment. Community response to noise is dependent on the intensity of the sound source, its duration, the proximity of noise-sensitive land uses, and the time of day the noise occurs.

Sound is measured in logarithmic units called decibels (dB). Given that the human ear cannot perceive all pitches or frequencies of sound, noise measurements are typically weighted to correspond to the limits of human hearing. This adjusted unit of measure is known as the dBA, which filters out sound in frequencies above and below human hearing. A noise level change of 3 dBA or less is barely perceptible to average human hearing. However, a 5 dBA change in noise level is clearly noticeable. The noise level associated with a 10 dBA change is perceived as being twice as loud; whereas the noise level associated with a 20 dBA change is considered to be four times as loud and would therefore represent a “dramatic change” in loudness.

To account for sound fluctuations, environmental noise is commonly described in terms of the equivalent sound level. The equivalent sound level is the constant noise level that conveys the same noise energy as the actual varying instantaneous sounds over a given period. Fluctuating levels of continuous, background, and/or intermittent noise heard over a specific period are averaged as if they had been a steady sound. The day-night sound level (L_{dn}), expressed in dBA, is the 24-hour average noise level with a 10-dBA correction penalty for the hours between 10 p.m. and 7 a.m. to account for the increased sensitivity of people to noises that occur at night. Typical background day-night noise levels for rural areas are anticipated to range between an L_{dn} of 35 and 50 dBA, whereas higher-density residential and urban areas background noise levels range from 43 dB to 72 dBA (EPA 1974). Common indoor and outdoor noise levels are listed in Table 3-39.

Table 3-39. Common Indoor and Outdoor Noise Levels

Common Outdoor Noises	Sound Pressure Levels (dB)	Common Indoor Noises
	110	Rock Band at 5 m (16.4 ft)
Jet Flyover at 300 m (984.3 ft)		
	100	
		Inside Subway Train (New York)
Gas Lawn Mower at 1 m (3.3 ft)		
	90	
		Food Blender at 1 m (3.3 ft)
Diesel Truck at 15 m (49.2 ft)		Garbage Disposal at 1 m (3.3 ft)
	80	
		Shouting at 1 m (3.3 ft)
Gas Lawn Mower at 30 m (98.4 ft)	70	Vacuum Cleaner at 3 m (9.8 ft)
Commercial Area		Normal Speech at 1 m (3.3 ft)
	60	
		Large Business Office
	50	Dishwasher Next Room
Quiet Urban Daytime		
	40	Small Theater, Large Conference Room
Quiet Urban Nighttime		Library
Quiet Suburban Nighttime		
	30	
		Bedroom at Night
Quiet Rural Nighttime		Concert Hall (Background)
	20	
		Broadcast and Recording Studio
	10	
		Threshold of Hearing
	0	

Source: Arizona DOT 2008

The perceived loudness or intensity between a noise source and a receptor may change because of distance, topography, vegetation, water bodies, and structures. The closer a receptor is to a noise source the louder the noise seems; for every doubling of distance from a source the intensity drops by about 6 dBA over land and about 5 dBA over water. Topography, vegetation, and structures can change noise intensity through reflection, absorption, or deflection. Reflection tends to increase the intensity, while absorption and deflection tend to decrease the intensity.

The City of Oak Ridge has established quantitative noise level limits based on adjacent property uses, as codified in Article XII of the City's Zoning Ordinance. Properties adjacent to the CRN Site consist of the Clinch River Industrial Park on the north side and the ORR on the east side. The Reservoir is adjacent to the remainder of the CRN Site, with the nearest residential areas located on the opposite bank. Oak Ridge's most stringent guidelines apply to properties with adjacent residential uses, setting a maximum noise limit of 80 dBA during the hours of 7:00 a.m. to 10:00 p.m. and a maximum of 75 dBA between 10:00 p.m. and 7:00 a.m. Additionally, during the hours of 7:00 a.m. to 10:00 p.m., the sound level should not exceed 65 dBA for more than 50 percent of a one-hour survey period or 70 dBA for more than 10 percent of a one-hour survey period. From 10:00 p.m. to 7:00 a.m., the sound level should not exceed 55 dBA for more than 50 percent of a one-hour survey period or 60 dBA for more than 10 percent of a one-hour survey period. These restrictions are specific to outdoor spaces, at the lot boundary (City of Oak Ridge 2020).

Neither Roane County nor the State of Tennessee have developed noise regulations that specify acceptable community noise levels. However, EPA noise guidelines recommend outdoor noise levels in public use areas do not exceed L_{dn} of 55 dBA, which is sufficient to protect the public from the effect of broadband environmental noise in typical outdoor and residential areas. These levels are not regulatory goals but are "intentionally conservative to protect the most sensitive portion of the American population" with "an additional margin of safety" (EPA 1974). The U.S. Department of Housing and Urban Development (HUD) considers an L_{dn} of 65 dBA or less to be compatible with residential areas (HUD 1985).

3.14.1.1 Noise Receptors

Sensitive noise receptors include residences or other developed sites where frequent human use occurs, such as churches, schools, cemeteries, and facilities for outdoor or community use (e.g., parks, libraries, and community centers). Based on site reconnaissance conducted during the preparation of the ESPA and updated via review of recent aerial photography and maps, locations with potential noise sensitivity within a 1-mile radius of the CRN Site boundary were identified. The sensitive receptors are shown in Figure 3-23 and include approximately 150 residences, one private school, eight cemeteries, and three facilities for outdoor/community use. The facilities include Gallaher Recreation Area to the west of the CRN Site, and the Bradbury Community Center and Soaring Eagle Campground to the south.

Apart from the Hensley Cemetery, which is located on the CRN Site, the closest sensitive noise receptors are residences located on Blackburn Lane, approximately 850 feet east-northeast of Area 1 and 1,500 feet south of Area 2. Other potential noise receptors include recreators on the Reservoir that boat in the waters adjacent to the CRN Site.

3.14.1.2 Ambient Noise Levels

In July and December of 2013, as part of the ESPA, a noise assessment was conducted to establish typical ambient noise levels at and in the area surrounding the CRN Site. Nine sampling locations were selected to provide a general representation of ambient sound levels within the local area that surrounds the CRN Site. Two sampling locations (Noise Sampling Locations 1 and 2 in Figure 3-23) were within the CRN Site boundary. Additional sampling locations were selected to represent the surrounding community, including Noise Sampling Locations 3 through 8 in Figure 3-23. An additional noise sampling location was established at the Melton Hill Dam Recreational Area approximately 4 miles east of the CRN Site (see Figure 3-17).

Based on data collected from these locations in 2013, typical onsite sound levels ranged between 46 and 48 dBA during the daytime and between 41 and 49 dBA during the nighttime. The L_{dn} ranged between 49 and 55 dBA. Offsite sound levels ranged between 42 and 63 dBA during the daytime and between 35 and 58 dBA during the nighttime. The offsite L_{dn} ranged between 51 and 64 dBA. Ambient noise within the CRN Site and the surrounding local community was observed to come from various sources including vehicle traffic, bioacoustical sources (i.e., general wildlife, livestock, birds, insects, and humans), the natural environment (i.e., wind through foliage and rain) and mechanical sources (i.e., construction/industrial equipment, farming equipment, and watercraft/boating).

There have been no large-scale development or land use changes in the areas surrounding the CRN Site or on the CRN Site itself that would result in significant changes to ambient noise levels reported in the 2013 noise assessment. Therefore, noise levels obtained during the 2013 survey continue to be representative of current ambient noise levels.

3.14.1.3 Reasonably Foreseeable Future Actions in Proximity to the CRN Site

As noted in Section 3.1.3, TVA identified several foreseeable future actions in proximity to the CRN Site. The scope of these other proposed actions may entail the alteration of ambient noise levels within their respective project areas. However, the specific details regarding the scope of these actions are lacking. Furthermore, none of the identified reasonably foreseeable future actions is overlapping geographically with the CRN Project Area, and noise emissions from each of these potential foreseeable future actions would attenuate to minimal levels over distance such that there would not be an aggregately greater effect with the construction or operation of the CRN Nuclear Technology Park. None of these actions are considered to have a causal relationship to the proposed development of the CRN Site. As such, no further consideration of reasonably foreseeable future actions and their effects on noise are included in TVA's analysis.

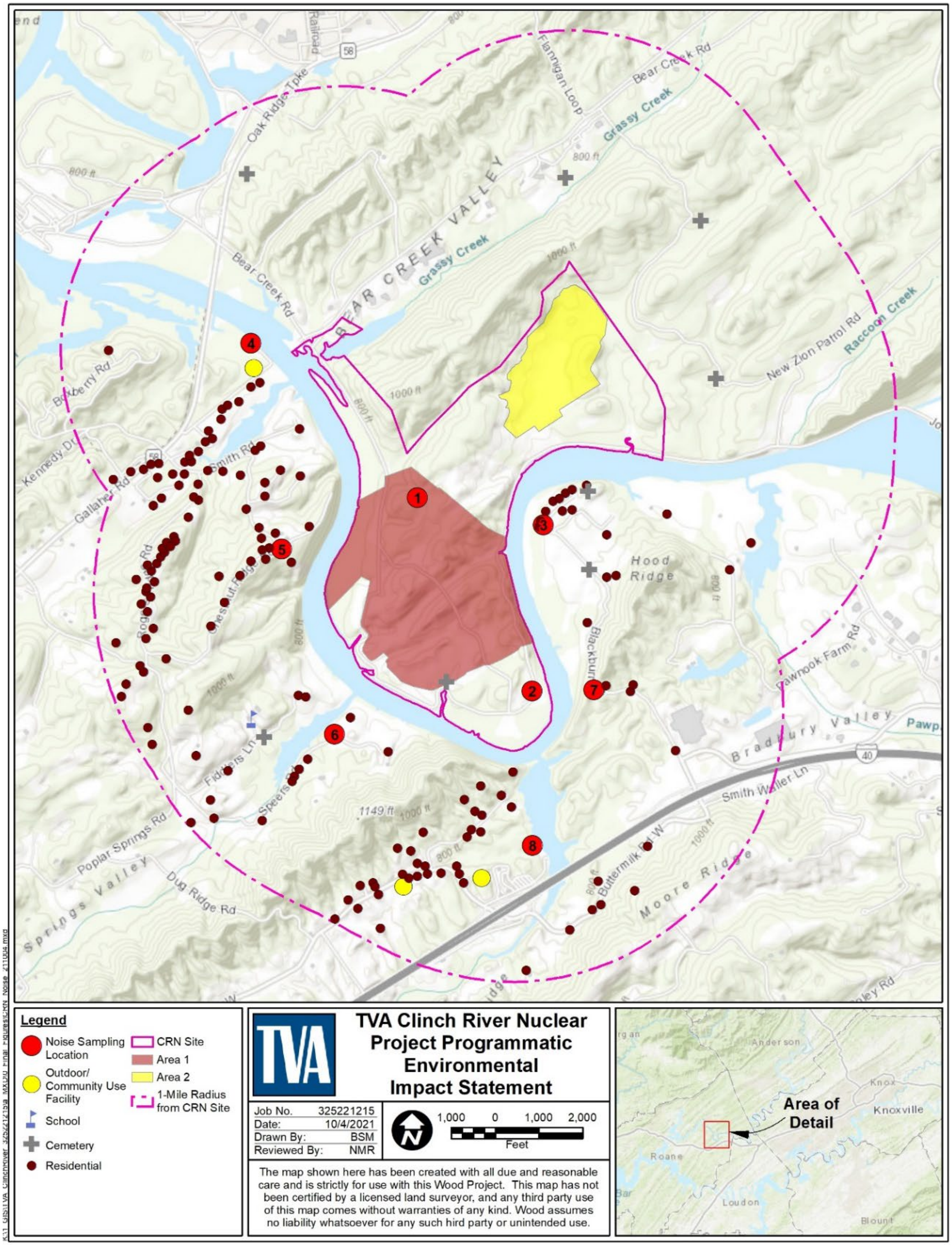


Figure 3-23. Noise Sampling Locations and Sensitive Receptors Within a 1-Mile Radius of the CRN Site

3.14.2 Environmental Consequences

3.14.2.1 Alternative A – No Action Alternative

Under Alternative A, TVA would not construct or operate a Nuclear Technology Park at the CRN Site. Therefore, there would be no impacts to noise receptors resulting from the proposed action under this alternative and ambient noise levels would remain similar to current conditions.

3.14.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced Non-LWRs

3.14.2.2.1 Construction

Under Alternative B, construction activities associated with the development of a Nuclear Technology Park at Area 1 are expected to generate noise through 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), machine backup-alarms, and blasting. Maximum noise levels for the majority of construction equipment range from 76 to 84 dBA at a distance of 50 feet from the noise source; however, impact equipment, such as the use of pile drivers, can result in notably higher noise levels (up to 101 dBA at 50 feet). Therefore, the bounding parameter for maximum expected sound level due to construction activities, measured at 50 feet from the noise source, is 101 dBA (Table 2-4). Most construction activities would occur during normal daylight hours between 7:00 a.m. and 5:00 p.m. In cases where activities are required outside of normal working hours (e.g., for continuous concrete pours), noise levels would be limited to 65 dBA or less at the CRN Site border.

The closest sensitive receptors to Area 1 are residences located on Blackburn Lane, approximately 850 feet to the east-northeast at the closest point. Based on straight line noise attenuation, maximum noise levels from construction equipment operated within Area 1 would attenuate to 76.4 dBA at the closest residence. While this is notably higher than current offsite ambient noise levels, it illustrates an infrequent, worst case-scenario where the loudest potential activities (101 dBA at a distance of 50 feet) occur at the Area 1 boundary closest to the residence. In contrast, the maximum noise from most construction equipment (84 dBA or less at a distance of 50 feet) operated within Area 1 would attenuate to levels below 60 dBA at the nearest residence. While this may exceed the EPA's recommended Ldn guidance of 55 dBA for residential areas, it is below the HUD's recommendation of 65 dBA and conforms to the City of Oak Ridge's daytime residential noise limits. Furthermore, construction equipment typically does not operate at maximum levels continuously; actual noise levels are generally expected to be lower than those described above and may be further reduced by vegetation, topography, and the use of modern, well-maintained equipment, mufflers, and hydraulic systems. TVA would require the construction contractor develop a blasting plan to include notifications to local officials, emergency departments, and neighboring businesses and residents.

Construction activities associated with Alternative B would also occur outside of Area 1, both within the CRN Site boundaries (i.e., onsite laydown and road upgrade areas) and within associated offsite areas (i.e., BTA, TN 95 Access, and offsite transmission line ROW) (see Figure 2-1). Portions of the onsite laydown area and road upgrades are slightly closer to the Blackburn Lane residences than is Area 1. However, the development of these areas would be relatively short-term, and once established, the laydown area would primarily be used to store construction equipment and materials. Noise associated with use of the laydown area and onsite roads during the construction phase would generally consist of equipment moving to and from the primary construction area (Area 1), resulting in noise levels significantly lower than the maximum levels discussed above. Additionally, construction in associated offsite areas would take place on federal property managed by the DOE or TVA, which is undeveloped or industrial in nature and not near residences or other sensitive receptors. Therefore, there would be no noise impacts resulting from offsite construction activities.

Persons recreating on the Reservoir would likely occasionally experience noise levels above those recommended by the EPA and HUD for residential and public use areas when boating in waters adjacent to Area 1 or the associated on and offsite construction areas. However, boaters would only be exposed to these noise levels intermittently, for a brief duration as they pass active construction areas. Other sensitive receptors (i.e., schools, cemeteries, and facilities for outdoor or community use) are located at distances at which noise levels during construction activities would be less than those described for the closest residences, and often comparable to ambient levels. Overall, construction noise would be expected to attenuate to levels below HUD’s recommendation of 65 dBA for residential areas and below the City of Oak Ridge’s daytime residential noise limits. During some construction activities, maximum noise levels could be higher; however, this would occur infrequently and would be short term and limited to daytime hours. For these reasons, noise impacts of construction activities under Alternative B would be minor.

There is also a potential for noise impacts associated with an increase in traffic related to workforce vehicles and construction/transport traffic. Roadway traffic noise is not usually a serious problem for people who live more than 500 feet from heavily traveled freeways or more than 100 to 200 feet from lightly traveled roads (FHWA 2011). Due to the nature of the decibel scale and the attenuating effects of noise with distance, a doubling of traffic volume would result in an approximately 3 dBA increase in noise level, which would not normally be a perceptible noise increase (FHWA 2011). Noise levels would vary over the course of the construction period based on the number of workers commuting to the CRN Site, with higher noise levels generated during the peak construction period. TVA estimates that up to 3,666 worker vehicles (3,300 construction workers and 366 operational workers, at peak overlap) and 90 construction/transport vehicles would access the CRN Site per day, with most of the increased traffic concentrated at shift changes. The composition of this traffic would include passenger cars and light-duty trucks driven by the 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).

Approximately 80 percent of traffic during peak construction (3,005 vehicles) would access the site via TN 58 and Bear Creek Road, while the remaining 20 percent (751 vehicles) are expected to utilize TN 95 and Jones Island Road. Project-related traffic would result in considerable increases in traffic volume on Bear Creek Road, which has a current AADT of 651 (TDOT 2021a), and on Jones Island Road, which is a private, undivided road on DOE property that currently supports minimal traffic. Noise levels along these roadways would increase substantially compared to current levels, as traffic volumes are expected to be at least several times their current volumes during peak construction. However, properties adjacent to both Bear Creek Road and Jones Island Road are either undeveloped or industrial; there are no sensitive noise receptors within 500 feet of either roadway.

Therefore, there would be no noise impacts to sensitive receptors as a result of increased traffic on Bear Creek Road and Jones Island Road.

Peak construction-related traffic would increase volumes on TN 58 and TN 95 by approximately 20 percent or less. As the traffic volume would not result in a doubling of the current traffic volumes on these roadways, the increase over current noise levels is estimated to be less than 3 dBA and as such there would be no discernable increase in traffic noise along these roadways. As traffic noise impacts would be limited to roadways with no adjacent sensitive noise receptors, construction-related traffic would have no impact on noise levels at residences or other sensitive areas in the surrounding community.

3.14.2.2.2 Operation

Operation of a Nuclear Technology Park at Area 1 would require the use of various equipment that may generate noise. Tests of emergency warning sirens would be conducted periodically, with advance notification to the public. The primary source of continuous noise during operation would be the mechanical draft cooling towers, which operate at 70 dBA or less at a distance of 1,000 feet. The nearest offsite residence is approximately 1,900 feet southwest of the proposed cooling tower block location at Area 1, across the Reservoir. Based on straight line noise attenuation, it is estimated that noise levels from the cooling tower would attenuate to 64.4 dBA at the nearest residence. While this is higher than the EPA's recommended Ldn guidance of 55 dBA for residential areas, it is below the HUD's recommendation of 65 dBA. Additionally, cooling towers emit noise of a broadband nature, which is largely indistinguishable from and is less obtrusive than noise of a specific tonal nature (such as transformer or loudspeaker noise).

Residential cooling tower noise levels of 64.4 dBA or less would also fall below the City of Oak Ridge's daytime residential noise limits, and below the maximum nighttime noise limit of 70 dBA. However, as cooling towers would operate continuously, the maximum predicted noise levels would exceed the City's established limits of 55 dBA for more than 50 percent of a one-hour survey period or 60 dBA for more than 10 percent of a one-hour survey period during overnight hours. Because estimates of cooling tower noise attenuation are based on bounding criteria, operational noise may result in lower noise levels than those predicted and may be further attenuated by intervening vegetation and topography. When designs for specific reactor technology(s) and associated cooling technologies are developed, TVA would conduct further analysis and/or modeling to determine offsite noise impacts. As operational noise would generally attenuate to levels below the HUD's recommendation of 65 dBA for residential areas, and with implementation of noise abatement if deemed necessary to remain below local noise guidelines, impacts to sensitive noise receptors from operation of a Nuclear Technology Park at Area 1 would be minor.

Implementation of Alternative B would also involve operation of new transmission infrastructure, which may include new switchyards, a connection from the existing 161-kV line along Bear Creek Road to the southeast to 500-kV line, and relocation of the 161-kV line along the edge of Area 1. Under certain wet weather conditions, high-voltage transmission lines may produce an audible low-volume hissing or crackling noise from corona discharge (the electrical breakdown of air into charged particles). Under normal conditions, corona-generated noise is not audible, and during rain showers, the corona noise would likely not be readily distinguishable from background noise. During very moist, non-rainy conditions, such as heavy fog, the resulting corona noise may produce a very minor increase in background noise levels; however, this would be limited to the immediate vicinity of the transmission lines and would not be perceptible at the nearest sensitive noise receptors. Therefore, there would be no noise impacts from the operation of associated transmission infrastructure.

During operation, there would be an increase in traffic on local roadways resulting from workers commuting to the CRN Site. TVA estimates that up to 1,500 worker vehicles (500 operational workers and 1,000 additional workers during refueling) would access the CRN Site per day, during peak operation. Similar to the construction period, approximately 80 percent of traffic (1,200 vehicles) are expected to access the site via TN 58 and Bear Creek Road, while 20 percent (300 vehicles) would utilize TN 95 and Jones Island Road. Traffic noise impacts would be similar to impacts during the construction period because Bear Creek Road and Jones Island Road would experience the greatest increases in traffic volume, and therefore, traffic noise. TN 58 and TN 95 would not experience significant traffic increases in relation to current volumes, and as such, traffic noise along these roadways would not increase perceptibly. While the magnitude of traffic noise impacts would be somewhat less than the traffic noise associated with the construction period due to the smaller traffic volumes, operational impacts would be long term. However, as noticeable traffic noise increases would be limited to Bear Creek Road and Jones Island Road, which have no adjacent sensitive noise receptors, operational traffic would have no impact on noise levels at residences or other sensitive areas in the surrounding community.

3.14.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced Non-LWRs

Under Alternative C, a Nuclear Technology Park would be constructed on Area 2 of the CRN Site. Noise impacts would be similar to those discussed under Alternative B because construction activities, offsite area improvements, assumptions regarding workforce traffic and the distribution of traffic accessing the site, and the reactor and cooling tower specifications and design parameters would be consistent with that described above. However, as the boundary of Area 2 is located at a slightly greater distance (approximately 1,500 feet) from the residences across the Reservoir, construction noise impacts would be incrementally less at the closest sensitive receptors. Maximum noise levels from construction equipment (101 dBA at a distance of 50 feet) operated within Area 2 would attenuate to 71.5 dBA at the closest residence, while the maximum noise from most construction equipment (84 dBA or less at a distance of 50 feet) would attenuate to levels below 55 dBA at the nearest residence. Therefore, similar to Alternative B, the majority of construction noise would attenuate to levels below federal recommendations for residential areas, while exceedances would be infrequent, short-term, and limited to daytime hours.

The location of the cooling tower block in Area 2 has not yet been determined; however, assuming that it would be set back from the existing transmission line ROW, it would be greater than 1,900 feet north of the closest residences, resulting in operational impacts incrementally less than those described under Alternative B. As operational noise would generally attenuate to levels below the HUD's recommendation of 65 dBA for residential areas, and with implementation of noise abatement if deemed necessary to remain below local noise guidelines, impacts to sensitive noise receptors from operation of a Nuclear Technology Park at Area 2 would be minor.

3.14.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced Non-LWRs

Under Alternative D, a Nuclear Technology Park would be constructed on Areas 1 and 2 of the CRN Site. Noise impacts would be similar to those discussed under Alternative B because construction activities, offsite area improvements, assumptions regarding workforce traffic and the distribution of traffic accessing the site, and the reactor and cooling tower specifications and design parameters would be consistent with that described under Alternative B. During construction and operation, noise sources would be spread over a larger portion of the CRN Site, potentially impacting a larger number of residential receptors. However, the maximum potential noise levels would be bounded by those discussed under Alternative B, as the distance to the closest residential receptor would be the same. Therefore, impacts to sensitive noise receptors from operation of a Nuclear Technology Park at Areas 1 and 2 would be minor.

3.14.2.5 Summary of Impacts to Noise

As summarized in Table 3-40, noise impacts associated with the construction and operation of a Nuclear Technology Park at the CRN Site would be minor.

Table 3-40. Summary of Noise Impacts

Alternative	Project Phase	Impact	Severity
Alternatives B, C, D	Construction	Generation of noise from operation of construction equipment and machinery.	Minor; construction noise at offsite residential receptors would typically attenuate to levels below HUD's recommendation of 65 dBA for residential areas. Exceedances would be intermittent, short-term, and limited to daytime hours. Based on distance from receptors, noise levels from construction at Area 1 would be slightly higher than those associated with Area 2. Therefore, the magnitude of impact is as follows: Alternative D > Alternative B > Alternative C.
		Noise impacts resulting from an increase in construction-related traffic on surrounding roadways.	No impact; notable traffic noise increases expected along Bear Creek Road and Jones Island Road due to increases in traffic volume, which would be the same for all alternatives. However, there would be no traffic noise impacts due to lack of sensitive noise receptors.
	Operation	Generation of noise from facility operation, including use of mechanical draft cooling towers.	Minor; cooling tower noise, which would be the primary source of continuous operational noise, would be abated if necessary to remain below City of Oak Ridge residential noise guidelines. Therefore, impacts to sensitive noise receptors would be minor. Based on the distance from receptors, the magnitude of impact is as follows: Alternative D > Alternative B > Alternative C.

Alternative	Project Phase	Impact	Severity
		Corona noise from operation of transmission systems would contribute an increase in background noise levels during certain wet weather conditions.	Limited to the immediate vicinity of transmission lines; would not be perceptible at the nearest sensitive noise receptors. Noise impacts would be minimal and similar across all alternatives.
		Noise impacts resulting from an increase in operational traffic on surrounding roadways.	No impact; notable traffic noise increases expected along Bear Creek Road and Jones Island Road due to increases in traffic volume, which would be the same across all alternatives. However, there would be no traffic noise impacts due to lack of sensitive noise receptors.

3.15 Socioeconomics

3.15.1 Affected Environment

3.15.1.1 Land Use

The CRN Site is located within the city limits of Oak Ridge in eastern Roane County, Tennessee. The northwestern portion of Loudon County and part of the southwestern portion of Anderson County are also included within the CRN Site vicinity (6-mile radius from the center of the CRN Site).

Land use in the unincorporated areas outside of city limits is regulated by the respective counties, primarily through zoning and subdivision regulations. Control of land use in the cities is regulated by the individual municipalities, which have zoning authority for the lands within their boundaries. Counties and municipalities use comprehensive plans to guide land use.

In Roane County outside of the corporate city limits, land use is regulated by the county zoning resolution, which establishes zoning districts and development standards. The five municipalities in Roane County, including Harriman, Kingston, Oak Ridge, Oliver Springs, and Rockwood, have zoning ordinances. The Roane County Future Land Use Plan, adopted in 1998, covers the unincorporated areas of the county. The plan identifies the best direction for growth and recommends future land use patterns for the year 2020 based on land suitability and future land use demands.

In Anderson County outside of the corporate city limits, land use is regulated by the county zoning resolution, which establishes zoning districts and development-related requirements. The five municipalities in Anderson County, including Clinton, Oak Ridge (partially in Roane County), Rocky Top (formerly Lake City), Oliver Springs (partially in Roane and Morgan Counties), and Norris, have zoning ordinances. Anderson County does not have a current land use plan. The county is in the process of updating its 20-year-old growth plan. However, the Anderson County Growth Plan Map was updated in 2007. It identifies urban growth boundaries encompassing planned growth areas adjacent to the cities of Clinton, Rocky Top (formerly Lake City), Norris, and Oak Ridge.

In the unincorporated areas of Loudon County, the county zoning ordinance regulates land use and imposes development requirements. The five municipalities within Loudon County, including Philadelphia, Lenoir City, Greenback, Loudon, and Farragut, have zoning ordinances. The Loudon County Growth Management Plan – 20-Year Land Use Plan map identifies future land use for the county and municipalities, with nonresidential uses concentrated in the cities of Loudon and Lenoir City and along major highways.

Although the CRN Site is within the city limits of Oak Ridge, local zoning laws and regulations or regional land use plans do not apply to federal property. The City of Oak Ridge designates federally controlled lands within its city limits as “Federal Industry and Research” lands. These lands only become subject to local zoning regulations upon transfer from federal ownership.

The only federal or state public lands on or adjacent to the CRN Site are owned and managed by TVA and DOE. There are no national or state parks, national wildlife refuges, or Tribal lands on or adjacent to the CRN Site.

TVA establishes land use zones within its reservoir land management plans. The 2009 Watts Bar Reservoir Land Management Plan (RLMP) (TVA 2009) and the 2020 TVA Natural Resource Plan (TVA 2020) govern the zones of the Reservoir where the CRN Site is located. TVA develops RLMPs using the Single Use Parcel Allocation methodology which defines separate parcels of reservoir lands and allocates those parcels and affiliated land rights to a single land use allocation zone.

The reservoir land management planning process involves allocation of reservoir land to one of seven defined land use zones, six of which are comprised of property owned by TVA in fee. The term "land use zone" refers to a descriptive set of criteria given to distinct areas of land based on location, features, and characteristics. The definition of a land use zone provides a clear statement of how TVA would manage public land, and allocation of a parcel to a particular land use zone identifies that land for specific uses. Further, the implementation of an RLMP minimizes conflicting land uses and makes it easier to handle requests for use of public land.

Allocation changes that are needed for non-administrative purposes must be completed during the normal land planning cycle, either through a supplement or an amendment to a portion of reservoir lands in an RLMP, or through a revision of all reservoir lands in an RLMP. If land use allocation changes are needed on the Watts Bar Reservoir that do not meet the criteria for an 'off-cycle' allocation change, an amendment to the 2009 RLMP is warranted. This type of change was processed in July 2021 when TVA amended the 2009 Watts Bar RLMP which modified the land use allocation of eight parcels affecting 231.2 acres (TVA 2021k).

The CRN Project Area primarily includes Watts Bar RLMP parcels that are designated as Zone 2 – Project Operations. Per the Watts Bar RLMP, Zone 2 includes "TVA reservoir land currently used for TVA operations and public works projects. It includes… [l]and used for TVA power projects operations: generation facilities, switchyards and transmission facilities and rights-of-way." TVA updated the land use designations for several parcels on the CRN Site from Zone 3 to Zone 2 to support future power generation activities in the July 2021 amendment.

The Clinch River Property also includes the Grassy Creek HPA parcel which is designated as Zone 3 – Sensitive Resource Management/Natural Area. The land immediately north of the HPA, Bear Creek Industrial Park, is reservoir land allocated to Zone 5-Industrial. The proposed new 161-kV transmission line that extends from the CRN Site offsite to Bear Creek Road would cross through a portion of the HPA and the Industrial Park; however, no zone change would be required.

The Oak Ridge Wildlife Management Area, where hunting is seasonally authorized when conditions allow, is adjacent to the CRN Site within ORR. Further, hunting access is also seasonally authorized when conditions allow on the CRN Site as part of the Oak Ridge Wildlife Management Area managed hunts, until site development activities begin on the CRN Site.

Potential future transmission line modifications may also be required along the 500-kV transmission line beyond the CRN Site boundary to the Bethel Valley substation. TVA has an easement for this land which lies outside of the jurisdiction of the Watts Bar RLMP and is managed by the DOE but consist of existing transmission land uses.

3.15.1.2 Demographics

The following subsections describe the demographic characteristics of the population within the geographic area of interest, defined as Anderson, Knox, Loudon, and Roane Counties in Tennessee. These counties are those most likely to incur economic, labor force, and infrastructure effects due to the proposed action. This subsection includes the demographic characteristics of permanent area residents, as well as transients who may temporarily live in or visit the area but have permanent residences elsewhere, and migrant workers who travel into the area for seasonal employment and then leave once their jobs are completed. Data used in this subsection were derived from the U.S. Census Bureau's (USCB) decennial censuses and American Community Survey (ACS) 5-year estimates, as well as the USDA's Census of Agriculture data on farms and farm workers. Data regarding future population projections were prepared by the UT's Boyd Center for Business and Economic Research.

3.15.1.2.1 Resident Population

Potentially affected populations near the CRN Site including those of the City of Oak Ridge and others within a 10-mile radius are listed in Table 3-41.

Table 3-41. Population of Municipalities within 10 miles of the CRN Site

Municipality	Population: 2019
Oak Ridge	29,037
Farragut	22,631
Lenoir City	9,162
Harriman	6,126
Loudon	5,747
Kingston	5,927
Oliver Springs	4,468

Source: USCB 2019

While Oak Ridge is the largest city within 10 miles of the CRN Site, the geographic area of interest is dominated by the City of Knoxville, in Knox County. As shown in Table 3-42, the geographic area of interest had a total population of 642,580 in 2019. More than 71 percent of that population resides in Knox County, with nearly 29 percent (186,173 people) within the Knoxville city limits. In comparison, Roane County, the location of the CRN Site, contains 8.3 percent of the area's resident population (USCB 2019).

Table 3-42. Recent Population and Growth Rates of Counties in the Geographic Area of Interest

County	2000	2010	2015	2019	Annual Growth Rate: 2010-2019 (%)
Anderson County, TN	71,330	74,257	75,430	76,061	0.27
Knox, County, TN	382,032	423,748	444,348	461,104	0.98
Loudon County, TN	39,086	47,102	50,229	52,340	1.24
Roane County, TN	51,910	54,156	53,162	53,075	-0.22
Total Geographic Area of Interest	544,358	599,263	623,169	642,580	0.80
State of Tennessee	5,689,283	6,234,968	6,499,615	6,709,356	0.85

Sources: USCB 2000; USCB 2010; USCB 2015; USCB 2019

Population data provided in Table 3-42 indicates that the population of the geographic area of interest grew at an average rate of 0.8 percent per year between 2010 and 2019. The average annual population growth rate between 2010 and 2019 ranged from -0.23 percent per year in Roane County to 1.24 percent per year in Loudon County.

Long-term population trends and projections for the geographic area of interest are provided in Table 3-43. Historic population data, from 1970 through 2015, were obtained from the USCB's decennial censuses and ACS 5-year estimates. The UT's Boyd Center for Business and Economic Research provides county-level population projections through the year 2070, which is assumed to encompass the majority of the proposed Nuclear Technology Park's initial 40-year operating period. The future projections indicate that the population within the geographic area of interest is expected to continue growing, though at a slower rate than in recent decades.

Table 3-44 provides the resident population's age and gender distribution within the geographic area of interest and the State of Tennessee. Women make up slightly more than half of the population in all of the counties. Knox County has the youngest population in the area with a median age of 37.4 years, while the other three counties have median ages noticeably higher, ranging from 43.3 years in Anderson County to 47.6 years in Loudon County. The median age for the geographic area of interest is 44.9 years, compared to the State's median age of 38.7 years (USCB 2019).

The racial and ethnic distribution of residents within the geographic area of interest is provided in Table 3-45. The geographic area of interest is less racially and ethnically diverse than Tennessee as a whole. White residents are the most prominent race in all four counties within the geographic area of interest, comprising 84.4 percent of the total population. African American residents make up 6.9 percent of the population within the area, while Hispanic residents represent 4.3 percent of the population (USCB 2019).

Table 3-43. Historical and Projected County Populations in the Geographic Area of Interest, 1970-2070

	Anderson County		Knox County		Loudon County		Roane County		Geographic Area of Interest	
Year	Population	Annual Percent Growth	Population	Annual Percent Growth	Population	Annual Percent Growth	Population	Annual Percent Growth	Population	Annual Percent Growth
1970	60,300	NA	276,293	NA	24,266	NA	38,881	NA	399740	NA
1980	67,346	1.17	319,694	1.57	28,553	1.77	48,425	2.45	464018	1.61
1990	68,250	0.13	335,749	0.50	31,255	0.95	47,227	-0.25	482481	0.40
2000	71,330	0.45	382,032	1.38	39,086	2.51	51,910	0.99	544358	1.28
2010	74,257	0.41	423,748	1.09	47,102	2.05	54,156	0.43	599263	1.01
2015	75,430	0.32	444,348	0.97	50,229	1.33	53,162	-0.37	623169	0.80
2020	77,151	0.46	473,996	1.33	54,454	1.68	53,285	0.05	658,886	1.15
2025	78,500	0.35	494,503	0.87	57,606	1.16	53,386	0.04	683,995	0.76
2030	79,454	0.24	513,318	0.76	60,311	0.94	53,111	-0.10	706,193	0.65
2035	80,197	0.19	531,397	0.70	62,691	0.79	52,587	-0.20	726,872	0.59
2040	80,872	0.17	549,800	0.69	64,917	0.71	51,956	-0.24	747,543	0.57
2045	81,560	0.17	568,606	0.68	67,203	0.70	51,318	-0.25	768,688	0.57
2050	82,280	0.18	587,800	0.68	69,712	0.75	50,723	-0.23	790,515	0.57
2055	82,995	0.17	607,234	0.66	72,468	0.79	50,177	-0.22	812,874	0.57
2060	83,731	0.18	627,120	0.65	75,426	0.82	49,683	-0.20	835,961	0.57
2065	84,524	0.19	647,574	0.65	78,518	0.82	49,249	-0.17	859,865	0.57
2070	85,377	0.20	668,482	0.65	81,718	0.81	48,876	-0.15	884,453	0.57

Sources: USCB 2010; USCB 2015; Boyd Center for Business and Economic Research 2019

Table 3-44. Age and Gender Distribution in the Geographic Area of Interest and State

	Anderson County		Knox County		Loudon County		Roane County		Geographic Area of Interest		Tennessee	
Age Groups	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Under 5 years	4,115	5.4	26,465	5.7	2,687	5.1	2,422	4.6	35,689	5.6	40,6438	6.1
5 to 14 years	9,079	11.9	54,407	11.8	5,823	11.1	5,570	10.5	74,879	11.7	84,0813	12.5
15 to 24 years	8,602	11.3	71,866	15.6	5,539	10.6	5,939	11.2	91,946	0.1	87,4712	13.0
25 to 44 years	17,888	48.1	120,186	26.1	10,411	19.9	11,336	21.4	159,821	0.2	174,9986	26.1
45 to 64 years	21,390	28.1	116,986	25.4	14,358	27.4	16,015	30.2	168,749	0.3	176,2283	26.3
65 years and over	14,987	19.7	71,194	15.4	13,522	25.8	11,793	22.2	111,496	0.2	107,5124	16.0
Total	76,061	100	461,104	100	52,340	100	53,075	100	642,580	12.1	670,9356	100
Median Age (years)	43.3		37.4		47.6		46.4		44.95		38.7	
Gender												
Male	37,152	48.8	224,184	48.6	25,614	48.9	26,124	49.2	313,074	48.7	3,273,278	48.8
Female	38,909	51.2	236,920	51.4	26,726	51.1	26,951	50.8	329,506	51.3	3,436,078	51.2

Source: USCB 2019

Table 3-45. 2019 Racial and Ethnic Percentage Distribution within the Geographic Area of Interest

Racial or Ethnic Category	Anderson County	Knox County	Loudon County	Roane County	Geographic Area of Interest	Tennessee
Total population (persons)	76,061	461,104	52,340	53,075	642,580	6,709,356
White alone	89.1	82.3	87.7	92.7	84.4	73.8
Racial and ethnic minorities	10.9	17.7	12.3	7.3	15.6	26.2
Black or African American	3.5	8.7	0.9	2.3	6.9	16.6
American Indian and Alaska Native	0.5	0.2	0.1	0.4	0.3	0.2
Asian	1.3	2.2	0.7	0.8	1.8	1.7
Native Hawaiian and Other Pacific Islander	0.1	0.0	0.0	0.0	0.0	0.1
Some other race	0.2	0.2	0.1	0.1	0.2	0.2
Hispanic or Latino	2.9	4.3	8.8	1.8	4.3	5.4
Multiracial	2.4	2.1	1.7	1.9	2.1	2.0

Source: USCB 2019

3.15.1.2.2 Transient Population

Transient populations include people from outside the geographic area of interest who work in or visit locations such as large workplaces, schools, hospitals and nursing homes, correctional facilities, hotels and motels, recreational areas, or special events in the area. Though relatively rural in nature, the region surrounding the CRN Site has numerous tourist attractions and events that contribute to the transient population.

The transient population within the geographic area of interest was evaluated in the ESPA ER and the NRC FEIS. Transient population projections were derived from survey data collected to identify the events, facilities, parks, and attractions that contribute to the total transient population within the region. Over 100 events and attractions were identified within a 50-mile radius of the CRN Site, contributing approximately 500,000 peak daily visitors to the total transient population. Nearly 70 percent of this population occurred 20 to 30 miles from the CRN Site and included a combination of commuters, tourists, recreationists, and event attendees. Only a small percentage of the transient population was associated with facilities or events located within 10 miles of the CRN Site.

3.15.1.2.3 Migrant Labor

The USCB defines a migrant laborer as someone who works seasonally or temporarily and moves one or more times per year to perform seasonal or temporary work. Migrant labor in the geographic area of interest consists mainly of construction workers and migrant farm laborers. The 2017 Census of Agriculture indicated that 12 farms in the area employed migrant labor, but the total number of migrant workers was not disclosed (USDA-NASS 2017). It is anticipated that while migrating construction workers would outnumber migrant agricultural workers, they would be negligible compared to the total population.

3.15.1.3 Employment and Income

3.15.1.3.1 Employment

Total employment and employment values by industry for the geographic area of interest (Anderson, Knox, Loudon, and Roane Counties) are represented in Table 3-46. The principal economic centers in the geographic area of interest are Knoxville, TN (Knox County), Oak Ridge, TN (Anderson and Roane Counties), and Loudon, TN (Loudon County). Of these economic centers, Knoxville, TN is the largest.

Table 3-46 shows number of jobs by industry in the geographic area of interest. In Anderson County, as of 2019, the industry with the highest employment level was manufacturing with 11,818 jobs (26.2 percent increase), whereas in Knox County employment levels were greatest in healthcare and social assistance with 40,667 jobs (11.1 percent increase). By comparison, the respective leading employment sectors in Louden and Roane counties were manufacturing with 3,771 jobs (17.6 percent increase) and professional, scientific, and technical services with 6,976 jobs (19.5 percent) (USBEA 2019a).

The total labor force of the geographic area of interest in 2020 was 323,596 persons; of those, 303,911 people were employed. From 2010 to 2020, the number of employed people in the geographic area of interest increased by approximately six percent. During the same period, employment in Tennessee increased by approximately nine percent (BLS 2010 and BLS 2020).

A total of 19,685 people were unemployed in the geographic area of interest in 2020, while 245,532 were unemployed in the State of Tennessee in 2020. In the geographic area of interest, the unemployment rates in 2020 range from 5.9 percent (Knox County) to 6.7 percent (Anderson County). The unemployment rate in the geographic area of interest as a whole was 6.1 percent in 2020, while the State of Tennessee had an unemployment rate of 7.4 percent (BLS 2010 and BLS 2020).

The largest employer within the geographic area of interest is the DOE Y-12 National Security Complex located in Anderson and Roane Counties, which employs 11,627 persons. The largest employer in Knox and Anderson counties are the Knox County Schools and the Oak Ridge School District with 9,515 employees and 1,323 employees, respectively (East Tennessee Economic Development Agency 2021).

Work force data for the heavy construction industry was analyzed for the states of Tennessee, North Carolina, Georgia, and Kentucky because the heavy construction industry would be expected to draw workers from a larger geographic area than would general construction. In 2020, there were 16,560 people employed in heavy and civil engineering construction in Tennessee, 12,265 in Kentucky, 35,043 in North Carolina, and 34,579 people in Georgia (BLS & STL FRED 2021a, 2021b, 2021c, 2021d).

Table 3-46. Employment by Industry

	Anderson Co., TN			Knox Co., TN			Loudon Co., TN			Roane Co., TN		
Industry Type	**2010**	**2019**	**Percent Change**	**2010**	**2019**	**Percent Change**	**2010**	**2019**	**Percent Change**	**2010**	**2019**	**Percent Change**
Total employment	48,435	50,998	5%	288,226	328,096	14%	20,661	24,095	17%	24,477	26,015	6%
Farm employment	457	445	-3%	1,037	942	-9%	1,022	1,027		522	538	3%
Nonfarm employment	47,978	50,553	5%	287,189	327,154	14%	19,639	23,068	17%	23,955	25,477	6%
Private nonfarm employment	42,293	45,186	7%	251,132	292,081	16%	17,284	20,679	20%	20,048	21,516	7%
Forestry, fishing, and related activities	66	(D)		224	226	1%	(D)	(D)		(D)	(D)	
Mining, quarrying, and oil and gas extraction	281	(D)		695	441	-37%	(D)	(D)		(D)	(D)	
Utilities	(D)	(D)		11	(D)		(D)	6		(D)	(D)	
Construction	3,394	2,215	-35%	15,444	18,787	22%	1,511	1,779	18%	968	(D)	
Manufacturing	9,361	11,818	26%	12,092	13,932	15%	3,207	3,771	18%	1,277	1,178	-8%
Wholesale trade	821	(D)		13,712	13,560	-1%	(D)	470		492	456	-7%
Retail trade	3,984	4,367	10%	34,325	37,450	9%	2,304	2,670	16%	2,438	2,436	0%
Transportation and warehousing	(D)	1,052		9,680	(D)		905	1,362	50%	(D)	(D)	
Information	212	364	72%	6,023	5,888	-2%	98	217	121%	115	85	-26%
Finance and insurance	1,810	1,841	2%	14,049	17,096	22%	769	906	18%	425	499	17%

	Anderson Co., TN			Knox Co., TN			Loudon Co., TN			Roane Co., TN		
Industry Type	**2010**	**2019**	**Percent Change**	**2010**	**2019**	**Percent Change**	**2010**	**2019**	**Percent Change**	**2010**	**2019**	**Percent Change**
Real estate and rental and leasing	1,048	1,168	11%	12,193	15,979	31%	804	994	24%	548	644	18%
Professional, scientific, and technical services	6,930	4,880	-30%	18,732	21,233	13%	1,099	1,097	0%	5,836	6,976	20%
Management of companies and enterprises	85	59	-31%	3,736	7,294	95%	12	50	317%	90	66	-27%
Administrative and support and waste management and remediation services	2,976	4,454	50%	23,634	26,755	13%	1,183	1,253	6%	2,265	1,951	-14%
Educational services	317	318	0%	4,077	5,824	43%	137	245	79%	137	186	36%
Health care and social assistance	4,514	5,081	13%	36,593	40,667	11%	1,449	1,710	18%	2,055	2,136	4%
Arts, entertainment, and recreation	533	581	9%	5,611	7,488	33%	(D)	461		193	258	34%
Accommodation and food services	3,072	3,529	15%	24,368	28,054	15%	(D)	1,851		1,362	1,447	6%

Industry Type	Anderson Co., TN			Knox Co., TN			Loudon Co., TN			Roane Co., TN		
	2010	2019	Percent Change	2010	2019	Percent Change	2010	2019	Percent Change	2010	2019	Percent Change
Other services (except government and government enterprises)	2,167	2,556	18%	15,933	18,730	18%	1,477	1,698	15%	1,139	1,307	15%
Government and government enterprises	5,685	5,367	-6%	36,057	35,073	-3%	2,355	2,389	1%	3,907	3,961	1%
Federal civilian	1,031	855	-17%	3,908	3,624	-7%	163	159	-2%	471	396	-16%
Military	255	215	-16%	1,496	1,379	-8%	164	151	-8%	181	148	-18%
State and local	4,399	4,297	-2%	30,653	30,070	-2%	2,028	2,079	3%	3,255	3,417	5%

Source: USBEA - CAEMP25N Total Full-Time and Part-Time Employment by NAICS Industry (USBEA 2019a)
Note: (D) Not shown to avoid disclosure of confidential information; estimates are included in higher-level totals.

3.15.1.3.2 Income and Taxes

Table 3-47 presents household income distribution and poverty information. Median household income in the geographic area of interest ranges from roughly $50,000 in Anderson County to just over $58,000 in Loudon County.

Table 3-47. Household Income Distribution (Percent of Households)

Income range	Anderson County	Knox County	Loudon County	Roane County	Geographic Area of Interest	Tennessee
Total Households	30,541	187,319	20,669	20,901	259,430	2,597,292
Less than $10,000	6.9	7.1	5.6	7.4	7.0	6.9
$10,000 to $14,999	5.5	4.5	5.0	6.9	4.8	5.2
$15,000 to $24,999	12.0	10.1	7.6	10.0	10.1	10.6
$25,000 to $34,999	11.2	9.5	10.4	10.3	9.8	10.4
$35,000 to $49,000	14.1	13.0	13.4	12.3	13.1	14.0
$50,000 to $74,999	18.2	17.4	20.8	18.3	17.8	18.3
$75,000 to $99,999	12.0	13.2	13.3	13.1	13.0	12.4
$100,000 to $149,999	11.9	14.0	15.4	12.7	13.8	12.8
$150,000 to $199,999	4.7	5.6	4.3	5.1	5.4	4.7
$200,000 or more	3.6	5.7	4.3	3.9	5.2	4.8
Median Household Income	50,392	57,470	58,065	53,367	55,824	53,320

Source: USCB 2019

Table 3-48 presents the per capita income trends for the geographic area of interest. Per capita personal income ranged from $41,917 in Roane County to $51,758 in Knox County in 2019. The average personal per capita income in the State of Tennessee was $48,652 in 2019, with an average annual increase of 4 percent between 2010 and 2019. This is similar to the trends for the geographic area of interest where per capita increased an average of 3 to 4 percent during this same period (USBEA 2019b).

Table 3-48. Per Capita Income Trends

Geographic Area	2010	2019	Percentage Change	Annual Average Growth (Percent)
Anderson County, TN	34,420	43,045	25%	3%
Knox County, TN	37,305	51,758	39%	4%
Loudon County, TN	36,448	50,154	38%	4%
Roane County, TN	32,833	41,917	28%	3%
Tennessee	35,652	48,652	36%	4%

1. All dollar estimates are in thousands of current dollars (not adjusted for inflation).
2. Source: USBEA 2019b

Anderson, Knox, Loudon, and Roane Counties are the tax districts that are assumed to be most directly affected by the proposed CRN project. Total annual tax revenues for Anderson, Knox, Loudon, and Roane Counties for fiscal year (FY) 2014-2015 through FY 2019-2020 are shown in Table 3-49. Several revenue categories would be affected by the construction and operation of new power production units. These include income taxes on corporate profits, sales and use taxes on construction- and operation-related purchases and on purchases made by the project workforce.

Table 3-49. Total Revenues for Anderson, Knox, Loudon, and Roane Counties

Fiscal Year	Anderson County	Knox County	Loudon County	Roane County
2014-2015	$100,887,707	$830,536,160	$77,053,052	$87,866,243
2015-2016	$104,144,274	$861,567,066	$70,088,027	$94,486,088
2019-2017	$106,912,531	$933,557,733	$71,312,112	$95,590,990
2017-2018	$117,982,389	$888,539,822	$74,772,271	$98,027,047
2018-2019	$131,803,876	$949,960,033	$76,797,684	$100,628,605
2019-2020	$125,039,889	$946,467,910	$77,806,009	$104,406,455

Source: Tennessee Controller of the Treasury 2021b.

Corporate taxes, sales and use taxes, and property taxes contribute to the total funds for the State of Tennessee. The percentage of appropriation by category for state funds for FY 2020-2021 (July 2020 through June 2021) is shown in Table 3-50.

Table 3-50. Appropriation of Tennessee State Funds for Fiscal Year 2020-2021

Tax Appropriation Category	Percentage
Education	40%
Health & Social Services	28%
Law, Safety, & Correction	10%
Cities & Counties	7%
Transportation	6%
Resources & Regulation	3%
General Government	3%
Business & Economic Development	3%

Source: State of Tennessee 2020.

Corporate income taxes are levied pursuant to guidelines contained in Title 67 of the TCA. Businesses in Anderson, Knox, Loudon, and Roane counties have tax incentives available to them, including capital-investment tax credits.

Under Section 13 of the TVA Act of 1933, TVA makes tax-equivalent payments to eight states, including the State of Tennessee. TVA pays five percent of its gross proceeds from the sale of power (with certain exclusions) to states and counties where its power operations are carried out. 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.

The State of Tennessee then allocates its tax-equivalent payments from TVA in accordance with Title 67 “Taxes and Licenses”, Chapter 9 “Payments in Lieu of Taxes”, Part 1 “Tennessee Valley Authority (Tennessee State Revenue Sharing Act)”. The TVA tax-equivalent payments are divided as follows:

- 48.5 percent is retained by the State of Tennessee
- 48.5 percent is distributed to local governments
- 3 percent is paid to impacted local governing areas that are experiencing TVA construction activity on facilities made to produce power.

3.15.1.4 Community Characteristics
The four counties that comprise the geographic area of interest either provide and maintain their own community services and infrastructure or contract with one another to provide specific services to their individual populations. Community facilities and services include public or publicly funded facilities such as police protection and other emergency services (ambulance/fire protection), schools, hospitals and other health care facilities, libraries, churches, and community centers.

3.15.1.4.1 Housing

Table 3-51 provides a summary of the housing stock for Anderson, Knox, Loudon, and Roane counties. A majority of the total existing housing units in the geographic area of interest are occupied, ranging from 81 percent in Roane County to 91 percent in Knox County. The majority of these housing units are owner-occupied, ranging from 59 percent in Knox County to 70 percent in Loudon County. Accordingly, a lower number of housing units are rental units, ranging from 19 percent in Roane County to 33 percent in Knox County. Vacancy rates in the geographic area of interest range from nine percent in Knox County to 19 percent in Roane County (USCB 2019).

Table 3-51. Housing Characteristics in Anderson County, Knox County, Loudon County, and Roane County

County/ Community	Total Housing Units	Number Occupied	% Total Occupied	Number Owner-Occupied	% Owner-Occupied	Number Renter-Occupied	% Renter-Occupied	Number Vacant	% Vacant
Anderson County	34,971	30,541	87%	20,746	59%	9,795	28%	4,430	13%
Knox County	205,620	187,319	91%	120,390	59%	66,929	33%	18,301	9%
Loudon County	23,083	20,669	90%	16,076	70%	4,593	20%	2,414	10%
Roane County	25,657	20,901	81%	16,143	63%	4,758	19%	4,756	19%

Source: USBC 2019

Some construction workers and some visiting operational staff may have a need for temporary housing in the geographic area of interest. There are 63 hotels, inns, and resorts listed on the Tennessee Department of Tourism Development website in the Knoxville/Middle East Tennessee region (TN Dept of Tourist Development 2021). And within the geographic area of interest there are approximately 9,400 hotel rooms.

3.15.1.4.2 Education

Table 3-52 identifies primary and secondary educational facilities in the geographic area of interest along with their enrollments, number of teachers and student-to-teacher ratios. The geographic area of interest encompasses eight public school districts and several private school systems. Together, these facilities provide 200 schools that serve over 96,217 elementary, middle, and high school students (IES NCES 2021a and IES NCES 2021b). For the 2019 academic year, the overall student-teacher ratio for these schools was 14.2:1 (Table 3-52). Within the geographic area of interest, Knox County has the highest level or student enrollment, 69,020 students, over 131 schools, and Roane County has the smallest student enrollment, 7,177 students, over 22 schools (IES NCES 2021a and IES NCES 2021b).

Table 3-52. Public and Private Schools in Anderson, Knox, Loudon, and Roane Counties

	Total # Schools	Elementary	Middle	Secondary	Student Enrollment	Teachers (FTEs)[a]	Student to Teacher Ratio
Anderson							
Anderson County School District	18	10	4	4	6,436	419.5	15.3:1
Oak Ridge School District	8	5	2	1	4,775	323.1	14.8:1
Clinton City Schools	3	3	0	0	974	62	15.7:1
Private Schools	4				303	18.7	16.2:1
Knox							
Knox County School District	91	54	16	21	60,735	4069.5	14.9:1
Tennessee School for the Deaf	2	1	0	1	132	41	3.2:1
Private Schools	38				8,153	669.4	12.2:1
Loudon							
Loudon County	3	1	1	1	2,435	134.7	18.1:1
Lenoir City	9	4	3	2	4,966	307.6	16.1:1
Private Schools	2				131	15	8.7:1
Roane							
Roane County School District	17	6	5	6	6,514	408.3	16.0:1
Private Schools	5				663	283.7	2.3:1
Total	200				96,217	6752.5	14.2:1

Source: IES NCES 2021a and 2021b

Note: [a]FTE = Full Time Equivalent Employee (part-time workers are reported as a fraction of one full-time worker

3.15.1.4.3 Police

Based on 2019 Federal Bureau of Investigation (FBI) data, the numbers of sworn law enforcement officers by county range from 42 in Roane County to 430 in Knox County (FBI 2019). In addition to county level law enforcement, individual cities maintain their own police departments with jurisdictions usually limited by the city limits. The number of sworn law enforcement officers by county is shown in Table 3-53.

Table 3-53. Law Enforcement Services

County	Number of Law Enforcement Officers	Residents	Officer to Resident Ratio
Anderson County	64	76,061	1:1,188
Knox County	430	461,104	1:1,072
Loudon County	57	52,340	1:918
Roane County	42	53,075	1:1,264

Source: FBI 2019 and USCB 2018

The recommended police officer-to-resident ratio ranges from 1 to 4 officers per 1,000 residents, or a police-to-resident ratio between 1:250 and 1:1,000. Officer-to-resident ratios by county in the geographic area of interest range from approximately 1:900 in Loudon County to 1:1,200 in Roane County (Table 3-53). The Officer-to-resident ratio for Loudon County is within the recommended range. However, office-to-resident ratios for Anderson, Knox, and Roane Counties are slightly under the recommended ratio of 1:1,200.

3.15.1.4.4 Fire

Fire departments staffed by volunteer and/or paid firefighters provide fire services in the geographic area of interest. The number of volunteer and career firefighters in each county, last reported in 2021, are detailed in Table 3-54. In addition, the Oak Ridge National Laboratory fire department employs 40 career firefighters (Fire Department 2021).

Table 3-54. Fire Services

County	Number of Firefighters[a]	Residents	Officer to Resident Ratio
Anderson	214	76,061	1:355
Knox	553	461,104	1:834
Loudon	202	52,340	1:259
Roane	156	53075	1:322

Source: Fire Department 2021, USCB 2018
Note:[(a)] Includes volunteer and career firefighters

The National Fire Protection Association estimates that in 2018 there were 1,115,000 firefighters in the U.S. (NFPA 2021). Dividing the 2018 estimated population of the U.S. (327,167,434) by the number of firefighters provides a ratio of 1 firefighter for every 293 persons (USCB 2018). Table 3-54 shows the firefighter-to-resident ratio which ranges from 1:259 in Loudon County to 1:834 in Knox County. Firefighter-to-resident ratios in the area of geographic interest, with the exception of Knox County, are relatively close to the national average.

The City of Oak Ridge Fire Department would provide the primary fire and emergency medical services (EMS) emergency response to the CRN Site. The City of Kingston Fire Department would be the primary backup for the CRN Site.

3.15.1.4.5 Medical Services

County health departments in the geographic area of interest provide general medical services such as pediatric and women's health clinics, immunization programs, environmental health, and social services. The Anderson County Health Department is located in Clinton; the County's Emergency Preparedness Department and Disaster Response Team are affiliated with the Health Department. The Knox County Health Department is located in Knoxville; emergency preparedness is managed through the Knox County Health Department. The Roane County Health Department is located in Rockwood. General health services in Loudon County are provided by the Tennessee Department of Health. There are 11 medical centers in the geographic area of interest for the CRN Site (TN Department of Health 2021). There are several county-based EMS services within the geographic area of interest. Anderson County operates six full time Advanced Life Support paramedic units, and five Basic Life Support units on a limited schedule. Roane County Office of Emergency Services EMS Division operates four Advanced Life Support paramedic units. Knox and Loudon Counties EMS services are provided by Rural/Metro Corporation emergency and non-emergency fleet.

3.15.1.4.6 Water and Wastewater

Residents within the geographic area of interest obtain drinking water from both communal water systems and individual wells. Anderson, Knox, Loudon, and Roane Counties are served by 16 major public water systems that obtain water from surface waterbodies. The four-county region is served by 20 major wastewater-treatment systems. The CRN Site would be serviced the City of Oak Ridge Public Works Department, which manages the City's water and wastewater treatment plants, water distribution system, and wastewater collection system (City of Oak Ridge 2021). The City of Oak Ridge Public Works Department obtains its water from the Melton Hill Reservoir, obtaining a maximum water capacity of 9.9 MGD. The average daily consumption is 7.7 MGD with an excess of 2.2 MGD. The Rarity Ridge treatment facility operated by the City of Oak Ridge would be expected to provide wastewater treatment for the CRN Site. This plant has a maximum total capacity of 0.6 MGD, with an excess of 0.5 MGD.

3.15.1.5 Reasonably Foreseeable Future Actions in Proximity to the CRN Site

As noted in Section 3.1.3, TVA identified several foreseeable future actions in proximity to the CRN Site. The scope of these other proposed actions is expected to result in both construction phase and operational phase workforce requirements that could contribute to regional population increases and associated impacts on the local economy and availability of community facilities and services. Specific foreseeable future actions that may affect workforce availability, housing, and the adequacy of services in communities also served by the CRN Project include the potential development of the Kairos Hermes Reactor Project, the development of the new airport by the City of Oak Ridge (both at the ETTP, the proposed construction of new production facilities at Y-12 complex, and potential development at the Horizon Center Industrial Park. Each of these actions is located within the same socioeconomic geographic area of interest as that of the CRN project. As such, further consideration of reasonably foreseeable future actions and their effects on socioeconomic resources are included in the following section as appropriate.

3.15.2 Environmental Consequences

3.15.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, the CRN Site would remain undeveloped and managed in accordance with the Watts Bar RLMP. Therefore, there would be no impacts to land use, demographics, employment or income, or community characteristics in the geographic area of interest.

3.15.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced Non-LWRs

3.15.2.2.1 Land Use

As discussed in Section 3.15.1.1, local zoning ordinances are not applicable to the CRN Site. However, site land use is subject to the TVA Watts Bar RMLP. The CRN Site is designated by the RMLP as Zone 2 – Project Operations; therefore, the construction of a nuclear power generation facility is compatible with the area's existing land use designation. At such time as TVA constructs and operates one or more advanced nuclear reactors on the CRN Site, this parcel would be re-classified from "planned" reservoir land to "power plant property" and would be removed from the land planning process.

As discussed above, the proposed new 161-kV transmission line which spans the CRN Site within and adjacent to the existing 500 kV ROW and extends to Bear Creek Road intersects a small portion of land designated as Zone 3 (Sensitive Resource Management) and Zone 5 (Industrial).

The potential future transmission line modifications along the 500-kV transmission line would occur on lands that are outside of the CRN Site boundary that are managed by the DOE and are not subject to the Watts Bar RLMP. The modifications would be consistent with the use of the existing transmission corridor and would occur on land where TVA already has easements.

Alternative B would entail the development of the majority of the CRN Site in a manner that is consistent with the existing RLMP designations. Therefore, impacts associated with land zoning and land management plans are minor.

3.15.2.2.2 Demographics

3.15.2.2.2.1 Construction

The estimated construction workforce needed for the development of a Nuclear Technology Park at Area 1 would vary over the course of the construction period, averaging approximately 1,764 workers and peaking at 3,300 workers. Based on TVA's and DOE's experience in nuclear and energy facility construction, several assumptions were depended on to bound the construction workforce composition with respect to workforce commuting and relocation. The following assumptions concerning plant construction are as follows:

- Construction workers commute up to 50 miles, thus workers within 50 miles of the CRN Site area are considered local.
- 80 percent of field craft laborers would be available within 50 miles of the CRN Site area.
- 20 percent of the field craft laborers would relocate to within 50 miles of the CRN Site area and seek temporary housing.

- 80 percent of the non-manual field laborers would relocate to within 50 miles of the CRN Site and seek permanent housing.
- 20 percent of the non-manual field laborers would be available within 50 miles of the CRN Site.

These assumptions have been found to be consistent with worker location assumptions for other recent NRC licensing actions. As the geographic area of interest already supports DOE's ORR, additional information regarding the likelihood of a higher proportion of locally supplied labor and materials was also incorporated. Substantial local expertise and supply chain businesses exist in the geographic area of interest as well, which may mitigate some of the need for both labor, support services, and materials acquisition from outside the area. Table 3-55 summarizes the labor requirements expected for construction and includes estimates of the necessary number of skilled craft workers needed to be employed from outside the geographic area of interest.

Table 3-55. Projected Peak Construction Employment Onsite Labor Requirements

Labor Category	Responsibilities	Estimated Percent of Total Workforce	Peak Workforce Need	Needed from Outside the Geographic Area of Interest
Civil/Architectural Workforce	Earthwork, Yard Pipe, Piling, Concrete and Reinforcing Steel, Rigging, Structural/Miscellaneous Steel, Fire Proofing, Insulation, Coatings/Painting	25	825	166
Mechanical/Piping Workforce	Nuclear Steam Supply System; Turbine Generator; Condenser; Cooling Towers, Process Equipment; Heating, Ventilation, and Air-Conditioning; Piping; Tubing; Valves; Hangers/Supports	24	792	158
Electrical Workforce	Electrical Equipment, Cable Tray, Conduit, Supports, Cable and Wire, Connections and Terminations	14	462	92
Site Support Workforce	Scaffolding, Equipment Operation, Transport, Cleaning, Maintenance, etc.	14	462	92
Non-manual Workforce	Management, Supervision, Field Engineering, Quality Assurance/Quality Control, Environmental/Safety and Health, Administration, and Startup	23	759	607
	Total	**100**	**3,300**	**1,115**

Based on the assumptions outlined above, it is expected that during the peak construction employment, approximately 1,115 of the 3,300 workers (roughly 34 percent) would move into the geographic area of interest. It is assumed that in-migrating workers would settle in the geographic area of interest in a pattern similar to the residency pattern of the existing DOE ORR workforce. 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 reside in Knox County, six percent reside in Loudon County, and 17 percent reside in Roane County.

It is also assumed that each worker who relocates into the geographic area of interest would bring a family. The average household size (including single-person households) in Tennessee is approximately 2.53. Therefore, an in-migrating workforce of 1,115 would increase the geographic area of interest's population by roughly 2,821, or by approximately 0.4 percent compared to the projected 2025 population.

In addition to the construction workforce, there likely would be a time during peak construction employment when advanced nuclear reactor unit(s) are operating, while others may still be under construction. During this overlap, 366 operations employees are anticipated to join the 3,300 construction workers onsite. This results in a peak overlapping construction and operations workforce of 3,666. It is assumed that 250 of the 366 overlapping operations workers would migrate from outside of the geographic area of interest, resulting in a peak in-migrating workforce of 1,365. Assuming each worker who relocates into the geographic area of interest would bring a family, the total area population would increase by roughly 3,453, or by approximately 0.5 percent as a result of peak construction activities. Table 3-56 details the expected residency of the in-migrating construction workers and families.

Table 3-56. Estimated Population Increase and Employment in the Geographic Area of Interest during the Peak Construction Employment Period

County	In-Migrating Workers	Population Increase	Projected 2025 Population	Percent Increase
Anderson	369	934	78,500	1.19
Knox	683	1,728	494,503	0.35
Loudon	82	207	57,606	0.36
Roane	231	584	53,386	1.09
Total	**1,365**	**3,453**	**683,995**	**0.50**

As an in-migrating workforce of 1,365 workers and their families during peak construction-period employment would cause a population increase of 0.5 percent, there would not be a noticeable effect on the population demographics of the geographic area of interest as a whole or on the individual counties. Therefore, the impact associated with construction at Area 1 on area demographics would be minor.

3.15.2.2.2.2 Operation

It is estimated that 500 employees would be required during regular operations-related activities at a Nuclear Technology Park at Area 1. Based on the current residential distribution of DOE-related ORR operations workforces, TVA has estimated that 50 percent of the operations workforce for the proposed plant would already reside within the geographic area of interest. The remaining 250 workers would need to be hired from outside the area and would relocate to the geographic area of interest.

It is assumed that like the construction workforce, all in-migrating operation employees would bring their families. Using the average Tennessee household size of approximately 2.53, it is estimated that the geographic area of interest would experience a population increase of 633 people. As with the construction workforce, it is also assumed that the in-migrating operation workers would settle in the geographic area of interest, comparable to the residency pattern of the existing DOE-related ORR workforce. The subsequent operations-related increase in the population of the geographic area of interest is summarized in Table 3-57. The in-migration of operations workers and their families would result in a population increase of less than 0.1 percent in the geographic area of interest. Therefore, the impact associated with regular operational employees at Area 1 on area demographics would be minor.

Table 3-57. Estimated Population Increase in the Geographic Area of Interest during Operations, Not Including Outage Workers

County	Workers	Population Increase	Projected 2025 Population	Percent Increase
Anderson	67	170	78,500	0.22
Knox	125	316	494,503	0.06
Loudon	15	38	57,606	0.07
Roane	43	109	53,386	0.20
Total	**250**	**633**	**683,995**	**0.09**

In addition to the full-time operations workforce at Area 1 on the CRN Site, it is estimated that 1,000 temporary workers would be needed every 18 to 24 months for outages. As the geographic area of interest has a higher concentration of energy industry labor, it is believed that half of the needed labor could be acquired from within the geographic area of interest, meaning that only 500 workers would temporarily migrate into the surrounding area during the 30- to 60-day outage period. Based on the infrequent nature and limited length of time for refueling outages, it is assumed that the temporary refueling workers would not permanently relocate to the geographic area of interest and would not bring families. The maximum size of the in-migrating workforce during operations (250 operations workers and 500 outage workers) is approximately two-thirds the size of the in-migrating peak employment construction workforce (1,115). The in-migrating construction workforce and their families would constitute approximately 0.5 percent of the baseline population, which is assumed to have a minor impact on the surrounding area. As the in-migrating operations workers, including outage workers, would be significantly fewer than the number of in-migrating construction workers, population increases associated with the operations workforce would not noticeably affect the demographic character of the geographic area of interest or any of its counties and, therefore, the overall impact would be minor.

3.15.2.2.3 Employment and Income

3.15.2.2.3.1 Construction

<u>Employment</u>

Construction of a Nuclear Technology Park under Alternative B would result in an in-migration of construction workers which would stimulate spending on goods and services and would likely create new indirect service jobs in the geographic area of interest. Direct and indirect economic impacts can be predicted using employment and income multipliers which provide an estimate of increases and or decreases due to a given action. The U.S. Department of Commerce Bureau of Economic Analysis calculates multipliers for each industry based on earnings within a specific region. This model is called the Regional Input-Output Modeling System (RIMS II).

RIMS II multipliers were obtained during the ESPA ER for the geographic area of interest (Anderson, Knox, Loudon, and Roane Counties). The RIMS II direct-effect employment multiplier for construction jobs is 1.7415, meaning that for every newly created construction job, an estimated 0.7415 jobs are created in the region. Based on the construction job multiplier and a peak construction workforce of up to 3,300 persons, construction on the CRN Site under Alternative B would create approximately 2,447 indirect jobs within the region. The 3,300 construction jobs combined with the newly created 2,447 indirect jobs represent approximately 1.8 percent of the labor force in the geographic area of interest.

Indirect jobs created are assumed to be service-related and not specialized roles and therefore it is anticipated that these jobs would be filled by the labor force within the geographic area of interest. If the 2,447 indirect jobs are filled by unemployed persons in the geographic area of interest, it would result in a decrease of unemployment by 12.4 percent.

The construction workforce, of up to 3,300 total, including 1,365 in-migrating workers, would have a positive effect on the geographic area of interest for the duration of the construction period. The creation of the 2,447 indirect jobs would likely reduce unemployment and create opportunities in the service-related industry, uplifting the regional economy. Therefore, the impact of construction on employment would be beneficial and moderate.

<u>Income and Taxes</u>

Under Alternative B, the size of the workforce and associated payroll spending would vary year to year. Assuming an average of 1,764 workers per year, an estimated 78.7 million annually would be spent on construction wages. At peak construction (3,300 workers) this rises to 147.3 million. The Bureau of Economic Analysis direct-effect earning multiplier for the geographic area of interest is 1.6998, meaning for every one dollar earned by a construction worker, an additional 0.6998 dollars is added to the regional economy. During average construction needs (1,764 workers) an estimated 55.1 million is added to the regional economy. During peak construction (up to 3,300 workers) an estimated 103.1 million would be added to the regional economy. The anticipated impact of construction related income within the geographic area of interest is anticipated to be beneficial and moderate.

Primary tax revenues associated with construction within the Nuclear Technology Park would be from state sales taxes from worker expenditures, worker property taxes, sales taxes from material and supplies purchases, and TVA payments in lieu of taxes. Retail expenditures by the construction workforce throughout the geographic area of interest would generate sales and use taxes. Workers would spend some of their income on goods and services that may be taxed. The purchase of construction materials and supplies for the CRN project would also generate sales taxes. Projected retail expenditures and construction materials and supplies purchasing during construction are not available. However, it is estimated that a minimum of 89 to 121 million each year would be spent during construction activities, on which a majority would be subject to sales taxes.

TVA payments to jurisdictions within the geographic area of interest in lieu of taxes would also support jurisdictional revenue and budgets in support of community facilities and services. Therefore, the potential impact of taxes within the geographic area of interest would be minor and beneficial.

3.15.2.2.3.2 Operation

Employment

Up to 500 workers are needed to support operations at CRN Site Area 1 which is approximately 0.15 percent of the 2020 labor force of the geographic area of interest labor. The additional 1,000 supplemental outage workers represent 0.31 percent of the geographic area of interest labor force. Peak overlap of these two operational work forces represents 0.46 percent of the labor force within the geographic area of interest.

RIMS II multipliers were obtained during the ESPA ER for the geographic area of interest. The RIMS II direct-effect employment multiplier for the utilities industry is 2.2149, meaning that for every newly created operations-related job, an estimated 1.2149 jobs are created in the region. Based on the utilities industry job multiplier and a maximum operations workforce of up to 500 persons, operation of the CRN Site would create approximately 607 indirect jobs within the region. The combined 500 operations CRN Site jobs and the newly created 607 indirect jobs represents 0.34 percent of the labor force in the geographic area of interest.

The indirect jobs are assumed to be service-related and not specialized roles and therefore would be filled by the labor force within the geographic area of interest. If the jobs are filled by unemployed or underemployed persons in the geographic area of interest. If the 607 indirect jobs are filled by unemployed persons in the geographic area of interest, it would result in a decrease of unemployment by 3.1 percent.

The up to 1,000 supplemental outage workforce required during periodic refueling would temporarily reside in the geographic area of interest for approximately 30-60 days per refueling outage. Therefore, the effect on the economy would be smaller than the permanent operations workforce.

TVA would also purchase materials and supplies for operation and maintenance of the CRN Site. It is estimated that 50% of TVA’s annual operation expenditures would be made in the geographic area of interest, resulting in approximately 44.4 million annually in local expenditures. These purchases would support employment in other sectors of the economy.

The operations workforce and supplemental outage workforce employed during operations at the CRN Site would have positive economic effects on the geographic area of interest. The operations workforces would help create indirect jobs and provide opportunities in service-related industries as well as boost the regional economy. However, given the size of the economies and workforces in the geographic area of interest the effect of the operational workforces on are employment would be minor and beneficial, in the context of the larger economy of the geographic area of interest.

Income and Taxes

TVA plans on employing up to 500 full-time operations workers at the CRN Site. Based on published occupation employment salary information, the annual mean wage in May 2020 for occupations related to power plant operations in the Knoxville Metropolitan Statistical

Area was $75,990 (BLS 2021b). Based on the anticipated 500 worker operations workforce an estimated 37.9 million annually would be spent on operations wages. In addition, prorating the anticipated salary to the 30-60 outage period, TVA would pay approximately 3.7 to 7.4 million every 18 to 24 months to temporary outage workers. Approximately 500 of the outage workers would come from the geographic area of interest, therefore TVA would pay 1.9 to 3.7 million to local workers every 18 to 24 months. The Bureau of Economic Analysis direct-effect earning multiplier for the geographic area of interest is 1.5423, meaning for every one dollar earned by a utility industry worker, an additional 0.5423 dollars is added to the regional economy. During operation of the CRN Site an estimated 20.6 million would be added to regional economy. The anticipated impact of operations related income within the geographic area of interest is anticipated to be minor and beneficial.

Primary tax revenues associated with operation activities and by workforce expenditures include state sales taxes, worker property taxes, and TVA payments in lieu of taxes. Because operations would require fewer workers than construction, it is expected that beneficial tax impacts during operation would be slightly smaller than impact during construction.

Sales and use taxes are generated through retail expenditures in the geographic area of interest by the operations workforce and the supplemental outage workforce. Workers would spend some of their income on good and services that may be taxed, contributing to local sales tax in the geographic area of interest.

Compared to total dollars of taxes collected within the geographic area of interest, the TVA in-lieu of tax payment is relatively small, but it would increase during and after construction of the Nuclear Technology Park. State distributed TVA in lieu of tax payments would also support revenue and budgets in support of public facilities and services. Therefore, the potential impacts to income in the geographic area of interest is anticipated to be minor and beneficial.

3.15.2.2.4 Community Characteristics

Direct impacts to community facilities and services occur when a community facility is displaced or access to the facility is altered or impeded. Activities associated with site preparation, construction, and operation of the proposed project would be limited to the CRN Site and adjacent offsite activities. Proposed project activities would not result in the displacement of any community facilities nor cut off access to any facilities in the vicinity of the CRN Site. Therefore, direct impacts to community facilities or services under Alternative B would be minor.

Indirect impacts occur when a proposed action or project results in a population increase that would generate greater demands for services and/or affect the delivery of such services. The following subsections address the potential for indirect impacts to community services during construction and operation of the proposed project.

3.15.2.2.4.1 Construction

<u>Housing</u>

Availability of housing in the geographic area of interest is described in Subsection 3.15.1.4.1 and illustrated in Table 3-51. During the peak overlap period of construction and operation, up to 3,666 workers would be at the CRN Site. Of these workers, approximately

2,301 are expected to already reside in the geographic area of interest. The remaining approximately 1,365 are expected to be in-migrating to the geographic area of interest.

Within the geographic area of interest, there are over 29,000 vacant housing units. Therefore, it is likely adequate housing would be available to accommodate all workers and their families during the peak overlap period, as the 1,365 in-migrating workers and their families would occupy less than 5 percent of the over 29,000 vacant housing units and over 9,400 hotel rooms in the geographic area of interest. The potential impacts on housing due to the in-migrating workforce during site preparation and construction (including peak overlap) would be minor.

Education

Based on 2019 USCB data, approximately 11.7 percent of the population of Tennessee is between 5 and 14 years old and 14.3 percent of the population is between 15 and 24 years old. During the peak period where construction and operational workforces overlap, it is estimated that there would 1,365 in-migrating workers and their families that include approximately 404 persons between 5 and 14 years old, and 494 persons between 15 and 24 years old (totaling approximately 898 school age students, Table 3-58). This would result in an increase of 0.9 percent in the current school enrollment in the geographic area of interest. The 0.9 percent increase in school enrollment in the geographic area of interest would change the student to teacher ratio from 14.2 students per teacher to 14.4 students per teacher. Additionally, in each individual county, the increase in the student to teacher ratio would be 0.3 students per teacher or less. Therefore, impacts to education within the geographic area of interest would be minor.

Table 3-58. School Enrollment During Peak Construction Overlap

County	Students Enrolled in Public & Private School	Teachers (FTEs)[a]	Student to Teacher Ratio	Construction-related Population Increase - Percent by County	Construction Peak Overlap School-age Population Increase	Population Increase Student to Teacher Ratio
Anderson	12,488	823.3	15.2:1	27	242	15.5:1
Knox	69,020	4,779.9	14.4:1	50	449	14.5:1
Loudon	7,532	457.3	16.5:1	6	54	16.6:1
Roane	7,177	692	10.4:1	17	153	10.6:1
Total	96,217	6,752.5	14.2:1	100	898	14.4:1

Source: IES NCES 2021a, IES NCES 2021b
Note: [a]FTE = Full Time Equivalent Employee (part-time workers are reported as a fraction of one full-time worker)

Police

Table 3-53 identifies the number of sworn law enforcement officers and the officer-to-resident ratio for the four counties in the geographic area of interest. The recommended ratio of officers to residents is 1 to 4 officers per every 1,000 residents, or 1:250 to 1:1,000. Table 3-59 details the percent increase in ratio from the peak overlap workforce population increase, as 1.2, 0.4, 0.4, 1.0 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 minor.

Table 3-59. Law Enforcement to Resident Ratios during Construction

County	Number of Law Enforcement Officers	Residents	Officer to Resident Ratio	Population Increase	Officer to Resident Ratio for Population Increase	% Increase Between Officer to Resident Ratios
Anderson	64	76,061	1:1,188	934	1:1,203	1.2
Knox	430	461,104	1:1,072	1,728	1:1,076	0.4
Loudon	57	52,340	1:918	207	1:922	0.4
Roane	42	53,075	1:1,264	584	1:1,278	1.0

Source: FBI 2019

Fire

The existing levels of fire protection services in the geographic area of interest are described in Subsection 3.15.1.4.4. Firefighter-to-resident ratios range from 1:259 in Loudon County to 1:834 in Knox County. 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 3-54. Table 3-60 shows the percent increase in ratio from the population increase due to the peak overlap workforce in each county. Based on the percentage increase in firefighters-to-resident ratios, the impact of in-migrating construction-related population to police services would be minor.

Table 3-60. Firefighters to Resident Ratios during Construction

County	Number of Firefighters	Residents	Ratio of Firefighters to Residents	Population Increase	Firefighter to Resident Ratio with Population Increase	% Increase in Firefighter to Resident Ratios
Anderson	214	76,061	1:355	934	1:360	1.2
Knox	553	461,104	1:834	1,728	1:837	0.4
Loudon	202	52,340	1:259	207	2:260	0.4
Roane	165	53,075	1:322	584	2:324	1.1

Source: Fire Department 2021

Medical Services

Subsection 3.15.1.4.5 describes the available medical services in the geographic area of interest. During construction of the CRN Site, onsite medical personnel would be able to treat minor injuries to workers. Extensive injuries would be treated at a medical center near the CRN Site. The small influx of temporary construction workers is not anticipated to disrupt existing medical services in the geographic area of interest. An addition of approximately 3,453 peak overlap workforce and their families would increase the population in the geographic area of interest by 0.5 percent and would not disrupt existing medical services. Therefore, impacts to medical services would be minor.

Water and Wastewater

Total anticipated construction water use would be approximately 0.23 MGD. Water and wastewater would be provided by the City of Oak Ridge Public Works Department. The City of Oak Ridge has a daily excess of 2.2 MGD of water. Potable water needed to support construction activities represents less than 11 percent of the existing excess capacity based on average demand. Therefore, construction impacts on the water supply facilities would be minor and temporary.

The City of Oak Ridge Rarity Ridge wastewater treatment facility has a maximum treatment capacity of 0.6 MGD. At the peak of the construction process, a maximum of 183,300 gpd or 0.17 MGD of wastewater would be produced. If half of the workforce's water consumption would occur onsite, approximately 40 to 50 gallons of wastewater per worker per day would be generated. 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 minor and temporary.

3.15.2.2.4.2 Operation

Operational characteristics of the CRN Nuclear Technology Park include workforces and infrastructure demands that are less than that described above for the construction phase. As such, the operational workforce and their associated families would result in a small demographic change that would place fewer demands on community services (emergency services, medical services, education, housing, water and wastewater treatment). Thus, the potential effects on these community facilities and services during operation are bounded by the findings of impacts during construction. Therefore, impacts of operation on community facilities and services within the geographic area of interest are also considered to be minor, but long term.

3.15.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced Non-LWRs

Under Alternative C, the impacts on land use would be the same as those discussed for Alternative B. As such, impacts associated with Alternative C on land use for the CRN Site would be minor.

Under Alternative C, effects of construction and operation activities at Area 2 on demographics, employment and income, and community characteristics (housing, education, police, fire, medical, and water services) in the geographic area of interest would be the same as those described for Alternative B. Impacts associated with construction would be temporary and short term, whereas those associated with operations would be long term. Therefore, impacts of Alternative C would be minor and adverse on demographics and community facilities and services, but minor and beneficial on employment and income and taxes.

3.15.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced Non-LWRs

Under Alternative D, the impacts on land use would be the same as those discussed for Alternative B. As such, all impacts associated with Alternative D on land use for the CRN Site would be minor.

Under Alternative D, effects of construction and operation activities at Areas 1 and 2 on demographics, employment and income, and community characteristics (housing, education, police, fire, medical, and water services) in the geographic area of interest would be the same as those described for Alternative B. Impacts associated with construction would be temporary and short term, whereas those associated with operations would be long term. Therefore, impacts of Alternative D would be minor and adverse on demographics and community facilities and services, but minor and beneficial on employment and income and taxes.

3.15.2.5 Potential Contributing Effects of Other Reasonably Foreseeable Future Actions

As described in Section 3.15.1.5, several reasonably foreseeable future actions were identified in proximity to the CRN Site that would occur within the same geographic area of interest as that of the CRN project. Specific details regarding employment and revenue generated by these other actions and their respective timing (construction duration, start of operations) are generally lacking. However, the proposed workforce of the Kairos Hermes project is 425 (212 off-peak) workers, and the maximum onsite operational phase workforce is 68 worker (Kairos 2021). Depending on the timing of implementation of this and other reasonably foreseeable projects, localized effects associated with workforce availability, housing availability, and the adequacy of services potentially may occur in combination with the proposed development of the CRN Site. Although the construction workforces are typically larger than that of operational workforces, many of these workers are expected to be drawn from the existing ROI and as such impacts of housing and many community services are expected to be minor. Locally increased demands on water and wastewater treatment would also be expected with each of these actions and depending on the timing of these projects and any proposed plans to improve treatment capacity may be expected to result in minor to moderate impacts to water and wastewater services.

3.15.2.6 Summary of Impacts to Socioeconomics

As summarized in Table 3-61, socioeconomic impacts related to the construction and operation of a Nuclear Technology Park at the CRN Site would be minor to moderate.

Table 3-61. Summary of Impacts to Socioeconomics

Alternative	Project Phase	Impact	Severity
Land Use			
Alternatives B, C, D	Construction and Operation	Land use designation and land management plans.	Minor; construction of the Nuclear Technology Park at the CRN Site is expected to occur primarily in alignment with existing zone designations.
Demographics			
Alternatives B, C, D	Construction	Population increases in the geographic area of interest associated with in-migrating construction workforce and their families.	Minor; peak construction employment would result in a population increase of 0.5 percent which would not cause a noticeable effect on the population demographics. Impacts would be the same across all action alternatives.
	Operations	Population increases in the geographic area of interest associated with in-migrating operations workforce and their families.	Minor; the in-migration of operations workers and their families would result in a population increase of the area by less than 0.1 percent. Additional workers needed during refueling outages would be in the area temporarily. Impacts would be

Alternative	Project Phase	Impact	Severity
			the same across all action alternatives.
Employment and Income			
Alternatives B, C, D	Construction	Job creation due to development of CRN Site and associated indirect job creation, resulting decrease of unemployment in geographic area of interest.	Impacts to employment would be moderate and beneficial and the same for all action alternatives.
		Payroll and associated earning multiplier and tax generation to impact economy in geographic area of interest.	Impacts to income and taxes would be minor to moderate and beneficial and the same for all action alternatives.
	Operations	Impacts similar but less than those described for construction.	Minor and similar as those for construction, but less adverse and beneficial.
Community Characteristics			
Alternatives B, C, D	Construction	Increased demand on available housing and on existing education facilities, police services, fire services, medical services, and water use.	Impacts to community services and characteristics would be minor and the same for all alternatives.
	Operations	Impacts similar but less than those described for construction.	Minor and similar as those for construction Minor to moderate potential cumulative impacts on water/wastewater treatment.

3.16 Environmental Justice

3.16.1 Affected Environment

Environmental justice has been defined as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies (EPA 2018). According to EPA, environmental justice goals are achieved when everyone enjoys the same degree of protection from environmental and health hazards and has equal access to the decision-making process to have a healthy environment in which to live, learn and work. On February 11, 1994, President Clinton signed EO 12898 Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. EO 12898 mandates that some federal-executive agencies consider environmental justice as part of their NEPA process. On January 27, 2021, President Biden issued EO 14008 Tackling the Climate Crisis at Home and Abroad. Amongst other objectives, the EO calls for the federal government to make environmental justice a defining feature of the response to the climate crisis by developing programs, policies, and activities to address current and historic injustices and by investing and building a clean energy economy that spurs economic opportunity for disadvantaged communities. For these reasons, TVA routinely considers environmental justice impacts as part of the project decision-making process. Guidance for addressing environmental justice considerations in this PEIS includes CEQ's Environmental Justice Guidance under the NEPA (CEQ 1997).

TVA also considered information requirements for environmental justice determinations in the NUREG-1555 and the NRC's Environmental Issues Associated with New Reactors Interim Staff Guidance (Combined License and Early Site Permit COL/ESP-ISG-026). This guidance suggests that a 50-mile radius (i.e., the CRN Site region) could reasonably be expected to establish the outer limit of all potential impacts associated with the proposed action. Thus, all census block groups that are located within or are intersected by the boundary of the CRN Site region are included in the environmental justice analysis. The 50-mile region extends into three states: Tennessee, North Carolina, and Kentucky. These states are considered an appropriate geographic area for comparative analysis. Demographic characteristics of populations within the region were assessed using 2015-2019 American Community Survey 5-year estimates provided by the USCB (USCB 2021a) to identify specific block groups within the region that exceed environmental justice thresholds.

3.16.1.1 Minority Populations

The CEQ defines minority as any race and ethnicity, as classified by the USCB, that is: Black or African American; American Indian or Alaska Native; Asian; Native Hawaiian and Other Pacific Islander; some other race (not mentioned above); two or more races (also referred to as multiracial); or a race whose ethnicity is Hispanic or Latino (CEQ 1997).

Identification of minority populations requires analysis of individual race and ethnicity classifications as well as comparisons of all minority populations in the region. Thus, each minority category was evaluated separately, and the total of all minority categories combined was evaluated as the aggregate minority population. Aggregate minority population is calculated as the total population minus people who identified themselves as White, Not Hispanic or Latino. Minority populations exist if either of the following conditions is met:

- The minority population of the impacted area exceeds 50 percent of the total population.
- The ratio of minority population is meaningfully greater (i.e., greater than or equal to 20 percent) than the minority population percentage in the general population or other appropriate unit of geographic analysis (CEQ 1997).

For each of the block groups within a 50-mile radius from the CRN Site, the percentage of the block group's population represented by each minority category was calculated. If any block group minority percentage exceeded 50 percent, then the block group was identified as containing a minority population. Each state served as the geographic area of comparison for the block groups within that state that fell within the 50-mile radius. Percentages of each minority category within each state were calculated. The individual block group percentages were compared to the appropriate state percentage. If any block group percentage exceeded the corresponding state percentage by 20 percentage points or more, then a minority population was determined to exist within that block group.

Table 3-62 and Figure 3-24 identify the census block groups with minority populations, as defined above, within the 50-mile region surrounding the CRN Site. There are 760 census block groups in the region, of which approximately 4.2 percent (32 block groups) have an individual minority population and/or an aggregate minority population that exceed one of the above criteria. The majority of the block groups with a minority population are located within the geographic area of interest discussed in Subsection 3.15 (i.e., Anderson, Knox, Loudon, and Roane counties), and most that exceed the threshold criteria for minority populations do so because of the number of Black or African American residents. Knox County has 21 block groups with minority populations, primarily located within the City of Knoxville. Loudon County also has three block groups with minority populations, while Anderson and Roane Counties each have one. The closest minority block group to the CRN Site is located in Loudon County, approximately 8 miles to the south.

In addition to the identification of minority populations based on census data, two locations of potential significance to minority communities were identified: the Wheat Community Burial Ground and the community of Scarboro. The African American Wheat Community Burial Ground is located approximately 1 mile northwest of the northern boundary of the CRN Site on the east side of TN 58. Approximately 90 to 100 graves with no inscribed markers are present within this cemetery. It is presumed that slaves that lived and worked on plantations and farms in the area are buried here. Historical records indicate the cemetery dates from the mid-19th century. The Scarboro community is a small residential area in Anderson County within the City of Oak Ridge, approximately 8 miles northeast of the CRN Site and approximately 0.5 miles from the ORR Y-12 plant. It is separated from the Y-12 plant by Pine Ridge. The community was established in 1950 to provide housing and an elementary school to African American Oak Ridge residents. The population of Scarboro has remained predominantly African American.

Table 3-62. Minority and Low-Income Populations within 50-Mile Radius of CRN Site

STATE/County	Total Number of Block Groups	Black or African American	American Indian or Native Alaskan	Asian	Native Hawaiian or Other Pacific Islander	Some Other Race	Hispanic or Latino	Multiracial[1]	Aggregate[2]	Low-Income[3]
		Number of Minority or Low-Income Block Groups[4]								
TENNESSEE	**746**									
Anderson	53	0	0	0	0	0	0	1	0	7
Bledsoe	8	0	0	0	0	0	0	0	0	1
Blount	78	1	0	0	0	0	0	0	1	2
Bradley	6	0	0	0	0	0	0	0	0	0
Campbell	32	0	0	0	0	0	0	0	0	4
Claiborne	4	0	0	0	0	0	0	0	0	0
Cumberland	32	0	0	0	0	0	0	0	0	0
Fentress	12	0	0	0	0	0	0	0	0	0
Grainger	6	0	0	0	0	0	0	0	0	0
Hamilton	2	0	0	0	0	0	0	0	0	0
Jefferson	12	0	0	0	0	0	0	0	0	0
Knox	242	17	0	0	0	0	3	0	17	31
Loudon	31	0	0	0	0	0	3	0	1	0
McMinn	34	0	0	0	0	0	0	0	0	7
Meigs	6	0	0	0	0	0	0	0	0	0
Monroe	28	0	0	0	0	0	0	0	0	2
Morgan	15	1	0	0	0	0	0	0	1	1
Overton	3	0	0	0	0	0	0	0	0	0
Pickett	1	0	0	0	0	0	0	0	0	0
Polk	7	0	0	0	0	0	0	0	0	0

STATE/County	Total Number of Block Groups	Black or African American	American Indian or Native Alaskan	Asian	Native Hawaiian or Other Pacific Islander	Some Other Race	Hispanic or Latino	Multiracial[1]	Aggregate[2]	Low-Income[3]
		Number of Minority or Low-Income Block Groups[4]								
Putnam	2	0	0	0	0	0	1	0	0	0
Rhea	19	0	0	0	0	0	0	0	0	3
Roane	41	0	0	1	0	0	0	0	0	0
Scott	16	0	0	0	0	0	0	0	0	2
Sevier	39	0	0	0	0	0	2	0	1	1
Union	14	0	0	0	0	0	0	0	0	0
Van Buren	1	0	0	0	0	0	0	0	0	0
White	2	0	0	0	0	0	0	0	0	0
KENTUCKY	**4**									
McCreary	2	0	0	0	0	0	0	0	0	0
Whitley	2	0	0	0	0	0	0	0	0	1
NORTH CAROLINA	**10**									
Cherokee	3	0	0	0	0	0	0	0	0	0
Graham	5	0	1	0	0	0	0	0	0	1
Swain	2	0	0	0	0	0	0	0	0	0
50-mile Region Total	**760**	**19**	**1**	**1**	**0**	**0**	**9**	**1**	**20**	**63**
	State Population	Percentage of Population								
TENNESSEE	6,709,356	16.6%	0.2%	1.7%	0.1%	0.2%	5.4%	2.0%	26.2%	15.2%
KENTUCKY	4,449,052	8.0%	0.2%	1.5%	0.1%	0.1%	3.7%	2.0%	15.4%	17.3%
NORTH CAROLINA	9,535,483	21.1%	1.1%	2.8%	0.1%	0.2%	9.4%	2.2%	36.9%	14.7%

[1] Persons who identified themselves as a member of two or more races.
[2] Everyone except persons who identified themselves as White, Not Hispanic or Latino.
[3] Based on poverty status of individuals in family households and in non-family households.
[4] Block groups where minorities and low-income populations exceed 50 percent or exceed the state average by 20 percentage points or more.

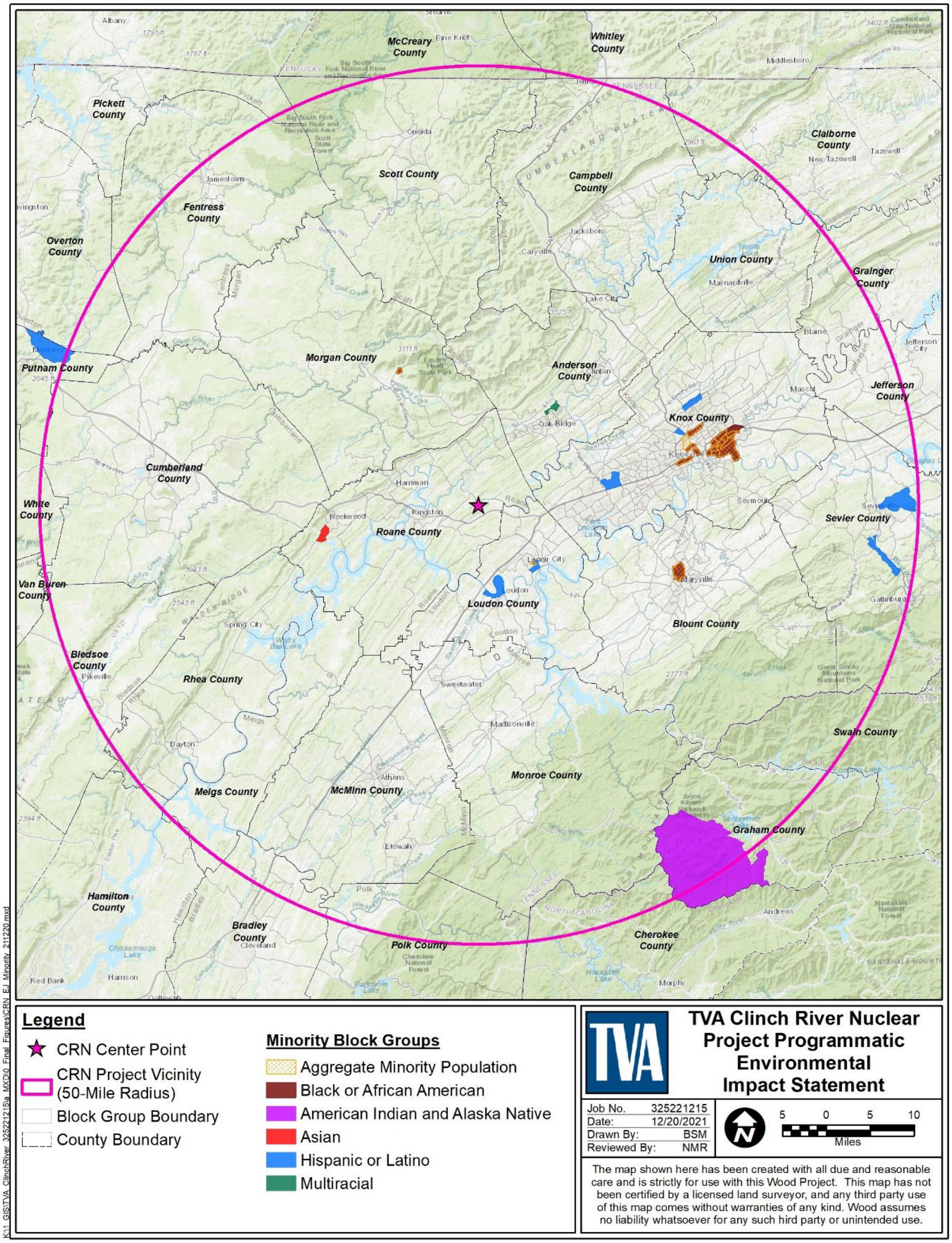


Figure 3-24. Block Groups with Minority Populations within 50 Miles of the CRN Site

3.16.1.2 Low-Income Populations

The nationwide poverty level is determined annually by the USCB and varies by the size of family and number of related children under 18 years of age. The 2020 USCB Poverty Threshold for an individual under the age of 65 is an annual income of $13,465, and for a family of four it is an annual household income of $26,695 (USCB 2021b). For the purposes of this assessment, the low-income population consists of individuals or families whose annual household income is below the USCB poverty thresholds. A low-income environmental justice population exists if either of the following two conditions is met:

- The low-income population exceeds 50 percent of the total population.
- The ratio of low-income population significantly exceeds (i.e., greater than or equal to 20 percent) that of the general population or the appropriate geographic areas of analysis.

The same 50-mile geographic region was used for this analysis (i.e., all census block groups that are located within or are intersected by the boundary of the CRN Site region). The number of low-income individuals in each census block group was divided by the total number of individuals within that block group to obtain the percentage of low-income persons per block group. These were compared to the respective state percentages to determine the block groups with low-income populations that meet either of the criteria listed above.

Table 3-62 and Figure 3-25 illustrate the number and distribution of low-income block groups within the 50-mile radius. Table 3-62 also displays the percentage of low-income individuals within each state. Among the 760 block groups within the 50-mile radius, 13.3 percent (63 block groups) meet the low-income criteria. The majority of the low-income population (38 block groups) are in the geographic area of interest, most of which (31 block groups) are located in the City of Knoxville, in Knox County. There are also seven low-income population block groups in Anderson County, in the cities of Oak Ridge and Clinton. The closest low-income population to the CRN Site is located in Oak Ridge, in Anderson County, approximately 8 miles northeast of the CRN Site.

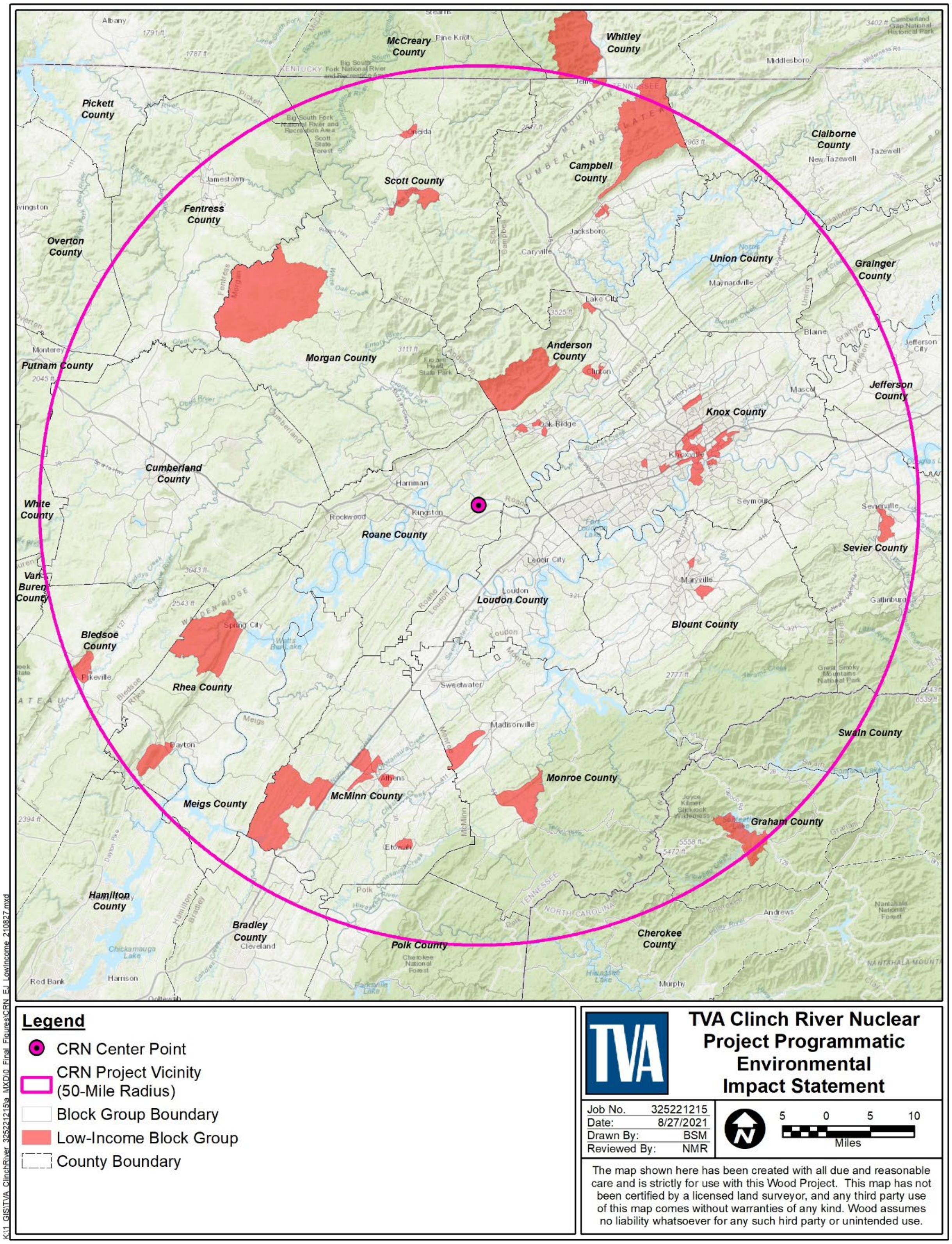


Figure 3-25. Block Groups with Low-Income Populations within 50 Miles of the CRN Site

3.16.1.3 Communities with Unique Characteristics

The characterization of potentially affected environmental justice populations also includes the identification of any unique economic, social, or human health circumstances and lifestyle practices of minority and low-income populations that could result in disproportionately high and adverse impacts to these populations from proposed project actions. Such circumstances and practices may include, for example, exceptional dependence on subsistence resources such as fish and wildlife, unusual concentrations of minority or low-income population within a compact area (e.g., Native American settlement), or pre-existing health conditions within a community that might make it more susceptible to potential plant-related impacts. Migrant workers, who are often members of minority or low-income populations, may also warrant additional consideration. Because they travel and can spend a significant amount of time in an area without being actual residents, migrant workers may be unavailable for counting by census takers and thus underrepresented in USCB minority and low-income population counts.

As part of TVA's ESPA, inquiries were made to local agencies, such as planning departments and social services agencies, health departments, academic institutions, and local businesses. None of the persons contacted identified any unique economic, social, or human health circumstances and lifestyle practices through which minority or low-income populations could be disproportionately adversely affected by the proposed plant construction and operation. Notably, previous public health assessments and sampling efforts in the community of Scarboro indicate that chemical, metal, and radionuclide concentrations are not elevated above a regulatory health level of concern and the residents of Scarboro are not being exposed to harmful levels of substances from the Y-12 plant. Additionally, health conditions within Roane County were investigated in regard to the release of fly ash following a dike failure at the TVA Kingston Fossil Plant in December 2008; lung function tests found that abnormalities for those living within a 2-mile radius of the spill were of a similar distribution to the population living outside that radius. In summary, no pre-existing health conditions were found specific to Anderson, Knox, Loudon, or Roane County, Tennessee or the other counties in the region that might make residents more susceptible to potential plant-related impacts.

Migrant populations within the economic region are generally associated with local construction activity and agricultural activities in the area. However, based on migrant worker data collected by the Census of Agriculture (see Section 3.15.1.2.3), as well as local outreach conducted by TVA and the NRC, migrant labor occurring in the region is minimal. No migrant labor populations were identified that would require further consideration.

3.16.1.4 Reasonably Foreseeable Future Actions in Proximity to the CRN Site

As noted in Section 3.1.3, TVA identified several foreseeable future actions in proximity to the CRN Site. The scope of these other proposed actions may have the potential to result in impacts to minority or low-income populations if these populations are present in the areas surrounding the respective project locations. However, the specific details regarding the scope of these actions are unknown at this time. Furthermore, none of the identified reasonably foreseeable future actions is overlapping geographically with the CRN Project Area nor is considered to have a causal relationship to the proposed development of the CRN Site. As such, no further consideration of reasonably foreseeable future actions and their effects on environmental justice populations are included in TVA's analysis.

3.16.2 Environmental Consequences

3.16.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, a nuclear technology park would not be constructed or operated at the CRN Site and there would be no impacts to environmental justice populations associated with the proposed actions.

3.16.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced Non-LWRs

3.16.2.2.1 Construction

Under Alternative B, construction would occur primarily within the CRN Site boundaries or the associated offsite areas. All associated offsite activities are located on federal property managed by TVA or DOE, near the CRN Site. Physical and environmental impacts from construction activities, such as construction noise, visual discord, fugitive dust, and equipment emissions, would attenuate with distance, intervening foliage, and terrain. Thus, direct construction-related impacts would be limited to the properties adjacent to the CRN Site and associated offsite areas, which are largely industrial or undeveloped. The closest minority or low-income block groups are located approximately 8 miles north of the CRN Site in the City of Oak Ridge and approximately 8 miles south in Loudon County. These environmental justice communities would not be affected by any physical or environmental construction-related impacts given their distances from the site.

Increased traffic during construction would be expected to have a minor to moderate impact on local roads, and moderate impacts at TN 58 and Bear Creek Road. No identified environmental justice communities are located along these local roads in the areas likely to be impacted by the construction traffic. Although the Wheat Community Burial Ground is located off TN 58, construction traffic would not impede public access to the cemetery. No temporary detours of traffic to local offsite roads as a result of the construction at 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.

Beneficial socioeconomic impacts related to facility construction, both directly and indirectly, are described in Section 3.15.2.2.3. These include increased employment opportunities and associated wages, as well as generation of additional tax revenues which contribute to community services and programs. These beneficial impacts would be realized across the geographic area of interest, including in minority and low-income communities. An increased demand for housing in the geographic area of interest has the potential to increase rental housing costs and displace low-income renters. However, as the in-migrating construction workforce would occupy less than five percent of the more than 29,000 vacant housing units in the geographic area of interest (see Section 3.15.2.2.4.1), there is ample housing available to support the workforce. Thus, nearby minority and low-income populations, including the Scarboro community, would not be adversely impacted by the construction-related demand for housing. Overall, construction-related impacts to environmental justice communities would be minor and would not be disproportionate based on the distribution patterns of minority and low-income populations.

3.16.2.2.2 Operation

Similar to construction, operational impacts associated with noise, visual impacts, air quality, and traffic would generally be limited to the areas adjacent to the CRN Site where no minority or low-income populations were identified. Additionally, operation of the Nuclear Technology Park would result in additional employment opportunities and associated wages, and generation of tax revenues that would be realized by the geographic area of interest, including minority and low-income populations. Housing impacts for the in-migrating operational workforce would be long-term but of lesser magnitude than the construction workforce; thus, operational demand for housing would not adversely affect minority or low-income populations.

Section 3.20 assesses the radiological doses to the local population, concluding that doses would be within NRC and EPA dose standards. For normal operation, annual collective doses to the public, based on the population within the 50-mile CRN Site region, were estimated to be within the regulatory limits for protection of the maximum exposed individual and negligible compared to background doses. In addition, in the event of a severe accident, the 50-mile population dose risks and the population fatality risks for the advanced nuclear reactors considered in the PPE are less than those calculated for other operating reactors or new reactors currently under construction and the individual fatality risks are several orders of magnitude below the NRC safety goals. Based on the spatial distribution of the low-income and minority populations, operational impacts on environmental justice populations would be minor and would not be disproportionate as impacts would be similar throughout the region, much of which consists of non-environmental justice populations.

3.16.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced Non-LWRs

Under Alternative C, a Nuclear Technology Park would be constructed and operated at Area 2 of the CRN Site. As the workforce characteristics and socioeconomic impacts would be the same as those described under Alternative B, and the distance between Area 2 and identified environmental justice communities is similar to that described for Area 1, impacts to environmental justice communities would be the same as those described under Alternative B. Construction and operation of the Nuclear Technology Park at Area 2 would have minor impacts on minority and low-income populations which would not be disproportionate compared to non-environmental justice populations.

3.16.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced Non-LWRs

Under Alternative D, a Nuclear Technology Park would be constructed and operated at Area 1 and Area 2 at the CRN Site. Although development would be spread out between the two areas, impacts to environmental justice communities would be the same as those described in Alternative B, as the distance from the CRN Site to identified minority and low-income communities would essentially be the same. Therefore, construction and operation of the Nuclear Technology Park at Area 1 and Area 2 would have minor impacts on minority and low-income populations which would not be disproportionate compared to non-environmental justice populations.

3.16.2.5 Summary of Environmental Justice Impacts

As summarized in Table 3-63, TVA has determined that impacts to environmental justice populations related to the development of the CRN Site and associated offsite areas would be minor and would not be disproportionate compared to non-environmental justice populations which comprise the majority of the population of the region.

Table 3-63. Summary of Environmental Justice Impacts

Alternative	Project Phase	Impact	Severity
Alternatives B, C, D	Construction	Physical and environmental impacts associated with construction activities, such as noise, visual impacts, fugitive dust, air quality, and increased traffic would be localized to areas adjacent to the CRN Site and associated offsite areas. Socioeconomic benefits, including increased employment opportunities and wages and generation of additional tax revenues, would be realized by the geographic area of interest, including minority and low-income populations.	Due to distance from the CRN Site, impacts to environmental justice populations would be minor and would not be disproportionate. Impacts would be the same across Alternatives B, C, and D.
	Operation	Similar to construction, with addition of potential health impacts associated with radiological doses.	Radiological effects to the population in the region associated with normal operation would be within be within the regulatory limits for protection of the maximum exposed individual and negligible compared to background doses. Therefore, operational impacts to environmental justice populations would be minor and would not be disproportionate. Impacts would be the same across Alternatives B, C, and D.

3.17 Archaeological Resources and Historic Structures

3.17.1 Affected Environment

3.17.1.1 Statutory and Regulatory Background

Federal agencies are required by the NHPA and NEPA to consider the possible effects of their undertakings on historic properties. Undertaking means any project, activity, or program that is funded under the direct or indirect jurisdiction of a federal agency or is licensed, permitted, or assisted by a federal agency. An agency may fulfill its statutory obligations under NEPA by following the process outlined in the regulations implementing Section 106 of NHPA, at 36 CFR Part 800. Under these regulations, considering an undertaking's possible effects on historic properties is accomplished through a four-step review process: 1) initiation (defining the undertaking and the area of potential effects [APE], and identifying the consulting parties); 2) identification (studies to determine whether cultural resources are present in the APE and whether they qualify as historic properties); 3) assessment of adverse effects (determining whether the undertaking would damage the qualities that make the property eligible for the NRHP); and resolution of adverse effects (by avoidance, minimization, or mitigation). Throughout the process the agency must consult with the appropriate SHPO, federally recognized Indian tribes that have an interest in the undertaking, and any other party with a vested interest in the undertaking.

Cultural resources include prehistoric and historic archaeological sites, districts, buildings, structures, and objects, and locations of important historic events that lack material evidence of those events. Cultural resources that are included or considered eligible for inclusion in the NRHP maintained by the National Park Service are called historic properties. To be included or considered eligible for inclusion in the NRHP, a cultural resource must possess integrity of location, design, setting, materials, workmanship, feeling, and association. In addition, it must also meet one of four criteria: (a) association with important historical events; (b) association with the lives of significant historic persons; (c) having distinctive characteristics of a type, period, or method of construction, or representing the work of a master, or having high artistic value; or (d) having yielded or having the potential to yield information important in history or prehistory.

If the agency determines (in consultation) that the undertaking's effect on a historic property within the APE would diminish any of the qualities that make the property eligible for the NRHP (based on the criteria for evaluation at 36 CFR Part 60.4), the effect is said to be adverse. Examples of adverse effects would be ground disturbing activity in an archaeological site, or erecting structures within the viewshed of a historic building in such a way as to diminish the structure's integrity of feeling or setting. Federal agencies are required to resolve the adverse effects of their undertakings on historic properties. Resolution may consist of avoidance (such as choosing a project alternative that does not result in adverse effects), minimization (such as redesign to lessen the effects), or mitigation. Adverse effects to archaeological sites are typically mitigated by means of excavation to recover the important scientific information contained within the site. Mitigation of adverse effects to historic structures sometimes involves thorough documentation of the structure by compiling historic records, studies, and photographs. Agencies are required to consult with SHPOs, tribes, and others throughout the Section 106 process and to document adverse effects to historic properties resulting from agency undertakings.

3.17.1.2 APE

APE is defined at 36 CFR Part 800.16(d), as "the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historic properties, if any such properties exist." For the currently proposed actions at the CRN Site and associated offsite areas, the APE consists of the areas where ground-disturbing activities would take place (land clearing, construction, roadway improvements, and transmission line modifications), and areas within a one-half mile radius of all proposed new above-ground features that would have unobstructed views to those features. The area of ground-disturbing activities is referred to as the project footprint; areas within which visual effects could occur on historic properties is referred to as the project viewshed.

- Alternative A is the No Action Alternative, and therefore, no APE was established.
- The APE for Alternative B includes the boundary of Area 1, and the laydown area (Figure 2-1), as well as the associated viewshed.
- For Alternative C, the APE includes the boundary of Area 2, the laydown area (Figure 2-2), and the associated viewshed.
- The APE for Alternative D includes the boundary of Area 1 and Area 2, the laydown area (Figure 2-3), and the viewsheds associated with Area 1 and Area 2.
- All three action alternative APEs also include:
    - The proposed 161-kV transmission line corridor that would be built from Area 2 north toward DOE property, and the viewshed associated with the new transmission line.
    - The TN 95 Access (Jones Island Road from the CRN Site to the intersection with TN 95), and the viewshed of the proposed roadway improvements (which could include highly visible safety features such as guardrails, signage, and light poles).
    - Modifications within the BTA.

3.17.1.3 Cultural Resources in the APE

3.17.1.3.1 Archaeological Surveys

Two early archaeological investigations included the project footprint and vicinity. Cyrus Thomas (1897) visited the Project Area during his riverboat survey of the Clinch River in the 1890s. He documented a pair of precontact earthen mounds on the opposite shore but did not record any sites on the CRN Site. Charles Nash of the University of Tennessee (UT) explored the area in the 1940s and recorded five archaeological sites (40RE104-108) on the CRN Site. These were described as a village site with an earthen mound, three large village sites, and one small site of unknown cultural association. Nash was unable to complete a report due to the outbreak of World War II (Jolley 1982).

Several archaeological investigations have been carried out in the project footprint in the modern era, in connection with various federal undertakings. Beginning in the 1970s, as part of its planning effort for the CRBRP on the CRN Site, TVA contracted with UT for archaeological surveys and excavations of several sites. As part of that effort Schroedl (1972) revisited the sites that Nash had identified and recorded four historic Euro-American farmstead sites (40RE119, 40RE120, 40RE121, and a historic cemetery (the Hensley Cemetery, 40RE119). Schroedl (1974a) also documented the ruins of several rural domestic and agricultural structures, including a log cabin (40RE123), on the CRN Site, and provided archaeological site numbers for those resources. In November 1973, it was discovered that the historic log structure at 40RE123 had been completely destroyed by parties unknown. UT also identified site 40RE124 (Schroedl 1990), an earthen mound within the boundaries of site 40RE105 (identified by Nash in 1941). Schroedl (1974a) also identified 40RE128, a Woodland period open habitation site. Nick Fielder (1975) surveyed Bear Creek Valley and recorded five additional archaeological sites, 40RE125, 40RE135, 40RE138, 40RE139, and 40RE140 (cave).

Following these identification efforts, UT (under TVA's direction) carried out intensive investigations of several sites (Cole 1974; Schroedl 1974b, 1974c). Schroedl conducted excavations at sites 40RE107, 40RE108, 40RE124, and 40RE127 in the mid-1970s. The most intensive efforts were focused on site 40RE124, a Late Woodland burial mound, and 40RE108, a shell midden occupied during multiple precontact time periods. Jolley (1982) conducted a survey of previously unexplored areas at the CRN Site in the winter of 1981-1982 and identified 17 additional sites (40RE151-40RE169). Jolley also identified two stone pile clusters, one with 19 stone piles and one with 15 stone piles. Jolley suggested these could be prehistoric burial mounds similar to those previously recorded in the Powell River area and the Bear Creek watershed. Jolley recommended no further investigation for sites 40RE151, 40RE152, 40RE153, 40RE154, 40RE155, 40RE156, 40RE157, 40RE158, 40RE159, 40RE160, 40RE161, 40RE162, 40RE163, and 40RE164. He also recommended that in the event of potential disturbance, sites 40RE166, 40RE167 and two unassigned loci (L-19 and L-20) be further investigated and that site 40RE165 was a "significant cultural resource".

UT also conducted a survey of a ca. 50.9-acre tract in the north extremity of the CRN Site, in the Grassy Creek Area (Turner 1988). This survey failed to identify any archaeological sites. A geoarchaeological investigation completed in 1999 along the shoreline in the CRN Site indicated a high probability for deeply buried alluvial deposits that could contain intact archaeological sites dating to the past 13,000 years (Leigh 1999).

DuVall and Associates, Inc. completed an archaeological survey in 1995 in the northwestern portion of the project archaeological APE during the planning stages for proposed modifications to TN 58 and TN 95 (Pace 1995), on behalf of TDOT. This survey identified seven archeological sites within the new ROW needed for the road modifications. Two of these sites (40RE138 and 40RE139) are in the project archaeological APE, and two (40RE135 and 40RE233) are partially within the APE. Additionally, site 40RE232 (of undetermined NRHP eligibility) is located outside of, but adjacent to, the project archaeological APE. Site 40RE233 was recommended as potentially eligible for the NRHP under Criterion A; and further investigation was recommended. Lastly, profile cuts were made in the riverbanks in the vicinity of Gallaher Bridge during the 1995 survey. No precontact artifacts were found; only historical items that were presumed to be from the construction of the bridge in the 1960s were found.

In late 2002, TVA conducted an archaeological survey (Stanyard et al. 2003) of a 188-acre tract on the CRN Site. This survey revisited five of the previously recorded sites; the locations of historic sites 40RE121 and 40RE122 were confirmed, but the survey was unable to relocate sites 40RE156, 40RE167, or 40RE158, which indicated the sites may not have been extant. The survey also identified three previously unrecorded sites. These included two small, precontact sites (40RE547 and 40RE548) consisting of lithic artifacts of unknown cultural affiliation and a Woodland site (40RE549) with stone and ceramic artifacts and deposits potentially extending to 5 meters in depth.

When TVA began studies for the ESPA, TVA contracted with TRC Environmental Corporation (TRC) to perform two systematic archaeological surveys of the CRN Site (Barrett et al. 2011a; Barrett et al. 2011b). These surveys excluded the area surveyed by Stanyard et al. (2002) but included areas that were investigated in 1970s and 1980s and revisited all of the previously recorded sites in those areas. The first survey (Barrett et al. 2011a) focused on areas to be affected by geotechnical investigation, totaling 156.7 acres. This survey revisited 12 previously identified sites (40RE106, 40RE107, 40RE108, 40RE120, 40RE129, 40RE152, 40RE153, 40RE154, 40RE159, 40RE163, 40RE165, and 40RE166) and identified five additional sites (40RE585-589). The authors recommended that sites 40RE106, 40RE107, 40RE108, 40RE165, and 40RE166 are eligible for the NRHP and should be avoided. The authors further concluded that sites 40RE120, 40RE152, 40RE154, and 40RE163 are ineligible for the NRHP and no further work is recommended at these sites. The site number for 40RE129 has been vacated. No further work was recommended at 40RE129. The survey did not identify any evidence of site 40RE159, and this site was assumed to have been destroyed during previous site activities. No further work was recommended at 40RE159. Additionally, no further work was recommended for site 40RE153 because it was located outside of the winter 2011 survey area for the site investigations and infrastructure improvements work (Barrett et al. 2011a). TVA determined that sites 40RE106-108, 40RE165, and 40RE166 are potentially eligible for the NRHP. TVA consulted with the SHPO in February 2011 with regard to the findings of the winter 2011 survey. The SHPO concurred with TVA's determinations on NRHP eligibility (Appendix E).

The second survey (Barrett et al. 2011b) focused on the remaining areas within the CRN Site not covered by the first survey or the 2002 survey; it encompassed 692 acres. The second survey resulted in the identification of 15 previously unrecorded sites (40RE590-598, 40RE600-602, and 40RE605-607) and three isolated finds and the report (Barrett et al. 2011b) provided NRHP eligibility recommendations for those as well as for 20 previously identified sites in their 692-acre survey area. The authors recommended sites 40RE585, 40RE586, 40RE587, and 40RE589 as ineligible for listing on the NRHP and recommended no further work at these sites. Site 40RE588 is the historic Hensley Cemetery, which was recommended as ineligible for the NRHP. However, because of the presence of human burials, avoidance was recommended for the cemetery (Barrett et al. 2011b). Twelve of the 15 previously unrecorded sites investigated were recommended as potentially eligible for the NRHP (40RE104, 40RE105, 40RE106, 40RE108, 40RE124, 40RE128, 40RE140, 40RE167, 40RE549, 40RE595, 40RE600, and 40RE601). The remaining 23 sites and the three isolated finds were recommended as ineligible for the NRHP. The survey also investigated two caves. No cultural material was identified in these caves; therefore, no further work was recommended for these locations. TVA consulted with the SHPO in August 2011 regarding the results of the spring 2011 survey. The SHPO concurred with TVA's determinations on NRHP eligibility and requested that the 12 potentially eligible sites identified in the survey be avoided by all ground-disturbing activities or subjected to Phase II archaeological testing investigations (Appendix E).

New South Associates previously conducted an archaeological survey that included a ca. 14.6-acre tract of DOE land in the northwestern part of the project footprint (Reed et al. 2011). Survey and testing of 40RE233 was performed in January 2008, May 2009, and July 2010. Site 40RE233 lies partially within the CRN project footprint. This site is known historically as the Happy Valley temporary worker housing area. The site was occupied by African American workers at the K-25 Oak Ridge Gaseous Diffusion Plant, part of the Manhattan Project during World War II. Based on the investigation, DOE and the Tennessee SHPO agreed, in consultation, that site 40RE233 is eligible for the NRHP under Criteria A, C, and D. Site 40RE219, the Wheat Community African Burial Ground (outside the CRN project footprint), was also reinvestigated and further investigation of the immediate vicinity of the cemetery was recommended if ground disturbing activities were to occur in this area.

In the winter of 2014-2015, after TVA began considering possible roadway improvements along Bear Creek Road near the mouth of Grassy Creek, including the Bear Creek Road/TN 58 interchange, TVA completed a phase I archaeological survey (Hunter et al. 2015) of the areas that would be affected by this work. AMEC Foster Wheeler carried out the survey and compiled the report. This survey encompassed an area of approximately 110.5 acres. The survey included a revisit of previously recorded sites 40RE135, 40RE138, 40RE139, and 40RE202. Although a small portion of 40RE233 extended into the survey area, that site was not revisited, as the recent DOE investigations of that site made any additional survey unnecessary. The AMEC Foster Wheeler survey also identified one previously unrecorded isolated find, a non-site locality. Based on the investigation, TVA found that three of the revisited archaeological sites are ineligible for inclusion in the NRHP; that site 40RE135 had been destroyed by the construction of the Gallaher Road/TN 587 overpass; that no deposits associated with 40RE139 are located in the survey area; and that site 40RE202 has been destroyed by the construction of a sedimentation basin for the adjacent K-1515 Sanitary Water Treatment Plant. It was determined that site 40RE138 may have research potential and should be avoided by TVA's project if possible.

These surveys have identified a total of 59 archaeological sites and one historic cemetery within the project footprint. TVA consulted with the Tennessee SHPO and federally recognized Indian tribes regarding the 2002 cultural resources survey, the two archaeological surveys conducted in 2011, the 2015 survey, and the 2011 architectural survey. TVA consulted with the Eastern Band of Cherokee Indians, Cherokee Nation, Chickasaw Nation, Alabama Quassarte Tribal Town, Muscogee (Creek) Nation, Alabama-Coushatta Tribe of Texas, Thlopthlocco Tribal Town, Seminole Nation of Oklahoma, Eastern Shawnee Tribe of Oklahoma, Absentee Shawnee Tribe of Oklahoma, Kialegee Tribal Town, United Keetoowah Band of Cherokee Indians in Oklahoma, Seminole Tribe of Florida, Shawnee Tribe, and Poarch Band of Creek Indians. The SHPO has concurred with TVA's determinations on the eligibility of the 59 archaeological sites and one cemetery that have been identified within the CRN Site. The TVA and the SHPO agree that 16 of the archaeological sites (40RE104, 40RE105, 40RE106, 40RE107, 40RE108, 40RE124, 40RE128, 40RE138, 40RE140, 40RE165, 40RE166, 40RE167, 40RE549, 40RE595, 40RE600, and 40R601) are potentially eligible for listing in the NRHP, and the remaining 44 archaeological sites, four isolated finds, one non-site locality, and the cemetery are ineligible for listing in the NRHP. In addition, based on the DOE's consultation with SHPO, site 40RE233 (which extends into the APE) is also considered eligible for the NRHP.

TVA also consulted with federally recognized tribes with cultural interest in Roane County, Tennessee. TVA received a reply from the United Keetoowah Band of Cherokee Indians in Oklahoma on August 29, 2011, who stated they had no objections to TVA's proposed undertaking. In April 2015, in response to notification from TVA regarding the expanded APE, the Muscogee Nation responded they were unaware of any culturally significant sites within the project areas and concurred with TVA's determination that Site 40RE233 is eligible for the NRHP and would be avoided. ESPA ER Appendix A includes letters sent to and received from regulatory agencies and Indian tribes regarding the cultural resources consultation associated with the proposed SMR project.

None of these prior surveys included a small (approximately 2-acre) section of land on DOE property that would be affected by the proposed 161-kV transmission line, or the areas to be affected by the proposed road improvements on the TN 95 Access (Jones Island Road and the Jones Island Road/TN 95 intersection). Therefore, TVA contracted with Wood Environment and Infrastructure, Inc. (Wood) for an archaeological survey (Hunter et al. 2021) that included these areas, in connection with the proposed CRN Nuclear Technology Park project. This survey included the footprint of proposed improvements to the TN 95 Access. It also included a corridor for the proposed 161-kV transmission line, including a small section of DOE land that would be affected. The survey revisited six previously recorded archaeological sites (40RE101, 40RE103, 40RE104, 40RE156, 40RE159, and 40RE162) but did not identify any archaeological deposits associated with any of the sites. The survey identified two previously unrecorded sites (40RE631 and 40RE632). The results of the survey indicate that site 40RE632 (a low-density precontact site of unknown cultural affiliation) lacks research value and is ineligible for inclusion in the NRHP, and that 40RE631, a late nineteenth/early twentieth-century farmstead site that contains structural remains and artifact scatters, may be eligible for the NRHP. TVA consulted with the Tennessee SHPO and federally recognized Indian tribes regarding these findings. The SHPO did not disagree with TVA's survey or NRHP eligibility recommendations for the identified sites, but did request updated site forms. The SHPO also noted that TVA completed background research related to the project after beginning the field survey and asked that TVA detail the steps that TVA would take to ensure that background research is completed prior to fieldwork in future surveys. In addition, SHPO requested that site 40RE631 be avoided or subjected to additional archaeological evaluation. TVA has provided the updated site forms and is providing the information that SHPO requested.

Based on these surveys and TVA's consultation to date, the project footprint contains 12 archaeological sites that TVA has determined, in consultation, are potentially eligible for inclusion in the APE: 40RE106, 40RE108, 40RE124, 40RE128, 40RE138, 40RE140, 40RE167, 40RE549, 40RE595, 40RE600, 40RE601, and 40RE631. A small portion of archaeological site 40RE233, which the DOE and TN SHPO have agreed is eligible for the NRHP, extends into the CRN project footprint. One historic cemetery (40RE119, Hensley Cemetery) is located in the project footprint. Although this cemetery does not qualify for inclusion in the NRHP, TVA does not plan to affect this site and would take steps to ensure that the cemetery remains undisturbed by TVA's actions. Finally, TVA considers the two stone pile sites identified by Jolley, which have not been intensively investigated, to be potentially eligible as they may be precontact sites associated with Native American spiritual activity or burial of the dead. Prior to any ground-disturbing project activities within 100 meters of either site, TVA would conduct additional investigations of the site and consult further with the Tennessee SHPO and federally recognized Indian tribes.

3.17.1.3.2 Historic Architectural Surveys

TVA conducted a survey of historic architectural properties within the APE in connection with the Clinch River SMR project (Karpynec 2011). This survey focused on the viewshed of the powerblock area. The survey identified no properties listed in, or eligible for, listing in the NRHP within the viewshed within 0.5 mile. In 2015, TVA conducted a desktop review within the 0.5-mile radius to identify any NRHP-listed, -eligible, or potentially eligible historic architectural properties. This review included close examination and comparison of the following: the 1941 and 1968 (photo revised 1990) editions of the USGS Elverton, TN 7.5-minute quadrangle; the 1941 and 1998 editions of the Bethel Valley, TN 7.5-minute quadrangle; the 1939 TVA Watts Bar Reservoir land acquisition maps; and current aerial photography available from public domain sources through ESRI ArcGIS. Structures shown on the 1941 quadrangles that were absent from later editions were considered to be non-extant. Structures shown in the same location on both quadrangles and also visible in current aerial photography were considered to be extant structures that are at least 70 years old.

Seven structures within the CRN Technology Park APE appear on both the 1941 USGS quadrangles and later editions. Structure 2 (a barn) does not appear on current aerial imagery and has apparently been demolished. Four of the structures (numbers 4-7) are within the 2011 APE and were recommended ineligible by TRC in 2011. Structures 1 and 3 are within 0.5 mile of Areas 1 and 2 but were not included in the 2011 survey. On the 1939 TVA land acquisition map, Structure 1 is indicated as a two-story frame house surrounded by scattered fruit trees, a smoke house, and a shed. This property is located in the western side of the 0.5-mile radius, on the opposite shore of the Reservoir. The 1939 map shows Structure 3 as a one-story frame house surrounded by an orchard and several outbuildings: a barn, two chicken houses, a smoke house, and two corn cribs. This property is located in the east side of the 0.5-mile radius, on the opposite side of the Reservoir, near the base of Hood Ridge.

A TVA archaeologist visited Structures 1 and 3 on May 8, 2015 and documented them with photographs. Structure 1 was extant and in good condition and shows signs of having been modified by at least one modern addition. Structure 3 was abandoned and in poor condition. Neither structure is within the undertaking's viewshed. No part of the proposed project would be visible from a person standing at either property. At Structure 1, views would be blocked by a stand of mature trees on the property, as well as a wooded area along the top of the hill overlooking the Reservoir. Structure 3 is entirely surrounded by thick secondary vegetation and is not visible from Industrial Park Road, which is the nearest public road. TVA found that both structures are outside the APE. TVA consulted with the Tennessee SHPO regarding this finding, and the SHPO agreed. Therefore, TVA finds there are no NRHP-listed or -eligible historic architectural properties within the viewsheds associated with Areas 1 and 2.

In 2021, TVA completed a survey of historic architectural properties in the viewshed of the Jones Island Road portion of the project, as part of a cultural resources survey that also included the archaeological survey described above (Hunter et al. 2021). The survey included a viewshed analysis of areas within 0.5 mile of the proposed Jones Island Road and Jones Island Road/TN 95 improvements. The viewshed analysis took into consideration vegetation, topography, land use/land cover, and the built environment and created a model of areas that would have direct lines of sight to the Jones Island Road portion of the project. This survey identified nine architectural resources within the 0.5-mile radius. TVA recommends that eight of these resources do not meet criteria of eligibility for the NRHP. TVA recommends that one property (FS-5), which consists of a circa 1830 Colonial Revival house located near the south edge of the 0.5-mile radius on the opposite side of the Reservoir, is eligible for the NRHP under Criterion C for its architectural significance in relation to regional architectural styles. However, based on the viewshed analysis, no unobstructed views to the project would be possible from this property due to topography and vegetation (which includes abundant evergreen trees); therefore, property

FS-5 is not located in the APE. TVA has not, therefore, identified any NRHP-listed or -eligible historic architectural properties in the undertaking's APE.

In 2016, TVA began considering a number of alternative actions to provide additional flow in order to regulate water temperatures in the Clinch River during times of low water levels, depending on the reactor design ultimately selected for the site. Among the alternatives being considered were possible modifications to Melton Hill Dam, located approximately 3.5 river miles upstream from the CRN site. The modifications under consideration included some that might involve physical and visual changes to the dam. Melton Hill Dam is the principal feature of the Melton Hill Hydroelectric Project, which was constructed 1960-1965. The Melton Hill Hydroelectric Project was listed in the NRHP in 2016. It meets the NPS significance Criteria A and C for its historical and engineering significance at the local and state levels as an integral part of the Tennessee Valley Authority Hydroelectric Project. TVA re-determined the APE to include Melton Hill Dam, and a 0.5-mile radius surrounding it, and consulted with the Tennessee SHPO regarding the enlarged APE. The SHPO agreed with this APE modification by letter dated August 23, 2016. Depending on the technology selected for deployment at the CRN Site, it is possible that instead of modifying the Melton Hill Dam structure, TVA could manage releases from the Melton Hill Dam to augment flow and maintain water quality. Details regarding the need for augmentation of Melton Hill Dam Flow and its associated impacts would be evaluated further in a subsequent NEPA review when more technology-specific design and construction information is available.

In summary, the two historic architectural surveys and TVA's desktop review have identified one historic architectural property within the APE that is listed in the NRHP – the Melton Hill Hydroelectric Project. The review did not identify any unlisted properties that are eligible for listing in the NRHP.

3.17.1.3.3 Programmatic Agreement

TVA and the SHPO executed a PA to address the management of cultural resources affected by the Clinch River SMR Project (*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*). In July 2015, TVA received a response from the United Keetowah Band of Cherokee Indians in Oklahoma acknowledging the revised PA. This response is also included in ESPA ER Appendix A. The PA was initially signed in August 2015, was later revised, and signed in April 2016 by TVA and May 2016 by the SHPO. In August 2016, TVA reinitiated consultation with the SHPO under Section I.A of the PA to expand the CRN Project APE to include the Melton Hill Dam and a 0.5-mile radius around the dam. The PA stipulates the steps that TVA would take in order to make any needed changes to the APE as project plans develop; identify historic properties in the APE; evaluate the project's potential effects on historic properties; and seek ways to avoid, minimize, or mitigate adverse effects on historic properties.

3.17.1.4 Reasonably Foreseeable Future Actions in Proximity to the CRN Site

As noted in Section 3.1.3, TVA identified several foreseeable future actions in proximity to the CRN Site. The scope of these other proposed actions may entail adverse effects to archaeological resources and historic structures within their respective project footprints or viewsheds. However, the specific details regarding the scope of these actions are lacking. Furthermore, none of the identified reasonably foreseeable future actions is overlapping geographically with the CRN Project Area nor are considered to have a causal relationship to the proposed development of the CRN Site. As such, no further consideration of reasonably foreseeable future actions and their effects on archaeological resources and historic structures are included in TVA's analysis.

3.17.2 Environmental Consequences

3.17.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, TVA would continue to manage the CRN Site and the public would continue to have access to the Hensley Cemetery and to the CRN Site for hunts managed by TWRA, but no site disturbance is planned. Therefore, there would be no impacts to existing archaeological resources located at or in the vicinity of the CRN Site in association with implementation of the No Action Alternative. As TVA would make no changes to Melton Hill Dam under Alternative A, and no historic architectural properties are located within the viewshed of the CRN Site, Alternative A would not result in adverse impacts to any historic architectural properties.

3.17.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced Non-LWRs

Four of the potentially eligible archaeological sites (40RE106, 40RE107, 40RE108, and 40RE601) are located within the Area 1 footprint area and could be adversely affected by Alternative B. In addition, potentially eligible site 40RE595 is located near Bear Creek Road and potentially eligible site 40RE631 is located near the TN 95 Access. Both of these sites could be adversely affected by roadway improvements associated with Alternative B. Once specific project plans are available, TVA would, as required by the PA, take steps to evaluate potential effects of Alternative B on archaeological sites. Should any activities associated with Alternative B have potential for physical effects on any of the potentially eligible archaeological sites, TVA would conduct additional investigations to generate the data needed for full evaluations of the NRHP eligibility status of those sites. TVA would seek ways to avoid or minimize adverse project impacts on NRHP-eligible archaeological sites, and if avoidance or sufficient minimization are not possible, TVA would mitigate the adverse effects. TVA would consult with the Tennessee SHPO and federally recognized tribes throughout the process. Based upon the above referenced impacts from construction activities on historic and cultural resources, impacts would be moderate and appropriately mitigated in conjunction with the terms of the PA.

As TVA would make no changes to Melton Hill Dam under Alternative B, and no historic architectural properties are located within the viewshed of the CRN Site, Alternative B would not result in adverse impacts to any historic architectural properties.

3.17.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced Non-LWRs

One potentially eligible archaeological site (40RE549) is located within the footprint associated with Area 2. As with Alternative B, roadway improvements on Bear Creek Road and the TN 95 Access could result in adverse impacts to potentially eligible site 40RE595 and potentially eligible site 40RE631. As described for Alternative B, once specific project plans are available, TVA would undertake steps required in the PA including additional investigations, determination of NRHP eligibility, mitigation, and consultation with the Tennessee SHPO and federally recognized tribes. Impacts from construction activities on historic and cultural resources impacts would be moderate and appropriately mitigated in conjunction with the terms of the PA.

As TVA would make no changes to Melton Hill Dam under Alternative B, and no historic architectural properties are located within the viewshed of the CRN Site, Alternative C would not result in adverse impacts to any historic architectural properties.

3.17.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced Non-LWRs

Four of the potentially eligible archaeological sites (40RE106, 40RE107, 40RE108, and 40RE601) are located within the Area 1 footprint area and one potentially eligible archaeological site (40RE549) is located within the footprint associated with Area 2, both of which could be adversely affected by Alternative D. In addition, potentially eligible site 40RE595 is located near Bear Creek Road and potentially eligible site 40RE631 is located near the TN 95 Access. Both of these sites could be affected by roadway improvements associated with Alternative D. As described for Alternative B, once specific project plans are available, TVA would undertake steps required in the PA including additional investigations, determination of NRHP eligibility status, mitigation, and consultation with the Tennessee SHPO and federally recognized tribes. Impacts from construction activities on historic and cultural resources impacts would be moderate and appropriately mitigated in conjunction with the terms of the PA.

As TVA would make no changes to Melton Hill Dam under Alternative B, and no historic architectural properties are located within the viewshed of the CRN Site, Alternative D would not result in impacts to any historic architectural properties.

3.17.2.5 Summary of Impacts to Archaeological Resources and Historic Structures

As summarized in Table 3-64, TVA has determined that impacts to cultural resources resulting from the alternatives would be moderate with mitigation as required and outlined in the PA. There would be no impacts to archaeological resources and historic structures associated with operations of the Nuclear Technology Park. Any site-specific impacts that are analyzed in the future that are expected to fall outside of the bounding analysis in this PEIS will be analyzed in subsequent NEPA analysis.

Table 3-64. Summary of Impacts to Archaeological Resources and Historic Structures

Alternative	Project Phase	Impact	Severity
B	Construction	Potential disturbance of six NRHP potentially eligible archaeological sites. No impacts to eligible historic architectural properties.	Moderate adverse effects, mitigated through PA actions.
C	Construction	Potential disturbance to three NRHP potentially eligible archaeological sites. No impacts to eligible historic architectural properties.	Moderate adverse effects, mitigated through PA actions.
D	Construction	Potential disturbance to seven NRHP potentially eligible archaeological sites. No impacts to eligible historic architectural properties.	Moderate adverse effects, mitigated through PA actions.

3.18 Solid and Hazardous Waste

3.18.1 Affected Environment

3.18.1.1 Solid Waste

Regulations concerning the generation, management, handling, storing, treating, and disposal of solid wastes are contained in federal regulations issued and administered by the EPA, and in Tennessee regulations administered by the TDEC. Nonradioactive wastes are managed in accordance with applicable federal, state, and local laws, regulations, and permit requirements as well as TVA procedures, including the CAA, CWA, and the Resource Conservation and Recovery Act of 1976, as amended (RCRA). Preliminary descriptions of the Nuclear Technology Park's solid waste and nonradioactive hazardous waste systems and bounding chemical parameters are presented in Chapter 2. Any hazardous waste produced at the proposed CRN Site would be administered in accordance with RCRA, associated regulations and permits, the TDEC Hazardous Waste Management Program regulations, and any associated special permit conditions.

3.18.1.2 Hazardous Waste

As previously stated, TVA maintains multiple procedures for management of hazardous and mixed waste at their facilities, and any hazardous waste generated at the proposed CRN Site would be managed in accordance with applicable regulatory requirements and permit conditions. The proposed Nuclear Technology Park is expected to be a small quantity generator of hazardous wastes. As such, hazardous wastes produced by the Nuclear Technology Park would not be expected to have a notable effect on area disposal facilities. TVA maintains procedures for management of hazardous and mixed waste at their facilities, and these procedures would be followed for hazardous wastes generated at the CRN Site.

Small amounts of hazardous and mixed waste (waste containing radioactive and nonradioactive material) would be generated during routine operation, maintenance, refueling, radiochemical lab activities, and health protection activities. During development of the Nuclear Technology Park, specific hazardous and mixed waste management practices, treatment methods, and storage areas would be established, and industry standards and regulatory-compliant measures would be applied during all forms of handling hazardous and mixed wastes. All hazardous and mixed waste would be shipped offsite for treatment and/or disposal at licensed facilities.

TVA would implement a waste-minimization plan for the CRN Site that would be similar to those developed for other TVA nuclear power facilities. BMPs that could be part of a CRN waste-minimization plan include the following:

- Inventory identification and control that uses a tracking system to manage waste-generation data and waste-minimization opportunities.
- Work planning to reduce mixed-waste generation. (An example of work planning is pre-task planning to determine what materials and equipment are needed to perform the anticipated work.)
- Mixed-waste reduction, recycling, and reuse methods that maximize opportunities for reclamation and reuse of waste materials are used whenever feasible.
- Training and education of employees on the principles and benefits of waste minimization.

3.18.1.3 Reasonably Foreseeable Future Actions in Proximity to the CRN Site

As noted in Section 3.1.3, TVA identified several foreseeable future actions in proximity to the CRN Site. The scope of these other proposed actions is expected to result in both construction phase and operational phase solid and hazardous waste generation. Specific foreseeable future actions that may contribute wastes to landfills served by the CRN Project include the potential development of the Kairos Hermes Reactor Project, the development of the new airport by the City of Oak Ridge (both at the ETTP, the proposed construction of new production facilities at the Y-12 complex, and potential development at the Horizon Center Industrial Park. None of the identified reasonably foreseeable future actions is overlapping geographically with the CRN Project Area nor is considered to have a causal relationship to the proposed development of the CRN Site. Specific details regarding volumes of solid wastes generated by these other actions and their respective timing (i.e., construction duration, start of operation) are currently unavailable. However, depending on the timing of implementation of these various projects, localized increases in wastes sent to regional landfills may occur that could reduce existing landfill capacity.

3.18.2 Environmental Consequences

3.18.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, advanced nuclear reactors would not be constructed, operated, maintained, or potentially decommissioned at the CRN Site. As such, under the No Action Alternative, the CRN Site would generate no construction- or operation-related nonradioactive solid or hazardous wastes; therefore, there are no impacts associated with nonradioactive solid wastes.

3.18.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced Non-LWRs

3.18.2.2.1 Solid Waste

3.18.2.2.1.1 Construction

It is expected that various types of solid waste would be generated during construction activities at Area 1 on the proposed CRN Site. These wastes would include nonhazardous nonradioactive wastes such as construction and demolition waste, wood, metal, paper, municipal solid waste, and debris collected on trash screens at the water-intake structure. TVA predicts that up to 290 tons per month of nonradioactive, nonhazardous waste could be generated during construction and operation of a Nuclear Technology Park at the CRN Site. This prediction was based on the average waste generated at the Watts Bar Nuclear (WBN) site during the 3-year duration when WBN Unit 2 was being constructed and WBN Unit 1 was operating and represents a conservative upper bound. WBN Units 1 and 2 are larger reactors and require more staff than the advanced nuclear reactors planned for the CRN Site.

Construction activities associated with Area 1 would produce solid waste materials from excavation and land clearing. TVA could construct and operate a permitted, onsite construction and demolition landfill to accommodate construction waste produced by excavation and land clearing at Area 1. Any construction debris and other associated waste (including municipal solid waste) not disposed of onsite would be managed by a solid-waste disposal vendor, shipped from the CRN Site, and disposed of at authorized sanitary landfills in accordance with TVA standard procedures. Solid waste would be managed by a TVA-approved solid waste disposal vendor and disposed in a state-approved sanitary landfill, such as the Chestnut Ridge Sanitary Landfill.

Waste-minimization procedures would be implemented, and standard processes related to the handling of nonradioactive solid waste utilized at other TVA plants would be employed at the CRN Site. Any generated solid waste would typically be managed by a solid-waste disposal vendor and disposed of at authorized sanitary landfills in accordance with TVA standard procedures. The disposal vendor applicant would be required to confirm that they would comply with all applicable federal, state, and local requirements and standards for handling, transporting, and disposing of solid waste.

Solid wastes generated during construction at the CRN Site would be managed by TVA in compliance with applicable federal, state, and local laws, ordinances, and regulations intended to prevent or minimize adverse environmental impacts. Therefore, it is expected the impacts from nonradioactive solid wastes generated during the construction activities for CRN units would be minimal, and no further mitigation would be warranted. Therefore, solid waste impacts due to construction are minor.

3.18.2.2.1.2 Operation

Management procedures regarding solid waste management at Area 1 would likely be comparable to procedures used at TVA's Watts Bar Nuclear Plant. Operational solid wastes such as office waste, cardboard, wood, or metal would be recycled or reused to the furthest degree possible. Based on a 3-year average (2014 through 2016) of solid nonhazardous waste generated at WBN Units 1 and 2, TVA estimates an upper bound value of 290 tons of trash per month. Since this amount of solid waste per month generated by Watts Bar Nuclear Plant is meaningfully greater than what is expected to be eventually produced by the reactors in the CRN PPE, 290 tons per month provides a conservative upper bound to use in this analysis. TVA plans to dispose of municipal solid waste such as resins and debris from the trash racks and screens gathered from the water-intake structure using offsite, licensed commercial disposal facilities. TVA would follow all pertinent federal, state, and local requirements and standards for handling, transporting, and disposing of solid waste.

Specific measures and controls that would be implemented to limit adverse impacts to land during operations include:

- Minimize potential impacts through compliance with permitting requirements, BMPs, and TVA procedures.
- Develop and follow a waste minimization plan to reduce the amount of waste that is generated.
- Generate and dispose of nonhazardous nonradioactive waste according to applicable local, state, and federal regulations, including the Solid Waste Disposal Act, as amended, and 40 CFR Part 261, "Identification and Listing of Hazardous Waste," and TVA procedures.
- Comply with Waste Minimization Plans developed for existing TVA reactors to address hazardous waste management, treatment (decay in storage), work planning, waste tracking, and awareness training.
- Perform inspections for compliance with applicable waste management laws and regulations and TVA procedures.
- As appropriate, train employees to follow applicable procedures and waste regulations.

Strategies to manage solid wastes would be similar to the existing solid waste management strategies at existing TVA nuclear plants, in accordance with all applicable federal, state, and local requirements and standards, and the effective practices for reusing, recycling, and minimizing waste. As such, it is expected that impacts from solid wastes generated during the construction and operation of any CRN units would be minimal, and no further mitigation would be warranted.

3.18.2.2.2 Hazardous Waste

3.18.2.2.2.1 Construction

As stated previously in Section 3.3.2.2.1, there would be underwater excavation and dredging required along the shoreline, for construction of the intake and discharge structures needed for operation of plants to be constructed in the Nuclear Technology Park. In addition, underwater excavation and dredging would be required to bury the diffuser pipe at the discharge. The Lower Clinch River sediments are listed as impaired for mercury, PCBs, and chlordane. Additional legacy contamination present in the portion of the Reservoir adjacent to the CRN Site includes radionuclides from DOE activities.

As described in Section 3.3.2.2.1, TVA is party to the Watts Bar Interagency Agreement, along with the USACE, DOE, TDEC, and the EPA, to coordinate review of permitting and other use authorization activities that could result in the disturbance, re-suspension, removal, and/or disposal of contaminated sediments in the Reservoir. 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 that disturb sediments do not further degrade surface water quality would be followed. Any sediment removed may also contain manmade radionuclides; therefore, coordination of the disposition of the sediment with DOE is also anticipated. Excavated sediments would be managed as potentially hazardous and contaminated and would be disposed in accordance with applicable state and federal regulations, along with any applicable or relevant requirements from the Watts Bar Interagency Agreement's associated CERCLA decision documents, based on the results of analyses for hazardous or radioactive contaminants. It is expected that any hazardous waste impacts from stream bed evacuation during construction activities would be minor.

Any other hazardous wastes generated during construction would be disposed of at a licensed facility in accordance with Tennessee solid-waste regulations. It is expected that any hazardous waste impacts generated during construction activities would be minor.

3.18.2.2.2.2 Operation

As stated previously, it is anticipated that reactors in the Nuclear Technology Park would be a small quantity generator of hazardous waste. These wastes would be packaged, transported and disposed using a TVA-approved vendor. TVA maintains procedures for management of hazardous and mixed wastes at their facilities.

The term "mixed waste" refers specifically to waste that contains both hazardous waste and source, special nuclear, or byproduct material. Because radioactive materials at nuclear power facilities are regulated by NRC and hazardous wastes are regulated by EPA and authorized states, nuclear power facilities managing mixed waste must meet the requirements of both regulatory regimes.

Additionally, entities that generate, treat, store, or dispose of mixed wastes are subject to the requirements of the Atomic Energy Act, the Solid Waste Disposal Act of 1965, as amended by the RCRA in 1976, and the Hazardous and Solid Waste Amendments, which amended RCRA in 1984. In the State of Tennessee, the EPA has authorized the state to regulate those portions of the federal act under RCRA.

Nuclear power facilities typically do not generate large volumes of hazardous or mixed waste due to industry-wide, ongoing efforts to reduce mixed-waste generation. A 1990 survey conducted by NRC identified the types of hazardous and potentially mixed low-level waste listed below as common to reactor facilities. The types of hazardous and potentially mixed waste that would be generated by any reactors selected for Area 1 is expected to be consistent with the types identified by the survey. Types of hazardous or mixed waste may include:

- Waste oil from pumps and other equipment
- Chlorinated fluorocarbons resulting from cleaning, refrigeration, degreasing, and decontamination activities
- Organic solvents, reagents, compounds, and associated materials such as rags and wipes
- Metals such as lead from shielding applications and chromium from solutions and acids
- Metal-contaminated organic sludge and other chemicals
- Aqueous corrosives consisting of organic and inorganic acids

Specific hazardous and mixed waste management practices, treatment methods, and storage areas have not been established for Area 1 of the Nuclear Technology Park. However, industry standard and regulatory compliant hazardous chemical control and radiological control measures would be applied during testing, handling, and storage (accumulation area) of hazardous and mixed wastes. In accordance with hazardous material management regulations in 40 CFR 261 and 265, onsite storage of hazardous and mixed wastes is limited. Therefore, hazardous, and mixed wastes would be shipped offsite for treatment or disposal after a short accumulation period.

Examples of BMPs for hazardous and mixed waste storage and disposal include:

- Development of an emergency response plan
- Segregation of hazardous and mixed wastes from nonhazardous wastes
- Securing waste accumulations areas
- Posting accumulation areas with signs containing language similar to the following: “MIXED/HAZARDOUS WASTE AREA” and “DANGER-UNAUTHORIZED PERSONNEL-KEEP OUT”
- Use of secondary containment and the presence of spill kits for liquid hazardous and mixed waste storage
- Compliant container labeling
- Routine inspections of waste accumulation areas
- Any other pertinent and applicable permit requirements

Furthermore, TVA maintains procedures for management of hazardous and mixed waste at their facilities and would abide by the applicable federal and state regulations.

The development and implementation of hazardous and mixed waste management BMPs and a Waste Minimization Plan would ensure that generation of hazardous and mixed wastes is minimized by the advanced nuclear reactor units in Area 1. Due to the projected small volume of hazardous and mixed waste, no significant emissions or releases of hazardous materials are expected as a result of mixed waste management practices. Therefore, it is believed that environmental impacts from hazardous and mixed waste management would be minor.

3.18.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced Non-LWRs

Solid and hazardous waste generation and associated management practices, and impacts during construction and operation under Alternative C, would be the same as those discussed for Alternative B. TVA would manage solid and hazardous wastes in accordance with all applicable federal, state, and local requirements and standards and apply recycling and waste minimization practices. As such, impacts from nonradioactive solid and hazardous wastes generated under Alternative C would be minor.

3.18.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced Non-LWRs

Under Alternative D, construction-related solid wastes generated during construction of the facility would be similar to those described under Alternative B; Solid and hazardous waste generation and associated management practices and impacts during operation under Alternative D would be the same as those discussed for Alternative B. TVA would manage solid and hazardous wastes in accordance with all applicable federal, state, and local requirements and standards and apply recycling and waste minimization practices. As such, impacts from nonradioactive solid and hazardous wastes generated under Alternative D would be the same as Alternative B during construction and operation, but would still be minor.

3.18.2.5 Summary of Impacts to Solid and Hazardous Waste

As summarized in Table 3-65, impacts resulting from solid and hazardous wastes during construction are minor. During operation of advanced nuclear reactors, impacts from solid and hazardous wastes are also expected to be minor.

Table 3-65. Summary of Impacts from Solid and Hazardous Wastes

Alternatives	Project Phase	Impact	Severity
Alternatives B, C, D	Construction	Construction-related solid waste management and disposal. TVA could construct and operate a permitted, onsite construction and demolition landfill to accommodate construction solid waste produced by excavation and land clearing. Any construction debris and other nonhazardous wastes (including municipal solid	Minor impact. Application of waste minimization procedures would be utilized. Alternatives B, C, and D all have the same level of impact.

Alternatives	Project Phase	Impact	Severity
		waste) not disposed of onsite would be transported to an offsite sanitary landfill. Management and disposal of hazardous sediments excavated from the Reservoir.	
Alternatives B, C, D	Operation	Operation-related solid waste management and disposal.	Minor impact. Application of waste minimization procedures would be utilized. Municipal solid waste produced would be disposed of using offsite licensed commercial disposal facilities.
		Operation-related hazardous wastes management and disposal.	Minor impact. Waste minimization procedures would be utilized. Hazardous and mixed wastes would be shipped offsite to licensed facilities for treatment and disposal after a short accumulation period. Implementation of BMPs would help reduce the quantity of hazardous waste to be disposed of.

3.19 Public Safety and Nonradiological Health

3.19.1 Affected Environment

3.19.1.1 Occupational Safety

Workplace health and safety regulations are designed to eliminate personal injuries and illnesses from occurring in the workplace. The Occupational Safety and Health Administration (OSHA) is the main statute protecting the health and safety of workers in the workplaces. TVA has a robust safety conscious culture that is focused on awareness and understanding of workplace hazards, prevention, intervention, and active integration of BMPs to avoid and minimize hazards.

Personnel at TVA are well trained about health and safety practices and are conscientious about following procedures for reducing or eliminating occupational hazards through implementation of safety practices, training, and control measures.

Programs and process for workplace safety that are communicated to work crews include the following:

- *Pre-Job Brief* – allows the worker to think through a job and use that knowledge to make the job as safe as possible.

- *Two-Minute Rule* (situational awareness) – take time before starting a job to familiarize yourself with the work environment and to identify conditions that were not identified during the pre-job brief.
- *Stop When Unsure* – when confronted with a situation that creates a question and what to do is uncertain, stop and get help.
- *Self-Check* – use of “STAR” acronym to promote self-check awareness: **S**top and focus, **T**hink what would happen with right or wrong action, **A**ct correctly, **R**eview that the results are as expected.
- *Procedure Use and Adherence* – allows for proper application of procedures and work packages based on expected activities.
- *Flagging and Operational Barriers* – key to ensure control of the work zones and avoidance of exposure to work hazards by public.
- *Three-Way Communication* – essential for all job tasks to ensure they are completed safely and productively.

TVA’s Safety Standard Programs and Processes would be strictly adhered to during the implementation of the proposed actions. The safety programs and processes are designed to identify actions required for the control of hazards in all activities, operations, and programs. It also establishes responsibilities for implementing OSHA and state requirements.

3.19.1.2 Etiological (Disease-Causing) Agents

Public and occupational health can be compromised by activities at the CRN Site that might result in the growth of disease-causing microorganisms (etiological agents). Thermal discharges from the proposed cooling system into the Reservoir have the potential to increase the growth of thermophilic microorganisms (microorganisms that favor warmer water). The types of microorganisms of concern for public and occupational health include enteric pathogens (such as *Salmonella* spp. and *Pseudomonas aeruginosa*), bacteria (such as *Legionella* spp.), thermophilic fungi, and freeliving amoeba (such as *Naegleria fowleri* and *Acanthamoeba* spp.). These microorganisms are known to occur in many types of freshwater bodies such as lakes, rivers, and thermally polluted effluents from power plants throughout the U.S. and proliferate during warm summer months. Water quality within the Upper Tennessee River Basin is discussed further in Section 3.3.1.1.3.

Epidemiological reports from the State of Tennessee indicate a very low risk of outbreaks from etiologic agents associated with recreational water. Available data assembled by the U.S. Centers for Disease Control and Prevention (CDC) for the years 2016 to 2019 report that outbreaks of Legionellosis, Salmonellosis, or Shigellosis in Tennessee were low compared to the number of cases nationally (CDC 2021a). Although *Naegleria fowleri* is common in freshwater ponds, lakes, and reservoirs throughout the southern states, only one case was reported in Tennessee between 1962 and 2020 (CDC 2021b). The main recreational activities associated with the Reservoir near the proposed Nuclear Technology Park are boating, fishing, and hunting. Recreational areas located within the proposed CRN Site vicinity are described in detail in Section 3.10.

3.19.1.3 Electromagnetic Fields

Operation of power transmission systems generate both electric and magnetic fields, referred to collectively as EMFs. Public and worker health can be compromised by acute and chronic exposure to electrical sources associated with power transmission systems, including switching stations (or substations) on the site and transmission lines connecting the plant to the regional electrical distribution grid. Transmission lines operate at a frequency of 60 Hz (60 cycles per second), which is considered to be an extremely low frequency.

The existing transmission corridors at the CRN Site are discussed in Section 2.4.2. Potential transmission system upgrades required to support the construction of a plant or a combination of plants generating a maximum of 800 MWe, which would connect the Nuclear Technology Park to the grid are also identified in Section 2.4.2.

3.19.1.4 Reasonably Foreseeable Future Actions in Proximity to the CRN Site

As noted in Section 3.1.3, TVA identified several foreseeable future actions in proximity to the CRN Site. The scope of these other proposed actions is expected to result in impacts to public safety and nonradiological health. However, none of the identified reasonably foreseeable future actions is overlapping geographically with the CRN Project Area nor is considered to have a causal relationship to the proposed development of the CRN Site. Specific details regarding these other actions and their respective timing (i.e., construction duration, start of operation) are lacking. As such, no further consideration of reasonably foreseeable future actions and their effects on public safety and nonradiological health are included in TVA's analysis.

3.19.2 Environmental Consequences

3.19.2.1 Alternative A – No Action Alternative

Under the No Action Alternative, no activities would be undertaken in conjunction with the development of the CRN Site or associated offsite areas. TVA's safety conscious efforts would continue such that no changes to current public safety and nonradiological health are anticipated under this alternative. Therefore, Alternative A would not have an impact on public safety and nonradiological health.

3.19.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced Non-LWRs

3.19.2.2.1 Construction

Construction under Alternative B would include a range of activities including clearing and grubbing, excavation, and transport of materials and workforce. The equipment required for construction of a Nuclear Technology Park includes dozers, compactors, dump trucks, scrapers/pans, track hoes and diesel pumps. Deep excavations can result in increased risks to workforce health and safety. Customary industrial safety standards including OSHA requirements for workers engaged in excavation activities would help reduce these risks. Also, the establishment of appropriate BMPs and job site safety plans would describe how job safety would be maintained during the project. These BMPs and site safety plans address the implementation of procedures to ensure that equipment guards, housekeeping, and personal protective equipment are in place; the establishment of programs and procedures for lockout, right-to-know, hearing conservation, heavy equipment operations, excavations, and other activities; the performance of employee safety orientations and regular safety inspections; and the development of a plan of action for the correction of any identified hazards. All of these measures would help ensure that job site safety risks are reduced.

The U.S. Bureau of Labor Statistics provides reports that account for occupational injuries and illnesses as incidence rates, which represent the number of injuries and illnesses per 100 full-time workers (full-time equivalent employees [FTEs]). Additionally, the State of Tennessee also tracks annual incidence rates of injuries and illnesses for “utility system construction”. In 2019, the national incidence rate for “utility system construction” was 2.1 illness/injuries per 100 FTEs (BLS 2021a) and the Tennessee incidence rate for “utility system construction” was 1.8 illnesses/injuries per 100 FTEs (BLS 2021c). It is TVA policy that all contractors have in place a site-specific health and safety plan prior to operation on TVA properties. The contractor site-specific health and safety plans must address the hazards and controls as well as contractor coordination for various construction tasks. With the high level of safety awareness and preparation during construction activities, safety and security plans and safety awareness would reduce potentially large safety risks (e.g., excavations, working at heights, blasting) down to a minor and temporary impact.

The highway and rail transportation network arterials located near the CRN Site are I-40 (south of the CRN Site), TN 58 (northwest of CRN Site), and TN 95 (northeast of CRN Site). Existing access to the CRN Site is provided via Bear Creek Road (from either of the three arterials). However, in conjunction with the construction of the CRN Nuclear Technology Park, TVA would develop the TN 95 Access which would carry approximately 20 percent of the construction traffic. As indicated in Section 3.12.2 impacts to the traffic conditions on roadways surrounding the CRN Site would be generally minor. Impacts are expected to be moderate at Bear Creek Road and TN 95 due to increased traffic on TN 95 and moderate at primary CRN Site access at Bear Creek Road intersection and on Bear Creek Road due to delays entering CRN Site during peak hours.

Nonradiological traffic related effects are primarily a function of workforce related commuting but are also influenced by trips associated with the delivery of materials to the CRN Site. As indicated in the PPE value (Table 2-4), construction phase activities would entail an average workforce of 2,200 workers, and a peak workforce of 3,300 workers on a daily basis. Assuming an average of 1.3 workers per vehicle, the peak workforce would entail an estimated 2,539 vehicles that would enter and leave the CRN site on a daily basis. This would equate to an estimated increase of 5,078 trips that would be construction related on the regional roadway network. Assuming the average commuting distance of 50 miles for each worker and a similar distance for shipping of materials, the total annual construction fatalities related to building the facility represent an approximate 7.5 percent increase over the average 10 traffic fatalities per year that occurred in Roane County from 2012 to 2016. This percentage represents negligible increases relative to the current traffic fatality risks in the areas surrounding the proposed CRN Site. As such nonradiological impacts on traffic related safety would be minor.

Use of BMPs, safety procedures, and security measures would minimize possible safety effects. Therefore, impacts to public safety and nonradiological health from the implementation of Alternative B would be minor.

3.19.2.2.2 Operation

3.19.2.2.2.1 Workforce Safety

TVA’s Safety Standard Programs and Processes would be strictly adhered to during the proposed actions. The safety programs and processes are designed to identify actions required for the control of hazards in all activities, operations, and programs. It also establishes responsibilities for implementing OSHA and state requirements. Use of BMPs, safety procedures, and security measures would minimize possible safety effects. Therefore, impacts to workplace safety from the implementation of Alternative B would be minor.

3.19.2.2.2.2 Etiological (Disease-Causing) Agents

Operation under Alternative B would result in a thermal discharge to the Reservoir. Such discharges of warmer water have the potential to increase the growth of thermophilic microorganisms, including etiological agents, both in the CWS and the Clinch River. Thermophilic microorganisms include enteric (intestinal) pathogens such as *Salmonella* spp., *Pseudomonas aeruginosa*, thermophilic fungi, bacteria such as *Legionella* spp., and free-living amoeba such as *Naegleria fowleri* and *Acanthamoeba* spp. These microorganisms could result in potentially serious human health concerns, particularly at high exposure levels. However, as described above, the reported incidence of these outbreaks in in Tennessee in recent years is low compared to the number of cases nationally (CDC 2021a). While it is possible that the thermal discharge from reactors in Area 1 could have an impact on the abundance of etiological agents present in the Reservoir, the thermal plume would be small under normal operating conditions at most times of the year. Based on the historically low risk of diseases from etiological agents in Tennessee and the limited extent of thermal impacts to the Reservoir, the impacts on human health would be minor.

3.19.2.2.2.3 Electromagnetic Fields

In NUREG-1437, Rev 1 (NRC 2013), the NRC indicates that the greatest electrical shock hazard from a transmission line is direct contact with the conductors and that tower designs preclude direct public access to the conductors. However, electrical shocks can occur without physical contact. Secondary shock can happen when humans make contact with either capacitively charged bodies (such as a vehicle parked near a transmission line) or magnetically linked metallic structures (such as fences near transmission lines). The shock received by the person could be painful. The intensity of the shock would depend on the EMF strength, the size of the object, and the degree of insulation between the object, the person, and the ground. (NRC 2013).

The National Electrical Safety Code (NESC) is the basis for design criteria that are intended to limit the risk of shock and other hazards due to transmission lines. The NESC calls for transmission lines to be designed with minimum vertical clearances to the ground so that the short-circuit current to ground produced from the largest anticipated vehicle or object is limited to less than 5 milliamperes. In NUREG 1437, Rev. 1, NRC indicated that the electrical shock issue is of small significance for transmission lines that are operated in adherence with the NESC (NRC 2013).

Like the existing transmission lines, all new transmission lines, switchyards, and associated structures required for power generation and distribution at the CRN Site and associated offsite areas would conform to the applicable NESC guidelines. Therefore, the impact on the public from acute effects of EMFs would be minor.

Because public exposure to EMFs from existing transmission lines would not change and EMFs associated with new transmission lines would be localized and can be decreased to negligible levels, impacts to the public resulting from EMF exposure would be minor. As such, impacts of EMFs on public and worker health is minor.

3.19.2.2.2.4 Occupational Health

In general, occupational health risks to workers and onsite personnel engaged in activities related to building and operating nuclear power plants would be dominated by occupational injuries (e.g., falls, electric shock, asphyxiation) or occupational illnesses. Historically, actual injury and fatality rates at nuclear reactor facilities have been lower than the average U.S. industrial rates. In 2019, the U.S. Bureau of Labor Statistics reported that the rate for “nuclear electric power generation” was 0.2 illness/injuries per 100 FTEs (BLS 2021a). The State of Tennessee also tracks annual incidence rates of injuries and illnesses for “utility system construction” but not for nuclear power generation. These records of statistics, combined with those discussed previously in Section 3.19.2.2.1, are used to estimate the likely number of occupational injuries and illnesses for the proposed new unit.

Occupational injury and fatality risks are reduced by strict adherence to NRC and OSHA safety standards, practices, and procedures to minimize worker exposures to injuries or illnesses (29 CFR Part 1910). Appropriate state and local statutes also must be considered when assessing the occupational hazards and health risks associated with the proposed Nuclear Technology Park. Compliance with site permits, adherence to worker safety and health procedures, and application of BMPs would be protective of workers during all phases of Nuclear Technology Park projects. TVA would implement Health and Safety Plans for the proposed site for building and operating SMRs. TVA would implement OSHA requirements throughout all phases of the proposed project. TVA would require all its employees, contractors, and subcontractors to review and comply with all safety policies and safe work practices, including all Federal and State regulations.

3.19.2.2.2.5 Transportation Related Effects

Nonradiological traffic related effects are primarily a function of workforce related commuting but are also influenced by trips associated with the delivery of materials to the CRN Site. As indicated in the PPE value (Table 2-4), operational phase activities would entail an average workforce of 500 workers on a daily basis. Normal delivery and services trips to the CRN Site are notably smaller than that expected during construction. Additionally, 1,000 temporary workers are estimated to be needed for refueling outages. Assuming an average of 1.3 workers per vehicle, the operational workforce would entail an estimated 385 vehicles that would enter and leave the CRN site on a daily basis. This would equate to an estimated increase of 770 trips that would be operations related on the regional roadway network. Assuming the average commuting distance of 50 miles for each worker the total annual operations fatalities related to building the facility represent an approximate 2 percent increase over the average 10 traffic fatalities per year that occurred in Roane County from 2012 to 2016. This percentage represents negligible increases relative to the current traffic fatality risks in the areas surrounding the proposed CRN Site. As such nonradiological impacts on traffic related safety would be minor.

3.19.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced Non-LWRs

Under Alternative C, Area 2 and associated offsite areas would be developed in a manner similar to those described for development of Area 1 under Alternative B as the proposed actions, activities, and project elements would be similar. However, based on the area of land disturbance and related construction effort, impacts to public safety and nonradiological health under Alternative C would be slightly less than, those described for Alternative B. Operational impacts would be the same as Alternative B. Based on the discussion of the potential impacts and mitigation strategies above, impacts to public safety and nonradiological health from construction and operation of a Nuclear Technology Park under Alternative C would be minor.

3.19.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced Non-LWRs

Under Alternative D the CRN Site and associated offsite areas would be developed in a manner similar to those described for Alternative B. Although Alternative D would entail the development of both Area 1 and Area 2 and would therefore entail additional effort for site preparation, equipment operation, and development. However, the proposed actions, activities, and project elements would be similar to those previously described for Alternative B. Therefore, impacts to public safety and nonradiological health under Alternative D are similar, but incrementally greater than those described for Alternative B. As such, impacts to public safety and nonradiological health under Alternative D would be minor.

3.19.2.5 Summary of Impacts to Nonradiological Public Health and Safety

As summarized in Table 3-66, TVA has determined that public safety and nonradiological health impacts associated with the implementation of Alternatives B, C, and D would be minor. This includes impacts relating to construction activities as well as impacts of operation, including workplace safety, etiological agents, electromagnetic fields, and occupational health.

Table 3-66. Summary of Impacts to Public Safety and Nonradiological Health

Alternative	Project Phase	Impact	Severity
Alternatives B, C, D	Construction	Potential impacts during construction would be associated with activities including clearing and grubbing, excavation, and transport of materials and workforce.	Use of BMPs, safety procedures, and security measures would minimize possible safety effects. Minor increase in rate of transportation-related accidents during construction. Impacts associated with these activities would be minor. Based on magnitude of land area and construction activities, severity of impact as follows: Alternative D is greater than Alternative B, which is greater than Alternative C.
	Operation	Workforce safety hazards.	Use of BMPs, safety procedures, and security measures would minimize possible safety effects. Impacts to workplace safety would be minor.

Alternative	Project Phase	Impact	Severity
		Disease-Causing Agents: Thermal discharges from the proposed cooling system into the Clinch River have the potential to increase the growth of thermophilic microorganisms.	Epidemiological reports from the State of Tennessee indicate a very low risk of outbreaks from etiological agents associated with recreational water. Impacts resulting from an increase of thermophilic microorganisms would be minor.
		Electromagnetic Fields: Operation of power transmission systems generates both electric and magnetic fields, which have the potential to impact public and worker health. Potential for acute effects (electric shock) from transmission lines and associated equipment.	Transmission lines operate at an extremely low frequency, energy dissipated within the ROW and the very low residual amount is reduced to background levels near the ROW edge. Design would conform to NESC guidelines to enhance worker/public safety. Tower designs preclude direct public access to the conductors. Overall, impact from electromagnetic fields would be minor.
		Occupational Health: Occupational injuries and illnesses could result during operation.	Occupational injury and fatality risks are reduced by strict adherence to NRC and OSHA safety standards, practices, and procedures. Impact to occupational health would be minor.
		Transportation Related Effects: Potential for minor increase in transportation-related accident rate.	Minor increase in rate of transportation-related accidents during construction. Strict adherence to BMPs and OSHA standards during construction activities would minimize possible safety effects. Transportation related impacts would be minor.

3.20 Radiological Effects of Normal Operation

3.20.1 Affected Environment

3.20.1.1 Exposure Pathways

Small quantities of radioactive gases and liquids are expected to be released to the environment during normal operation of the Nuclear Technology Park. The major pathways of concern are those that could result in any significant offsite radiological dose. The relative importance of a pathway depends on the type and amount of radioactivity released, its environmental transport mechanism, and usage of the land surrounding the CRN Site (e.g., residences, gardens). Factors such as the relative location of homes and the local production of milk cattle and vegetable gardens are taken into consideration when evaluating pathways of radiological exposure. In addition, the environmental transport mechanisms for gaseous effluents are dependent on the meteorological characteristics of the area, and for liquid effluents, are dependent on the characteristics of the affected water sources in the area.

Radiation doses to humans from the potential release of radionuclides during operation of the CRN Nuclear Technology Park have been evaluated for gaseous emissions released to the atmosphere and for liquid effluents released into the Reservoir. The critical pathways to humans for routine releases at the CRN Site are radiation exposure from submersion in air, inhalation of contaminated air, and ingestion (e.g., drinking milk from an animal that feeds on open pasture near the CRN Site, eating vegetables and meat raised near the CRN Site, eating fish caught in the Reservoir, and drinking water from downstream sources). Other less significant pathways considered include external irradiation from radionuclides deposited on the ground surface, activities on the shoreline of the Reservoir, and direct radiation from the Nuclear Technology Park. The relative importance of the potential pathways to humans has been evaluated by calculating the doses from routine operation for each pathway.

The release of small amounts of radioactive effluents is permitted as long as releases comply with the requirements in Title 10 of the CFR (10 CFR) Part 20 and 40 CFR Part 190. The design and operation of the Nuclear Technology Park at the CRN Site would also limit gaseous and liquid effluent releases such that doses to the public would be ALARA in accordance with the objectives of 10 CFR 50, Appendix I.

The exposure pathways considered and the calculation methods used to estimate doses to the maximally exposed individual (MEI) and to the population within 50 miles surrounding the CRN Site were based on 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 50, Appendix I, and on NRC RG 1.111, Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light Water-Cooled Reactors. The MEI is defined as a member of the general public at an assumed location that results in the maximum possible calculated dose. The source terms used in estimating exposure pathway doses were based on the total projected bounding site release activity levels, based on the PPE approach. There are no unusual animals, plants, agricultural practices, game harvests, or food processing operations within the surrounding region requiring special consideration.

Exposure pathways considered when evaluating dose to nonhuman biota include the following: ingestion of aquatic foods, ingestion of water, external exposure from water immersion or surface effect, inhalation of airborne radionuclides, external exposure to immersion in gaseous effluent plumes, and surface exposure from deposition of iodine and particulates from gaseous effluents.

3.20.1.2 Exclusion Area Boundary
As defined in 10 CFR Part 100, the Exclusion Area Boundary (EAB) identifies the area surrounding the reactor(s), in which TVA has the authority to determine all activities including exclusion or removal of personnel and property from the area. The boundary on which limits for the release of radioactive effluents are based is bounded by the property boundary and is identified in Figure 2-1. There are no residents living in this exclusion area and access within the property boundary is controlled. Areas outside the EAB are unrestricted areas in the context of 10 CFR Part 20 and open to the public.

3.20.1.3 Reasonably Foreseeable Future Actions in Proximity to the CRN Site
As noted in Section 3.1.3, TVA identified several foreseeable future actions in proximity to the CRN Site. The scope of these other proposed actions is expected to result in radiological effects that could contribute to regional impacts. Many of the proposed actions identified entail both construction and operational phase activities, but do not have radiological effects. However, those listed that have a potential to contribute to cumulative radiation exposures include the past operations at ORR, the existing and proposed ORR facilities (Y-12, ORNL, and disposal sites); the existing EnergySolutions Bear Creek Facility, and proposed operations at the CRN site, and the proposed Kairos Power Hermes Project. Furthermore, none of the identified reasonably foreseeable future actions are considered to have a causal relationship to the proposed development of the CRN Site. However, given the presence of other facilities in the vicinity of the CRN Site that may have radiological emissions and associated effects, further consideration of reasonably foreseeable future actions and their effects on radiological effects are included in the following section as appropriate.

3.20.2 Environmental Consequences
The information provided in the following sections is based on the analysis in the ESPA for SMRs located at Area 1 of the Nuclear Technology Park at the CRN Site. For the purposes of this Draft PEIS, this analysis is used as a surrogate for SMRs and advanced non-LWRs located at Area 1, to evaluate potential impacts.

3.20.2.1 Alternative A – No Action Alternative
Under this alternative, a Nuclear Technology Park at the CRN Site would not be constructed. As such, there would be no radiological effects.

3.20.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced Non-LWRs
Estimates of doses to the MEI and the general population during routine operation for Alternative B, and for both the liquid and gaseous effluent pathways, are described in the following paragraphs. Dose modeling to evaluate the dose from the direct radiation pathway, though not conducted for this Draft PEIS, would be conducted at a later date in conjunction with potential technology-specific construction applications to the NRC and subsequent NEPA analysis, as necessary. The direct radiation doses from the reactors are expected to be negligible based on operating data for existing large PWRs. NUREG-1437, Rev. 1 (NRC 2013), states that direct radiation from an LWR is due primarily to Nitrogen-16, a radionuclide produced in the reactor core, and because the primary coolant of an LWR is contained in a heavily shielded area, dose rates in the vicinity of LWRs are generally undetectable and less than 1 millirem (mrem)/year at the site boundary. However, it was

conservatively assumed in the ESPA that the total direct radiation dose from all units on the CRN Site would be 1 mrem/year at the site boundary.

3.20.2.2.1 Liquid Pathways

The LADTAP II computer program, as described in NUREG/CR-4013, LADTAP II – Technical Reference and User Guide, was used to calculate hypothetical doses to the MEI and to the general population surrounding the CRN Site from normal operation of the SMR(s) at the CRN Site. This program implements the radiological exposure models described in NRC RG 1.109 to estimate the dose resulting from modeled radioactive releases in liquid effluents. A conservative site-specific mean flowrate was used and the transit time from liquid discharge to receptor was conservatively assumed to be zero.

LADTAP II was used to evaluate both internal and external doses to the MEI and the general population from radionuclides in liquid effluents based on the following pathways:

- Internal exposure from ingestion of aquatic foods
- Internal exposure from ingestion of drinking water
- Internal exposure from ingestion of milk and meat from livestock consuming water and pasture feed from farms irrigated by contaminated water
- Internal exposure from ingestion of vegetables and fruits from farms irrigated by contaminated water
- External exposure to shoreline sediments
- External exposure from boating and swimming

Aquatic food consumption rates, water consumption rates, and aquatic recreation usage rates used for the average individual and the MEI are based on the values in NRC RG 1.109 Tables E-4 and E-5, respectively. Population consumption rates of aquatic food obtained from the Reservoir are for the projected 2067 population within 50 miles of the CRN Site. The resulting liquid effluent doses are shown in Table 3-67. Although contaminants were not detected in sediments near the CRN Site, the TDEC Division of Water Pollution Control has issued fish consumption advisories for Watts Bar Reservoir due to PCBs and for Melton Hill Reservoir due to PCBs and chlordane. These fish consumption advisories were issued because these contaminants were detected in sediments in other areas of these reservoirs.

Table 3-67. Liquid Effluent Doses from All Units to MEI (mrem/yr)

Pathway	Total Body	GI-LLI	Liver	Kidney	Lung	Skin	Thyroid	Bone
Fish	9.2E-02	4.5E-02	1.1E-01	3.2E-02	1.2E-02	0	3.2E-02	1.6E-01
Invertebrate	2.3E-02	2.3E-01	5.2E-02	7.7E-03	2.0E-03	0	7.7E-03	3.4E-02
Drinking	1.3E-02	1.7E-02	2.1E-02	1.8E-01	1.5E-02	0	1.8E-01	1.9E-02
Shoreline activities	1.1E-04	1.1E-04	1.3E-04	1.3E-04	1.3E-04	7.0E-04	1.3E-04	1.3E-04
Swimming	8.8E-06	8.8E-06	1.0E-05	1.0E-05	1.0E-05	0	1.0E-05	1.0E-05
Boating	4.4E-06	4.4E-06	5.1E-06	5.1E-06	5.1E-06	0	5.1E-06	5.1E-06

Pathway	Total Body	GI-LLI	Liver	Kidney	Lung	Skin	Thyroid	Bone
Irrigated Vegetables	2.2E-02	3.2E-02	6.8E-02	1.8E-01	2.2E-02	0	1.8E-01	2.1E-01
Irrigated Milk	1.4E-03	1.5E-02	5.1E-02	2.5E-01	1.4E-02	0	2.5E-03	1.1E-02
Irrigated Meat	3.5E-02	9.9E-02	4.2E-02	5.0E-03	1.7E-03	0	5.0E-01	1.4E-01
Total Dose	1.7E-01	4.4E-01	3.1E-01	6.6E-01	6.8E-02	7.0E-04	6.6E-01	5.4E-01
Age group[1]	Adult	Adult	Child	Child	Child	Teen	Child	Child

[1]The age group receiving the maximum dose for each organ shown.
Notes:
GI-LLI = Gastrointestinal – Lower Large Intestine
mrem/yr = millirems per year
MEI = maximum exposed individual

3.20.2.2.2 Gaseous Pathways

The GASPAR II computer program was used to calculate hypothetical doses from gaseous pathways to offsite receptors from normal operation of the SMR(s) at the CRN Site. This program, described in NUREG/CR-4653, GASPAR II – Technical Reference and User Guide, implements the radiological exposure models described in NRC RG 1.109 for radioactivity releases in gaseous effluents. Routine dilution and deposition estimates were calculated using the XOQDOQ modeling program, which is the dispersion model for evaluating routine releases recommended by the NRC in NUREG/CR-2919, XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations. Site-specific, validated meteorological data for June 2011 through May 2013 were used as input to the model. The site-specific dilution and deposition estimates were used by the GASPAR II computer program to calculate radiation doses.

By using projections of food production and consumption rates coupled with the projected population within a 50-mile radius of the CRN Site, GASPAR II evaluated both external and internal hypothetical exposures to gaseous effluents from the operation of the SMR(s) at the CRN Site based on the following pathways:

- External exposure to gases
- External exposure to ground contaminated by gases
- Inhalation of gases
- Ingestion of milk contaminated from the grass-to-cow-to-milk pathway
- Ingestion of contaminated vegetables and meats

Annual consumption rates for the average individual and the MEI were obtained from NRC RG 1.109 Tables E-4 and E-5, respectively. The projected total 2067 population within a 50-mile radius of the CRN Site as a function of direction and distance was used in the analysis. The resulting gaseous effluent doses are shown in Table 3-68.

Table 3-68. Gaseous Effluent Doses from All Units to MEI

Location	Pathway		Dose for All Units (mrem/yr)							
			Total Body	**GI-Tract**	**Bone**	**Liver**	**Kidney**	**Thyroid**	**Lung**	**Skin**
Site Boundary (0.21 miles WNW)	External	Plume	4.0E+01	4.0E+01	4.0E+01	4.0E+01	4.0E+01	4.0E+01	4.1E+01	8.4E+01
		Ground	2.9E+00	2.9E+00	2.9E+00	2.9E+00	2.9E+00	2.9E+00	2.9E+00	3.3E+00
		Total	4.3E+01	4.3E+01	4.3E+01	4.3E+01	4.3E+01	4.3E+01	4.3E+01	8.8E+01
	Inhalation	Adult	4.8E+00	5.0E+00	9.4E-01	5.0E+00	5.1E+00	4.1E+01	6.6E+00	0
		Teen	4.9E+00	5.0E+00	1.2E+00	5.2E+00	5.3E+00	5.2E+01	7.7E+00	0
		Child	4.3E+00	4.3E+00	1.4E+00	4.7E+00	4.7E+00	6.2E+01	6.7E+00	0
		Infant	2.5E+00	2.5E+00	7.3E-01	2.8E+00	2.8E+00	5.5E+01	4.2E+00	0
	All	Adult	4.8E+01	4.8E+01	4.4E+01	4.8E+01	4.8E+01	8.4E+01	5.0E+01	8.8E+01
		Teen	4.8E+01	4.8E+01	4.4E+01	4.8E+01	4.8E+01	9.5E+01	5.1E+01	8.8E+01
		Child	4.7E+01	4.7E+01	4.4E+01	4.8E+01	4.8E+01	1.0E+02	5.0E+01	8.8E+01
		Infant	4.5E+01	4.5E+01	4.4E+01	4.6E+01	4.6E+01	9.8E+01	4.8E+01	8.8E+01
Residence (0.66 miles WNW)	External	Plume	5.0E+00	5.0E+00	5.0E+00	5.0E+00	5.0E+00	5.0E+00	5.1E+00	1.1E+01
		Ground	4.3E-01	4.3E-01	4.3E-01	4.3E-01	4.3E-01	4.3E-01	4.3E-01	5.1E-01
		Total	5.4E+00	5.4E+00	5.4E+00	5.4E+00	5.4E+00	5.4E+00	5.4E+00	1.1E+01
	Inhalation	Adult	6.0E-01	6.2E-01	1.1E-01	6.3E-01	6.4E-01	5.1E+00	8.2E-01	0
		Teen	6.1E-01	6.3E-01	1.4E-01	6.5E-01	6.6E-01	6.4E+00	9.6E-01	0
		Child	5.4E-01	5.4E-01	1.7E-01	5.8E-01	5.9E-01	7.6E+00	8.2E-01	0
		Infant	3.1E-01	3.1E-01	8.9E-02	3.5E-01	3.4E-01	6.8E+00	5.2E-01	0
Vegetable Garden (1.15 miles WNW)	Veg	Adult	1.1E+00	1.1E+00	3.7E+00	1.1E+00	1.0E+00	4.0E+00	1.0E+00	0
		Teen	1.5E+00	1.5E+00	5.8E+00	1.6E+00	1.5E+00	5.2E+00	1.4E+00	0
		Child	3.1E+00	3.0E+00	1.4E+01	3.2E+00	3.1E+00	1.0E+01	3.0E+00	0
Meat Animal (0.70 miles WNW)	Meat	Adult	7.0E-01	7.5E-01	2.7E+00	7.0E-01	6.9E-01	9.0E-01	6.8E-01	0
		Teen	5.5E-01	5.8E-01	2.3E+00	5.6E-01	5.5E-01	7.0E-01	5.4E-01	0
		Child	9.6E+00	9.8E+00	4.3E+00	9.8E+00	9.6E+00	1.2E+00	9.6E-01	0

Location	Pathway		Dose for All Units (mrem/yr) Total Body	GI-Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
MEI	All	Adult	7.8E+00	7.9E+00	1.2E+01	7.9E+00	7.8E+00	1.5E+01	8.0E+00	1.1E+01
		Teen	8.1E+00	8.1E+00	1.4E+01	8.2E+00	8.1E+00	1.8E+01	8.4E+00	1.1E+01
		Child	1.0E+01	1.0E+01	2.3E+01	1.0E+01	1.0E+01	2.4E+01	1.0E+01	1.1E+01
		Infant	5.8E+00	5.8E+00	5.5E+00	5.8E+00	5.8E+00	1.2E+01	6.0E+00	1.1E+01
		Max	1.0E+01	1.0E+01	2.3E+01	1.0E+01	1.0E+01	2.4E+01	1.0E+01	1.1E+01
		Group	Child	Child	Child	Child	Child	Child	Child	All

Note: In the first four rows for the MEI, MEI doses are obtained by conservatively summing the residence total external dose with the residence inhalation, vegetable, and meat maximum doses even though they are not all at the same location.

3.20.2.2.3 Impacts to Members of the Public

This subsection summarizes the impacts to individuals from radioactive effluents released during normal operation of the Nuclear Technology Park at Area 1. Impacts to the public are evaluated by comparing estimated dose to regulatory acceptance criteria. Doses to the MEI and collective doses to the public were evaluated.

Doses to the MEI from liquid effluent from all units are shown in Table 3-67 (all units), and doses from gaseous effluent are shown in Table 3-68 (all units).

Table 3-69 summarizes the estimated doses to the MEI per operating unit and compares them to the ALARA design objectives from 10 CFR Part 50, Appendix I to determine compliance with dose rates protective of the general public. All of the doses are less than or equal to the corresponding regulatory dose limits in 10 CFR Part 50, Appendix I; thus, the criteria are met.

Table 3-69. Compliance of MEI Annual Doses Per Unit with 10 CFR 50, Appendix I Criteria

Type of Dose	Location	Annual Dose	Limit[5]
Liquid Effluent[1]			
Total Body (mrem)	Reservoir	2.0E-02	3
Maximum Organ – GI-LLI (mrem)	Reservoir	9.7E-02	10
Gaseous Effluent			
Gamma Air[2] (mrad)	Site Boundary	9.5E+00	10
Beta Air[2] (mrad)	Site Boundary	1.2E+01	20
Total Body[3] (mrem)	Residence	9.0E-01	5
Skin[3] (mrem)	Residence	1.9E+00	15
Iodines and Particulates[4]			
Maximum Organ – Thyroid (mrem)	Residence/Garden/Meat	4.5E+00	15

[1]Annual liquid effluent doses for the MEI determined by LADTAP II; the MEI is the adult receptor.
[2]Annual gaseous effluent doses for the MEI determined by GASPAR II; dose for a receptor at the site boundary, near ground level.
[3]Annual gaseous effluent external doses for the MEI determined by GASPAR II.
[4]Annual gaseous effluent total thyroid doses from iodines and radioactive material in particulate form for the MEI determined by GASPAR II.
[5]Dose limits in 10 CFR 50, Appendix I.

Notes:
mrem = millirem
mrad = millirad
MEI = maximum exposed individual

Annual doses to the MEI from the Nuclear Technology Park are summarized in Table 3-70. The sum of the direct radiation dose, liquid effluent dose, and gaseous effluent dose yields an annual total body dose of 11.0 mrem/year. (As discussed previously, the direct radiation dose would be negligible but is assumed to be 1 mrem/year.) Similarly, the sum of direct, liquid, and gaseous contributions for the thyroid and the bone pathways yields a total dose of 25 mrem/year and 24 mrem/year respectively. The EPA radiation protection standards in 40 CFR Part 190 provide criteria that apply to the annual dose equivalent received by members of the general public exposed to planned discharges of radioactive materials from the operation of nuclear power plants. The most restrictive portion of the standards specified in this regulation states that the annual dose equivalent shall not exceed 25 mrem/year to the whole body. The regulation also provides standards limiting the annual dose equivalent to the thyroid (75 mrem/year) and any other organ (25 mrem/year). As shown in Table 3-70, the total body annual dose, estimated to be 11.0 mrem/year, is below the limit of 25 mrem/year. Similarly, total doses to the thyroid and bone also are below their respective limits. This annual dose was compared to EPA's environmental radiation protection standards for individual members of the public from 40 CFR 190.10 to determine compliance. The doses are less than the corresponding regulatory dose limits; thus, the criteria are met. As indicated in NUREG-1555, demonstration of compliance with the limits of 40 CFR 190 is considered to also indicate compliance with the 100 mrem limit in 10 CFR 20.1301.

Table 3-70. Compliance of MEI Doses from All Units with 40 CFR 190.10 Criteria (mrem/yr)

Pathway	Liquid[1]	Gaseous[2]	Direct[3]	Total[4]	Limit[5]
Total Body	1.7E-01	1.0E+01	1.0E+00	1.1E+01	25
Thyroid	6.6E-01	2.4E+01	0.0E+00	2.5E+01	75
Other Organ - Bone	5.4E-01	2.3E+01	0.0E+00	2.4E+01	25

[1]Annual liquid effluent doses for the MEI determined by LADTAP II; the MEI is the adult receptor for total body dose and the child for thyroid and bone dose.
[2]Annual gaseous effluent doses for the MEI determined by GASPAR II; the MEI is the child receptor.
[3]Annual direct dose is assumed to be 1 mrem per year.
[4]Site totals are summed across receptors and locations to provide a conservative site total.
[5]Dose limits in 40 CFR 190.10.

Notes:
mrem/yr = millirems per year
MEI = maximum exposed individual

Collective doses to the population from liquid and gaseous effluents are shown in Table 3-71 and Table 3-72, respectively. Annual collective doses to the public based on the population within 50 miles of the CRN Site also were estimated based on the operation of all SMR units. Table 3-73 shows the total body and thyroid doses from all liquid and gaseous pathways expressed in units of person-rems per year. For comparison, Table 3-73 also includes the annual collective background radiation dose calculated from the estimated population within 50 miles of the CRN Site in 2067 and the average natural background dose in the U.S. of approximately 311 mrem/year. The total of the doses to the population for the total body (68 person-rem/year) and thyroid (100 person-rem/year) are negligible compared to the background dose of over 820,000 person-rem/year.

Table 3-71. Liquid Effluent Doses Per Unit to Population Within 50 Miles[1] (person-rem/yr)

Pathway	Total Body	Thyroid
Sport fish	7.1E-01	1.7E-01
Commercial fish	7.8E-01	1.5E-01
Sport invertebrate	1.3E-01	6.3E-02
Commercial invertebrate	3.9E-01	1.7E-01
Drinking water	3.8E-01	1.2E+00
Shoreline activities	3.4E-02	3.4E-02
Swimming	4.1E-03	4.1E-03
Boating	2.0E-03	2.0E-03
Irrigated milk	2.2E-04	9.3E-04
Irrigated meat	1.7E-04	2.1E-04
Irrigated non-leafy vegetables	5.3E-04	4.0E-04
Irrigated leafy vegetables	6.7E-05	3.2E-04
Total Dose	2.4E+00	1.8E+00

[1]Annual liquid effluent dose for the 50-mile population determined by LADTAP II.

Notes: person-rem/yr = person-rems per year

Table 3-72. Gaseous Effluent Dose per Unit to Population Within 50 Miles[1] (person-rem/yr)

Pathway	Total Body	Thyroid
Plume	8.0E-01	8.0E-01
Ground	5.7E-01	5.7E-01
Inhalation	1.4E+00	8.1E+00
Vegetable	7.7E+00	7.6E+00
Cow milk	1.8E+00	4.7E+00
Meat	2.6E+00	2.8E+00
Total Dose	1.5E+01	2.5E+01

[1]Annual gaseous effluent dose for the 50-mile population determined by GASPAR II.

Notes: person-rem/yr = person-rems per year

Table 3-73. Doses from All Units to Population Within 50 Miles (person-rem/yr)[1]

Pathway	Total Body	Thyroid
Liquid	9.6E+00	7.2E+00
Gaseous		
Noble gases	3.2E+00	3.2E+00
Iodines	8.0E-02	4.0E+01
Particulates	2.9E+00	2.3E+00

Pathway	Total Body	Thyroid
C-14	4.0E+01	4.0E+01
H-3	1.3E+01	1.3E+01
Gaseous Total	6.0E+01	1.0E+02
Pathways Total	6.8E+01	1.0E+02
Background Radiation[2]	8.3E+05	

[1]Doses per unit multiplied by 4 to approximate doses from all units

[2]The background dose is obtained by multiplying the average natural background dose rate in the U.S. of 311 mrem/yr (0.311 rem/yr) by the 2067 population of 2.66E6 persons.

Because the doses to members of the public from operation of the Nuclear Technology Park at the CRN Site based on the example analyses are calculated to be within the regulatory limits for protection of the MEI and the contribution to the collective population dose is estimated to be negligible compared to background, the radiological impacts to members of the public from normal operation of the Nuclear Technology Park at the CRN Site would be minor.

3.20.2.2.4 Impacts to Biota Other than Members of the Public

This subsection examines potential radiation exposure pathways to biota other than members of the public to determine if these pathways could result in doses to biota greater than the doses predicted for humans. This assessment uses surrogate biota species that provide representative information on the various dose pathways potentially affecting broader classes of living organisms, including the important terrestrial and aquatic species identified for the CRN Site. Surrogates are used because important attributes are well defined and are accepted as a method for judging doses to biota. As described in NUREG/CR-4013 the use of surrogate biota in this analysis includes the use of algae as a surrogate for aquatic plants and the use of invertebrates as a surrogate for freshwater mollusks and crayfish. Other surrogates used in this analysis include fish, muskrat, raccoon, heron, and duck. There are no unusual plants, animals, or pathways in the vicinity of the CRN Site that would require specific evaluation.

Doses to surrogate biota from liquid effluents were calculated using the LADTAP II program and the parameters included in the computer program. As described in NUREG-CR/4013, pathways evaluated for aquatic biota include internal exposure from bioaccumulation and external exposure from swimming and the shoreline. Exposure pathways for terrestrial biota include ingestion of aquatic biota and external exposure from swimming and the shoreline.

Because the GASPAR II program does not perform biota dose calculations, the human doses calculated for the gaseous pathway were assumed to be applicable to biota. Because biota are closer to the ground than are humans, the ground deposition doses calculated by the GASPAR II computer program were doubled. This is consistent with the approach used for biota in LADTAP II. It was also assumed that the internal dose and the external plume dose received by the biota are the same as the doses received by humans. This is reasonable because the plume dose is independent of the size of the receptor, and it is conservative because the internal dose for humans is based on a much longer retention period than would be expected for biota.

The total doses to surrogate biota from liquid and gaseous effluents released from normal operation of the Nuclear Technology Park at the CRN Site are shown in Table 3-74. The total dose to each of the biota was calculated by summing the annual doses from gaseous and liquid pathways in millirad (mrad) per year (mrad/year). The total doses also were converted to units of mrad/day for comparison to criteria for the protection of biota.

Use of exposure guidelines, such as 40 CFR Part 190, which regulate radionuclide exposure from commercial nuclear facilities to members of the public in unrestricted areas, is considered very conservative when evaluating calculated doses to biota. As noted in NUREG-1555, Subsection 5.4.4, the International Council on Radiation Protection uses human protection to infer environmental protection from the effects of ionizing radiation. In addition, no biota have been discovered that show significant changes in morbidity or mortality due to radiation exposures from nuclear power plants.

The International Atomic Energy Agency (IAEA) and National Council on Radiation Protection and Measurements (NCRP) reported that a chronic absorbed dose rate of no greater than 1,000 mrad/day would ensure protection of aquatic organism populations. IAEA also concluded that a chronic absorbed dose rate of 100 mrad/day or less does not appear to cause observable changes in terrestrial animal populations. As shown in Table 3-74, total doses to the surrogate aquatic animals are 0.0045 mrad/day for fish and 0.021 mrad/day for invertebrates. For surrogate terrestrial biota, total body doses range from 0.23 mrad/day for the raccoon to 0.25 mrad/day for the heron. The highest of these doses (0.021 mrad/day for aquatic biota and 0.25 mrad/day for terrestrial biota) are significantly less than their respective dose rate criteria based on the NCRP and IAEA guidance (i.e., 1 rad/day and 0.1 rad/day for aquatic and terrestrial biota, respectively).

Because the doses to surrogate biota presented in Table 3-74 are significantly below the IAEA/NCRP biota dose guidelines, the impact to biota other than members of the public due to operation of the Nuclear Technology Park at the CRN Site is minor.

Table 3-74. Nonhuman Biota Dose Rates from All SMR Units at the CRN Site

Biota	Gaseous[1] (mrad/yr)	Liquid[2] (mrad/yr)	Total[3] (mrad/yr)	Total[4] (mrad/day)
Algae	0	2.5E+00	2.5E+00	6.7E-03
Invertebrate	0	7.6E+00	7.6E+00	2.1E-02
Fish	0	1.6E+00	1.6+00	4.5E-03
Muskrat	8.4E+01	3.4E+00	8.7E+01	2.4E-01
Raccoon	8.4E+01	1.3E+00	8.5E+01	2.3E-01
Heron	8.4E+01	8.9E+00	9.3E+01	2.5E-01
Duck	8.4E+01	3.2E+00	8.7E+01	2.4E-01

[1]Total body dose determined from GASPAR II for human receptors located 0.25 mi from the reactor release point was used to model biota dose.
[2]Biota dose from liquid effluent as modeled from LADTAP II.
[3]Annual total body dose for biota from gaseous and liquid effluent.
[4]Daily total body dose for biota from gaseous and liquid effluent as determined by dividing the annual dose by 365 days per year.
Notes: mrad/yr = millirads per year; mrad/day = millirads per day

3.20.2.2.5 Occupational Doses

The projected radiation dose to a construction worker from licensed operation would be less than 100 mrem annually as specified in 10 CFR 20.1301. The annual occupational dose to operational workers, including outage activities, is dependent on the specific plant design chosen, and is determined in accordance with applicable criteria in 10 CFR 20 and 10 CFR 50 Appendix I. Individual doses to operational workers would be maintained within 5 rem annually as specified in 10 CFR 20.1201 and incorporate ALARA provisions to maintain doses below this limit. Therefore, the impacts from radiation exposure to the operation workforce would be minor based on individual doses for workers being maintained within regulatory limits.

3.20.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced Non-LWRs

Under Alternative C, the cumulative electrical output is the same as that under Alternative B and the radiological effects for Area 2 are considered to be similar to Area 1, based on the close proximity of the locations. Therefore, the environmental consequences from the radiological effects of normal operation would also be minor for Alternative C.

3.20.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced Non-LWRs

Under Alternative D, the cumulative electrical output is the same as that under Alternative B and the radiological effects are considered to be similar to Area 1, based on the close proximity of Area 1 and Area 2. Therefore, the environmental consequences from the radiological effects of normal operation would also be minor for Alternative D.

3.20.2.5 Potential Contributing Effects of Other Reasonably Foreseeable Future Actions

As described in Section 3.20.1.3, several existing and reasonably foreseeable future actions were identified in proximity to the CRN Site that may have radiological emissions. These include existing operations at ORNL, the Y-12 complex, the existing EnergySolutions Bear Creek Facility, and the proposed Kairos Hermes Project.

In the 2020 ORR Annual Site Environmental Report, (DOE 2021) detailed analysis of the effective dose received by the MEI from air pathways was determined to be 0.4 mrem/yr. The effective dose to the MEI from water, including drinking, bathing, irrigating, recreating, and fish consumption, was determined to be 2 mrem/yr. The effective dose from consumption of wildlife harvested on the ORR, including turkeys, geese, and deer, was determined to be 0.07 mrem/yr. Combined, the annual dose to the hypothetical MEI from normal operations at ORR is 3 mrem/yr. This is approximately 1 percent of the average background radiation dose in the United States (DOE 2021). According to Kairos Power the proposed Hermes Project would result in an estimated total body dose to the hypothetical MEI from gaseous effluents and direct radiation during operation would be 1.2 mrem/yr. (Kairos Power 2021).

There are several non-DOE facilities on or near the ORR that could also contribute to radiation doses to the public. In 2017, DOE requested information from these facilities regarding their potential radiation doses to members of the public, and fifteen facilities responded with information about their dose contributions. Ten facilities had no radiological emissions. Three facilities reported annual doses from airborne releases with annual doses of 0.4 mrem, 0.21 mrem, and less than 10 mrem. Doses from direct radiation ranged from none to 2 mrem based measurements at the facility and immediate surrounding (DOE 2018).

The sum of the direct radiation dose, liquid effluent dose, and gaseous effluent dose yields an annual total body dose of 11 mrem/yr for the MEI due to operations of the Nuclear Technology Park at the CRN Site. (See Section 3.20.2.2.3, Impacts to Members of the Public, for further details.) Even if it is conservatively assumed that an individual could be exposed to a total dose based on adding the ORR's total dose estimate of 3 mrem/yr, 1.2 mrem/yr from the Kairos Power Hermes Project, and the other non-DOE sources evaluated by the DOE, the cumulative dose impact would be less than the NRC dose limit for members of the public of 100 mrem/yr. Accordingly, cumulative radiological impacts to members of the public during operation would be minor and the incremental contribution to cumulative impacts from the Nuclear Technology Park at the CRN Site would also be minor.

3.20.2.6 Summary of Impacts from Radiological Effects of Normal Operation

As summarized in Table 3-75, the impacts of radiological effects from normal operation at the CRN Site are minor. Doses to members of the public and to operation workforces would be maintained within regulatory limits as part of normal operation and, therefore, the environmental impacts are considered to be minor. Additionally, doses to biota would be well below the IAEA/NCRP biota dose guidelines. Therefore, the environmental impact to biota other than members of the public due to the radiological effects of normal operation at the CRN Site is minor.

Table 3-75. Summary of Impacts from the Radiological Effects of Normal Operation

Alternative	Project Phase	Impact	Severity
Alternatives B, C, D	Operation	Direct dose from normal operation.	Minor impacts. Direct doses from nuclear plants are negligible (less than 1 mrem/year at the site boundary). Cumulative effects from other nearby facilities are minor.
		Release of liquid radiological effluents.	Minor impacts. Doses to the maximally exposed individual (i.e., member of the public) from liquid and gaseous effluents would meet the regulatory limits in 10 CFR 20, 40 CFR 190, and 10 CFR 50, Appendix I. Dose to occupation workers would also meet the applicable regulatory limits. The total of the doses to the population near the CRN Site are negligible compared to the background dose. Doses to aquatic and terrestrial biota are well below the IAEA/NCRP biota dose guidelines. In addition, no biota have been discovered that show significant changes in morbidity or mortality due to radiation exposures predicted for nuclear power plants.

Alternative	Project Phase	Impact	Severity
		Release of gaseous radiological effluents.	Minor impacts. Doses to the maximally exposed individual (i.e., member of the public) from liquid and gaseous effluents would meet the regulatory limits in 10 CFR 20, 40 CFR 190, and 10 CFR 50, Appendix I. Dose to occupation workers would also meet the applicable regulatory limits. The total of the doses to the population near the CRN Site are negligible compared to the background dose. Doses to aquatic and terrestrial biota are well below the IAEA/NCRP biota dose guidelines. In addition, no biota have been discovered that show significant changes in morbidity or mortality due to radiation exposures predicted for nuclear power plants.

3.21 Uranium Fuel Use Effects

The environmental effects from the uranium fuel cycle (UFC) to support operation of SMRs at the CRN Site using Table S-3, "Table of Uranium Fuel Cycle Environmental Data," in 10 CFR 51.51, are described and assessed in this subsection. The UFC is defined as the total of those options and processes associated with the provision, utilization, and ultimate disposition of fuel for nuclear power reactors.

3.21.1 Affected Environment

3.21.1.1 Uranium Fuel Cycle

The fuel cycles for SMRs and advanced non-LWRs are assumed to be similar to the UFC cycle referenced in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," Rev. 0 (NRC 1996) and Rev. 1 (NRC 2013), for the purposes of impact evaluations.

The evaluation in this section addresses the following stages of the UFC:

- Uranium mining and milling
- Conversion to uranium hexafluoride
- Enrichment of uranium-235
- Fabrication of reactor fuel
- Reprocessing of irradiated fuel

Natural uranium is extracted from the earth through either open-pit or underground mining or by an in-situ leaching (ISL) process. Recent UFC trends include increasing use of ISL, which does not produce mine tailings and lowers the release of radon gas. ISL involves injecting an acidic solution into the groundwater aquifer to partition uranium from a solid to aqueous phase and then pumping the uranium-rich solution to the surface for further processing. The ore or leaching solution is processed to produce uranium oxide (U_3O_8). The uranium oxide is then converted to uranium hexafluoride (UF_6) in preparation for the enrichment process.

The UF_6 is transported to a separate facility for uranium enrichment. Uranium enrichment involves increasing the percentage of the more fissile isotope U-235 and decreasing the percentage of the isotope U-238. Current enrichment technologies use only a small fraction of the electrical energy per separation unit compared to gaseous diffusion, which was assumed to be the means of enrichment as the basis for Table S-3 of 10 CFR 51.51.

At a fuel-fabrication facility, the enriched uranium is converted from UF_6, typically to UO_2. The UO_2 is formed into pellets, inserted into hollow rods, and loaded into fuel assemblies. The fuel assemblies are placed in the reactor to produce power. For advanced non-LWRs, the fuels being considered include homogenous fuel salts (e.g., U-Cl) and HALEU TRISO coated pebble fuel.

Existing LWRs use nuclear fuel more efficiently due to higher fuel burnup. Less uranium fuel per year of reactor operation is required to generate the same amount of electricity as compared to basis for Table S-3 of 10 CFR 51.51.

After a significant amount of the U235 contained within a fuel assembly has decayed, the nuclear fission process becomes inefficient, and spent fuel assemblies are then replaced. For existing LWRs, spent fuel assemblies are placed in an onsite, interim, wet storage to allow for short-lived fission product decay and to reduce the heat generation rate. Afterward, the fuel assemblies are transferred to dry storage casks and stored onsite at an Independent Spent Fuel Storage Installation (ISFSI) while awaiting transportation to a spent fuel storage facility or a waste repository.

The Nuclear Non-proliferation Act of 1978 banned any reprocessing or recycling of spent fuel from U.S. commercial nuclear power. The ban on reprocessing spent fuel was lifted in 1981, but the combination of economics, uranium ore stockpiles, and nuclear industry stagnation provided little incentive for the industry to pursue reprocessing. The Energy Policy Act of 2005 authorized the DOE to research and develop proliferation-resistant fuel recycling and transmutation technologies that minimize environmental or public health and safety effects. Therefore, federal policy does not prohibit reprocessing, but there are currently no mature projects pursuing commercial reprocessing or recycling of spent fuel in the U.S.

Table S-3 of 10 CFR 51.51 provides estimates of the environmental effects of the UFC. The effects are calculated for a reference 1000 MWe LWR operating at an annual capacity factor of 80 percent for an effective electric output of 800 MWe. This LWR design is referred to as the reference plant throughout this section. Data are calculated and presented in tables for land use, water consumption, thermal effluents, radioactive releases, waste burial, and radiation doses. In accordance with 10 CFR 51.51, the data in Table S-3 is required to be used as the basis for evaluation of an SMR proposed project. For the purposes of this Draft PEIS, it is assumed that the analysis for SMRs is also bounding for advanced non-LWRs.

In developing the reference plant data, the NRC staff considered two UFC options. The “no recycle” and “uranium-only recycle” options differ only in the resting place of spent fuel. The “no recycle” option assumes that all spent fuel would be stored at a federal waste repository. The “uranium-only recycle” option assumes that spent fuel would be reprocessed to recover unused uranium, which would be returned to the UFC. The reference plant values provided for reprocessing, waste management, and transportation are from the UFC option resulting in the larger environmental effect.

The reference plant values provided in Table S-3 were derived from industry averages for each type of facility or operation associated with the UFC. Recognizing that this approach results in a range of values for each estimate, the NRC staff defined the assumptions or factors to be applied so the calculated values are not underestimated. This conservative bounding approach was intended to ensure that the actual environmental effects are less than the quantities shown for the reference plant and envelop the widest range of operating conditions for SMRs.

The NRC regulation recommends evaluating UFC parameters, nuclear plant characteristics, and impacts to the environment based on a reference plant. To determine the annual fuel requirement, the NRC staff defined the “reference plant” as a 1,000 MWe LWR. The characteristics of the reference plant include an 80 percent capacity factor, a 12-month fuel reloading cycle, and an average fuel burnup rate of 33,000 megawatt-days (MWd) per metric ton (MT) of uranium (MTU). Table S-3 of 10 CFR 51.51 does not address the length of time that the reference plant would operate. However, the Atomic Energy Act authorizes the NRC to issue licenses for commercial power reactors to operate for up to 40 years and permits the renewal of operating licenses for up to an additional 20 years at a time dependent upon assessments of whether the plant can continue to operate safely and protect the environment during its initial licensing period and any period of extended operation. The length of time that a plant would be licensed, and any period of extended operation, would also depend on the specific technology and the type of license. Due to the variability of technologies discussed in this PEIS, the assumed 60-year lifetime of the reference plant (i.e., a 40-year initial licensing term plus one 20-year license renewal term), is considered to be bounding of these reactor technologies. There are no specific limitations in the Atomic Energy Act or the NRC’s regulations restricting the number of times a license may be renewed. The sum of the initial fuel loading and all of the expected reloads for the lifetime of the reference plant is divided by the assumed 60-year lifetime to obtain an average annual fuel requirement. This quantity of fuel was determined for both BWRs and PWRs; the higher annual requirement, a BWR using 35 MTU, was chosen in Section 6.2.3, paragraph 3, of NUREG-1437, “Generic Environmental Impact Statement for License Renewal of Nuclear Plants,” Rev. 0 (NRC 1996), as the basis for the reference plant.

In NUREG-1437, Rev. 0, the NRC staff provided a detailed analysis of the environmental effects of the UFC. NUREG-1437, Rev. 1 (NRC 2013), provides a less detailed analysis and often references NUREG-1437, Rev. 0 for additional details. Although NUREG-1437, Rev. 0 and Rev. 1, are specific to license renewal, the information is potentially relevant because the SMRs described by the PPE use the same fuel cycle process and the same type of fuel as the reference plant. Section 6.2 of NUREG-1437, Rev. 0 discusses the sensitivity to changes in the UFC on the environmental effects in detail.

In the past, uranium market conditions led to the closing of most domestic uranium mines and mills, and substantially reduced the environmental effects in the U.S. from these activities. Thus, the majority of uranium purchased by U.S. reactors has historically been imported. The environmental effects of mining and milling effects are still bounded by the reference numbers in NUREG-1437, Rev. 0 and Rev. 1. Therefore, for the purposes of this analysis, the reference plant estimates have not been reduced.

The maximum net power output of the proposed Nuclear Technology Park would be no more than 800 MWe. A capacity factor of 98 percent is assumed, resulting in an effective net power output 784 MWe. The ratio of the effective net power output value for the Nuclear Technology Park as described by the PPE (784 MWe) to the net electrical output for the 1,000 MWe reference plant (800 MWe) provides a scaling factor of 0.98 to convert reference plant values to park-specific values at the CRN Site. The environmental effects of the UFC from operating SMRs or advanced non-LWRs at the CRN Site were evaluated to assess qualitative effects to the environment as discussed in Section 0.

3.21.1.2 Radioactive Waste

Radioisotopes are produced during the normal operation of nuclear reactors through the processes of fission and activation. Radioisotopes can leave the reactor coolant via plant systems designed to remove impurities, via small leaks that occur in the reactor coolant system and auxiliary systems, or via breaching of systems for maintenance. Therefore, each plant generates radioactive waste that can be liquid, solid, or gaseous. This section describes the liquid, gaseous, and solid radioactive waste management systems proposed to be used as part of the operation of one or more SMRs and/or advanced non-LWRs at the CRN Site. For the purpose of this PEIS, the bounding values have been developed for the quantities of radioactive wastes that are projected to be generated and processed and then stored or released as liquid or gaseous effluents or as solid waste equivalent to 800 MWe of power generation. The radioactive waste management system is designed to minimize releases from reactor operations to ALARA values. These systems are designed and maintained to meet the requirements of 10 CFR Part 20 and 10 CFR Part 50, Appendix I. For the purposes of this Draft PEIS, it is assumed that the analysis for SMRs is also representative or bounding for advanced non-LWRs. Any site-specific impacts that are analyzed in the future that are expected to fall outside of the bounding analysis in this PEIS will be analyzed in subsequent NEPA analysis.

3.21.1.2.1 Liquid Radioactive Waste

The liquid radioactive waste systems would be designed to control, collect, process, handle, store, and dispose of liquid radioactive waste generated as the result of normal operation, including anticipated operational occurrences. Sources of liquid radioactive waste include leakage from systems, wastes generated by processing systems, and maintenance activities. During the design phase of the selected technologies that might be constructed in the Nuclear Technology Park, these sources and potential sources would be identified and collection and processing systems would be designed to remove the radioactivity to the extent that the processed liquid can be recycled or discharged in accordance with the requirements of 10 CFR 20 and the ALARA principles of 10 CFR 50, Appendix I. Discharges would be to the Reservoir and would be controlled and monitored to measure the activity released. Liquid waste processing systems would be designed to maintain the radiation exposures of plant personnel ALARA. The total projected bounding annual release activity in liquid effluents from the CRN Site is 887 Ci/yr.

3.21.1.2.2 Gaseous Radioactive Waste

Typical gaseous radioactive wastes include vents from collection tanks and processing equipment and noncondensables in steam systems. The radioactive isotopes contained in these waste streams can include fission product iodines and the noble gas fission products, xenon and krypton, as well as activation products such as argon-41 and cobalt-60. These wastes would be collected and processed to decrease the radioactivity content to the point that they can be released to the environment through a controlled and monitored release point (plant vent or plant stack). The typical processing technique is one of holdup or delay to allow the short-lived activity to decay. Adsorption on activated charcoal or compression and storage are two methods used to create the necessary holdup time. Processing systems would be designed to process gaseous wastes generated by normal plant operation and anticipated operational occurrences.

Minor leakage of radioactive gases from plant systems to building atmosphere would be detected by area radiation monitors. Ventilation systems would process these gases by filtration, if needed, and direct them to a controlled and monitored release point.

Gaseous radioactive waste discharges would be controlled to the requirements of 10 CFR 20 and the ALARA principles of 10 CFR Part 50, Appendix I. Gaseous radioactive waste system equipment would be designed to ensure occupational exposures to plant personnel are ALARA. The total projected bounding release activity in gaseous waste from the CRN Site is 7,130 Ci/yr.

3.21.1.2.3 Solid Radioactive Waste

Solid radioactive wastes are produced by multiple activities in a nuclear power station. The solid waste can be either wet or dry, depending on whether the source is a processing activity, maintenance, or other function such as housekeeping. A solid radioactive waste management system is designed to collect, monitor, segregate, process, and prepare solid radioactive wastes prior to and for their shipment or onsite storage. The systems design for reactors to be placed in the Nuclear Technology Park would ensure that the wastes are handled, processed, and stored in a manner that minimizes exposure to plant personnel and the public in accordance with 10 CFR 20 and 10 CFR 50, Appendix I. Wastes would be packaged to meet DOT (49 CFR 173 and 178) and NRC (10 CFR 71) regulations for transportation of radioactive material. Radioactive waste would be transported to either a licensed waste processing facility or a licensed low-level radioactive waste disposal facility. The projected bounding total annual activity of solid radioactive waste from the CRN Site is 57,200 Ci/yr. The projected bounding generated volume of solid radioactive waste from the CRN Site is 5,000 ft^3/yr.

3.21.1.3 Spent Fuel Storage

Many of the reactor designs considered for the CRN Site would likely require onsite spent fuel storage, in a spent fuel pool and/or ISFSI for dry cask storage, depending on the technology selected. The SMR designs being considered require spent fuel to be stored in the spent fuel pool for at least 5 years before being stored in interim dry cask storage. For SMR designs, the spent fuel pool is planned to be sized to hold approximately 20 years of spent fuel. The expected lifetime of the SMRs are to be at least 60 years. For the purposes of this Draft PEIS, it is assumed that the spent fuel storage requirements for SMRs are also representative or bounding for advanced non-LWRs. Therefore, it is planned that an ISFSI would be required for the CRN Site, scaled appropriate to the selected technology, and be of a similar design to a facility for a traditional nuclear plant site.

3.21.1.4 Transportation of Radioactive Materials

As detailed in the following subsections, the SMR designs considered in the ESPA do not meet all of the conditions for the reactor and fuel provided in 10 CFR 51.52(a). For example, for SMRs, the fuel enrichment can be greater than four percent by weight and fuel burnup can be greater than 33,000 MWd per MT. Therefore, additional analyses of fuel transportation effects were required for the ESPA to account for normal conditions and for accidents. Advanced non-LWRs would require detailed future analyses as they do not meet the conditions for use of 10 CFR 51.52, Table S4. For the purposes of this Draft PEIS, it is assumed that the analysis for SMRs is also representative or bounding for advanced non-LWRs.

Nonradiological effects from the transportation of fuel (new and spent) and other radiological wastes are traffic density (i.e., due to the increased number of vehicles resulting from fuel or waste shipments), weight of the loaded truck or railcar, heat from the fuel cask, and transportation accidents. The NRC evaluated the environmental effects of transportation of fuel and waste for existing LWRs and found the impacts to be minor. The NRC analyses provided the basis for Table S-4 in 10 CFR 51.52, which summarizes the environmental effects of transportation of fuel and radioactive wastes to and from a reference plant. Table S-4 addresses two categories of environmental consideration: (1) normal conditions of transport, and (2) accidents during transport.

Paragraphs 10 CFR 51.52(a)(1) through (5) delineate specific conditions a reactor licensee must meet to use Table S-4 as part of its ER. For reactors not meeting all of the conditions in paragraph (a) of 10 CFR 51.52, paragraph (b) of 10 CFR 51.52 requires further analysis of the transportation effects.

The conditions in paragraph (a) of 10 CFR 51.52 establishing the applicability of Table S-4 are reactor core thermal power, fuel form, fuel enrichment, fuel encapsulation, average fuel irradiation, time after discharge of irradiated fuel before shipment, mode of transport for unirradiated fuel, mode of transport for irradiated fuel, radioactive waste form and packaging, and mode of transport for radioactive waste other than irradiated fuel. The following subsections describe the characteristics of the SMRs and advanced non-LWRs at the CRN Site relative to the conditions of 10 CFR 51.52 for use of Table S-4. If the conditions of Table S-4 are not met, detailed transportation accident analyses are required.

3.21.1.4.1 Reactor Core Thermal Power

Paragraph 10 CFR 51.5(a)(1) requires that for comparison to the reference plant, the new reactor must have a core thermal power level not exceeding 3,800 MWt. The advanced nuclear reactor designs considered for the CRN Site have a combined maximum thermal power level of 2,420 MWt. Therefore, the sum of the thermal power for all new reactors at the that potentially would be sited within the Nuclear Technology Park would meet this condition.

The initial core loading of the reference plant is 100 MTU. For LWRs, the surrogate SMR core contains 96 fuel assemblies. The mass of the uranium in the fuel assemblies is 0.304 MTU per fuel assembly, resulting in an initial core loading of about 30 percent of the 100 MTU assumed for the reference plant.

3.21.1.4.2 Fuel Form

Paragraph 10 CFR 51.52(a)(2) requires that the reactor fuel be in the form of sintered UO_2 pellets. Sintering is a process by which a powdered material is compacted and heated, without melting, to form a solid mass. Fuel for the SMRs at the CRN Site would be a sintered UO_2 fuel. Therefore, the requirement is met for SMRs. Advanced non-LWRs would use fuel salts or TRISO fuel pebbles and would require detailed future analyses as they do not meet the conditions of Table S4.

3.21.1.4.3 Fuel Enrichment

Paragraph 10 CFR 51.52(a)(2) requires that the reactor fuel have a U-235 enrichment not exceeding four percent by weight. The LWR fuel is enriched up to five percent, which exceeds this condition. NUREG/CR-6703, "Environmental Effects of Extending Fuel Burnup Above 60 GWd/MTU" (NRC 2001), supported the conclusion that environmental impacts of enrichments up to five percent were bounded by the impacts reported in Table S-4. However, a detailed transportation accident analysis was performed for LWRs for fuel enriched up to five percent. Some of the Non-LWRs under consideration would use HALEU fuel and, therefore, do not meet this requirement and would require future detailed analyses.

3.21.1.4.3.1 Fuel Encapsulation

Paragraph 10 CFR 51.52(a)(2) requires that the reactor fuel pellets be encapsulated in Zircaloy rods. The LWR fuels use Zircaloy cladding and, therefore, meet the requirement. Non-LWRs would use fuel salts or TRISO fuel pebbles and would require future detailed analyses.

3.21.1.4.3.2 Average Fuel Irradiation

Paragraph 10 CFR 51.52(a)(2) requires that the average fuel burnup not exceed 33,000 MWd per MTU. The average burnup for the LWR fuel assembly would be less than or equal to 51,000 MWd per MTU, which exceeds the limits of Table S-4. However, NUREG/CR-6703 supports the conclusion that the environmental impacts of higher fuel burnup rates were bounded by the impacts reported in Table S-4. Non-LWRs would use fuel salts or TRISO fuel pebbles, does not meet the Table S-4 conditions, and therefore would require future detailed analysis.

3.21.1.4.3.3 Time After Discharge of Irradiated Fuel Before Shipment

Paragraph 10 CFR 51.52(a)(3) requires that no irradiated fuel assembly be shipped until at least 90 days after it is discharged from the reactor. The analysis provided by the NRC and referenced in Table S-4 assumes 150 days of decay time before shipment of any irradiated fuel assemblies (AEC 1972). NUREG/CR-6703 assumes a minimum of five years between removal from the reactor and shipment. NUREG-1437, Rev. 1, indicates that the NRC specifies five years as the minimum cooling period when it issues certificates of compliance for casks used for shipment of power reactor fuel. Therefore, five years is considered the minimum decay time expected before shipment of irradiated fuel assemblies. SMRs and advanced non-LWRs at the CRN Site would have a minimum five-year storage capacity, to accommodate cooling of irradiated fuel before removal from the spent fuel pool and transfer to onsite dry storage or transport offsite. Therefore, the requirement could be met.

3.21.1.4.3.4 Mode of Transport for Unirradiated Fuel

Paragraph 10 CFR 51.52(a)(5) requires that unirradiated fuel be shipped to the reactor site by truck. Fuel is expected to be shipped to the CRN Site by truck from a fuel fabrication facility as far away as Washington State. Table S-4 includes a condition that truck shipment would not exceed 73,000 pounds. Fuel shipments to the CRN Site would comply with this and other state and federal requirements. Therefore, the criterion could be met.

3.21.1.4.3.5 Mode of Transport for Irradiated Fuel

Paragraph 10 CFR 51.52(a)(5) allows irradiated fuel to be shipped by truck, rail, or barge. Irradiated fuel is expected to be shipped from the CRN Site by truck. Currently, the DOE is responsible for spent fuel transportation from reactor sites.

Table S-4 of 10 CFR 51.52 includes a condition that the heat generated from irradiated fuel per shipping cask in transit would not exceed 250,000 British thermal units (Btu)/hour. Using the guidance provided in ANSI/ANS 5.1-2014, “American National Standard for Decay Heat Power in Light Water Reactors,” a conservative estimate of the heat load in a shipping cask is approximately 233,000 Btu/hour. This estimate is based on the following assumptions and PPE values: the NRC approved General Atomics GA-4 or similar cask would be used for shipping spent fuel (NUREG-2125, Spent Fuel Transportation Risk Assessment (NRC 2014b); SMR fuel assemblies are one-third the length of standard PWR fuel assemblies; 12 SMR fuel assemblies would be shipped in a GA-4 shipping cask; the power density of each fuel assembly is approximately 9 MWt; fuel assemblies are burned through three fuel cycles and loaded into casks five years after the core offload of the third fuel cycle; fuel burnup is 51 giga-watt days (GWd)/MTU; and 0.304 MTU per assembly. Several of the proposed fuel assembly designs for SMRs are similar or the same as the existing U.S. LWR fleet. Also, while many advanced non-LWR fuel design elements are in development, assessing and adhering to the CFR requirements are part of the design process. Therefore, while no new cask has final design explicitly performed for shipment of irradiated SMR or advanced non-LWR reactor fuel, it is expected that the Table S-4 criterion would be met for fuel shipments from the CRN Site.

3.21.1.4.3.6 Radioactive Waste Form and Packaging

Paragraph 10 CFR 51.52(a)(4) requires that radioactive waste be shipped from the reactor in packages and in a solid form (with the exception of irradiated fuel). The low-level waste (LLW) generated by the SMRs and advanced nuclear reactors at the CRN Site would be prepared, packaged, and shipped according to DOT regulations. Therefore, the requirement could be met.

3.21.1.4.3.7 Mode of Transport for Radioactive Waste

Paragraph 10 CFR 51.52(a)(5) requires that the mode of transportation of LLW be either by truck or rail. LLW is expected to be shipped from the CRN Site by truck in accordance with state and federal requirements, including limiting shipments to 73,000 pounds. Therefore, the requirement could be met.

3.21.1.4.3.8 Number of Truck Shipments

The NRC references the “Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants,” also referred to as “WASH-1238” (AEC 1972), for transportation impacts from the 10 CFR 51.52 Table S-4 reference reactor. Table S-4 specifies the following conditions for traffic density: less than one truck shipment per day or less than three rail cars per month. The WASH-1238 truck shipments per year (traffic density) are compared to the CRN Site shipments in Table 3-76.

Table 3-76. Number of Radioactive Waste Shipments

Reactor Type	Waste Generation Rate	Number of Shipments per reactor-year	Normalized Shipments per reactor-year
Irradiated Fuel			
Reference LWR	30 MTU per year	60[1]	N/A
SMRs or advanced nuclear reactors at the CRN Site	56.1 MTU per year	46	137[1]
Solid Radioactive Waste			
Reference LWR	3,800 cubic feet per year	46	N/A
SMRs or advanced nuclear reactors at the CRN Site	5,000 cubic feet per year	61	75

[1] Source: AEC 1972

[2] Normalized based on 0.5 MTU per shipping container and the net power using a conservative 90 percent capacity for the 800 MWe CRN Site SMRs or advanced nuclear reactors.

N/A = Not Applicable

TVA estimates that 492 shipments of unirradiated fuel would be required for operating 800 MWe SMRs or advanced nuclear reactors described by the PPE over 40 years. In WASH-1238, the NRC assumed 18 shipments of new fuel would be made for the initial reactor loading of the 10 CFR 51.52 Table S-4 reference reactor and an additional six shipments per year for 39 years resulting in a total of 252 shipments (AEC 1972). The annual number of shipments of new fuel to the reference plant and the SMRs at the CRN Site are provided in Table 3-77. While the maximum number of fuel shipments for initial loading is 40, no reactor designs have been selected and the initial loading schemes are not known, the average annual number assumes the same number of fuel shipments over the 40-year lifetime of the SMRs or advanced nuclear reactors.

Table 3-77. Number of Truck Shipments of Unirradiated Fuel

Reactor Type	Number of Fuel Shipments		
	Initial Load[2]	Annual Reload[3]	Total
Reference LWR[1]	18[3]	6	252
SMRs or advanced nuclear reactors at the CRN Site	40 (maximum)	12 (assumed even loading over 40 years)	492
Normalized	N/A	15	600

[1]Source: AEC 1972

[2]Shipments of the initial core have been rounded up to the next highest whole number.

[3]The initial core load for the reference PWR in WASH-1238 was 100 MTU with 18 truck shipments (AEC, 1972).

N/A = Not Applicable

In the ESPA, TVA estimated that there would be 46 annual shipments of irradiated fuel from the CRN Site. As provided in Table 3-76, the normalized number of annual shipments is 137. The number of annual shipments of irradiated fuel from the reference reactor is 60 (AEC 1972).

The number of solid radioactive waste shipments from the CRN Site is based on a volume of 5,000 ft^3/yr. As shown in Table 3-76, the number of solid radioactive waste shipments from the CRN Site would be about 61 truck shipments per year normalized to 75 shipments per year.

As shown in Table 3-78, the sum of the number of yearly truck shipments of fuel and radioactive waste to and from the CRN Site is estimated to be 227 trucks per year, or less than one truck shipment per day. Table S-4 from 10 CFR 50.52 also states that the reference reactor would have less than one truck shipment per day. Therefore, the traffic density from the CRN Site would be comparable to the traffic density from the reference reactor.

The analyses for LWRs are presented in Section 3.20.

Table 3-78. CRN Site Comparisons to 10 CFR 51.52 Reference Conditions

Characteristic	Reference Reactor 10 CFR 51.52/WASH-1238[1]	CRN Site SMRs or Advanced Nuclear Reactors
Thermal Power Rating (MWt)	3800 MWt	2420 MWt
Fuel Form	Sintered uranium dioxide pellets	Sintered uranium dioxide pellets
U-235 Enrichment (%)	< 4	< 5
Fuel Rod Cladding	Zircaloy rods	Zircaloy rods
Average Fuel Irradiation (MWd per MTU)	≤ 33,000	≤ 51,000
Unirradiated Fuel		
Transport Mode	Truck	Truck
Irradiated Fuel		
Transport Mode	Truck, rail, or barge	Truck, rail, or barge
Decay time before shipment	> 5 years per contract with DOE	> 5 years per contract with DOE
Radioactive Waste		
Transport Mode	Truck or rail	Truck or rail
Waste Form	Solid	Solid
Packaged	Yes	Yes
Traffic Density (shipments)		
Unirradiated Fuel – Initial Loading	12	40
Unirradiated Fuel – Reload	15/year	12.3/year 15/year normalized
Irradiated Fuel	60/year	46/year 137/year – normalized
Radioactive Waste	46/year	61/year (75/year normalized)
Total	121/year	119.3/year (227 – normalized)
Trucks per day	< 1/day	< 1/day

[1]Source: AEC 1972

3.21.2 Environmental Consequences

3.21.2.1 Alternative A – No Action Alternative

Under this alternative, no completion or construction and operation of a Nuclear Technology Park would occur; therefore, there are no impacts.

3.21.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced Non-LWRs

The analysis below assumes the fuel cycles for SMRs and advanced non-LWRs are similar to the UFC cycle referenced in NUREG-1437, for the purposes of impact evaluations. Once TVA has selected the reactor technologies to be deployed at the CRN Site, subsequent NEPA analysis will specifically analyze any fuel cycle environmental impacts as appropriate.

3.21.2.2.1 Uranium Fuel Cycle

3.21.2.2.1.1 Land Use

Permanent land commitments are those that may not be released for use after plant shutdown and/or decommissioning. This limitation on land use is because decommissioning activities on the pertinent land may not remove sufficient radioactive material to meet the limits in 10 CFR 20, Subpart E, for release of land for unrestricted use. Temporary land commitments are for the life of the specific UFC plant (e.g., a mill, enrichment plant, or succeeding plants). Following completion of decommissioning, such land can be released for unrestricted use.

As provided in Table S-3 for the reference plant, the UFC disturbed land area and overburden requirements for the SMRs or advanced non-LWRs at the CRN Site are equated to an equivalently sized (in electrical power production) coal-fired power plant using strip-mined coal as a fuel and requiring the same area of disturbed land and overburden movement. The comparison shows that UFC land requirements for SMRs or advanced nuclear reactors at the CRN Site producing 800 MWe are equivalent to the coal mining land use requirements (disturbed land) for a coal-fired plant producing only approximately 88 MWe. Therefore, for equivalent energy production, the nuclear fuel cycle land use is approximately one-ninth that of coal.

Due to the recent increase in natural gas production in the U.S., the net electrical output associated with natural gas production was compared to the net electrical output from a Nuclear Technology Park at the CRN Site based on an equivalent area of disturbed land. It is estimated that natural gas production in Marcellus shale disturbs about 8.8 acres per well pad (cleared lands for pad and infrastructure). Each well pad contains on average two natural gas wells, and each well typically produces 10 million cubic feet (ft^3) of natural gas per day. Using conversion factors of 1,021 Btu per cubic foot of natural gas and an assumed power plant heat rate of 8,152 Btu per kilowatt-hour, the resulting net electrical output from natural gas production in the Marcellus shale is about 11.8 MWe/acre. For comparison, if the 21.6 acres of disturbed land required to support the fuel needs for an 800 MWe Nuclear Technology Park were dedicated to natural gas production, the land would only produce enough fuel for a gas fired plant producing approximately 255 MWe. Therefore, for equivalent energy production, the nuclear fuel cycle land use is approximately one-third that of natural gas.

If the quality and opportunity costs of the land are equivalent, then it is reasonable to state that land requirements for nuclear power are minor compared to coal-fired power plants and natural gas production. Therefore, it is concluded that the effect on land use to support the UFC for the Nuclear Technology Park is considered to be minor.

3.21.2.2.1.2 Water Use

Power stations supply electrical energy to the enrichment stage of the UFC. The primary water requirement of the UFC is waste heat removal from these power stations. Table S-3 of 10 CFR 51.51 provides a total water discharge (usage) within the UFC for the reference plant as 11,377 million gallons per year, less than four percent of the actual water used to cool the 1,000 MWe reference plant with once through cooling. Applying the 0.98 scaling factor, the water use within the UFC to support the Nuclear Technology Park is estimated to be approximately 11,149 million gallons per year. Therefore, the impact from the water used to manage power needs to support the Nuclear Technology Park are also minor assuming similar water sources to the reference plant.

According to Table S-3, the annual thermal discharge of power plants used within the UFC to support the 1,000 MWe reference plant would be approximately 4,063 billion Btu; this usage is less than five percent of the actual thermal discharge of the 1,000 MWe reference plant. The expected thermal effluent value to support the UFC for the Nuclear Technology Park would be approximately 3,982 billion Btu. Similarly, because the thermal effluent value for the proposed plants would be less than the thermal effluent value for the reference plant, the thermal discharge from the UFC for the Nuclear Technology Park would also be minor.

From 10 CFR 51.51, Table S-3 states that the consumptive water use of the UFC in support of the 1,000 MWe reference plant (i.e., water discharged to air from cooling towers) is two percent of the water consumption of the plant itself. Therefore, the water consumption from the UFC supporting the Nuclear Technology Park would have a minor effect with respect to water use.

3.21.2.2.1.3 Fossil Fuel Effects

Electrical energy and process heat would be consumed during various phases of the UFC. The electrical energy is often produced by combustion of fossil fuels (coal and/or natural gas) at conventional power plants. From 10 CFR 51.51, Table S-3, the electrical energy needs associated with the UFC associated with the reference plant are 323,000 MWh and represents less than five percent of the annual electrical power production of the reference plant. For the Nuclear Technology Park, the UFC electrical energy needs would be approximately 316,540 MWh, which is equivalent to 115,640 MT of coal or 132 million ft^3 of natural gas.

In NUREG-1437, Rev. 0, the NRC concludes that the effects of direct and indirect consumption of electric power for fuel cycle operations produced using fossil fuels are small and appropriate for the electric power being produced from uranium fuel by the reference plant. NUREG-1437, Rev. 1, does not provide any additional information that would alter this conclusion. Since the power output and UFC demands for the Nuclear Technology Park are less than those for the reference plant, the environmental effects from the combustion of fossil fuels associated with UFC operations would also be minor.

The NRC estimates that the carbon footprint of the UFC to support the 1,000 MWe reference plant for the 40-year plant life is about 17,000,000 MT of carbon dioxide (NRC 2011b). Scaling the 10 CFR 51.51 reference plant's UFC carbon footprint to obtain a UFC carbon footprint for the Nuclear Technology Park at the CRN Site, the carbon footprint for

40 years of UFC emissions would be approximately 16,660,000 MT. The average annual emission rate would then be approximately 416,000 MT. This rate compares to total annual emissions of 5,500,000,000 MT in 2011 for the entire U.S. Therefore, it is concluded that the carbon footprint associated with UFC operations would also be minor.

3.21.2.2.1.4 Chemical Effluents

According to 10 CFR 51.51, Table S-3, the gaseous effluents from the UFC supporting the reference plant are equivalent to the gaseous effluents from a 45 MWe coal power plant. Applying the 0.98 scaling factor to each of the gaseous effluents and summing them, the gaseous effluents from the UFC supporting the Nuclear Technology Park are equivalent to the gaseous effluents from a 44 MWe coal power plant. For an equivalent amount of energy produced with coal, the chemical effluents would be about 2.3 times greater. Therefore, it is concluded that the effects to the degradation of air quality from the power generation needed to support the UFC is minor.

Liquid chemical effluents produced during the UFC are associated with the fuel enrichment, fuel fabrication, and fuel reprocessing steps. While fuel reprocessing is not currently performed commercially in the U.S., the effluent amounts provided in 10 CFR 51.51, Table S-3, include potential reprocessing activities. Because the effluents at these quantities require only small amounts of dilution by the receiving bodies of water to achieve concentrations that are below established standards, the effects to the degradation of water quality from the power generation needed to support the UFC would be minor. Additionally, any liquid discharges into the navigable waters of the U.S. from power plants associated with UFC operations are subject to requirements and limitations set in NPDES permits issued by an appropriate federal, state, regional, local, or affected Native American tribal regulatory agency.

Tailings solutions and solids are generated during the milling process; however, these materials are not released in quantities that would be significantly different than currently used processes. The effect of all effluent waste streams (gaseous, liquid, and solid) associated with the UFC needs for the Nuclear Technology Park at the CRN Site are considered to be minor.

3.21.2.2.1.5 Radioactive Effluents for the UFC

From NUREG-1437, Rev. 1, Table 4.12.1.1-1, “Population Doses from Uranium Fuel Cycle Facilities Normalized to One Reference Reactor Year," the portion of dose commitment from radioactive gaseous effluents is 400 person-rem per year (person-rem/yr) and the portion of dose commitment from radioactive liquid effluents per year due to all UFC operations is 200 person-rem. Applying the 0.98 scaling factor for the Nuclear Technology Park, the dose commitment from radioactive gaseous and liquid effluents would be approximately 392 person-rem and 196 person-rem, respectively. Thus, the total 100-year environmental dose commitment from radioactive gaseous and liquid releases resulting from these portions of the UFC needed to support the Nuclear Technology Park is 588 person-rem/yr.

Currently, the radiological effects associated with Rn-222 and Tc-99 releases are not addressed in the reference plant data in 10 CFR 51.51, but they are accounted for in this PEIS for consistency with NUREGs. Most Rn-222 releases are from mining and milling operations and emissions from mill tailings, and most Tc-99 releases are from gaseous diffusion enrichment facilities. Although the gaseous diffusion plants in the U.S. have been shut down, the following assessment is based on the assumption that gaseous diffusion plants are in operation.

In Table 6.2 of NUREG-1437, Rev. 0, the NRC staff estimated the Rn-222 releases from mining plus milling and emanating from mill tailings required to support each year of operations of the 1,000 MWe reference plant to total 5,200 curies (Ci). The major risks from Rn-222 are bone and lung cancer, and there is a small risk from whole body exposure. The organ-specific dose weighting factors from 10 CFR Part 20 are applied to the bone and lung doses to estimate the 100-year dose commitment from Rn-222 to the whole body, which is estimated to be 140 person-rem for the reference plant. Using the 0.98 scaling factor, the Rn-222 releases from the UFC associated with Nuclear Technology Park are estimated to be 5,096 Ci and the estimated population dose commitment from mining, milling, and tailings before stabilization for each year of operation of the Nuclear Technology Park is estimated to be 136 person-rem.

In NUREG-1437, Rev. 0, the NRC staff also considered the potential health effects associated with the release of Tc-99 as part of UFC operations. It was found that the releases of Tc-99 are from chemical reprocessing of recycled UF_6 before it enters the isotope enrichment cascade. The annual Tc-99 releases (in Ci) from the reference plant and scaled releases from the Nuclear Technology Park are 0.012 Ci.

The major risks from Tc-99 are from exposure of the gastrointestinal tract and kidney; additionally, there is a small risk from whole-body exposure. Using the organ-specific dose weighting factors from 10 CFR 20, these individual organ risks were converted to a whole body 100-year dose commitment per year of operation: 100 person-rem for the reference plant and 98 person-rem for the Nuclear Technology Park.

Epidemiological studies have not consistently demonstrated adverse health effects in persons exposed to small (less than 10 rem) doses protracted over a period of many years (HPS 2019). However, a linear, no-threshold dose response relationship is used to describe the relationship between radiation dose and detriments such as cancer induction. This approach is accepted by the NRC as a conservative method for estimating health risks from radiation exposure, recognizing that the model may overestimate those risks. Based on this method, the risk to the public from radiation exposure using the nominal probability coefficient for total detriment can be estimated. This coefficient has the value of 570 fatal cancers, nonfatal cancers, and severe hereditary effects per 1,000,000 person-rem. The total whole body population doses (including Rn-222 and Tc 99) would be 840 person-rem/year for the 1,000 MWe reference plant and 822 person-rem/year for the Nuclear Technology Park. The estimated number of fatal cancers, nonfatal cancers, and severe hereditary effects would be less than one per year for both the 1,000 MWe reference plant and the new Nuclear Technology Park at the CRN Site, based on the conservative method described above.

Based on the information presented above, it is concluded that the environmental effect (population dose) from radioactive effluents from the UFC demands for the Nuclear Technology Park at the CRN Site would be minor. See Section 3.20.2 for further information related to the environmental consequences of radiological effluents.

3.21.2.2.1.6 Occupational Dose

As provided in Section 6.2.2.3 of NUREG-1437, Rev. 0, the annual occupational dose for the reference 1,000 MWe reactor attributable to all phases of the fuel cycle is 600 person-rem. The fuel cycle for the SMRs or advanced nuclear reactors would be similar to the fuel cycle for the reference plant. Individual occupational doses are maintained to meet the dose limits in 10 CFR Part 20, which is 5 rem/yr. Therefore, the environmental effects from this occupational dose are considered to be minor.

3.21.2.2.1.7 Summary

Using the evaluation process in NUREG-1437, Rev. 0 and Rev. 1, TVA examined the environmental effects of the UFC, including the dose from Rn-222 and Tc-99, as it relates to the operation of SMRs and advanced nuclear reactors at the CRN Site. Based on this evaluation, the environmental effects of the contributions to the UFC from the operation of SMRs or advanced nuclear reactors at the CRN Site are considered to be minor. Any site-specific impacts that are analyzed in the future that are expected to fall outside of the bounding analysis in this PEIS will be analyzed in subsequent NEPA analysis.

3.21.2.2.2 Radioactive Waste

Normal radioactive liquid and gaseous effluents would be controlled in accordance with 10 CFR 20. Therefore, the environmental effects associated with these radioactive waste streams are considered to be minor.

The CRN Site would enter into a contract to transport waste to either a licensed waste processing facility or a licensed low-level radioactive waste disposal facility. As discussed in Section 0, 10 CFR 51.52, Table S-4 addresses the environmental impacts from transportation of LLW. The assumed quantities (in Ci) of radioactive waste material generated are shown in 10 CFR 51.51, Table S-3, for the 1000 MWe reference plant, and for LLW disposal the NRC indicates in Table S-3 that no significant radioactive releases to the environment are expected (i.e., the environmental impact is considered to be minor). Additionally, if required, the impacts of construction and operation of onsite LLW storage facilities are considered to be minor. Therefore, environmental effects associated with solid radioactive waste management at the Nuclear Technology Park are considered to be minor.

3.21.2.2.3 Spent Fuel Storage

Environmental impacts from onsite spent fuel storage during the licensed life of existing LWRs have been studied extensively and are well understood. In the context of operating license renewal, the NRC provides descriptions of the storage of spent fuel during the licensed lifetime of reactor operations in NUREG-1437, Rev. 1. Radiological impacts are well within regulatory limits; thus, the radiological impacts of onsite storage during operations would be minimal. Onsite storage of spent fuel for advanced non-LWRs would also be required to meet the same regulatory limits. Therefore, the environmental effects associated with spent fuel storage during the life of the plant are considered to be minor.

In accordance with 10 CFR 51.23(b), the impact determination in NUREG-2157, “Generic Environmental Impact Statement for Contained Storage of Spent Nuclear Fuel” (NRC 2014a), regarding continued storage (i.e., the period following the term of the reactor operating license, reactor combined license, or ISFSI license) is incorporated into the Draft PEIS. The time frames analyzed in NUREG–2157 include the short-term time frame (i.e., 60 years beyond the licensed life of a reactor), the long-term time frame (i.e., an additional 100 years after the short-term time frame), and an indefinite time frame. The analysis in Section 4.20 of NUREG–2157 concludes that the potential impacts of spent fuel storage at the reactor site in both a spent fuel pool and in an onsite ISFSI would be minor during the short-term time frame. However, for the longer time frames for onsite storage, and for all time frames for away-from-reactor storage, Sections 4.20 and 5.20 of NUREG 2157 provide a range of potential impacts in some resource areas. These ranges reflect uncertainties that are inherent to analyzing environmental impacts on some resource areas over long time frames and are primarily driven by activities other than the continued storage of spent fuel at the reactor site. These uncertainties exist regardless of whether the impacts are analyzed generically or site specifically.

TVA is not considering off-site storage at this time. In the short-term time frame, which is the most likely time frame for the disposal of the fuel, the potential impacts of continued storage for onsite storage are minor and would, therefore, not be a significant contributor to the cumulative impacts for the CRN Site.

3.21.2.2.4 Transportation of Radioactive Materials

The environmental impacts of radioactive materials transportation were estimated using the RADTRAN 6.5 computer code. RADTRAN is a nationally accepted standard program and code for calculating the risks of transporting radioactive materials. RADTRAN was used in estimating the radiological doses and dose risks to populations and transportation workers resulting from incident-free transportation and to the general population from accident scenarios. For the analysis of incident-free transportation risks, the code used scenarios for persons who would share transportation routes with shipments, persons who live along the route of travel, and persons exposed at stops.

3.21.2.2.4.1 Transportation of Unirradiated Fuel

Table S-4 of 10 CFR 51.52 includes conditions related to radiological doses to transport workers and members of the public along transport routes. These doses, based on calculations in WASH-1238 (AEC 1972), are a function of the radiation dose rate emitted from the unirradiated fuel shipments, the number of exposed individuals and their locations relative to the shipment, the time of transit (including travel and stop times), and the number of shipments to which the individuals are exposed.

Calculation of worker and public doses associated with annual shipments of unirradiated fuel were performed using the WebTRAGIS 6.0 and RADTRAN computer codes. One of the key assumptions in WASH-1238 for the reference LWR unirradiated fuel shipments is that the radiation dose rate at 3 feet from the transport vehicle is 0.1 mrem/hour. This assumption is reasonable for the new plant technologies because the fuel materials would be low-dose rate enriched uranium and would be packaged similarly to the fuel analyzed in WASH-1238 (i.e., inside a metal container that provides sufficient radiation shielding).

For unirradiated fuel shipments, highway routes were analyzed using the routing computer code WebTRAGIS. The per trip dose values are combined with the average annual number of shipments of unirradiated fuel to calculate annual doses to the public and workers for comparison to Table S-4 dose values. The number of shipments per year is provided in Table 3-77. The incident free dose rates (in person-rem per shipment) were calculated by RADTRAN and are provided in Table 3-79. The dose rates ranged from 4.59E-03 person-rem/year for the transportation crew exposed at stops and 7.85E-03 person-rem/year for crew along the route to 5.81E-03 person-rem/year for the public in other vehicles along the transportation route.

Table 3-79. Total Shipment Cumulative Dose Summary

	Source		
	Unirradiated Fuel	**Radioactive Waste**	**Total**
Exposed Population			
Crew Dose (person-rem per year)			
At Stops	4.59E-03	1.61	1.61
Along Route	7.85E-03	2.55	2.56
Total Crew Dose			**4.17**
Public Dose (person-rem per year)			
At Stops			
Sharing Stops	2.15E-03	0.75	4.24
Residents	1.95E-04	0.102	0.102
Along Route			
Other Vehicles	5.81E-03	1.92	1.93
Residents	8.84E-04	0.328	0.329
Total Public Dose			**6.6**

3.21.2.2.4.2 Transportation of Irradiated Fuel

The analysis and associated environmental impacts of transporting spent fuel from the CRN Site to a spent fuel disposal facility will be deferred until a viable off-site location has been selected.

3.21.2.2.4.3 Transportation of Radioactive Waste

Incident-free transportation refers to transportation activities in which shipments reach their destination without releasing any radioactive cargo to the environment. Impacts from these shipments would be from the low levels of radiation that penetrate the radioactive waste shipping containers. Radiation doses could potentially occur to the following:

- Persons residing along the transportation corridors between the CRN Site and the potential repository
- Persons in vehicles passing a radioactive waste shipment
- Persons at vehicle stops for refueling, rest, and vehicle inspections
- Transportation crew workers

This analysis is based on shipment of radwaste by legal-weight trucks in either sea-land containers or high-integrity containers similar to those currently available. Each shipment is assumed to consist of a single shipping container from the CRN Site to Andrews, Texas.

The transportation route selected for a shipment determines the total potentially exposed population and the expected frequency of transportation-related accidents. For truck transportation, the route characteristics most important to the risk assessment include the total shipping distance between each origin-destination pair of sites and the population density along the route.

The population doses are calculated by multiplying the number of radioactive waste shipments per year by the per-shipment doses. The numbers of shipments per year are identified in Table 3-76. The incident-free dose rates (in person-rem per shipment) were calculated by RADTRAN and are provided in Table 3-79. The dose rates ranged from 1.61 person-rem/year for the transportation crew exposed at stops and 2.55 person-rem/year along the route to 1.92 person-rem/year for the public in other vehicles along the transportation route.

3.21.2.2.4.4 Comparison to 10 CFR 51.52 Table S-4

For an equal comparison to the reference reactor in 10 CFR 51.52 Table S-4, the number of shipments in Table 3-78 for the SMR or advanced nuclear reactor must be normalized. For each technology, the number of shipments is normalized based on net electric generation relative to the 1100 MWe and 80 percent capacity factor reference reactor analyzed in WASH-1238. Additionally, the unirradiated fuel shipments are adjusted to account for the initial core loading in the annual number of shipments for each reactor technology. The number of radioactive waste shipments is based on 3,800 ft^3 and 46 shipments per year from the reference reactor (from WASH-1238) or 82.6 ft^3 per shipment (2.34 cubic meters (m^3) per shipment). The resulting annual truck shipments normalized to the reference reactor are summarized in Table 3-78 (excluding transport of spent fuel). Annual doses provided in Table 3-79 are based on the normalized number of shipments.

Table 3-79 provides a total crew dose of 4.17 person-rem per reactor per year (excluding transport of spent fuel). While the estimate is more than the Table S-4 value, it is still considered small given the increased number of normalized shipments, and the greater assumed transportation distances (WASH-1238 uses 1,000 miles for unirradiated fuel shipments, 1,000 miles for irradiated fuel shipments, and 500 miles for radioactive waste shipments) (AEC 1972). The doses provided in Table 3-79 also assume the maximum dose rate for all shipment types, and the use of 30 minutes as the average time for a truck stop in the calculations.

Table 3-79 also provides a total public dose of 6.6 person-rem per reactor year (excluding transport of spent fuel). Onlookers are members of the public exposed to a shipping container for a short duration during periods when the transportation vehicle is stopped. While the estimate is more than the Table S-4 value, it is still considered small given the increased number of normalized shipments, the greater assumed transportation distances, and the increased populations along the transportation routes. Table S-4 does not provide a cumulative dose for the population exposed along the transportation routes for direct comparison.

3.21.2.2.4.5 Transportation Accident Analysis – Radiological Impacts

The reference reactor for 10 CFR 51.52 Table S-4 is an 1,100 MWe LWR with a capacity factor of 80 percent (1,100 MWe times 80 percent equals 880 MWe). The maximum generating output of the SMRs at the CRN Site as 800 MWe, and a station capacity factor of 90 percent (800 MWe times 90 percent equals 720 MWe) is conservatively assumed for this analysis. For the analysis below, the expected number of shipments is multiplied by the ratio, 1.22, to estimate the number of shipments normalized to the reference reactor used in Table S-4.

Transportation of Unirradiated Fuel

The following assumptions are made in this analysis of the transportation of unirradiated fuel:

- Unirradiated fuel would be transported to the CRN Site via truck in robust packages designed to protect the fuel from damage from dropping or puncture.
- The WASH-1238 analysis of postulated accidents during the transportation of unirradiated fuel found accident impacts to be negligible.
- As noted in NUREG-1815 (NRC 2006), accident frequencies are likely to be lower in the future than those used in the analysis in WASH-1238 because traffic accident, injury, and fatality rates have fallen since the initial analyses were performed.
- Advanced fuel behaves like fuel evaluated in the analyses provided in WASH-1238.
- Per NUREG-1815, there is no significant difference in the consequences of accidents severe enough to result in a release of unirradiated fuel particles to the environment between SMRs and previous-generation LWRs because the fuel form, cladding, and packaging are similar to those analyzed in WASH-1238.
- The fuel form, cladding, and packaging for the SMR designs considered in the PPE would be similar to the fuel form, cladding, and packaging for SMRs.

Based on this information, the dose impact from nuclides released from postulated accidents involving new fuel is assumed to be negligible when compared to dose from postulated irradiated fuel and radiation waste transportation accidents. Therefore, quantitative analysis of dose from new fuel accidents was not performed.

The radiological impacts from incident free transportation of unirradiated fuel were estimated using the WebTRAGIS 6.0 and RADTRAN 6.5 computer codes. The evaluation model assumes that unirradiated fuel is shipped from a fuel fabrication facility located in Richland, Washington, to the CRN Site. The fuel fabrication facility in Richland is the farthest fabrication facility in the U.S. from the CRN Site that is currently in operation; therefore, to maximize the transportation distance and potential impacts, it was used as a representative fuel fabrication facility for the purposes of the evaluation.

3.21.2.2.4.6 Transportation Accident Analysis – Non-Radiological Impacts

Non-radiological impacts associated with the postulated accidents are calculated for:

- Injuries and fatalities during transportation of unirradiated fuel
- Injuries and fatalities during transportation of radioactive waste

The non-radiological impacts from postulated accidents during transportation were evaluated using the WebTRAGIS code to define appropriate routing and the RADTRAN 6 code to calculate the non-radiological impacts (e.g., injuries and fatalities).

The non-radiological impacts were based on round-trip distances because the return of the empty truck is included in the evaluation. Therefore, the frequency (fatalities per reactor-year and injuries per reactor-year) was multiplied by two.

Transportation of Unirradiated Fuel

The evaluation model assumes that unirradiated fuel is shipped by truck from Richland, Washington, to the CRN Site. As shown in Table 3-77, the total number of lifetime shipments of unirradiated fuel for the CRN Site is postulated to be 492, and the average is 12.3 shipments per year. Multiplying by the ratio of 1.22, discussed above, the estimated number of shipments per year is 15 (i.e., 600 total shipments), normalized to the reference reactor used to estimate the parameters in 10 CFR 51.52 Table S-4.

The non-radiological fatality rates and injury rates normalized to the transportation rates for the reference reactor are provided in Table 3-80 and Table 3-81.

Table 3-80. CRN Site Model Non-Radiological Accident Analysis Results for Normalized Number of Shipments: Fatalities

	Fatalities per Shipment	Normalized Shipments Per Year	Fatalities per Year[1]	Fatalities per 100 Years
New Fuel	6.08E-05	15	1.82E-03	1.82E-01
Radioactive Waste	3.24E-05	75	4.86E-03	4.86E-01
Total	-	90	6.68E-03	6.68E-01

[1]The fatalities per year are calculated assuming a round trip for the truck. Therefore, the normalized number of shipments was doubled when calculating total route fatalities.

Table 3-81. CRN Site Model Non-Radiological Accident Analysis Results for Normalized Number of Shipments: Injuries

	Injuries per Shipment	Normalized Shipments Per Year	Injuries per Year[1]	Injuries per 10 Years
New Fuel	1.18E-03	15	3.54E-02	3.54E-01
Radioactive Waste	7.21E-04	75	1.08E-01	1.08E+00
Total	-	90	1.43E-01	1.43E+00

[1]The fatalities per year are calculated assuming a round trip for the truck. Therefore, the normalized number of shipments was doubled when calculating total route injuries.

Transportation of Radioactive Waste

The routing and accident parameters used to analyze non-radiological impacts of transporting radioactive waste were the same as those used to analyze the radiological impacts of transporting radioactive waste.

The annual volume of radioactive waste generated and shipped from the CRN Site would be 5,000 ft^3/yr. Table 3-76 shows the number of radioactive waste shipments from the CRN Site to be 61 shipments per year, and the number of shipments of radioactive waste (other than spent fuel) normalized to the reference reactor is 75 shipments per year.

The non-radiological fatality rates and injury rates normalized to the transportation rates for the reference reactor (excluding transport of spent fuel) are provided in Table 3-80 and Table 3-82.

Comparison to 10 CFR 51.52 Table S-4

For an equal comparison to the reference reactor in 10 CFR 51.52 Table S-4, the normalized number of shipments provided in the subsections above were used to determine the non-radiological environmental impacts due to transportation accidents. Table 3-80 and Table 3-82 indicate the fatal and non-fatal injury consequences, respectively, for unirradiated fuel and radioactive waste shipments based on the normalized numbers of shipments. The estimated number of fatal injuries is 6.68E-03 per reactor year for the CRN Site. The estimated number of non-fatal injuries is 1.43E-01 per reactor year (1.43 in 10 reactor years) for the CRN Site. The estimated numbers of fatal injuries and non-fatal injuries for the CRN Site are higher than the values for the reference reactor because the one-way shipping distances for unirradiated fuel and radioactive waste shipments are more than twice the distances assumed in the analyses for Table S-4 (WASH-1238). Considering these differences in the analyses, the impacts are comparable. Therefore, as the Table S-4 values are considered minor, the estimated numbers of fatal injuries and non-fatal injuries for the CRN Site are also minor.

3.21.2.2.4.7 Summary

A detailed analysis of the environmental impacts for the transportation of unirradiated fuel and radioactive waste transported to and from the CRN Site was performed in accordance with 10 CFR 51.52(b).

Reactors sited in the Nuclear Technology Park would have sufficient fuel pool storage capacity to enable a minimum cooling period of five years and sufficient storage capacity to permit irradiated fuel to cool sufficiently to meet the requirements of shipping casks available at the time the fuel is shipped.

In the analysis it was assumed that all shipments of unirradiated fuel and radioactive waste are by truck. The shipping weights would comply with federal, state, local, and tribal government restrictions as appropriate. The total number of shipments for the CRN Site (excluding transport of spent fuel) are outlined in Table 3-78, is 90 per year (normalized) which meets the Table S-4 requirement of less than one per day.

The radiological effects of incident-free conditions of transport (excluding transport of spent fuel) are summarized in Table 3-79. The values obtained from these analyses represent the impacts from incident-free transportation of radioactive materials to and from the CRN Site. The population doses to the transport crew and onlookers resulting from the new plant normalized to the reference reactor exceed Table S-4 values. However, these increases are reasonable given the different exposure parameters between WASH-1238 and the CRN Site RADTRAN model. Therefore, based on the analyses and above discussion, the environmental impacts of transportation of unirradiated fuel and radioactive waste are minor.

A detailed accident analysis of the environmental impacts for the transportation of unirradiated fuel and radioactive waste transported to and from the CRN Site was performed for LWRs in accordance with 10 CFR 51.52(b). As discussed above for incident free transportation, because the number of normalized shipments of radioactive waste are not significantly different from number of shipments from the reference reactor, the impacts from radiological accidents from the CRN Site are consistent with the minor impacts designation provided in 10 CFR 51.52, Table S4. The calculated dose risks are also minor. The non-radiological accident environmental impacts related to transportation of unirradiated fuel and radioactive waste are also consistent with the Table S-4 fatality and nonfatal injury rates. It is noted that this analysis does not account for future technology which may improve driver safety and further reduce accident rates.

Therefore, the overall corresponding impacts from accidents associated with the transportation of unirradiated fuel and radioactive waste to and from the Nuclear Technology Park at the CRN Site would be minor. The analysis and associated environmental impacts of transporting spent fuel from the CRN Site to a spent fuel disposal facility will be deferred until a viable off-site location has been selected.

3.21.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced Non-LWRs

Alternative C is for one or more non-LWR advanced nuclear reactors at Area 2 on the CRN Site. The potential environmental consequences discussed for Alternative B are also applicable to Alternative C, since the evaluation applies to the entire CRN site and is for cumulative electrical output not to exceed 800 MWe. Therefore, the environmental impacts from uranium fuel cycle, radioactive wastes, spent fuel storage and accidents associated with the transportation of fuel and waste to and from the CRN Site under Alternative C are also minor.

3.21.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced Non-LWRs

Alternative D is for one or more SMRs or advanced nuclear reactors at Area 1 and Area 2 on the CRN Site. The potential environmental consequences discussed for Alternative B are also applicable to Alternative D, since the evaluation applies to the entire CRN Site and is for cumulative electrical output not to exceed 800 MWe. Therefore, the environmental impacts from uranium fuel cycle, radioactive wastes, spent fuel storage and accidents associated with the transportation of fuel and waste to and from the CRN Site under Alternative D are also minor.

3.21.2.5 Summary of Impacts from Uranium Fuel Use

As summarized in Table 3-82, the impacts of uranium fuel use effects are minor. The combined environmental impacts from the UFC, the storage of spent fuel onsite, radioactive waste management, and the transportation of unirradiated fuel and radioactive waste are minor.

Table 3-82. Summary of Uranium Fuel Use Effects

Alternative	Project Element	Impact	Severity
Alternatives B, C, D	Uranium Fuel Cycle	Land Use.	Minor impacts. The UFC disturbed land area requirements for nuclear power are minor compared to coal-fired power plants and natural gas production.
		Water Use.	Minor impacts. The thermal discharge and water consumption from conventional power plants used to supply electricity for the UFC are minor.

Alternative	Project Element	Impact	Severity
		Fossil Fuel Use.	Minor impacts. The environmental effects from the combustion of fossil fuels associated with UFC operations and the overall carbon footprint for the UFC are minor.
		Chemical effluents / tailings from milling.	Minor impacts. The effect of all effluent waste streams (gaseous, liquid, and solid) associated with the UFC are minor.
		Radiological dose.	Minor impacts. The total population doses (including Rn-222 and Tc-99) from the UFC is conservatively estimated to be 822 person-rem/yr for the Nuclear Technology Park. The estimated number of fatal cancers, nonfatal cancers, and severe hereditary effects is less than one per year, based on the conservative linear no-threshold method.
	Radioactive Waste	Liquid waste generation.	Minor impacts. Liquid waste processing systems would be designed to maintain the radiation exposures of plant personnel ALARA. Discharges would be to the Reservoir and would be controlled and monitored to measure the activity released so that they remain within regulatory limits (10 CFR 20).
		Gaseous waste generation.	Minor impacts. Gaseous radioactive waste discharges would be controlled to the regulatory requirements of 10 CFR 20. Gaseous radioactive waste system equipment would be designed to ensure occupational exposures to plant personnel are ALARA.
		Solid waste generation.	Minor impacts. The Nuclear Technology Park would enter into a contract to transport waste to either a licensed waste processing facility or a licensed low-level radioactive waste disposal facility. No significant radioactive releases to the environment would be expected from the management of solid waste.

Alternative	Project Element	Impact	Severity
	Spent Fuel Storage	Radiological dose.	Minor impacts. The SMRs or advanced nuclear reactor designs considered for the CRN Site would require onsite spent fuel storage, in a spent fuel pool and/or ISFSI for dry cask storage, depending on the technology selected. Radiological impacts from onsite spent fuel storage would be maintained within regulatory limits. Ultimate disposal of irradiated fuel would be at a national waste repository.
	Transportation of Radioactive Materials	Radiological effects (dose).	Minor impacts. For normal conditions of transport, a total population dose of 10.1 person-rem per reactor year is conservatively estimated. The total crew (occupational) dose is conservatively estimated to be 19.1 person-rem per reactor year. These values are considered to be minor given the number of shipments estimated, transportation distances assumed, and increased population estimates. The population dose risk impact from accidents is small, much lower than the dose to the exposed population along the transportation route for normal conditions.
		Nonradiological effects (accidents during transport).	Minor impacts. Nonradiological effects from the transportation of fuel (new and spent) and other radiological wastes include traffic density, weight of the loaded truck or railcar, heat from the fuel cask, and transportation accidents. The NRC previously evaluated the environmental effects of transportation of fuel and waste for LWRs and found the impacts to be minor. The Nuclear Technology Park would have sufficient storage capacity to permit irradiated fuel to cool sufficiently to meet the requirements of shipping casks available at the time the fuel is shipped. Shipping weights would comply with federal, state, local, and tribal

Alternative	Project Element	Impact	Severity
			government restrictions as appropriate. The fatal and non-fatal injury consequences, respectively, for unirradiated fuel, and radioactive waste shipments are minor. The conservatively estimated number of fatal injuries associated with transportation accidents is slightly more than two fatal injuries in 100 reactor years.

3.22 Nuclear Plant Safety and Security

This section assesses the environmental impacts of postulated accidents involving proposed SMRs and advanced nuclear reactors, with a combined maximum net electrical output of no more than 800 MWe, at the CRN Site, and plant security including intentional destructive acts. It is divided into three subsections that address design basis accidents (DBAs), severe accidents, and plant security.

3.22.1 Affected Environment

The information provided in the following sections is based on the analysis in the ESPA for SMRs located at Area 1 of the Nuclear Technology Park at the CRN Site. For the purposes of this Draft PEIS, this analysis is used as a surrogate for SMRs and advanced non-LWRs located at Area 1 and/or Area 2, to evaluate potential impacts. Dose consequences associated with an accident occurring for a SMR or an advanced non-LWR at Area 2 are expected to be similar to those for an accident at Area 1 based on the close proximity of the locations. Additionally, this surrogate analysis assumed a 2-mile EPZ. The final EPZ has not yet been determined and will depend on the reactor technology selected. Detailed analyses for design basis accidents and severe accidents will be performed after any SMR and/or advanced non-LWR design has been selected for the Nuclear Technology Park at the CRN Site.

3.22.1.1 Design Basis Accidents

The potential consequences of postulated accidents are evaluated to demonstrate that SMRs and advanced nuclear reactors represented by a surrogate SMR based on a PPE approach could be constructed and operated at the CRN Site without undue risk to the health and safety of the public. As noted in Nuclear Energy Institute (NEI) 10-01, Industry Guideline for Developing a Plant Parameter Envelope (PPE) in Support of an Early Site Permit, Rev. 1 (NEI 2012) accident analyses model the time-dependent transport of radionuclides out of the reactor core through several pathways, each with different time-dependent removal mechanisms for radionuclides. Different reactor designs have different release pathways, and each pathway has different release rates and different radionuclide removal mechanisms. Therefore, the LWR vendor design that generated the largest post-accident dose was selected for use in the CRN Site-specific accident analysis. For the purposes of this Draft PEIS, it is assumed that the analysis for SMRs located at Area 1 is also representative or bounding for advanced non-LWRs, which are smaller and have lower power levels.

3.22.1.1.1 Selection of Accidents

Past PWR DBA analyses have shown that offsite doses due to a postulated loss-of-coolant accident (LOCA) are expected to more closely approach 10 CFR 50.34 (and 10 CFR 52.17) limits than other DBAs that may have a higher probability of occurrence but with resultant lower consequences. Therefore, the analysis evaluated one DBA involving consequences from a LOCA resulting from the single largest break size for the design with the largest power level per SMR unit of the designs being considered. The potential consequences of accidental releases from a DBA depend on the specific radionuclides released, the amount of each radionuclide released, and the meteorological conditions.

3.22.1.1.2 Evaluation Methodology

The LOCA source term (radionuclide activity released to the environment) selected for inclusion in the PPE is based upon vendor input and represents the design with the highest resulting doses at the EAB and the low population zone (LPZ) boundary from the SMR designs under consideration.

The PPE LOCA source term is based on a design that uses standard light water reactor fuel and assumes a core power level for a single unit at 800 MWt. The maximum average burnup assumed for the surrogate plant is 51 GWd/MTU. The methodology and analytical techniques used for development of the source term are similar to those used for large LWRs, and it is anticipated that comparable methodologies and techniques would be used in the development of the SMR accident source terms to be presented in the SMR design control documents.

Some of the baseline assumptions used to derive the source term include:

- Core melt is based on NRC RG 1.183 methodology and assumed design containment leakage with reduction after 24 hours
- Passive containment fission product removal processes

Doses for the LOCA are evaluated at the EAB and LPZ boundary. For environmental reviews, consequences are evaluated assuming realistic meteorological conditions. The evaluation uses the following parameters, as shown in Table 3-83:

- Short-term 50th percentile accident atmospheric dispersion factors (X/Qs) for the CRN Site
- Bounding vendor-provided LOCA doses
- X/Q values associated with the bounding vendor-provided LOCA doses

Doses are calculated based on the amount of activity released to the environment, the dispersion of activity during transport to the receptor (X/Q), the breathing rate at the receptor, and the applicable dose conversion factors. The only parameters that are site-specific are the X/Qs. Hence, it is reasonable to adjust the vendor LOCA doses for site-specific X/Q values.

For a given time step, the vendor dose is multiplied by the ratio of the site-specific X/Q to the vendor X/Q, as shown in the following equation:

$$Dose_{Site} = Dose_{Vendor}\left[\frac{(X/Q)_{Site}}{(X/Q)_{Vendor}}\right]$$

Table 3-83. CRN Site LOCA Doses

Location	Time (hours)	X/Q (sec/m³) Site (50th %)	X/Q (sec/m³) Vendor	*X/Q* Ratio (Site/Vendor)	Dose (rem TEDE) Vendor	Dose (rem TEDE) Site
EAB	0-2	5.58E-04	1.0E-03	0.56	4.4	2.4[1]
LPZ	0-8	4.27E-05	5.0E-04	0.085	4.4	0.38
	8-24	3.80E-05	3.0E-04	0.13	0.20	0.025
	24-96	2.94E-05	1.5E-04	0.20	0.05	0.0098
	96-720	2.04E-05	8.0E-05	0.26	0.06	0.015
				LPZ Total	4.8	0.43[1,2]

[1] Versus the 25 rem TEDE limit specific in 10 CFR 50.34 (and 10 CFR 52.17).
[2] Column total dose not equal sum of individual values due to rounding.

3.22.1.2 Severe Accidents

This section evaluates the potential environmental impacts of severe accidents at the CRN Site. Severe accidents are defined as accidents with substantial damage to the reactor core and degradation of containment systems. Subpart B of 10 CFR 52 requires applications for standard design certification to include information from the probabilistic risk assessment (PRA) of the design. The final design and PRA information was not available for the SMR and advanced nuclear reactor designs under consideration at the time of evaluation. Therefore, a reasonable, bounding estimate of the severe accident consequences for the PPE was made by evaluating the SMR design that represents the largest SMR considered for the CRN Site. This section uses preliminary PRA information for severe accidents for the largest SMR design, along with site-specific characteristics (e.g., meteorological, population, and land use data), to estimate the impacts of severe accidents. For the purposes of this Draft PEIS, it is assumed that the analysis for SMRs is also representative or bounding for advanced non-LWRs.

3.22.1.2.1 Severe Accident Evaluation Methodology

The MACCS2 computer code was developed specifically for the NRC to evaluate severe accidents at nuclear power plants. The NRC has approved MACCS2 analyses of environmental consequences for a new PWR design with passive safety features. The ratio of the thermal power rating of the previously analyzed PWR to the largest SMR considered for the CRN Site was used to estimate the source terms required for analysis of the impacts of severe accidents. Use of the largest SMR for the severe accident analysis is considered to provide representative accident consequences. The relative frequencies, source term chemical groups, and source term release fractions for the severe accident scenarios were calculated as part of the PRA for the SMR design with the maximum thermal output. This data was used together with the MACCS2 ATMOS module input files and an estimated core damage frequency (CDF) to approximate the consequences of severe accidents for the SMR.

The individual reactor considered for this analysis uses the maximum thermal power rating for a single reactor unit (800 MWt) from one of the potential SMR vendors, maximizing the severe accident consequences for an accident involving a single unit.

The CDF is a measure of the likelihood of severe accidents associated with reactor core damage. CDF is estimated using PRA modeling, which evaluates how changes to the reactor or auxiliary systems can change the severity of the accident. The vendor of the SMR considered in this analysis estimates the total CDF for the design to be approximately 4.65E-08 per reactor year (Ryr), which is lower than the CDF for traditional, large LWRs. Table 3-84 presents the relative frequency of each release category.

Table 3-84. Bounding CRN Site SMR Release Category Relative Frequencies

Release Category	Description	Relative Frequency (%)
IC	Intact Containment	91.9
BP	Containment Bypass	4.37
CFE	Early Containment Failure	3.11
CI	Containment Not Isolated	0.55
CFI	Intermediate Containment Failure	0.08
CFL	Late Containment Failure	0.000001
	Total	100

The SMR used in this analysis utilizes six severe accident sequences (i.e., release categories) as follows:

- Intact Containment (IC): Containment integrity is maintained throughout the accident. The release of radioactivity to the environment is due to nominal design leakage.
- Containment Bypass (BP): Radioactivity is released from the reactor coolant system to the environment via the secondary system or other interfacing system bypass. Containment failure occurs prior to the onset of core damage. This accident class contributes to the large, early release frequency (LERF).
- Containment Isolation Failure (CI): Radioactivity is released through a failure of the valves that close the penetrations between containment and the environment. Containment failure occurs prior to the onset of core damage. This accident class contributes to the LERF.
- Early Containment Failure (CFE): Radioactivity release occurs through a containment failure caused by some dynamic severe accident phenomenon after the onset of core damage but prior to core relocation. Such phenomena could

include hydrogen detonation, hydrogen diffusion flame, steam explosions, or vessel failures. This accident class contributes to the LERF.

- Intermediate Containment Failure (CFI): Radioactivity release occurs through a containment failure caused by some dynamic severe accident phenomenon after core relocation but before 24 hours have passed since initiation of the accident. Such phenomena could include hydrogen detonation / deflagration. This accident class contributes to large releases but does not occur early in the accident life cycle.
- Late Containment Failure (CFL): Radioactivity release occurs through a containment failure caused by some dynamic severe accident phenomenon more than 24 hours after initiation of the accident. Such phenomena could include the failure of containment heat removal. This accident class contributes to large releases but does not occur early in the accident life cycle.

The exposure pathways modeled include external exposure from the passing plume, external exposure from material deposited on the ground, inhalation of material in the passing plume or re-suspended from the ground, and ingestion of contaminated food and surface water. The MACCS2 code primarily addresses dose from the air pathway, but also calculates dose from surface runoff and deposition on surface water. The code also evaluates the extent of contamination. The analysis used site-specific meteorology and population data and included the ingestion pathway for the entire life cycle of the accident.

To assess human health impacts, TVA determined the collective dose, risk of early fatalities, and the risk of latent cancer fatalities from a severe accident for the population within a 50-mile radius. Economic costs were also determined, including the costs associated with short term relocation of people, decontamination of property and equipment, and interdiction of food supplies.

The MACCS2 calculations and accident frequency information are used to determine risk. The sum of the accident frequencies, the CDF, includes only internally initiated events. Risk is the product of frequency of an accident multiplied by the consequences of the accident. The consequence can be radiation dose, fatalities, economic cost or farmland that needs to be decontaminated. Dose-risk is the product of the collective dose times the accident frequency. Because the severe accident analysis addressed a suite of accidents (i.e., release categories), the individual risks are summed to provide a total risk (person-rem per Ryr). The same process was applied to estimating the risk of fatalities (fatalities per Ryr), the economic cost-risk (dollars per Ryr), and the risk of farmland decontamination (hectares per Ryr).

3.22.1.3 Plant Security

Licensee security programs and contingency plans deal with threats, thefts, and sabotage relating to nuclear facilities as part of the radioactive materials and activities that the NRC regulates (e.g., 10 CFR 73.55 for traditional LWRs licensed under 10 CFR part 50) in order to protect people and the environment. The NRC ensures safeguards and security by regulating licensees' security programs and contingency plans.

TVA has not yet developed site-specific security and contingency plans for the Nuclear Technology Park. However, TVA has in place detailed, sophisticated security measures to prevent physical intrusion into our nuclear plant sites by hostile forces seeking to gain access to nuclear reactors or other sensitive facilities or materials. These measures include, but are not limited to, intrusion detection and assessment systems, controlled access points, vehicle barrier systems, bullet and blast resistant enclosures and security personnel. TVA security personnel are trained and retrained to react to and repel hostile forces threatening TVA nuclear facilities. TVA's security measures and personnel are inspected and tested via force-on-force security exercises by the NRC. It is highly unlikely that a hostile force could successfully overcome these security measures and gain entry into sensitive facilities and even less likely that they could do this quickly enough to prevent operators from putting plant reactors into safe shutdown mode. TVA expects to follow the same approach for the Nuclear Technology Park in accordance with NRC regulations.

A security threat that is more frequently identified by members of the public or in the media are potential attacks using hijacked jet airliners, the method used on September 11, 2001, against the World Trade Center and the Pentagon. The likelihood of this now occurring is equally remote in light of today's heightened security awareness at airports and the Notice to Airmen (NOTAM) issued by the FAA, but this threat has been carefully studied for operating nuclear power plants. The NEI commissioned EPRI to conduct an impact analysis of a large jet airliner being purposefully crashed into sensitive nuclear facilities or containers including nuclear reactor containment buildings, used fuel storage ponds, used fuel dry storage facilities, and used fuel transportation containers (NEI 2012). Using conservative analyses, EPRI concluded that there would be no release of radionuclides from any of these facilities or containers because they are already designed to withstand potentially destructive events. The EPRI analysis used computer models to simulate a large commercial aircraft crashing into containment structures that were representative of all U.S. nuclear power containment types. The containment structures suffered some crushing and chipping at the maximum impact point but were not breached.

The NRC has amended its regulations to require applicants for new power reactors to perform a design-specific assessment of the effects on the facility of the impact of a large commercial aircraft under regulation 10 CFR 50.150, Aircraft Impact Assessment. TVA would ensure that each of the designs for the reactor technologies being considered for the CRN Site (SMRs and advanced non-LWRs) would follow the applicable requirements of 10 CFR 50.150 for AIA.

3.22.2 Environmental Consequences

3.22.2.1 Alternative A – No Action Alternative

Under this alternative, no completion or construction and operation of a Nuclear Technology Park would occur; therefore, there are no impacts.

3.22.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced Non-LWRs

3.22.2.2.1 Design Basis Accidents

Alternative B is for one or more advanced nuclear reactors at Area 1 on the CRN Site. There are no environmental criteria related to the potential consequences of DBAs. The calculated DBA doses shown in Table 3-83 are considerably smaller than the radiation dose limits of 10 CFR 50.67. Additionally, the site-specific analysis results demonstrate that the surrogate SMR DBA doses meet the site acceptance criteria of 10 CFR 50.34 (and 10 CFR 52.17). Therefore, the environmental consequences from DBAs at the CRN Site are of minor significance for any of the advanced nuclear reactor technologies being considered.

3.22.2.2.2 Severe Accidents

Alternative B is for one or more advanced nuclear reactors at Area 1 on the CRN Site. This subsection evaluates impacts of severe accidents from air, surface water, and groundwater pathways. The MACCS2 code was used to evaluate the doses from the air pathway and from water ingestion with site-specific data. MACCS2 does not model other surface water and groundwater dose pathways. These are analyzed qualitatively based on a comparison of doses from the atmospheric pathway for CRN Site to those of the existing fleet of U.S. nuclear reactors.

3.22.2.2.2.1 Air Pathways

The potential severe accidents for the SMR considered in this analysis were grouped into six accident classes (i.e., release categories) based on the similarity of their characteristics. The number and description of release categories is reactor design specific. Radionuclides that may be released are organized into groups having similar chemical characteristics. Each release category was assigned a set of characteristics representative of the chemical elements for that category. Each release category was analyzed with MACCS2 to calculate population dose, number of early and latent fatalities, economic cost, and the amount of farmland requiring decontamination. The analysis assumed that 99.5 percent of the population within the 2-mile EPZ of the CRN Site would be evacuated following declaration of a general emergency.

For each release category, risk was calculated by multiplying each consequence (population dose, fatalities, cost, and area of contaminated land) by the total CDF and the relative frequency for the release category. The sum of the long-term dose risk to the 50-mile population from atmospheric releases was calculated by MACCS2 for the 2-mile EPZ to be 7.71E-03 person-rem/Ryr (Table 3-86). As shown in Table 3-87 and Table 3-88, this 50-mile population risk is much lower than the risk estimated for (1) the five plants evaluated in NUREG-1150, *Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants*, (NRC 1990) (2) the other current operating reactors in the U.S., (3) the recently licensed AP1000 reactors at the Vogtle site, and (4) the NRC Safety Goals (51 CFR 30028).

For an additional comparison, as reported in Section 3.20, Table 3-73, the calculated collective total body dose based on the PPE source term from normal operation at the CRN Site due to radioactive effluents (liquid and gaseous) is 6.8E+01 person-rem/Ryr. As previously described, dose risk is the total population dose rate (in person-rem/Ryr) multiplied by the frequency, and normal operation has a frequency of one. Therefore, the calculated population dose risk for normal operation is also 6.8E+01 person-rem/Ryr. Comparison of this value to the severe accident dose risk of 7.71E-03 person-rem/Ryr indicates that the calculated dose risk from severe accidents is far less than the calculated dose risk from normal operation.

The economic risk or costs (in dollars per Ryr) of a severe accident are also provided in Table 3-86. The total cost calculation considered consequences, such as evacuation costs, value of crops/milk contaminated and condemned, cost of property decontamination, and indirect costs resulting from loss of property use and incomes as a result of the accident. The economic risk is the total costs associated with the severe accident multiplied by the frequency of the accident. The calculated economic risk of a severe accident for the largest potential SMR at the CRN Site is 29.3 dollars/Ryr. The area of farmland requiring decontamination was calculated by MACCS2 for the 2-mile EPZ to be

1.69E-04 hectares/Ryr. These impacts are lower than those presented in the FEISs for recently approved reactor license applications, such as Vogtle (NRC 2008), and are therefore found to be acceptable.

Table 3-85. Environmental Impacts within a 50-Mile Radius for Severe Accidents at CRN Site

	Population Dose Risk (person-rem per Ryr)		Risk of Fatalities (fatalities per Ryr)			
Release Category	**Water Ingestion**	**Total**	**Early**	**Latent**	**Economic Cost (dollars per Ryr)**	**Farmland Decontamination (hectares per Ryr)**
Containment Bypass (BP)	1.01E-04	6.12E-03	1.77E-11	3.19E-06	2.42E+01	1.35E-04
Early Containment Failure (CFE)	1.55E-05	1.26E-03	0.00E+00	6.57E-07	4.50E+00	3.08E-05
Containment Isolation Failure (CI)	2.18E-06	2.54E-04	2.28E-12	1.97E-07	5.73E-01	3.86E-06
Intact Containment (IC)	1.94E-07	4.79E-05	0.00E+00	2.21E-08	2.53E-02	3.40E-10
Intermediate Containment Failure (CFI)	2.07E-07	3.84E-05	4.06E-15	2.18E-08	4.09E-02	2.81E-07
Late Containment Failure (CFL)	4.50E-11	1.52E-07	0.00E+00	8.25E-11	6.05E-04	3.90E-09
Total	**1.19E-04**	**7.71E-03**	**2.00E-11**	**4.09E-06**	**2.93E+01**	**1.69E-04**

Table 3-86. Comparison of Environmental Risks for the PPE with Risks for Current-Generation Reactors at Five Sites Evaluated in NUREG−1150 and NRC Safety Goals

Reactor Facility	Core Damage Frequency (/Ryr)	50-mile Population Dose Risk (Person-rem/Ryr)	Fatalities (/Ryr)		Average Individual Fatality Risk (/Ryr)	
			Early	Latent	Early	Latent Cancer
Grand Gulf[1]	4.0E-06	5E+01	8E-09	9E-04	3E-11	3E-10
Peach Bottom[1]	4.5E-06	7E+02	2E-08	5E-03	5E-11	4E-10
Sequoyah[1]	5.7E-05	1E+03	3E-05	1E-02	1E-08	1E-08
Surry[1]	4.0E-05	5E+02	2E-06	5E-03	2E-08	2E-09
Zion[1]	3.4E-04	5E+03	4E-05	2E-02	9E-09	1E-08
PPE at the CRN Site[2]	4.7E-08	8E-03	2E-11	4E-06	1E-13	9E-12
NRC Safety Goals[3]	N/A	N/A	N/A	N/A	4E-07	2E-06

[1]Risks were calculated using the MACCS2 code and presented in NUREG-1150.
[2]Risks were calculated with MACCS2 code using CRN Site site-specific input.
[3]Provided by the NRC in the Safety Goal Policy Statement (51 FR 30028).

Note:
N/A = Not Applicable

Table 3-87. Comparison of Environmental Risks from Severe Accidents for PPE with Risks for New Nuclear Plants and Current Nuclear Power Plants Undergoing Operating License Renewal Review

	Core Damage Frequency (per year)	50-mile Population Dose Risk (person-rem/Ryr)
Current Reactor Maximum[1]	2.4E-04	6.9E+01
Current Reactor Mean[1]	3.1E-05	1.5E+01
Current Reactor Median[1]	2.5E-05	1.3E+01
Current Reactor Minimum[1]	1.9E-06	3.4E+01
AP1000 Reactor at Vogtle site[2]	2.4E-07	2.8E-02
PPE at the CRN Site[3]	4.7E-08	7.7E-03

[1]Based on MACCS2 calculations for over 70 current plants at over 40 sites (NUREG-2168).
[2]NUREG-1872 (FEIS for Vogtle ESP)
[3]Calculated with MACCS2 code using CRN Site-specific input

3.22.2.2.2.2 Surface Water Pathways

People can be exposed to radiation when airborne radioactivity is deposited onto surface water. The exposure pathways can include drinking the water, aquatic food, swimming, and shoreline pathways. Surface water bodies within 50 miles of the CRN Site include the Reservoir and other smaller bodies of water.

The NRC examined the aquatic food, swimming, and shoreline pathways in NUREG-0769, *Final Environmental Impact Statement Related to the Operation of Enrico Fermi Atomic Power Plant, Unit No. 2,* and demonstrated that the dose from the aquatic food pathway was more than ten times the dose from the combined swimming and shoreline doses. The examination concluded that the uninterdicted aquatic food pathway was the principal pathway of exposure and the swimming and shoreline pathways were not significant. The NRC also evaluated doses from the aquatic food pathway for nuclear power plants discharging to various bodies of water in NUREG-1437, Rev. 0. NUREG-1437, Subsection 5.3.3.3.3 concluded that the risk associated with the aquatic food pathway is small relative to the atmospheric pathway for most sites, including small and large river sites. The CRN Site is a good approximation of the generic small river site examined in the NUREG-0440, *Liquid Pathway Generic Study: Impacts of Accidental Radioactive Releases to the Hydrosphere from Floating and Land-based Nuclear Power Plants* (i.e., the source of the NUREG-1437 analysis).

MACCS2 was used to calculate the dose from drinking water pathway for surface water sources. The sum of the severe accident dose risk to the 50-mile population from drinking water was calculated by MACCS2 for the 2-mile EPZ to be 1.19E-04 person-rem/Ryr (Table 3-85). The total drinking water dose risk is very small in comparison to the total dose risk for the atmospheric pathways. This dose risk is also lower than the dose risk from the drinking water pathway presented in the FEIS for recently approved reactor license applications, such as Vogtle (NUREG-1872), and are therefore found to be acceptable.

3.22.2.2.2.3 Groundwater Pathways

People could receive a dose from groundwater pathways. Radioactivity released during an accident can enter groundwater that serves as a source of drinking water or move through an aquifer that eventually discharges to surface water. The MACCS2 code does not calculate the dose from groundwater pathways. NUREG-1437, Rev. 0, evaluated the groundwater pathway dose, based on the analysis in NUREG-0440. NUREG-0440 analyzed a core meltdown that contaminated groundwater and subsequently contaminated surface water. NUREG-0440 did not analyze direct groundwater drinking at small river sites because of the limited number of potable groundwater wells. Therefore, Subsection 5.3.3.4.1 of NUREG-1437, Rev. 0, concludes that the dose from the groundwater pathway for small river sites is considered to be “minor or nonexistent.” As stated previously, the CRN Site is a good approximation of the generic small river site examined in NUREG-0440.

3.22.2.2.2.4 Health Risks

Based on the total calculated dose risk from the SMR at the CRN Site considered in this analysis, the risk of early fatalities to the 50-mile population was calculated to be 2.00E-11 fatalities/Ryr and the risk of latent cancer fatalities to the 50-mile population was calculated by MACCS2 for the 2-mile EPZ to be 4.09E-06 fatalities/Ryr. These fatality risks are lower than the fatality risks presented in the FEIS for recently approved reactor license applications. For Vogtle, in NUREG-1872, fatality risks are reported as1.9E-10 early fatalities/Ryr and 1.9E-05 latent fatalities/Ryr. While these risks are site-specific and dependent on local meteorology and regional populations, CRN Site risks are considered comparable to other facilities.

In addition, the MACCS2 computer code estimated the average individual fatality risks to be 1.27E-13 per Ryr from early fatalities within about one mile of CRN Site and 9.12E-12 per year from latent cancer fatalities within 10 miles. These risks are well below the safety goals for the average individual early fatality and latent cancer fatality risks set by the NRC in the Safety Goal Policy Statement (51 FR 30028) − less than 0.1 percent of risk resulting from other accidents. As indicated in NUREG-2168, Environmental Impact Statement for an ESP at the PSEG Site, Final Report (NRC 2015), the individual risk of a prompt fatality from all other accidents to which members of the U.S. population are generally exposed is about 4E-04 per year, and the sum of cancer fatality risks resulting from all other causes for an individual is taken to be the cancer fatality rate in the U.S., which is about 2E-03 per year. The risks estimated for the CRN Site are much less than one-tenth of one percent of these everyday public risks.

3.22.2.2.2.5 Conclusions

These estimates of the environmental impacts of severe accidents are considered to be bounding for the SMRs or advanced nuclear reactors under consideration for the CRN Site. Also, as provided in Table 3-86 and Table 3-87, the 50-mile population dose risks and the population fatality risks are less than those calculated for other operating reactors or new reactors currently under construction and the individual fatality risks are several orders of magnitude below the NRC Safety Goals.

Based on the discussions in the subsections above, these environmental impacts are concluded to be minor.

3.22.2.2.3 Plant Security

TVA's implementation of detailed, sophisticated security measures at the CRN Site in accordance with NRC regulations, similar to those implemented at TVA's other nuclear facilities, would help prevent physical intrusion by hostile forces seeking to gain access to nuclear reactors or materials. These robust security measures would help prevent release of radioactive material as set forth in NRC regulations.

Furthermore, TVA would ensure that each of the designs for the reactor technologies being considered for the CRN Site (SMRs and advanced non-LWRs) would follow the applicable requirements of 10 CFR 50.150 for AIA.

In conclusion, under Alternative B (including Alternatives B1 and B2), the implementation of nuclear security measures and AIA are considered to have a minor and beneficial environmental impact as they prevent release of radionuclides by adversary force attacks.

3.22.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced Non-LWRs

Alternative C is for one or more advanced non-LWRs at Area 2 on the CRN Site. The potential environmental consequences discussed for Alternative B are also applicable to Alternative C, since the evaluation applies to the entire CRN site and is for a surrogate SMR that is considered to be representative or conservative. Therefore, the environmental consequences from DBAs and severe accidents would also be minor for Alternative C. Similarly, the implementation of nuclear security measures and AIA under Alternative C are similar to those under Alternative B and are considered to have a beneficial environmental impact as they prevent release of radionuclides by adversary force attacks.

3.22.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced Non-LWRs

Alternative D is for one or more advanced nuclear reactors at Area 1 and Area 2 on the CRN Site. The potential environmental consequences discussed for Alternative B are also applicable to Alternative D, since the evaluation applies to the entire CRN site and is for a surrogate SMR that is considered to be representative or conservative. Therefore, the environmental consequences from DBAs and severe accidents would also be minor for Alternative D. Similarly, the implementation of nuclear security measures and AIA under Alternative D are similar to those under Alternative B and are considered to have a beneficial environmental impact as they prevent release of radionuclides by adversary force attacks.

3.22.2.5 Summary of Impacts to Nuclear Plant Safety and Security

As summarized in Table 3-88, the impacts associated with DBAs, severe accidents, and plant security are considered to be minor. There are no specific environmental criteria related to the potential consequences of DBAs or severe accidents. However, the calculated DBA doses are considerably smaller than the radiation dose limits of 10 CFR 50.67 and meet the site acceptance criteria of 10 CFR 50.34 (and 10 CFR 52.17). Additionally, for severe accidents, the 50-mile population dose risks and the population fatality risks are less than those calculated for other operating reactors or new reactors currently under construction and the individual fatality risks are several orders of magnitude below the NRC Safety Goals. Therefore, the environmental consequences from DBAs and severe accidents at the CRN Site are considered to be minor. In addition, impacts from plant security include the implementation of nuclear safety measures and the requirements of 10 CFR 50.150, which are considered to have a beneficial environmental impact by preventing the release of radionuclides by adversary forces. Finally, 10 CFR 100.20(b) requires TVA to evaluate the nature and proximity of human-related hazards to establish site parameters for use in determining whether a plant design can accommodate commonly occurring hazards and whether the risk of other hazards is very low. The acceptability of a site depends on establishing that (1) an accident at a nearby facility will not result in radiological consequences that exceed the dose guideline in 10 CFR 50.34; (2) the accident poses no undue risk because it is sufficiently unlikely to occur; or (3) the nuclear power station can be designed so its safety will not be affected by the accident. Therefore, the impacts associated with plant safety and security are minor. Any site-specific impacts that are analyzed in the future that are expected to fall outside of the bounding analysis in this PEIS will be analyzed in subsequent NEPA analysis.

Table 3-88. Summary of Impacts Associated with Nuclear Plant Safety and Security

Alternative	Project Phase	Impact	Severity
Design Basis and Severe Accidents			
Alternatives B, C, D	Operation	Potential for radiological releases resulting from DBAs or severe accidents.	Minor impacts. Conservative or bounding analyses show that radiological dose to the public resulting from a postulate DBA meet regulatory limits. For severe accidents, the calculated dose risk from atmospheric pathways is far less than the calculated dose risk

Alternative	Project Phase	Impact	Severity
			from normal operation. Additionally, the total drinking water dose risk is very small in comparison to the total dose risk for the atmospheric pathways. For the CRN Site, dose from groundwater pathways is also considered to be negligible. For severe accidents, the conservatively calculated doses and associated estimates of early fatalities or latent cancer fatalities would be several orders of magnitude below the NRC Safety Goals.
		Economic impacts of a severe accident.	Minor impacts. The economic impacts of a severe accident include evacuation costs, lost value of contaminated crops/milk, cost of property decontamination, and indirect costs resulting from loss of property use and incomes. The calculated economic risk of a severe accident at the CRN Site is 29.3 dollars/Ryr and the area of farmland requiring decontamination for the 2-mile EPZ is 1.69E-04 hectares/Ryr. These impacts are lower than those presented in the FEISs for recently approved nuclear reactors.
Nuclear Plant Safety and Security			
Alternatives, B, C, D	Operation	Prevention of release of radionuclides resulting from nearby hazards or an adversarial force.	Minor (beneficial impacts). The implementation of nuclear safety measures and the requirements of 10 CFR 50.150 and 10 CFR 100.20 are considered to have a beneficial environmental impact by preventing the release of radionuclides resulting from nearby hazards or an adversarial force.

3.23 Decommissioning

3.23.1 Affected Environment

3.23.1.1 Decommissioning Regulations

The NRC requires that a nuclear facility be decommissioned per NRC regulations after cessation of operations by safely removing the facility from service and reducing residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license or release of the property under restricted conditions and termination of the license. NRC regulation 10 CFR 50.82, Termination of License specifies the actions that the NRC and licensee must take to decommission a nuclear power facility. The requirements for release of a nuclear power facility for unrestricted use is specified in 10 CFR 50.83, Release of Part of a Power Reactor Facility or Site for Unrestricted Use. The radiological criteria to be met for license termination are specified in 10 CFR 20, Subpart E. The NRC provides guidance to implement the rules in NUREGs in identifying specific methods for meeting the requirements. NRC regulations require the licensee to submit a post-shutdown decommissioning activities report (PSDAR) to the NRC and any affected States no later than two years after the date of permanent cessation of operation. The PSDAR includes:

- A description of site conditions
- The planned decommissioning activities
- A description of the methods used to ensure protection of workers and the public against radiation hazards
- A description of the planned final radiation survey
- An updated cost estimate
- A comparison of the cost estimate with funds set aside for decommissioning
- A plan for ensuring the availability of adequate funds for completing the project

Guidance and methods to evaluate the environment impacts during decommissioning of a facility are provided in NUREG-0586, Supplement 1, Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, Regarding the Decommissioning Nuclear Power Reactors, issued in 2002 (NRC 2002). This document supplements the Final Generic Environment Impact Statement on Decommissioning a Nuclear Facility, issued in 1998 (NUREG-0586) (NRC 1998). Detailed analysis of decommissioning alternatives and plans are not required by the NRC until after a decision has been made to cease operation. Therefore, the evaluation addresses only general environmental impacts of decommissioning.

For the purposes of the evaluating the environmental impacts of decommissioning the various reactor designs considered by this Draft PEIS, the decommissioning process and requirements for LWRs as described in NUREG-0586 are considered bounding of SMRs and advanced non-LWR reactor technologies under consideration by this Draft PEIS. Note that the construction of the selected reactors for the Nuclear Technology Park may be staggered and would likely over a period of 20 years or more. Therefore, decommissioning of the reactors would likely not occur concurrently.

3.23.1.2 Decommissioning Strategies

The three NRC approved strategies of decommissioning nuclear power facilities are:

1. **DECON**. A method of decommissioning in which structures, systems, and components that contain radioactive contamination are removed from a site and safely disposed at a commercially operated LLW disposal facility or decontaminated to a level that permits the site to be released for unrestricted use shortly after it ceases operation.

   The DECON option calls for the prompt removal of radioactive material at the end of the plant life. Under DECON, all fuel assemblies, nuclear source material, radioactive fission and corrosion products, and all other radioactive and contaminated materials above NRC-restricted release levels are removed from the plant. The reactor pressure vessel and internal components would be removed along with removal and demolition of the remaining systems, structures, and components with contamination control employed as required. This is the most expensive of the three options, primarily due to price escalation for disposal of LLW.

2. **SAFSTOR.** A method of decommissioning in which a nuclear facility is placed and maintained in a condition that allows the facility to be safely stored and subsequently decontaminated (deferred decontamination) to levels that permit release for unrestricted use.

   SAFSTOR is a deferred decontamination strategy that takes advantage of the natural dissipation (decay) of radiation. After all fuel assemblies, nuclear source material, radioactive liquid, and solid wastes are removed from the plant, the remaining physical structure would then be secured and mothballed. Monitoring systems would be used throughout the dormancy period and a full-time security force would be maintained. The facility would be decontaminated to NRC-unrestricted release levels after a period of up to 60 years, and the site would be released for unrestricted use. Although this option makes the site unavailable for alternate uses for an extended period, worker and public doses would be much smaller than under DECON, as would the need for radioactive waste disposal.

3. **ENTOMB.** A method of decommissioning in which radioactive contaminants are encased in a structurally long-lived material, such as concrete. The entombed structure is maintained, and surveillance is continued until the entombed radioactive waste decays to a level permitting termination of the license and unrestricted release of the property. During the entombment period, the licensee maintains the license previously issued by the NRC.

   This option reduces worker and public doses, but most power reactors would have radionuclides in concentrations exceeding the limits for unrestricted use even after 100 years. The NRC staff position is that entombment should be used as a last resort for the decommissioning of power reactor facilities, with the expectation that this method would be selected only under unique decommissioning circumstances. The ENTOMB method has not been used in the U.S. and is not envisioned for decommissioning of the Nuclear Technology Park at the CRN Site.

The strategy for decommissioning of the Nuclear Technology Park at the CRN Site (DECON or SAFSTOR or combination) does not have to be identified until PSDARs are issued for each selected reactor technology.

3.23.1.3 Decommissioning Phases

Reactors might be licensed and constructed in the Nuclear Technology Park over a period of 20+ years. to achieve aspirations of net-zero carbon emissions by 2050. Each reactor would have its own licensing timeframe, so it is expected that reactors would be decommissioned on a staggered basis over a number of years. Nevertheless, each plant to be decommissioned would follow NRC's four phase decommissioning process as described below.

Phase 1 is administrative and involves preparations to shut-down the facility and begin the decommissioning process. Activities include planning for decommissioning, determining the decommissioning option, physical changes to the facility, changes to the organization (i.e., destaffing, employee retention program, hiring decommissioning contractors), and determining licensing basis change. The PSDAR may be submitted prior to shutdown, which allows immediate decommissioning following certification of the permanent shutdown and removal of fuel. Phase 1 typically occurs 1 ½ to 2 ½ years before planned shutdown.

Phase 2 is the transition from operation to decommissioning. Fuel would be transferred from the reactor into the spent fuel pool. Isolation and stabilization of all unnecessary structures, systems, and components are conducted during this phase. There is benefit for chemical decontamination of the primary system and establishment of a nuclear island. Phase 2 lasts about ½ to 1 ½ years.

Phase 3 consists of the decontamination and dismantlement of the facility. Activities include maintaining and emptying spent fuel when the fuel is transferred to spent fuel storage, removing the nuclear steam supply system (NSSS) and reactor pressure vessel (RPV) internals, decontaminating buildings and components, segmenting and removing radioactive components, removing large components, and LLW packaging, transportation, and vendor processing/disposal. Phase 3 can take between 3 ½ to 10 years.

Phase 4 is license termination. Activities include final site characterization, final radiation survey for final license termination plan submitted at least 2 years before termination, and final site survey.

3.23.1.4 Decommissioning Environmental Standards

10 CFR 50.82, Termination of License, paragraph (a)(6)(ii) states that the licensee must not permit any decommissioning activity that "result in significant environmental impact not previously reviewed". 10 CFR 50.82, paragraph (a)(4) states that "Prior to or within 2 years following permanent cessation of operation, the licensee shall submit a PSDAR to the NRC, and a copy to the affected State(s)." The PSDAR must contain a description of the planned decommissioning activities along with a schedule for their accomplishment, a discussion that provides the reasons for concluding that the environmental impacts associated with site-specific decommissioning activities would be bounded by appropriate previously issued EISs, and a site-specific decommissioning cost estimate, including the projected cost of managing irradiated fuel".

The list of environmental items in NUREG-0586, Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, Supplement 1 issued in 2002 considers the technological advances in decommissioning to evaluate environmental impacts during decommissioning of nuclear power light water reactors. NUREG-0586 requires a full interdisciplinary analysis of all appropriate natural and human environmental resource factors.

3.23.2 Environmental Consequences

3.23.2.1 Alternative A – No Action Alternative

Under this alternative, construction, operation, or decommissioning of a Nuclear Technology Park would occur; therefore, there would be no impacts from decommissioning.

3.23.2.2 Alternative B – Nuclear Technology Park at Area 1 with SMRs and/or Advanced non-LWRs

Under Alternative B, the environmental impacts of decommissioning would be minor for all environmental resources. The air quality, water quality, and ecological impacts of decommissioning are expected to be substantially smaller than those experienced during facility construction or operation because the level of activity and the releases to the environment are expected to be smaller. Adverse socioeconomic impacts of decommissioning could result from the demands on, and contributions to, the community by the workers employed to decommission the facility and from reduction in the operations workforce.

The NRC identified in SECY-11-0181, Decommissioning Funding Assurance for Small Modular Nuclear Reactors, differences between potential SMR designs, such as those included in consideration for Alternative B, and previously licensed reactor designs that could impact decommissioning strategies (NRC 2011a). These differences include:

- Reduced size and quantity of components and equipment to be disposed
- Reduced area to be decontaminated (depending on the number of modules)
- Possible difficulty with accessibility for decontamination because of the small size of the components
- Possible difficulties related to the decommissioning of modules while other modules are in operation

The projected physical facility inventories associated with advanced nuclear reactor designs are expected to be less than those for currently operating nuclear reactors due to advances in technology, the smaller size reactor facility footprints anticipated to be sited at the Nuclear Technology Park, and simplified maintenance regimes for advanced nuclear reactors. Based on this comparison, the general environmental impacts identified in NUREG-0586 are bounding for any advanced nuclear reactor facility constructed and operated in the Nuclear Technology Park.

Therefore, the impacts associated with decommissioning would be minor. Further environmental reviews would be conducted at the time the PSDAR is submitted to refine the impact analysis associated with the specific reactor technology chosen for the Nuclear Technology Park.

3.23.2.3 Alternative C – Nuclear Technology Park at Area 2 with Advanced non-LWRs

As discussed in Section 3.22.1, the decommissioning process and requirements for traditional LWRs as described in NUREG-0586 are considered bounding of SMRs and advanced non-LWR technologies. Therefore, under Alternative C the environmental impacts of decommissioning non-LWR advanced nuclear reactors at Area 2 would be similar to those described under Alternative B and would be minor. Because advanced non-LWRs consist of a range of technologies with different existing and proposed nuclear fuel types, it is expected that additional NRC reviews would be conducted during the licensing process for non-LWR designs selected for construction and operation in the Nuclear Technology Park, to evaluate appropriate potential decommissioning strategies. Further environmental reviews would be conducted at the time the PSDAR is submitted to refine the impact analysis associated with decommissioning of the specific reactor technology chosen for the Nuclear Technology Park.

3.23.2.4 Alternative D – Nuclear Technology Park at Area 1 and Area 2 with SMRs and/or Advanced non-LWRs

Under Alternative D, the environmental impacts of decommissioning would be similar to those described for Alternative B and C. Therefore, the impacts associated with Alternative D due to decommissioning would also be minor.

3.23.2.5 Summary of Impacts from Decommissioning

A decommissioning plan relative to each potential reactor deployed at the CRN Site would be developed for approval by the NRC, with appropriate environmental reviews conducted prior to TVA preparation to decommission any potential plant in the future. For the purpose of evaluating future environmental impacts associated with decommissioning, LWRs as described in NUREG-0586 are considered bounding of the SMR and advanced non-LWR Reactor technologies that are being considered for the Nuclear Technology Park.

Environmental issues associated with decommissioning were analyzed in the Generic Environmental Impact Statement for License Renewal of Nuclear Power Plants, NUREG-1437 (NRC 1996). The potential environmental impacts of decommissioning are minor as shown in Table 3-89. Further environmental reviews would be conducted at the time a decommissioning plan is proposed.

Table 3-89. Summary of Impacts from Decommissioning

Alternative	Project Phase	Impact	Severity
Alternatives B, C, D	Decommissioning	Potential impacts to air quality, water quality, ecological resources, socioeconomics, and other resource areas as defined in NUREG-0586.	Minor impacts. Impacts of decommissioning are expected to be substantially smaller than those experienced during facility construction or operation because the level of activity and the releases to the environment are expected to be smaller. Also, per in general, as stated in NUREG-0586, decommissioning generally results in positive environmental impacts.

3.24 Unavoidable Adverse Environmental Impacts

Unavoidable adverse impacts are the effects of the proposed action on natural and human resources that would remain after mitigation measures or BMPs have been applied. Mitigation measures and BMPs are typically implemented to reduce a potential impact to a level that would be below the threshold of significance as defined by the CEQ and the courts. Impacts associated with the construction and operation of a Nuclear Technology Park at the CRN Site have the potential to cause unavoidable adverse effects to several natural and human environmental resources. TVA would reduce the potential for adverse effects to the extent practicable during the planning process. In addition, TVA would implement mitigation measures (Section 2.8) to further reduce potential adverse effects to certain environmental resources. Chapter 3 discusses in detail the potential impacts from construction and operation of the proposed Nuclear Technology Park at the CRN Site and presents mitigation and controls intended to lessen the adverse impacts. Unavoidable adverse impacts associated with construction and operation activities to each resource evaluated in the EIS where applicable are discussed below.

3.24.1 Unavoidable Adverse Impacts During Construction

Under Alternatives B, C, and D, most unavoidable adverse impacts from construction are attributable to activities involving land disturbance from preparing the CRN site such as vegetation clearing, excavation, grading, filling wetlands, filling or culverting intermittent streams and waterways, adding impervious surfaces, upgrading of onsite and offsite access routes and construction of new routes, and installation of intake and discharge structures.

It is estimated that depending on the alternative selected, up to approximately 632.9 acres of the CRN Site would be affected by construction activities, including approximately 553.9 acres that would be permanently covered by the facility or otherwise developed and approximately 79.0 acres that would be used temporarily as laydown during construction would result in an unavoidable adverse impact to terrestrial resources. Approximately 240 acres within Area 1 were previously disturbed during the CRBRP project as described in Section 2.4.1.1 and shown in Figure 3-22. The terrestrial communities mainly affected by the current proposed action include mixed evergreen-deciduous, deciduous, evergreen forest, woody wetlands, and herbaceous vegetation. Unavoidable adverse impacts on aquatic ecology would include physical alteration of habitat from in-filling of streams and ponds, associated alteration of adjacent riparian zones, placement of cofferdams, installation of new or replacement culverts and localized dredging activities, installation of shoreline stabilization measures, and ensuing localized changes in water quality. A total of 0.69 acres of nearshore underwater habitat is expected to be impacted by construction activities in the Reservoir. Impacts to streams would result in direct alteration and loss of aquatic habitat and associated riparian zones. These impacts would result from installation of the water intake structure, discharge piping, and improvements at the BTA. These habitat alterations would result in impacts to localized species composition and wildlife habitat for the lands immediately affected. However, due to the abundant habitat of similar quality within the vicinity of the project sites, the overall impact to is considered minor.

Forest and herbaceous vegetation that may offer some suitable summer roosting and/or foraging habitat to state- and federally listed bats would be removed under the action alternatives. In addition, proposed actions would occur in the vicinity of a transitional roosting cave used by federally listed gray bats. Depending on the duration between previous bat surveys and site-specific design, additional presence/absence surveys may be required prior to construction activities. Where feasible, tree removal would occur in winter to minimize impacts to roosting bats. Consultation with the USFWS under Section 7 of the

ESA would occur when specific designs have been selected and scope of the project has been refined. By implementing minimization measures such as winter tree removal and any additional conservation measures that may result from the Section 7 consultation, substantial impacts to state- and federally listed bats are not anticipated.

Unavoidable impacts to surface waters include the elimination of up to seven perennial streams (1,775 linear feet), six intermittent streams (2,655 linear feet), 13 ephemeral stream (3,931 linear feet), two small ponds (0.9 acre) within the CRN Project Area. Up to 9,050 lineal feet of shoreline would also be affected by the installation of shoreline stabilization and restoration measures. Additionally, there is anticipated to be local and temporary increase in sediments in water from increased erosion and construction stormwater runoff, and discharge of excavation dewatering. Unavoidable impacts associated with underwater excavation would result in minor localized changes in flow patterns along the reservoir bottom due to differences in bottom contours at the edges of the excavation zone, as well as temporary suspension of sediments during excavation. Unavoidable adverse impacts to wetlands include the permanent disturbance of 14.7 acres of 46 wetlands on the CRN Project Area, approximately 6.56 acres of wetlands would be permanently altered. These impacts overall are minor to moderate and would be mitigated through adherence to permit requirements and the provision of appropriate compensatory mitigative measures, if needed. Temporary impacts to water quality from runoff during construction could impact nearby receiving water bodies but would be reduced with application of appropriate BMPs.

Unavoidable localized increases in air emissions, noise, and visual discord would also occur during construction activities. Activities associated with the use of construction equipment may result in varying amounts of fugitive dust, emissions of pollutants and GHGs from land-disturbing activities, and noise that may potentially impact onsite workers, users of adjacent recreational lands and water bodies, and residents located across the reservoir, and visual discord from construction equipment. Workers would use appropriate protection and adhere to safety standards designed to minimize worker-related injuries. Emissions from onsite construction activities and equipment are minimized through implementation of BMPs including proper maintenance of construction equipment and vehicles. Overall, these impacts would be minor to moderate.

During the peak of construction, traffic generation would be substantial during key morning and afternoon commute times on principal access routes surrounding the CRN Site. However, with proposed roadway improvements at TN 58 and Bear Creek Road and along Bear Creek Road leading into the CRN Site, traffic impacts during construction would be minor, and the LOS metrics would be improved at most key intersections with the exception of TN 95 at Bear Creek Road. At this location, where the LOS is currently rated LOS F, traffic delays would worsen during construction due to heavy volumes during the peak hour associated with ORR and additional traffic using the TN 95 Access. This additional traffic would also increase noise and fugitive dust in areas proximate to these roads, potentially affecting sensitive noise receptors along the routes. Emissions from construction equipment are minimized through implementation of BMPs including proper maintenance of construction equipment and vehicles and dust suppression measures.

Construction could impact up to six of the 13 identified potentially eligible archaeological sites within or partially within the CRN Project Area, resulting in unavoidable adverse impacts to historic and cultural resources. Once specific project plans are available, TVA would undertake steps required in the PA between TVA, the TN SHPO, and federally recognized tribes including additional investigations, determination of NRHP eligibility status, and appropriate mitigation.

In the context of the availability of regional resources that are similar to those unavoidably adversely affected by the project, coupled with the application of appropriate BMPs, the adherence to permit requirements, and the temporary nature of construction activities, unavoidable adverse impacts of construction activities would range from minor to moderate.

3.24.2 Unavoidable Adverse Impacts During Operation

Operations of the Nuclear Technology Park would create an unavoidable adverse impact on air quality and GHG emissions. Operations would increase gaseous and particulate emissions from auxiliary systems (auxiliary boilers, diesel generators, gas turbines, and emergency equipment) and cooling towers. Visual impact from the cooling towers and associated plumes would, under certain conditions, result in an unavoidable adverse impact on visual aesthetics for the surrounding area. The scenic integrity would drop from moderate to low. These impacts would be minor to moderate and would be minimized through implementation of BMPs and adherence to parameters of the respective permits.

Potential unavoidable impacts associated with nonradiological public health and safety include general occupation health risks, occupational illnesses, and etiological agents from thermal discharges to the Reservoir. Radiological unavoidable impacts include the possibility of exposure from radon-222 and technetium-99 releases, which can cause bone and lung cancer and gastrointestinal tract and kidney complications respectively. However, these impacts would be reduced by adherence to NRC and OSHA safety standards.

Operation of the Nuclear Technology Park would contribute to unavoidable adverse impacts related to the uranium fuel cycle, transportation of fuels and wastes, and storage of spent fuel. Impacts include liquid and gases radioactive waste leakages and transportation of and permanent land commitments for storage of solid radioactive waste. All sources of radioactive waste and the transportation and storage of spent fuel would comply with NRC requirements.

The unavoidable adverse impacts of operating a Nuclear Technology Park at the CRN Site would range from minor to moderate.

3.25 Relationship of Short-Term Uses and Long-Term Productivity

NEPA requires a discussion of the relationship between short-term uses of the environment versus the maintenance and enhancement of long-term environmental productivity. This Draft PEIS focuses on the analyses of environmental impacts associated with the construction and operation of a Nuclear Technology Park at the CRN Site, as well as infrastructure improvements in associated offsite areas. These activities are considered short-term uses of the environment for the purposes of this section. In contrast, the long-term productivity is considered to be that which occurs beyond the conclusion of decommissioning the Nuclear Technology Park and associated infrastructure. This section includes an evaluation of the extent that the short-term uses preclude any options for future long-term use of the project site.

The uses of the human environment associated with the proposed action include unavoidable adverse impacts to resources associated with both construction and operation of the Nuclear Technology Park, as described above. Impacts which would cease or be reversed following plant decommissioning are considered short-term, because they would be restored to a state which supports long-term productivity following decommissioning. These include impacts to resources such as air quality, terrestrial ecology, aquatic ecology, noise, visual resources, and socioeconomic resources. The long-term productivity of those resources that can be restored following decommissioning would not be considered long-term. Impacts which cannot be reversed or would continue past decommissioning of the Nuclear Technology Park, may be considered long-term. These include impacts to resources such as land use, water resources, and impacts to historic properties. Long-term management of radioactive waste from operations and decommissioning and management of irradiated fuel that must be safeguarded and isolated for extended durations and therefore, represents a long-term commitment of resources long after decommissioning.

The short-term use of some resources and long-term use of others, and irreversible and irretrievable commitment of depletable resources would be offset by the benefit of the demonstration of nuclear technology capabilities. This benefit would be considered short-term, occurring during the operating life of the Nuclear Technology Park. This benefit would be much larger than the productivity of any other uses of those resources during the operational life of the Nuclear Technology Park. The Nuclear Technology Park would continue to have long-term benefits even after decommissioning, as plant structures and site infrastructure may be repurposed to other productive uses which could continue to support economic activity. Lastly, the operation of the Nuclear Technology Park would serve as a demonstration of nuclear technology as a viable option for electric power production at other sites, even after all of the reactors in the Nuclear Technology Park have been decommissioned.

3.26 Irreversible and Irretrievable Commitments of Resources

The term irreversible commitments of resources describes environmental resources that are potentially changed by the construction or operation of the proposed project that could not be restored to their prior state by practical means at some later time. Irreversible commitments generally occur to nonrenewable resources such as minerals or cultural resources and to those resources that are renewable only over long timespans, such as soil productivity. A resource commitment is considered irretrievable when the use or consumption is neither renewable nor recoverable for the use until reclamation is successfully applied. Irretrievable commitments generally apply to the loss of production, harvest, or other natural resources and are not necessarily irreversible. For example, the construction of a road through a forest would be an irretrievable commitment of the productivity of timber within the road ROW as long as the road remains. Mining of ore is an irreversible commitment of a resource as the ore cannot be restored once it is removed and used.

3.26.1 Irreversible Commitments of Resources

Commitment of land including permanently filled wetlands and streams, for the construction and operation of the Nuclear Technology Park and associated offsite areas would be largely unavailable for other uses. Permanent disturbances to wetlands, surface waters, and archaeological sites would be irreversible. Similarly, impacts to nonmobile biota during construction would also be irreversible. Consumptive water uses during construction and during operation of the Nuclear Technology Park would be irreversibly lost from Watts Bar Reservoir. Operation of the SMRs at the CRN Site generates radioactive, hazardous, and nonhazardous waste requiring disposal. These waste streams are to be treated at permitted facilities or disposed in permitted landfills. Land committed to the disposal of such wastes would have an irreversible impact on their use as it would be committed for that use with few other purposes.

3.26.2 Irretrievable Commitments of Resources

Irretrievable commitments of resources resulting from construction and maintenance of a Nuclear Technology Park at the CRN Site would be similar to those of any major construction project. Actual commitment of construction resources would depend on the potential reactor designs selected by TVA. It is anticipated that some metals, concrete, and other materials used in the construction of the Nuclear Technology Park would become contaminated or irradiated over the life of the facility operations. Much of that material cannot be reused or recycled. However, while the expected use of construction materials associated with construction of a Nuclear Technology Park are irretrievable, it is not detrimental to the availability of these resources. Additionally, nonrenewable energy in the form of fuels and electricity during construction, and operation of the Nuclear Technology Park. Ancillary (e.g., vehicles and equipment) usage, and power supplied for plant operations would be supplied from the overall TVA electrical grid which includes coal and gas-fired generation. However, the total amount consumed during construction and operation is very small compared to overall usage in the U.S.

Operation of the Nuclear Technology Park also requires the irretrievable commitment of uranium ore. The amount of uranium ore and existing highly enriched uranium in the U.S. and Russia that could be processed into fuel are available in sufficient quantities, so that the irreversible commitment during the operational life of the Nuclear Technology Park would be negligible.

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Name: **Chris Mausert-Mooney**
Education: B.S., Biology
Project Role: Technical Review
Experience: 11 years of experience in botany, threatened and endangered species monitoring/surveys, and wetland delineations

Name: **Valentina Montaldo Falero**
Education: M.S. (Laurea), Geology; Ph.D., Geology (Seismology)
Project Role: Geology and Soils (Seismicity)
Experience: 21 years of experience in seismic hazard assessment for critical facilities

Name: **Chelsey Nieman, Ph.D**
Education: Ph.D, Fisheries and Wildlife
Project Role: Aquatic Ecology
Experience: 7 years of experience in freshwater ecology

Name: **Rebecca Porath, CWB**
Education: M.S. and B.S., Wildlife and Fisheries Sciences
Project Role: Terrestrial Ecology, Endangered and Threatened Species
Experience: 22 years in environmental planning, NEPA analysis and documentation, ecological studies, and preparation of technical documents

Name: **Konrad Quast, Ph.D**
Education: B.S. and Ph.D, Hydrology and Water Resources
Project Role: Water Resources (Groundwater)
Experience: 20 years in hydrogeologic and environmental geochemical data analysis, interpretation, and preparation of technical reports

Name:	**Natalie Reiss**
Education:	B.A., Biology
Project Role:	Transportation, Visual Resources, Noise, Socioeconomics (Economics and Income and Community Characteristics), Environmental Justice
Experience:	7 years of experience in NEPA analysis and documentation
Name:	**Kurt Sichelstiel**
Education:	B.A., Geology
Project Role:	Water Resources (Groundwater)
Experience:	40 years of experience
Name:	**Randy Shuler, Ph.D, LSRP**
Education:	B.S., Biology; B.S., Biochemistry; Ph.D, Biochemistry and Molecular Biology
Project Role:	Nonradiological Public Health and Safety
Experience:	30 years of experience

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Name:	**Jeff Prendergast, PE**
Education:	B.S., Mechanical Engineering
Project Role:	Principle Project Manager
Experience:	13 years’ experience leading nuclear design projects
Name:	**Stephen Murphy, PE**
Education:	B.S., Mechanical Engineering
Project Role:	Deputy Project Manager
Experience:	7 years’ experience leading nuclear design projects
Name:	**Kenneth Snell, JD, PE**
Education:	B.S., Chemical Engineering; B.A., Environmental Studies; J.D. Law
Project Role:	Sr. Project Quality Control Specialist
Experience:	35 years’ experience in environmental permitting, compliance, and controls
Name:	**Mike Launi, PE, MBA**
Education:	M.E. and B.S., Nuclear Engineering; MBA
Project Role:	Technical Licensing Expert
Experience:	40 years’ experience in nuclear licensing
Name:	**Erwin Prater, PhD, MBA, CCM, CFA**
Education:	B.A., Geography/Mathematics; M.S. and Ph.D, Atmospheric Science; MBA
Project Role:	Meteorology & Climate Change
Experience:	30 years’ experience in air quality modeling, accidental release modeling, and consulting

Name: **David Gennardo, PE**
Education: B.S. and M.S., Nuclear Engineering
Project Role: Radiological Dose & Waste, Nuclear Plant Safety
Experience: 11 years’ experience in nuclear licensing activities, radiological studies, and safe shutdown analyses

Name: **Shannon McEwen-Barbas**
Education: B.A., History and Environmental Studies; M.A., Geography; M.S., Environmental Science and Policy
Project Role: Land Use, Demographics
Experience: 7 years’ experience in GIS, demographic, and statistical analysis

Name: **Constantine Petropoulos, PE, MBA**
Education: B.S. and M.S., Structural Engineering
Project Role: Nuclear Plant Security
Experience: 40 years’ experience in engineering, design, construction, and betterment of nuclear power plants

Name: **Bob Charles, MBA**
Education: B.S., Electrical Engineering; MBA
Project Role: Decommissioning
Experience: 48 years’ experience in nuclear, fossil, and solar power plants

Name: **Matthew Heerman, PE**
Education: B.S., Chemical Engineering
Project Role: Water Quality
Experience: 14 years’ experience in engineering of water and waste treatment systems

Name: **David Helm, PE**
Education: B.A., Economics; B.S., Chemical Engineering; M.S., Environmental Engineering
Project Role: Air Quality
Experience: More than 20 years’ experience in environmental compliance, engineering and permitting

CHAPTER 5 – LITERATURE CITED

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