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Draft Versatile Test Reactor Environmental Impact Statement

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Chapters 1-10

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This document is available on the DOE NEPA website (http://energy.gov/nepa/nepa-documents) for viewing and downloading.

Abstract: This *Versatile Test Reactor Environmental Impact Statement* (VTR EIS) evaluates the potential environmental impacts of proposed alternatives for the construction and operation of a new test reactor, as well as associated facilities that are needed for performing post-irradiation evaluation of test articles and managing spent nuclear fuel (SNF). In accordance with the Nuclear Energy Innovation Capabilities Act of 2017 (NEICA) (Pub. L. 115–248), DOE assessed the mission need for a versatile reactor-based fast-neutron source (or Versatile Test Reactor) to serve as a national user facility. DOE determined that there is a need for a fast-neutron spectrum VTR to enable testing and evaluating nuclear fuels, materials, sensors, and instrumentation for use in advanced reactors and other purposes. In accordance with NEICA, DOE is pursuing construction and operation of the 300 megawatt (thermal) VTR. The reactor would be a pool-type, sodium-cooled reactor that uses a uranium-plutonium-zirconium metal fuel. The analysis also includes the potential impacts from post-irradiation examination of test articles, management of spent fuel, and activities necessary for VTR driver fuel production.

The Idaho National Laboratory (INL) VTR Alternative would include the construction of the VTR adjacent to the Materials and Fuels Complex (MFC) at the INL Site. Existing MFC facilities, some requiring new equipment, would be used for post-irradiation examination and conditioning SNF. The Oak Ridge National Laboratory (ORNL) VTR Alternative would include the construction of a VTR and a hot cell building at ORNL. The hot cell building would provide post-irradiation examination and SNF conditioning capabilities. Both alternatives would require construction of a concrete pad for dry storage of SNF pending shipment

to an offsite storage or disposal facility. DOE does not intend to separate, purify, or recover fissile material from VTR driver fuel.

DOE also evaluates options for preparing the uranium/plutonium/zirconium feedstock for use in the reactor driver fuel (fuel needed to run the reactor) and for fabricating the driver fuel. Feedstock preparation would be performed using new capabilities installed in an existing building at the INL Site or the Savannah River Site (SRS). Fuel fabrication would be performed using existing or newly installed equipment in existing buildings at the INL Site or SRS.

Preferred Alternative: DOE's Preferred Alternative is the INL VTR Alternative. DOE would construct and operate the VTR at the INL Site adjacent to the MFC. Existing facilities within the MFC would be modified and used for post-irradiation examination of test assemblies. SNF would be treated to remove the sodium and converted into a form that would meet the acceptance criteria for a future permanent repository. The treated SNF would be temporarily stored at a new storage pad near the VTR.

DOE has no preferred option at this time for where it would perform reactor fuel production (feedstock preparation or driver fuel fabrication) for the VTR. This EIS evaluates options for both processes at the INL Site and at SRS. DOE will state its preferred options for feedstock preparation and driver fuel fabrication in the Final VTR EIS, if preferred options are identified before issuance.

Public Involvement: DOE issued a Notice of Intent to Prepare an environmental impact statement for a Versatile Test Reactor in the *Federal Register* (84 FR 38021) on August 5, 2019, to solicit public input on the scope and environmental issues to be addressed in this VTR EIS. Comments received during the August 5 through September 4, 2019, scoping period were considered in the preparation of this Draft EIS. Comments on this Draft EIS will be accepted following publication of the U.S. Environmental Protection Agency Notice of Availability. Comments can be submitted to the address provided above or emailed to VTR.EIS@nuclear.energy.gov. Opportunities to provide oral comments will be announced in news media near the DOE sites at a later date. Comments received during the comment period will be considered during the preparation of the Final EIS. Comments received after the close of the comment period will be considered to the extent practicable.

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ACRONYMS, ABBREVIATIONS, AND CONVERSION CHARTS

ACRONYMS, ABBREVIATIONS, AND CONVERSION CHARTS

ANS	Advanced Neutron Source
AoA	Analysis of Alternatives
APC	Air Pollution Control
AQD	Air Quality Division
APE	area of potential effects
ATR	Advanced Test Reactor
ATWIR	Annual TRU Waste Inventory Report
BCCs	Birds of Conservation Concern
BCR	Bird Conservation Region
BGEPA	Bald and Golden Eagle Protection Act
BJWSA	Beaufort-Jasper Water and Sewer Authority
BLM	Bureau of Land Management
CAA	Clean Air Act
CAIRS	Computerized Accident Incident Reporting System
CBCG	Columbia Basin Consulting Group
CEM	continuous emission monitoring
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFA	Central Facilities Area
CFR	*Code of Federal Regulations*
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	CO_2 equivalent
CSWTF	Central Sanitary Wastewater Treatment Facility
CWA	Clean Water Act
D&D	decontamination and decommissioning
DART	Days Away, Restricted or on-the-job Transfer
dB	decibels
dBA	A-Weighted Decibel Scale
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EA	environmental assessment
EBR	Experimental Breeder Reactor
EDGs	emergency diesel generators
EFF	Experimental Fuels Facility
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
EPHA	Emergency Planning Hazard Assessment
ERDA	U.S. Energy Research and Development Administration
ERO	Emergency Response Organization
ESA	Endangered Species Act
ESER	Environmental Surveillance, Education, and Research
ESRP	Eastern Snake River Plain
ETTP	East Tennessee Technology Park
ETW	Exceptional Tennessee Waters

FCF	Fuel Conditioning Facility
FFCA	Federal Facilities Compliance Act
FFTF	Fast Flux Test Facility
FMF	Fuel Manufacturing Facility
FONSI	Finding of No Significant Impact
FRR	Foreign Research Reactor
GEH	GE Hitachi Nuclear Energy
GHG	greenhouse gas
gpm	gallons per minute
GWP	global warming potential
HACs	hazardous air contaminants
HALEU	high assay, low-enriched uranium
HAPs	hazardous air pollutants
HAZMAT	hazardous materials
HEPA	high-efficiency particulate air
HEU	highly enriched uranium
HFEF	Hot Fuel Examination Facility
HFIR	High Flux Isotope Reactor
HLW	high-level radioactive waste
IAEA	International Atomic Energy Agency
IDA	International Dark-Sky Association
IDAPA	Idaho Administrative Procedures Act
IDEQ	Idaho Department of Environmental Quality
IDFG	Idaho Department of Fish and Game
IMCL	Irradiated Materials Characterization Laboratory
INF	irradiated nuclear fuel
INL	Idaho National Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
IPaC	Information for Planning and Consultation
IPDES	Idaho Pollutant Discharge Elimination System
ISA	Idaho Settlement Agreement
ISO	International Organization for Standardization
kV	kilovolt
L_{dn}	Day-Night Average Sound Level
L_{eq}	Equivalent Sound Level
LAMDA	Low Activation Materials Design and Analysis Laboratory
LANL	Los Alamos National Laboratory
LCF	latent cancer fatality
LEU	low-enriched uranium
LFTR	lead/lead-bismuth-cooled fast test reactor
LOS	level of service
LLW	low-level radioactive waste
MBTA	Migratory Bird Treaty Act
MCL	Maximum Contaminant Level
MEI	maximally exposed individual
MFC	Materials and Fuels Complex
MFFF	MOX Fuel Fabrication Facility
MHR	Multipurpose Haul Road
MLLW	mixed low-level radioactive waste

MOX	mixed oxide
MSFTR	molten-salt-cooled fast test reactor
MSR	molten salt reactors
MTHM	metric tons of heavy metal
MW	megawatts
MWh	megawatt hour
MWth	megawatts thermal
NAAQS	National Ambient Air Quality Standards
NASA	National Aeronautics and Space Administration
NEAC	Nuclear Energy Advisory Committee
NEPA	National Environmental Policy Act
NEICA	Nuclear Energy Innovation Capabilities Act of 2017
NERP	National Environmental Research Park
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHPA	National Historic Preservation Act
NNSA	National Nuclear Security Administration
NNSS	Nevada National Security Site
NO_2	nitrogen dioxide
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NRHP	National Register of Historic Places
O_3	ozone
ORR	Oak Ridge Reservation
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
PCBs	polychlorinated biphenyls
pCi/L	picocuries per liter
PGA	peak ground acceleration
PIDAS	Perimeter Intrusion Detection and Assessment System
$PM_{2.5}$	particulate matter less than or equal to 2.5 microns in diameter
PM_{10}	particulate matter less than or equal to 10 microns in diameter
PNNL	Pacific Northwest National Laboratory
PRISM	Power Reactor Innovative Small Module
PSD	Prevention of Significant Deterioration
PTC	permit to construct
R&D	research and development
RCRA	Resource Conservation and Recovery Act
REDC	Radiochemical Engineering Development Center
RESL	Radiological and Environmental Sciences Laboratory
ROD	Record of Decision
ROI	region of influence
RVACS	Reactor Vessel Auxiliary Cooling System
RWMC	Radioactive Waste Management Complex
SCDHEC	South Carolina Department of Health and Environmental Control
SCDNR	South Carolina Department of Natural Resources
SDA	Subsurface Disposal Area
SDWA	Safe Drinking Water Act
SGCN	Species of Greatest Conservation Need

SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SNF	spent nuclear fuel
SO_2	sulfur dioxide
SPD	Surplus Plutonium Disposition
SR	State Route
SRNL	Savannah River National Laboratory
SRNS	Savannah River Nuclear Solutions, LLC
SRPA	Snake River Plain Aquifer
SRR	Savannah River Remediation
SRS	Savannah River Site
SRTE	Savannah River Tritium Enterprise
STA	Secure Transportation Asset
SWAP	State Wildlife Action Plan
SWPPP	stormwater pollution prevention plan
SWPT	sanitary wastewater treatment plant
T&E	threatened and endangered
TAPs	toxic air pollutants
TDEC	Tennessee Department of Environment and Conservation
TRC	Total Reportable Cases
TREAT	Transient Reactor Test
TRU	transuranic
TSCA	Toxic Substances Control Act
TSP	total suspended particulates
TTHM	total trihalomethanes
TVA	Tennessee Valley Authority
TWPC	Transuranic Waste Processing Center
TWRA	Tennessee Wildlife Resources Agency
µg/L	micrograms per liter
U/Pu/Zr	uranium/plutonium/zirconium alloy
UK	United Kingdom
U.S.C.	*United States Code*
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGCRP	U.S. Global Change Research Program
USGS	U.S. Geological Survey
VOC	volatile organic compound
VRM	Visual Resource Management
VTR	Versatile Test Reactor
WAG	Waste Area Group
WIPP	Waste Isolation Pilot Plant
Y-12	Y-12 National Security Complex
ZPPR	Zero Power Physics Reactor

CONVERSIONS

METRIC TO ENGLISH			ENGLISH TO METRIC		
Multiply	**by**	**To get**	**Multiply**	**by**	**To get**
Area					
Square meters	10.764	Square feet	Square feet	0.092903	Square meters
Square kilometers	247.1	Acres	Acres	0.0040469	Square kilometers
Square kilometers	0.3861	Square miles	Square miles	2.59	Square kilometers
Hectares	2.471	Acres	Acres	0.40469	Hectares
Concentration					
Kilograms/square meter	4.46	Tons/acre	Tons/acre	0.224	Kilograms/square meter
Milligrams/liter	1 [a]	Parts/million	Parts/million	1 [a]	Milligrams/liter
Micrograms/liter	1 [a]	Parts/billion	Parts/billion	1 [a]	Micrograms/liter
Micrograms/cubic meter	1 [a]	Parts/trillion	Parts/trillion	1 [a]	Micrograms/cubic meter
Density					
Grams/cubic centimeter	62.428	Pounds/cubic feet	Pounds/cubic feet	0.016018	Grams/cubic centimeter
Grams/cubic meter	0.0000624	Pounds/cubic feet	Pounds/cubic feet	16,018.5	Grams/cubic meter
Length					
Centimeters	0.3937	Inches	Inches	2.54	Centimeters
Meters	3.2808	Feet	Feet	0.3048	Meters
Kilometers	0.62137	Miles	Miles	1.6093	Kilometers
Radiation					
Sieverts	100	Rem	Rem	0.01	Sieverts
Temperature					
Absolute					
Degrees C + 17.78	1.8	Degrees F	Degrees F - 32	0.55556	Degrees C
Relative					
Degrees C	1.8	Degrees F	Degrees F	0.55556	Degrees C
Velocity/Rate					
Cubic meters/second	2118.9	Cubic feet/minute	Cubic feet/minute	0.00047195	Cubic meters/second
Grams/second	7.9366	Pounds/hour	Pounds/hour	0.126	Grams/second
Meters/second	2.237	Miles/hour	Miles/hour	0.44704	Meters/second
Volume					
Liters	0.26418	Gallons	Gallons	3.7854	Liters
Liters	0.035316	Cubic feet	Cubic feet	28.316	Liters
Liters	0.001308	Cubic yards	Cubic yards	764.54	Liters
Cubic meters	264.17	Gallons	Gallons	0.0037854	Cubic meters
Cubic meters	35.314	Cubic feet	Cubic feet	0.028317	Cubic meters
Cubic meters	1.3079	Cubic yards	Cubic yards	0.76456	Cubic meters
Cubic meters	0.0008107	Acre-feet	Acre-feet	1233.49	Cubic meters
Weight/Mass					
Grams	0.035274	Ounces	Ounces	28.35	Grams
Kilograms	2.2046	Pounds	Pounds	0.45359	Kilograms
Kilograms	0.0011023	Tons (short)	Tons (short)	907.18	Kilograms
Metric tons	1.1023	Tons (short)	Tons (short)	0.90718	Metric tons
ENGLISH TO ENGLISH					
Acre-feet	325,850.7	Gallons	Gallons	0.000003069	Acre-feet
Acres	43,560	Square feet	Square feet	0.000022957	Acres
Square miles	640	Acres	Acres	0.0015625	Square miles

a. This conversion is only valid for concentrations of contaminants (or other materials) in water.

METRIC PREFIXES

Prefix	Symbol	Multiplication factor
exa-	E	1,000,000,000,000,000,000 = 10^{18}
peta-	P	1,000,000,000,000,000 = 10^{15}
tera-	T	1,000,000,000,000 = 10^{12}
giga-	G	1,000,000,000 = 10^{9}
mega-	M	1,000,000 = 10^{6}
kilo-	k	1,000 = 10^{3}
deca-	D	10 = 10^{1}
deci-	d	0.1 = 10^{-1}
centi-	c	0.01 = 10^{-2}
milli-	m	0.001 = 10^{-3}
micro-	µ	0.000 001 = 10^{-6}
nano-	n	0.000 000 001 = 10^{-9}
pico-	p	0.000 000 000 001 = 10^{-12}

Chapter 1
Introduction and Purpose and Need

1.0 INTRODUCTION AND PURPOSE AND NEED

1.1 Introduction

As required by the Nuclear Energy Innovation Capabilities Act of 2017 (NEICA) (Pub. L. 115–248), the U.S. Department of Energy (DOE) assessed the mission need for a versatile reactor-based fast-neutron[1] source (or Versatile Test Reactor [VTR]) to serve as a national user facility. DOE has determined that there is a need for a VTR and, in accordance with NEICA, is pursuing construction and operation of the VTR. To this end, DOE has prepared this environmental impact statement (EIS) in accordance with the National Environmental Policy Act (NEPA) and the Council on Environmental Quality (CEQ) and DOE NEPA regulations (40 Code of Federal Regulations [CFR] 1500 through 1508 and 10 CFR 1021, respectively). This EIS evaluates alternatives for a VTR and associated facilities for the irradiation and post-irradiation examination of test and experimental fuels and materials. The analysis also addresses options for VTR fuel production and evaluates the management of spent nuclear fuel (SNF) from the VTR.

1.2 Background

DOE's mission includes advancing the energy, environmental, and nuclear security of the United States and promoting scientific and technological innovation in support of that mission. DOE's 2014 to 2018 Strategic Plan (DOE 2014a) states that DOE will "support a more economically competitive, environmentally responsible, secure and resilient U.S. energy infrastructure." Specifically, "DOE will continue to explore advanced concepts in nuclear energy that may lead to new types of reactors with further safety improvements and reduced environmental and nonproliferation concerns."

In support of DOE's mission, the Office of Nuclear Energy has established research objectives intended to provide research, development, and demonstration activities that enable development of an advanced reactor pipeline. These objectives also are intended to enhance the long-term viability and competitiveness of the existing U.S. reactor fleet and implement and maintain a national strategic fuel cycle and supply chain infrastructure. Each of these research, development, and demonstration goals would benefit from a test reactor capable of a high flux of fast-spectrum neutrons, in other words, a reactor that would generate a large number of neutrons per second that are more energetic than those typical in a commercial light-water nuclear reactor. The United States currently lacks a facility able to produce a prototypic, fast-neutron-spectrum irradiation environment with high neutron flux. Such a facility would support the above objectives and is essential to testing and effective evaluation of nuclear fuels, materials, sensors, and instrumentation for use in advanced reactors.

Advanced reactors that operate in the fast-neutron spectrum offer the potential to have inherent safety characteristics incorporated into their designs. They can operate for long periods without refueling and reduce the volume of newly generated nuclear waste. Effective testing and development of advanced reactor technologies requires the use of fast neutrons comparable to those that would occur in actual advanced reactors. The high flux of fast neutrons allows accelerated testing, meaning that a comparatively short testing period would accomplish what would otherwise require many years to decades of exposure in a test environment with lower energy neutrons, a lower flux, or both. This accelerated testing would contribute to the development of materials and fuels for advanced reactors and generate data allowing advanced reactor developers, researchers, DOE, and regulatory agencies to

[1] Fast neutrons are highly energetic neutrons (ranging from 0.1 million to 5 million electron volts [MeV] and travelling at speeds of thousands to tens of thousands kilometers per second) emitted during fission. The fast-neutron spectrum refers to the range of energies associated with fast neutrons.

improve performance, understand material properties, qualify improved materials and fuels, evaluate reliability, and ensure safety. Accelerated testing capabilities would also benefit these same areas for the current generation of light-water reactors.

Many commercial organizations and universities are pursuing advanced nuclear energy fuels, materials, and reactor designs that complement DOE and its laboratories' efforts to advance nuclear energy. These designs include thermal[2] and fast-spectrum reactors that target improved fuel resource utilization and waste management, and the use of materials other than water for cooling. Their development requires an adequate infrastructure for experimentation, testing, design evolution, and component qualification. Available irradiation test capabilities are aging (most are over 50 years old). These capabilities are focused on testing materials, fuels, and components in the thermal neutron spectrum and do not have the ability to support the needs for fast reactors. Only limited fast-neutron-spectrum testing capabilities, with restricted availability, exist outside the United States.

Recognizing that the United States lacks a dedicated, fast-neutron-spectrum testing capability, DOE assessed current testing capabilities (domestic and foreign) against those needed to support the development of advanced nuclear technologies (DOE 2018a). DOE's purpose was to assess the mission need for, and cost of, a versatile reactor-based fast-neutron source with a high neutron flux, irradiation flexibility, multiple experimental environment (e.g., use of different coolants) capabilities, and sufficient volume for many concurrent users. This assessment identified a gap between required testing needs and available capabilities. That is, there currently is an inability to effectively test advanced nuclear fuels and materials in a fast-neutron-spectrum irradiation environment at high neutron fluxes. The Nuclear Energy Advisory Committee (NEAC) report, *Assessment of Missions and Requirements for a New U.S. Test Reactor* (NEAC 2017), confirmed the need for fast-neutron testing capabilities in the United States and acknowledged that no such facility is readily available domestically or internationally. The NEAC study was consistent with the conclusions of an earlier study, *Advanced Demonstration and Test Reactor Options Study* (INL 2017d). One strategic objective established in the 2017 study was to "provide an irradiation test reactor to support development and qualification of fuels, materials, and other important components/items (e.g., control rods, instrumentation) of both thermal and fast neutron-based…advanced reactor systems." DOE needs to develop the capability for large-scale testing, accelerated testing, and qualifying advanced nuclear fuels, materials, instrumentation, and sensors. This testing capability is essential for the United States to modernize its nuclear energy infrastructure and to develop transformational nuclear energy technologies that re-establish the United States as a world leader in nuclear technology commercialization.

The key recommendation of the NEAC report was that DOE "proceed immediately with pre-conceptual design planning activities to support a new test reactor" to fill the domestic need for a fast-neutron test capability. The considerations for such a capability include:

- An intense, neutron-irradiation environment with prototypic spectrum to determine irradiation tolerance and chemical compatibility with other reactor materials, particularly with coolants.
- Testing that provides a fundamental understanding of materials performance, validation of models for more rapid future development, and engineering-scale validation of materials performance in support of licensing efforts.
- A versatile testing capability to address diverse technology options and sustained and adaptable testing environments.

[2] Thermal neutrons are neutrons that are less energetic than fast neutrons (generally, less than 1 electron volt and travelling at speeds of less than 5 kilometers per second), having been slowed by collisions with other materials such as water. The thermal neutron spectrum refers to the range of energies associated with thermal neutrons.

- Focused irradiations, either long- or short-term, with heavily instrumented experimental devices, and the possibility to do in situ measurements and quick extraction of samples.
- An accelerated schedule to regain and sustain U.S. technology leadership and to enable the competiveness of U.S-based entities in the advanced reactor markets. This can be achieved through use of mature technologies for the reactor design (e.g., sodium coolant in a pool-type and metallic-alloy-fueled fast reactor) while enabling innovative experimentation.

A summary of preliminary requirements that respond to these considerations include providing:

- A high peak neutron flux with a prototypic fast-reactor-neutron-energy spectrum (i.e., neutron energy greater than 0.1 million electron volts); the target flux is 4×10^{15} neutrons per square centimeter per second or greater.
- A high neutron dose rate for materials testing (quantified as displacements per atom); the target is 30 displacements per atom per year or greater.
- An irradiation length that is appropriate for fast reactor fuel testing; the target is 0.6 meter to 1 meter.
- A large irradiation volume within the core region; the target is 7 liters.
- Innovative testing capabilities through flexibility in testing configuration and testing environment (coolants).

> - 4×10^{15} neutrons per square centimeter per second = 2.6×10^{16} neutrons per square inch per second
> - 0.6 meter to 1 meter = 2 feet to 3.3 feet
> - 7 liters = 0.25 cubic feet

- The ability to test advanced sensors and instrumentation for the core and test positions.
- Expedited experiment life cycle by enabling easy access to support facilities for experiments fabrication and post-irradiation examination.
- Management of the reactor driver fuel (fuel needed to run the reactor) while minimizing cost and schedule impacts.
- Access to the facility for testing as soon as possible by using proven technologies with a high technology readiness level.

Having identified the need for the VTR, NEICA directs DOE "to the maximum extent practicable, complete construction of, and approve the start of operations for, the user facility by not later than December 31, 2025." Secretary of Energy Rick Perry announced the launch of the VTR project on February 28, 2019, as a part of modernizing the nuclear research and development (R&D) user facility infrastructure in the United States.

The DOE *Mission Need Statement for the Versatile Test Reactor (VTR) Project, A Major Acquisition Project* (DOE 2018a) embraces the development of a well-instrumented, sodium-cooled, fast-neutron-spectrum test reactor in the 300 megawatt-thermal power level range. This design would offer a flexible, reconfigurable testing environment for known and anticipated testing. It is the most practical and cost-effective strategy to meet the mission need and address the constraints and considerations identified above. The deployment of a sodium-cooled, fast-neutron-spectrum test reactor is consistent with the conclusions of the test reactor options study (INL 2017d) and the NEAC recommendation (NEAC 2017).

DOE expects that the VTR, coupled with existing supporting R&D infrastructure, would offer the basic and applied physics, materials science, nuclear fuels, and advanced sensor communities a unique research capability. This capability would enable a comprehensive understanding of the multi-scale and multi-physics performance of nuclear fuels and structural materials to support developing and deploying advanced nuclear energy systems. To this end, DOE is collaborating with universities, commercial industry, and national laboratories to identify needed experimental capabilities.

1.3 Purpose and Need for Agency Action

The purpose of this DOE action is to establish a domestic, versatile, reactor-based fast-neutron source and associated facilities that meet identified user needs (e.g., providing a high neutron flux of at least 4×10^{15} neutrons per square centimeter per second and related testing capabilities). Associated facilities include those for the preparation of VTR driver fuel and test/experimental fuels and materials and those for the ensuing examination of the test/experimental fuels and materials; existing facilities would be used to the extent possible. The United States has not had a viable domestic fast-neutron-spectrum testing capability for over two decades. DOE needs to develop this capability to establish the United States' testing capability for next-generation nuclear reactors—many of which require a fast-neutron spectrum for operation—thus enabling the United States to regain technology leadership for the next generation nuclear fuels, materials, and reactors. The lack of a versatile fast-neutron-spectrum testing capability is a significant national strategic risk affecting the ability of DOE to fulfill its mission to advance the energy, environmental, and nuclear security interests of the United States and promote scientific and technological innovation. This testing capability is essential for the United States to modernize its nuclear energy industry. Further, DOE needs to develop this capability on an accelerated schedule to avoid further delay in the U.S. ability to develop and deploy advanced nuclear energy technologies. If this capability is not available to U.S. innovators as soon as possible, the ongoing shift of nuclear technology dominance to other nations will accelerate, to the detriment of the U.S. nuclear industrial sector.

1.4 Proposed Action and Scope of this EIS

DOE proposes to construct and operate the VTR at a suitable DOE site. DOE would use existing or expanded, co-located, post-irradiation examination capabilities as necessary to accomplish the mission. DOE would also use or expand existing facility capabilities to produce VTR driver fuel and to manage radioactive wastes and SNF. The DOE facilities would be capable of receiving test articles from the user community, as well as fabricating test articles for insertion in the VTR.

Candidate sites for construction and operation of the VTR include the Idaho National Laboratory (INL) near Idaho Falls, Idaho, and the Oak Ridge National Laboratory (ORNL), near Oak Ridge, Tennessee. DOE would perform most post-irradiation examination in existing, modified, or new facilities near the VTR, although there may be instances when test items would be sent to another location for evaluation. DOE would produce VTR driver fuel at the INL Site or the Savannah River Site (SRS) near Aiken, South Carolina. **Figure 1–1** shows the locations of these DOE sites. Chapter 2 describes the alternatives and options evaluated in this VTR EIS.

1.5 Decisions to be Supported

This VTR EIS provides the DOE decision-maker with important information regarding potential environmental impacts for use in the decision-making process. In addition to environmental information, DOE will consider other factors (e.g., cost, schedule, strategic objectives, technology needs, and safeguards and security) when making its decision. Decisions to be made by the DOE decision-maker regarding the VTR EIS project are whether to:

- Construct a VTR to create a fast-neutron source;
- Establish, through modification or construction, co-located facilities for post-irradiation examination of test products and for management of spent VTR driver fuel;
- Locate the VTR at the INL Site or at ORNL; and
- Establish VTR driver fuel production capabilities for feedstock preparation and fuel fabrication at the INL Site, SRS, or a combination of the two sites.

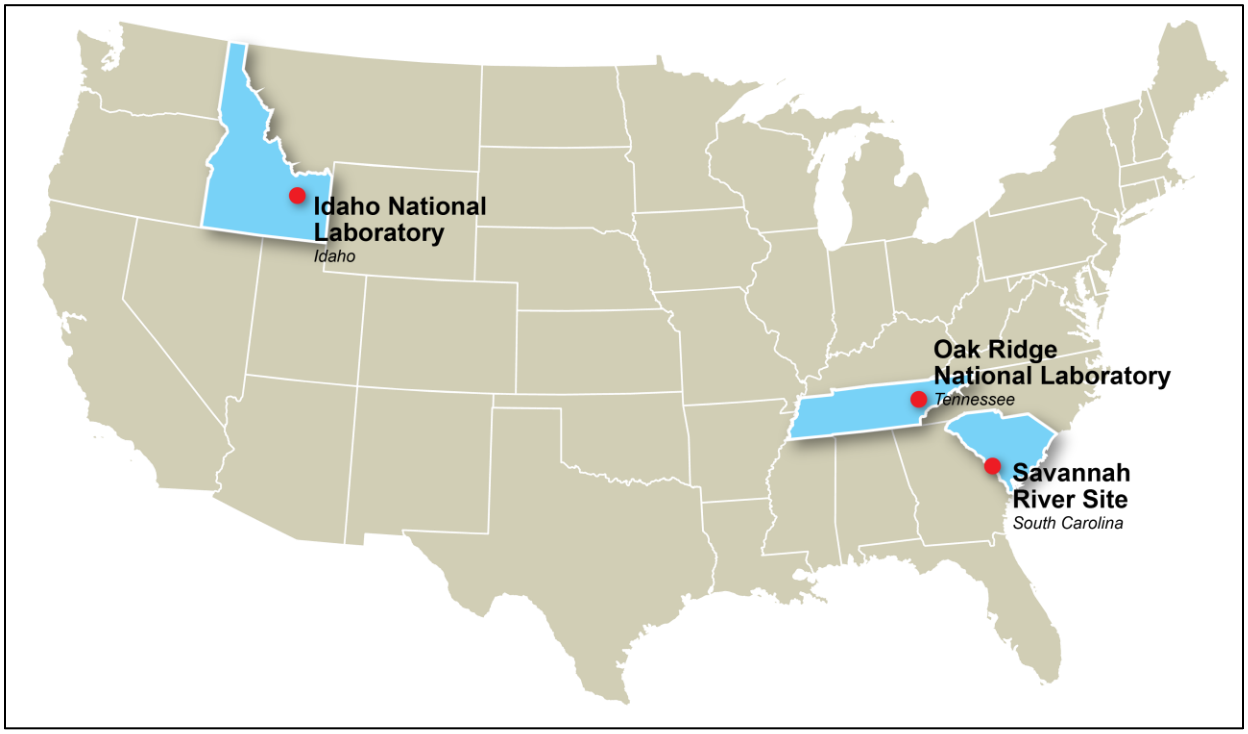


Figure 1–1. Location of Facilities Evaluated in this VTR EIS

There are subjects related to the VTR for which DOE will not make decisions based on the VTR EIS analysis. These subjects include:

DOE will not make a decision to employ a different reactor technology to provide the testing capabilities to meet the need for a fast-neutron source.

As directed by NEICA, DOE has determined that there is a mission need for a versatile reactor-based fast-neutron source. Having made that determination, to the maximum extent practicable, DOE is planning to complete construction of and approve the start of operations of a VTR by as soon as 2026.[3] To support this schedule, DOE proposes construction of a pool-type test reactor using sodium as a coolant. As discussed in Chapter 2, Section 2.2.1, DOE is selecting this technology because of its level of technical maturity. Because other technologies are less well developed, as discussed in Section 2.7, DOE will not make a decision regarding use of a different reactor technology to establish a fast-neutron source.

DOE will not make a decision to terminate R&D in support of nuclear energy.

As indicated in Section 1.2, Background, part of DOE's mission is to advance the energy, environmental, and nuclear security interests of the United States and to promote scientific and technological innovation in support of that mission. In fulfilling that mission, DOE will continue to explore advanced concepts in nuclear energy and support R&D that advances the state of knowledge, promotes safety, and may lead to new types of reactors.

[3] DOE's schedule is consistent with the NEICA direction for DOE "to the maximum extent practicable, complete construction of, and approve the start of operations for, the user facility by not later than December 31, 2025." Completion of construction and startup of operations are dependent on a number of factors including completion of this EIS, progress on design, and congressional appropriations.

1.6 Related NEPA Documents

DOE and other Federal agencies have prepared other NEPA documents related to the scope of the VTR project. These documents are discussed below. General or multi-site NEPA documents are discussed first followed by INL, ORNL, and SRS NEPA documents.

1.6.1 General or Multi-Site NEPA Documents

Liquid Metal Breeder Reactor NEPA Documents – In the 1970s, the U.S. Energy Research and Development Administration (ERDA), a predecessor agency of DOE, proposed the Liquid Metal Fast Breeder Reactor Program. ERDA prepared a programmatic EIS on the Liquid Metal Fast Breeder Reactor Program in 1975 (ERDA 1975), and prepared an EIS on Expansion of the U.S. Breeder Reactor Program, in June 1976 (ERDA 1976). DOE prepared a supplement to the 1975 document in May 1982 (DOE 1982). The U.S. Nuclear Regulatory Commission prepared an environmental statement in connection with its licensing process (NRC 1977). A supplement was published in 1982 (NRC 1982). As part of this program, the Clinch River Breeder Reactor Plant was a proposed liquid-sodium-cooled fast breeder reactor to be constructed and operated in East Tennessee. The project was terminated in 1983 (BRC 1985). Although the VTR would not be a breeder reactor, these NEPA documents are relevant because they were prepared for liquid-metal-cooled reactors that would use uranium-plutonium fuel.

Final Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility **(NI PEIS) (DOE/EIS-0310) (DOE 2000b)** – Under the authority of the Atomic Energy Act of 1954, as amended, DOE is responsible for ensuring the availability of isotopes for medical, industrial, and research applications. DOE is also responsible for meeting the nuclear material needs of other Federal agencies and undertaking R&D activities related to development of nuclear power for civilian use. To meet these responsibilities, DOE maintains nuclear infrastructure capabilities that support various missions. In the NI PEIS, DOE proposed to enhance these capabilities to:

- Produce isotopes for medical and industrial uses,
- Produce plutonium-238 for use in advanced radioisotope power systems for future National Aeronautics and Space Administration (NASA) space exploration missions, and
- Meet the Nation's nuclear R&D needs for civilian application.

In the Record of Decision (ROD) for the NI PEIS, published in the *Federal Register* on January 26, 2001 (66 FR 7877), DOE decided to reestablish domestic production of plutonium-238 to support U.S. space exploration. For this purpose, the Advanced Test Reactor (ATR) at the INL Site and the High Flux Isotope Reactor (HFIR) at ORNL would be used to irradiate neptunium-237 targets. Plutonium-238 production would not interfere with existing primary missions at ATR and HFIR. The Radiochemical Engineering Development Center at ORNL would be used for fabricating targets and separating plutonium-238 from the irradiated targets. In addition, the Fast Flux Test Facility (FFTF) near Richland, Washington, would be deactivated permanently and DOE would not construct the new accelerator(s) and new research reactor described in the NI PEIS. The NI PEIS is relevant because in the ROD (66 FR 7877), DOE decided that FFTF would be permanently deactivated and a new research reactor would not be constructed. This NEPA document is also relevant because some of the same facilities could be used to support the VTR project.

Final Waste Management Programmatic Environmental Impact Statement for Managing, Treatment, Storage, and Disposal of Radioactive and Hazardous Waste **(DOE/EIS-0200) (DOE 1997a);** ***Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement Eddy County, near Carlsbad, New Mexico*** **(DOE/EIS-0026-S-2) (DOE 1997b); and** ***Final Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security***

Administration Nevada National Security Site and Off-Site Locations in the State of Nevada **(DOE/EIS-0426) (DOE 2013c)** – Collectively, these three EISs evaluated waste management activities that affect many DOE sites and programs. The facilities discussed below would be used for managing waste generated by the VTR program.

Following the analysis in the *Waste Management Programmatic EIS*, DOE issued its programmatic decision selecting the alternatives for disposal of low-level and mixed low-level radioactive waste at regional disposal facilities. DOE's decision included continuing the use of onsite disposal for certain sites (including INL) where practicable (64 FR 69241). The Nevada Test Site (now the Nevada National Security Site [NNSS]) was one of the identified regional disposal sites. DOE also announced its decision that each DOE site would prepare its own transuranic waste for disposal at the Waste Isolation Pilot Plant (WIPP) facility (63 FR 3629).

The WIPP Disposal Phase Final Supplemental EIS was prepared to assess the potential environmental impacts of continuing the phased development of WIPP as a geologic repository for the safe disposal of transuranic waste. Following that analysis, DOE announced its decision to dispose of defense transuranic waste at WIPP following preparation of waste to meet WIPP's waste acceptance criteria (63 FR 3624).

The Final Site-Wide EIS for Continued Operation of the Nevada National Security Site analyzed the potential environmental impacts of alternatives for continued management and operation of NNSS, including its Environmental Management Mission, which includes operation of onsite low-level radioactive waste disposal facilities. In its December 30, 2014 ROD, the National Nuclear Security Administration selected the Expanded Operations Alternative for the low-level radioactive waste disposal portion of its Environmental Management Mission (79 FR 78421). The NNSS waste disposal facility is one of DOE's regional facilities that accepts waste meeting acceptance criteria for disposal. The selected alternative provides capacity to receive waste from offsite generators. The INL Site is one of the DOE sites that sends authorized waste streams to NNSS for disposal.

Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington **(Hanford Tanks EIS) (DOE/EIS-0391) (DOE 2012a)** – The Hanford Tanks EIS addressed proposed actions in three major areas: 1) retrieving and treating radioactive waste from underground storage tanks at Hanford; 2) decommissioning the FFTF and its auxiliary facilities; and 3) continued and expanded solid waste management operations, including disposal of low-level and mixed low-level radioactive waste. Only the FFTF activities are relevant to the VTR EIS and are discussed below.

The Hanford Tanks EIS evaluated three FFTF decommissioning alternatives: (1) No Action, (2) Entombment, and (3) Removal. DOE's Preferred Alternative for FFTF decommissioning was Alternative 2: Entombment, which would remove all above-grade structures, including the reactor building. Below-grade structures, the reactor vessel, piping, and other components would remain in place and be filled with grout to immobilize the remaining radioactive and hazardous constituents. An engineered modified Resource Conservation and Recovery Act Subtitle C barrier would be constructed over the filled area. The remote-handled special components would be processed at INL and returned to Hanford for disposal. Bulk sodium would be processed at Hanford for use in the Hanford Waste Treatment Plant.

In the ROD for the Hanford Tanks EIS (78 FR 75913), DOE decided to implement FFTF Decommissioning Alternative 2: Entombment. This alternative was chosen because it fulfills the programmatic objectives for closure of the FFTF facilities, is more cost effective, and is also the environmentally preferred alternative. Implementation of the Entombment Alternative would result in very low impacts to human health and the environment. This NEPA document is relevant because it evaluated FFTF decommissioning alternatives and reaffirmed DOE's decision in the NI PEIS to decommission FFTF. To date, this alternative has not been implemented and surveillance and maintenance activities continue at FFTF.

1.6.2 Idaho National Laboratory

Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Environmental Impact Statement **(SNF PEIS) (DOE/EIS-0203) (DOE 1995)** – The SNF PEIS analyzed, at a programmatic level, the potential environmental consequences over a 40-year period of alternatives related to the transportation, receipt, processing, and storage of SNF under the responsibility of DOE. It also addressed the site-wide actions anticipated to occur at the INL Site for waste and SNF management. In the first ROD (60 FR 28680), DOE decided to manage its SNF by type (fuel cladding and matrix material) at the Hanford Site, INL, and SRS. Under this decision, the fuel type distribution would be as follows:

- Hanford production reactor fuel would remain at the Hanford Site.
- Aluminum-clad fuel would be consolidated at SRS.
- Non-aluminum-clad fuels (including Naval SNF) would be transferred to INL.

In an amended ROD (64 FR 23825), DOE announced a decision to use a multi-purpose canister or comparable system for the loading and storage of DOE-owned SNF at the INL Site and transportation of this SNF for ultimate disposition outside the State of Idaho. Many of the issues addressed in the SNF PEIS are similar to the issues addressed in this VTR EIS, including SNF management, and management of other radioactive materials and nuclear wastes at INL.

Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel **(Sodium-Bonded EIS) (DOE/EIS-0306) (DOE 2000a)** – The Sodium-Bonded EIS evaluated strategies to remove or stabilize the reactive sodium contained in a portion of DOE's SNF inventory to prepare the SNF for disposal in a geologic repository. The Sodium-Bonded EIS analyzed, under the proposed action, six alternatives that employed one or more of the following technology options at nuclear fuel management facilities at SRS or INL. These options were electrometallurgical treatment, the plutonium-uranium extraction process, packaging in high-integrity cans, and the melt and dilute treatment process. In the ROD (65 FR 56565), DOE decided to implement the preferred alternative of electrometallurgically treating the Experimental Breeder Reactor-II SNF and miscellaneous small lots of sodium-bonded SNF at Argonne National Laboratory-West (now the Materials and Fuels Complex [MFC]) at INL. Because of the different physical characteristics of the Fermi-1 sodium-bonded blanket SNF (also analyzed in the Sodium-Bonded EIS), DOE decided to continue to store this material while alternative treatments are evaluated. This NEPA document is relevant because the sodium-bonded SNF used in the VTR would also need to be treated prior to disposal.

Resumption of Transient Testing of Nuclear Fuels and Materials at the Idaho National Laboratory, Idaho **(DOE/EA-1954) (DOE 2014b)** – This Environmental Assessment (EA) evaluated DOE activities associated with its proposal to resume testing of nuclear fuels and materials under transient high-power test conditions at the Transient Reactor Test (TREAT) Facility located about 0.5 miles northwest of MFC. The TREAT Facility provides a power transient test capability for fuels that would be tested under steady-state irradiation conditions in the VTR. This EA resulted in a Finding of No Significant Impact (FONSI) (DOE 2014c). This NEPA document is relevant because some of the same support facilities could be used for the VTR project.

Categorical Exclusion Determination, Sample Preparation Laboratory **(DOE-ID 2019c)** – This categorical exclusion determination considered constructing and operating an approximately 49,000 square foot, three-story, Sample Preparation Laboratory at MFC. The facility would supplement current capabilities at

MFC (e.g., the Irradiated Materials Characterization Laboratory and Hot Fuel Examination Facility) with a building dedicated to non-alpha sample preparation to study fuel and material performance in the nuclear environment at the micro, nano, and atomic scale. This project includes a shielded hot cell(s) to support sample preparation of non-alpha bearing materials with the ability to receive small- and medium-sized casks, as well as sort, size, polish, mount, and conduct initial analysis of materials specimens. This NEPA document is relevant because the Sample Preparation Laboratory is a support facility that could be used by the VTR project.

1.6.3 Oak Ridge National Laboratory

Environmental Assessment, Management of Spent Nuclear Fuel on the Oak Ridge Reservation, Oak Ridge, Tennessee **(DOE/EA-1117) (DOE 1996a)** – This EA evaluated the potential impacts of the management of SNF on the Oak Ridge Reservation (ORR) (including ORNL). SNF would be retrieved from storage; loaded into containers and transport casks that meet regulatory requirements; and shipped via truck to offsite storage at either SRS or INL. If separation by fuel type or repackaging were required, the SNF would be transferred by truck to a hot-cell facility for processing prior to offsite shipment. The proposed action also included construction and operation of a dry cask SNF storage facility at ORNL to enable reactor operations to continue in the event of an interruption of offsite SNF shipment. This EA resulted in a FONSI (DOE 1996b). This document is relevant because it deals with the management of SNF generated at ORNL.

1.6.4 Savannah River Site

Surplus Plutonium Disposition Supplemental Environmental Impact Statement **(DOE/EIS-0283-S2) (DOE 2015a)** – This Supplemental EIS evaluated the potential environmental impacts of alternatives for the disposition of surplus plutonium, which had no previously assigned disposition path. The evaluation included plutonium from pits declared "excess" to national defense needs and surplus non-pit plutonium. The analysis considered the impacts from disassembling pits at SRS or Los Alamos National Laboratory (LANL), so the plutonium could be further processed. The analysis also evaluated installation and operation of gloveboxes at the K Area Complex at SRS or LANL to process the plutonium to an appropriate form for disposition.

This Supplemental EIS is relevant to the VTR project because this VTR EIS evaluates an option of performing VTR driver fuel production at SRS. VTR reactor fuel production would involve the installation and operation of glovebox lines in an existing building at SRS. This Supplemental EIS also evaluated the use of gloveboxes installed in an existing SRS building. Although the processes are different, estimates of the installation and operation parameters for the Supplement EIS provided a basis for estimating certain parallel activities for this VTR EIS.

1.7 Public Involvement

On August 5, 2019, DOE published a Notice of Intent (NOI) in the *Federal Register* (84 FR 38021) to prepare this VTR EIS to evaluate the potential environmental impacts of constructing and operating a VTR capability. Publication of the NOI initiated a 30-day public scoping period.

NEPA-implementing regulations require an early and open process for determining the scope of an EIS and for identifying the significant issues related to the proposed action. To ensure that a full range of issues related to the proposed action are addressed, DOE invited Federal agencies, State, local, and tribal governments, and the general public to comment on the scope of the VTR EIS. Specifically, DOE invited comments on the identification of reasonable alternatives and specific environmental issues to be addressed.

During the scoping period, DOE hosted two interactive webcasts on August 27 and 28, 2019. The purpose of the webcasts was two-fold. The first purpose was to present information to the public about the NEPA process and the VTR project. The second was to invite public comments on the scope of the VTR EIS.

DOE received 45 comment documents,[4] in which 173 comments[5] were identified. Analysis of written and oral public comments submitted during the scoping period helped DOE further identify concerns and potential issues considered in the VTR EIS. Appendix G summarizes the scoping comments.

DOE is offering opportunities for public review and comment, including public hearings, on this Draft VTR EIS. Public involvement opportunities and public hearing information will be announced in newspapers in communities near potentially affected areas and in other communications with stakeholders. Comments received during the public comment period will be evaluated in preparing the Final VTR EIS. Comments received after the close of the public comment period will be considered to the extent practicable.

DOE plans to publish the Final VTR EIS in 2021. As required by CEQ regulations (40 CFR 1506.10), DOE will issue a ROD no sooner than 30 days after publication of the Environmental Protection Agency's Notice of Availability of the Final VTR EIS.

[4] A comment document is a communication in the form of a letter, an electronic communication (email), a transcription of a recorded phone message, or a transcript from an individual speaker at a public meeting or hearing, that contains comments from a sovereign nation, government agency, organization, or member of the public regarding the VTR EIS.
[5] A comment is a statement or question regarding the EIS content that conveys approval or disapproval of proposed actions, recommends changes, or seeks additional information.

Chapter 2
Description of Alternatives

2.0 DESCRIPTION OF ALTERNATIVES

2.1 Introduction

This chapter describes the alternatives being considered for the construction and operation of a new U.S. Department of Energy (DOE) facility, the Versatile Test Reactor (VTR). In order to fulfill the mission for which the VTR is proposed, DOE must operate additional facilities (either newly constructed or modified existing) and develop specialized capabilities. These associated facilities and capabilities are required in order to:

- Produce fuel for the VTR,
- Perform post-irradiation examination of test specimens, and
- Manage spent nuclear fuel.

In determining where in the DOE complex to construct the VTR and to establish the associated facilities, DOE goals include (1) co-locating the VTR and post-irradiation examination facilities, (2) using existing post-irradiation examination facilities to the extent practical, (3) leveraging (by adapting and using) current reactor and post-irradiation examination facility knowledge and experience, and (4) managing spent fuel on site, pending a DOE decision on disposition.

DOE identified two alternatives for the VTR: constructing and operating the VTR at the Idaho National Laboratory (INL) Site and constructing and operating the VTR at the Oak Ridge National Laboratory (ORNL). These alternatives include the siting, construction, and operation of the VTR, post-irradiation examination facilities, and spent fuel treatment and storage facilities. To the extent possible, existing facilities (modified as necessary) would be used for the VTR support facilities.

Regardless of the VTR alternative selected, nuclear fuel would be required to operate the reactor. The type of fuel planned for the VTR is not available from commercial nuclear fuel vendors, so DOE would produce the fuel. DOE identified the INL Site and the Savannah River Site (SRS) as options for fuel production. Site selection decisions for the VTR and fuel production capabilities are evaluated independently of each other in this environmental impact statement (EIS).

This chapter is organized as follows:

Section 2.1, Introduction – This section describes the purpose and intent of this chapter, as well as its organization.

Section 2.2, Proposed Versatile Test Reactor – This section describes the proposed VTR and its associated facilities.

Section 2.3, No Action Alternative – This section describes the No Action Alternative for a VTR.

Section 2.4, Idaho National Laboratory Versatile Test Reactor Alternative – This section presents the INL VTR Alternative. It describes the location, construction, and operation of the VTR at the INL Site, the modifications of existing INL facilities, and construction of a new spent fuel pad (a concrete slab for storage) to support VTR operation.

Section 2.5, Oak Ridge National Laboratory Versatile Test Reactor Alternative – This section presents the ORNL VTR Alternative. It describes the location, construction, and operation of the VTR, its associated facilities, and spent fuel pad at ORNL. It also discusses the operation of existing ORNL facilities that would support the VTR.

Section 2.6, **Reactor Fuel Production** – This section describes the options for producing VTR reactor fuels. It describes the possible sites and facilities for VTR fuel production at the INL Site and SRS. These options are evaluated independently from the VTR siting alternatives. The selection of reactor fuel production options can be made independently of the site selection for the VTR.

Section 2.7, Alternatives Considered and Dismissed from Detailed Analysis – This section covers alternatives and options considered by DOE but dismissed from further analysis in this EIS. It identifies each alternative and option and explains the rationale for dismissal.

Section 2.8, Preferred Alternative – This section addresses DOE's preferred alternative for the construction and operation of the VTR and its associated facilities. It also addresses DOE's preferred options for producing reactor fuel.

Section 2.9, Summary of Environmental Consequences – This section summarizes and compares the potential environmental consequences of the VTR alternatives and the reactor fuel production options. It also summarizes potential cumulative impacts of alternatives and options considered in this EIS and other existing or reasonably foreseeable actions.

Appendix B contains additional information describing the facilities required for the VTR project.

2.2 Proposed Versatile Test Reactor

DOE proposes to construct and operate the VTR at a suitable DOE site. DOE would use or expand existing, co-located, post-irradiation examination capabilities to accomplish this mission. Where necessary, requirements for expanding capabilities would involve the construction of new facilities. DOE would also use or expand existing facility capabilities to fabricate VTR driver fuel and test items[1] and to manage radioactive wastes. The following subsections provide non-site-specific descriptions of the VTR and associated facilities that would be included under both VTR action alternatives.

Driver (fuel) assembly located in the core contains the fuel needed to power the reactor and produces the fast neutron flux necessary for irradiation of test assemblies or specimens.

Reflector assembly surrounds the core and contains material to reflect neutrons back into the central part of the core.

Shield assembly is positioned outside of the reflector assemblies and contains material to absorb neutrons that pass through the reflector to reduce neutron damage to the reactor structural components.

Test assembly contains the test specimen and any in-core equipment needed to support the experiment. Instrumented test assemblies could be as long as 65 feet and are located in the core. Non-instrumented assemblies would be the same length as driver fuel assemblies (less than 13 feet) and may be located in the core or with the reflector assemblies.

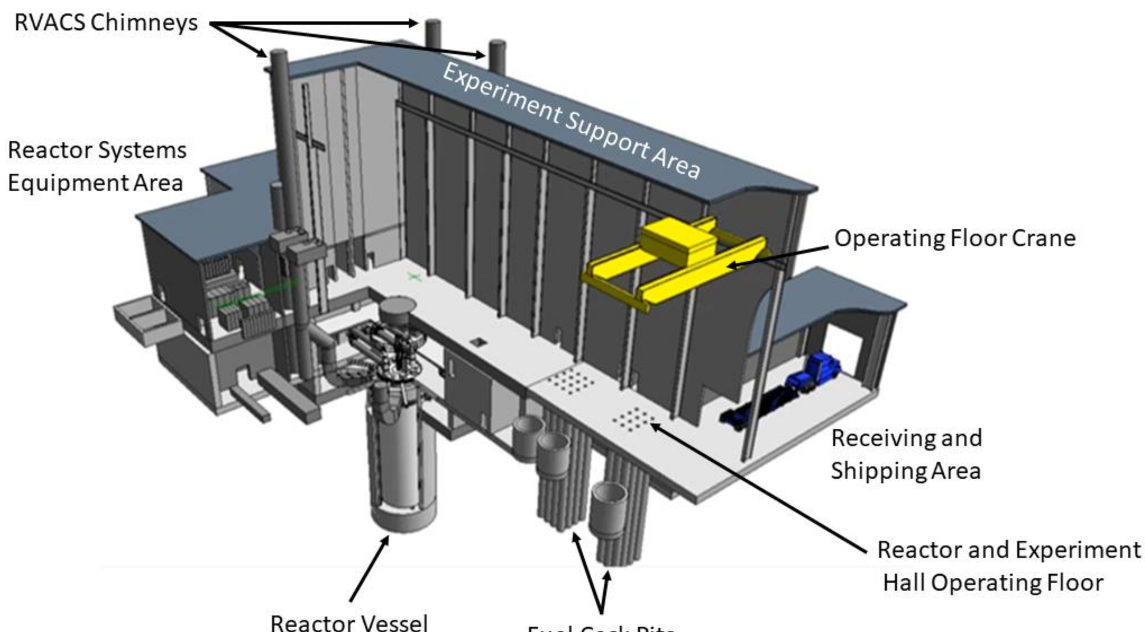
Test specimen is the material being exposed to a fast-neutron flux to determine the effects of the exposure and includes any capsule necessary to support the test. The test specimen can be no more than about 31 inches long.

2.2.1 Versatile Test Reactor

The principal objective of the VTR is to create a high flux of high-energy or "fast" neutrons within reactor test volumes (see Appendix B). This requires a departure from the light-water-moderated technology of current U.S. power reactors and the use of other reactor cooling technologies. The most mature technology that could generate the high-energy neutron flux is a sodium-cooled reactor. Experience with a pool-type configuration and metallic alloy fuels afford the desired level of technology maturity and safety approach. Sodium-cooled reactor technology has been successfully used in Idaho at the Experimental Breeder Reactor II (EBR-II), in Washington at the Fast Flux Test Facility (FFTF) and in Michigan at the Enrico Fermi Nuclear Generating Station Unit 1.

[1] As a user facility, the VTR would provide experimental capabilities for entities outside of DOE. These other entities could also fabricate test items for placement in the reactor.

The current VTR concept (see **Figure 2–1**) would make use of technologies incorporated into the GE Hitachi Nuclear Energy (GEH) Power Reactor Innovative Small Module (PRISM) design. The PRISM design[2] of a sodium-cooled, pool-type reactor satisfies the need to use a mature technology. The VTR would be an approximately 300-megawatt, thermal reactor, based on and sharing many design and safety features of the GEH PRISM. It also would incorporate technologies adapted from previous sodium-cooled fast reactor technologies (e.g., EBR-II and FFTF). The VTR's reactor, primary heat removal system, and safety systems would be similar to those of the PRISM design. VTR, like PRISM, would use metallic alloy fuels. The conceptual design for the first VTR driver fuel core proposes to use a uranium-plutonium-zirconium alloy fuel. Such an alloy fuel was tested previously in EBR-II, FFTF, and the INL Transient Reactor Test Facility. Later, reactor fuel could consist of varying enrichments of uranium and plutonium and could use other alloying metals in place of zirconium.



Key:
RVACS = Reactor Vessel Auxiliary Cooling System
Source: Modified from Bumgardner 2019.

Figure 2–1. Conceptual Design for the Versatile Test Reactor Facility

The VTR core design (see **Figure 2–2**), however, would differ from the PRISM core because it needs to meet the requirement for a high flux test environment that accommodates several test and experimental assemblies. Experiments would be placed in some locations normally occupied by driver fuel in the PRISM reactor. The VTR is not a power reactor. Therefore, no PRISM power conversion system and associated systems for the generation of electricity are needed. Heat generated by the VTR during operation would be dissipated through a secondary heat rejection system consisting of intermediate heat exchangers within the reactor vessel, a secondary sodium-cooling loop, and air-cooled heat exchangers. This system and the Reactor Vessel Auxiliary Cooling System (RVACS) would provide shutdown and emergency cooling. The RVACS would remove decay heat from the sodium pool by transferring the thermal energy through

[2] The PRISM design is based on the EBR-II reactor, which operated for over 30 years. The PRISM design most similar to the VTR is the 471 megawatt thermal MOD-A design. The U.S. Nuclear Regulatory Commission review of the PRISM reactor, as documented in NUREG-1368, *Preapplication Safety Evaluation Report for the Power Reactor Innovative Small Module (PRISM) Liquid-Metal Reactor* (NRC 1994), concluded that "no obvious impediments to licensing the PRISM design had been identified."

the reactor and guard vessel walls (with convective heat transfer through the argon gas in the annular gap between vessels). Heat is removed by naturally circulating air being drawn down through the inlets of four cooling chimneys, through risers on the exterior of the guard vessel, and up through the outlets of the cooling chimneys. No water would be used in either of the reactor cooling systems. The VTR reactor building's longest external dimensions would be about 280 feet by 180 feet with an experiment support area that extends 90 feet above the ground surface. The RVACS chimneys would be about 100 feet tall, extending above the experiment support area. Below-ground elements of the facility would include a structure that houses the reactor head access area, secondary coolant equipment rooms, the reactor vessel, test assembly storage areas, and fuel cask pits. The deepest of these, the reactor vessel silo, would extend to a floor level 93 feet below ground.

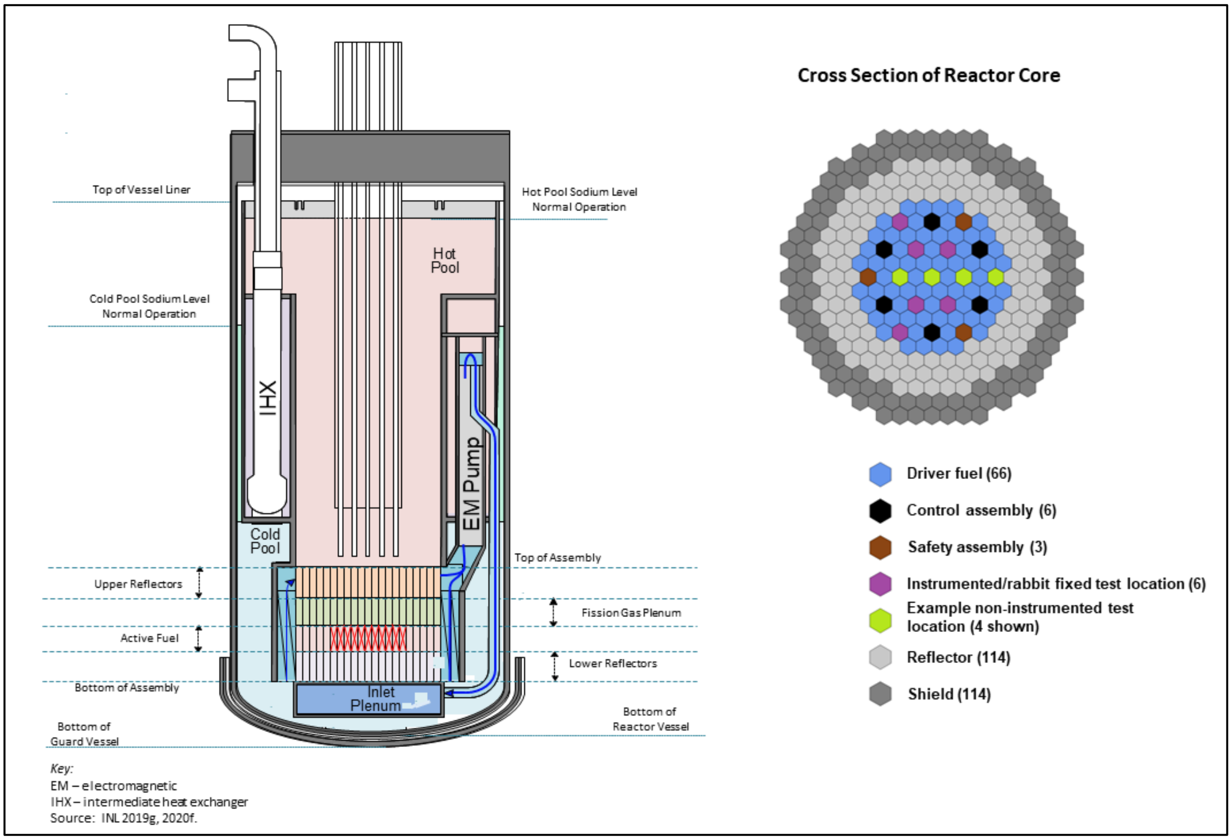


Figure 2–2. Versatile Test Reactor and Core Conceptual Designs

The core of the VTR would comprise 66 driver fuel assemblies. (See Section 2.6 for a discussion of the fuel and fuel production.) The VTR core would be surrounded by rows of reflector assemblies (a total of 114 assemblies) made of nonfuel material (HT-9 stainless steel). The reflector assemblies would be surrounded by rows of shield assemblies, totaling 114 assemblies, made of HT-9 stainless steel and containing neutron-absorbing boron carbide.

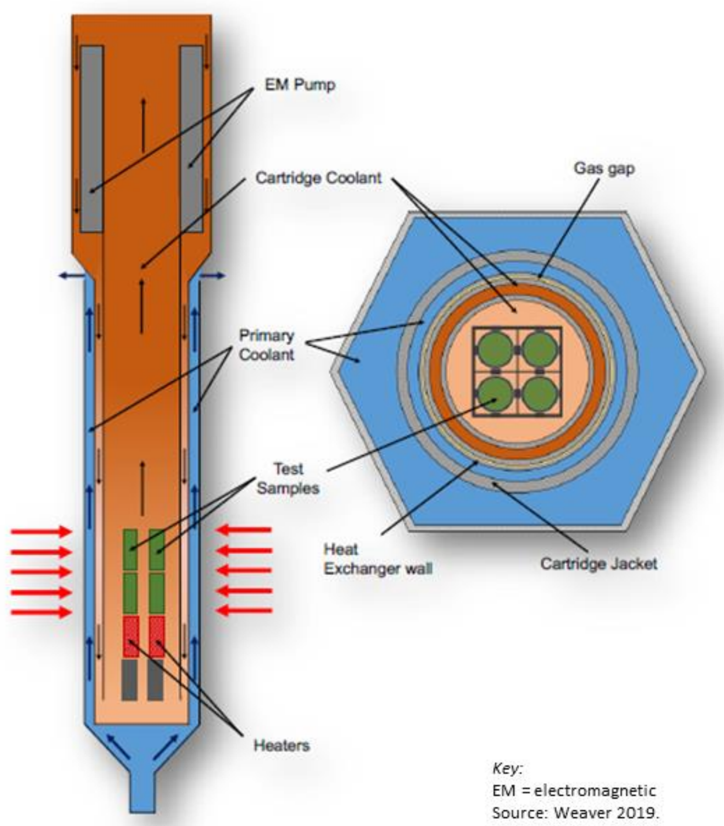
Non-instrumented experiments (containing test specimens) could be placed in multiple locations in the core or in the reflector region, by replacing a fuel or reflector assembly.[3] (Test pins may also be placed within a driver fuel assembly.) Instrumented experiments that would provide real-time information while

[3] Generally, the number of non-instrumented test locations are 4 in the core and an additional 10 in the reflector. However, the number of non-instrumented test locations relies upon the specific cycle-dependent physics and safety calculations. In any given test cycle the number of non-instrumented test assemblies could be more or less than these estimates. Also, non-instrumented test assemblies could be placed in an instrumented location.

the reactor is operating would require a penetration in the reactor cover for the instrumentation stalk and could only be placed in six fixed locations. At any time, one of these six locations could accommodate a "rabbit" test assembly that would allow samples to be inserted and/or removed while the reactor is in operation. The number of instrumented test locations, plus the flexibility in the number and location of non-instrumented tests, would strengthen the versatility of the reactor as a test facility.

Each test location could accommodate an experiment about the height of the core (80 centimeters) and could accommodate a test volume of more than 7 liters. Extended test assemblies would be used in the instrumented test locations. These test assemblies extend through the reactor head, and typically have various instrumentation leads, which are routed to the experiment rooms. Test specimens in these assemblies may be encapsulated in cartridges, so that the material being tested is fully contained. **Figure 2–3** shows one such test cartridge for testing materials that would require isolation from the primary coolant. Such a cartridge would allow testing of fuels and test materials in different coolant types (including sodium, gas, molten salts, and lead/lead-bismuth eutectic). Once operational, the VTR would run 3 test cycles per year, with each cycle averaging about 100 days long. After a typical cycle, a little less than one quarter of the driver fuel would be replaced. The VTR would annually generate up to 45 spent nuclear driver fuel assemblies or about 1.8 metric tons of heavy metal as spent fuel.

- 80 centimeters = 31 inches
- 7 liters = 0.24 cubic feet



Key:
EM = electromagnetic
Source: Weaver 2019.

Figure 2–3. Experimental Cartridge

The VTR would provide the capability to test fuels, materials, instrumentation, and sensors for a variety of existing and advanced reactor designs, including sodium-cooled reactors, lead/lead-bismuth eutectic cooled reactors, gas-cooled reactors, and molten-salt reactors. Test vehicles for coolants other than sodium would consist of enclosed cartridges that contain coolant and test material, thus isolating the experiments from the primary coolant. Due to the high flux possible in the VTR, accelerated testing for reactor materials would be possible. These experiments would expand the state-of-the-art knowledge of reactor technology. Tests and experiments could also be developed that would improve safeguards technologies. In addition to fast reactor test and experimentation, the VTR could be used for research on long-term fuel cycles, fusion reactor materials, and neutrino science/detector development.

The VTR would not be used as a breeder reactor. All of the driver fuel removed from the reactor core would be stored to allow radioactive decay to reduce decay heat and dose rates, and then conditioned for disposal. No nuclear materials would be removed from the fuel for the purpose of reuse as fuel.

2.2.2 Post-Irradiation Examination Facilities

Concurrent with the irradiation capabilities generated by the VTR, the mission requires the capabilities to examine the test specimens (irradiated in the reactor) to determine the effects of a high flux of high-energy or fast neutrons. Depending on the nature of the test requirements, highly radioactive test specimens would be removed from the reactor after a period of irradiation, ranging from days to years. Test specimens would then be transferred to a fully enclosed, radiation-shielded facility where they could be disassembled, analyzed, and evaluated remotely. The examination facilities are "hot-cell" facilities (see **Figure 2–4**).[4] These hot cells include concrete walls and multi-layered, leaded-glass windows several feet thick. Remote manipulators allow operators to perform a range of tasks on test specimens within the hot cell while protecting them from radiation exposure. An inert atmosphere is required in some hot cells. An inert atmosphere of argon would be used[5] in the hot cell to which test assemblies are initially transferred after removal from the VTR. The inert atmosphere may be necessary to prevent test specimen degradation or unacceptable reactions (e.g., pyrophoric) that could occur in an air atmosphere. To minimize on- or offsite transportation of the highly radioactive specimens, DOE intends that these post-irradiation hot cell facilities would be in close proximity to the VTR. After initial disassembly and examination in the inert atmosphere hot cell, test specimens may be transferred to other hot cells or other post-irradiation examination facilities for additional analysis.

Figure 2–4. Exterior and Interior Views of Hot Cell Facilities

[4] A 360-degree tour of the exterior of the INL Hot Fuel Examination Facility hot cell is available at https://inl.gov/360-tour/hot-fuel-examination-facility.

[5] Not all test specimens would require an inert atmosphere during disassembly, analysis, and evaluation. However, separate facilities are not proposed for test specimens that do not require initial post-irradiation examination in an inert atmosphere.

2.2.3 Other Support Facilities

Key nuclear infrastructure components required to support the VTR and post-irradiation examination include:

- Facilities for VTR driver fuel production and test item fabrication, and
- Facilities for management of spent VTR driver fuel.

Nuclear materials (specifically, plutonium and uranium) for the VTR driver fuel could be acquired from several sources, including the DOE complex, commercial facilities, or foreign countries. The nuclear materials would be converted into metallic form,[6] as necessary, and formed into ingots (oblong blocks of metal) from which the fuel would be fabricated. The ingots could be produced at one of the locations providing the nuclear materials. Alternatively, plutonium (that may require polishing,[7] conversion to metal, or both) could be shipped to one of the DOE sites being considered for reactor fuel production for feedstock preparation and creation of feedstock ingots. At the fuel fabrication facility, ingots of nuclear material would be melted and combined with zirconium to make the alloy for fabrication of the fuel pins and assemblies ready for insertion into the VTR. DOE plans to acquire metal uranium for fabricating VTR fuel from a commercial vendor.

DOE would collaborate with a range of university, commercial industry, and national laboratory partners for experiment development. Fabrication of the test and experimental articles could occur at DOE facilities or at university or commercial industry partners' facilities. As shown in Figure 2–1, the VTR facility would have experiment support areas in which final assembly (e.g., insertion of the test specimen into the test assembly) and verification of the test assemblies would be performed before insertion into the VTR reactor core.

Once it is operational, the VTR would generate up to 45 spent driver fuel assemblies per year.[8] DOE would use existing or new facilities at the locations identified in the site-specific alternatives for the management of spent driver fuel. Spent driver fuel would be temporarily stored at the VTR within the reactor vessel for about 1 year. After the fuel radioactively decays and cools sufficiently, driver fuel assemblies would be removed from the vessel, the surface sodium coolant would be washed off the assembly, and the assembly would be transferred in a cask to a new onsite spent fuel pad. After several years (at least 3 years), during which time the radioactive constituents would further decay, the assemblies would be transported in a transfer cask to a spent fuel treatment facility. The sodium that was enclosed within the driver fuel pins to enhance heat transfer would be removed using a melt-distill-package process. The entire spent driver fuel assembly would be chopped. The chopped material would be consolidated, melted, and vacuum distilled to separate the sodium from the fuel. To meet safeguards requirements, the nonfuel elements of the driver fuel assembly would serve as a diluent for the remaining spent fuel to reduce the fissile material concentration. The resulting material would be packaged in containers and temporarily stored in casks on a spent fuel pad, pending transfer to an offsite storage location. The location would be either an interim storage facility or a permanent repository when either becomes available for VTR spent driver fuel. The sodium removed from the fuel would be converted into a

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[6] The nuclear materials can exist in forms other than metal. For example, uranium can exist as uranium hexafluoride or uranyl nitrate. It would need to be processed in order to produce an oxide or metal. Both uranium and plutonium could exist as an oxide that would be chemically reduced to convert it to a metal.

[7] Polishing is the term used for removing undesirable components from plutonium. For example, americium-241 builds up from the decay of plutonium-241, so polishing to remove americium may be necessary to facilitate production (by minimizing worker radiation dose) and allow the use of gloveboxes instead of hot cells.

[8] Typically less than a quarter of the driver fuel assemblies would be replaced at the end of a test cycle. However, there could be atypical conditions when it would be necessary to replace a larger number of assemblies. In such instances, more than 45 assemblies could be removed from the core in a single year.

nonreactive salt, stabilized (if necessary), and packaged in containers as remote-handled low-level radioactive waste. End fittings and other nonfuel hardware could be incorporated in the melted fuel or removed, packaged, and disposed of as transuranic or low-level waste in accordance with their radiological characteristics. Radioactive waste would be processed, packaged, and disposed of (either on site or at an offsite facility).

Specific action alternatives proposed for analysis in this EIS include alternative DOE national laboratory sites for the construction and operation of the VTR, the provision of post-irradiation examination facilities, and the interim management of spent fuel. Under all action alternatives, the VTR would be an approximately 300-megawatt thermal, sodium-cooled, pool-type, metal-fueled reactor based on the GEH PRISM.

The reactor fuel production (feedstock preparation and fuel fabrication) options are considered independently of the alternatives for the VTR site. DOE identified two sites with the technological capabilities and capacities for feedstock preparation or fuel fabrication: the INL Site and SRS. The feedstock preparation and fuel fabrication options are discussed in Section 2.6.

2.3 No Action Alternative

Under the No Action Alternative, DOE would not pursue the construction and operation of a VTR. To the extent they are capable and available for testing in the fast-neutron-flux spectrum, DOE would continue to make use of the limited capabilities of existing facilities, both domestic and foreign. Domestic facilities that would likely be used, without modification, would include the INL Advanced Test Reactor (ATR) and the ORNL High Flux Isotope Reactor (HFIR). DOE would not construct new or modify existing post-irradiation examination or fuel treatment facilities to support VTR operation. Existing post-irradiation examination and fuel treatment facilities would continue to support operation of the existing reactors. Because there would not be a VTR under the No Action Alternative, there would be no need to produce VTR fuel. Therefore, no new reactor fuel production capabilities would be pursued. The No Action Alternative would not meet the purpose and need identified for the VTR (see Chapter 1, Section 1.3).

2.4 Idaho National Laboratory Versatile Test Reactor Alternative

Under the INL VTR Alternative, DOE would site the VTR near the Materials and Fuels Complex (MFC) at the INL Site (see **Figures 2–5** and **2–6**) and use existing hot cell and other facilities at MFC for post-irradiation examination and spent fuel treatment. MFC is the location of the Hot Fuel Examination Facility (HFEF), the Irradiated Materials Characterization Laboratory (IMCL), the Experimental Fuels Facility (EFF), the Fuel Conditioning Facility (FCF), the Fuel Manufacturing Facility (FMF) and the decommissioned Zero Power Physics Reactor (ZPPR). HFEF and IMCL (and other analytical laboratory facilities) would be used for post-irradiation examination and FCF for spent fuel treatment. EFF, FCF, FMF, and ZPPR would be used for reactor fuel production (see Section 2.6.2).

As shown in Figure 2–6, the VTR would be located on the east side of MFC. This location was selected primarily because the project would make use of numerous facilities at MFC. In addition, it is anticipated that relatively few environmental impacts would result from siting the facility there. The VTR complex would occupy about 25 acres. Additional land would be disturbed during the construction of the VTR complex for such items as temporary staging of VTR components, construction equipment, and worker parking In total, construction activities (anticipated to last 51 months) would result in the disturbance of about 100 acres, inclusive of the 25 acres occupied by the completed VTR complex. The 4 largest structures that would comprise the VTR are the reactor facility, electrical switchyard, 10 sodium-to-air heat exchangers, and an operations support facility. Various additional structures and equipment enclosures would be required. The existing Perimeter Intrusion Detection and Assessment System (PIDAS) security fencing around FMF and ZPPR would be extended to encompass most of the facility.

Figure 2–5. Proposed Versatile Test Reactor and Idaho National Laboratory Location Map

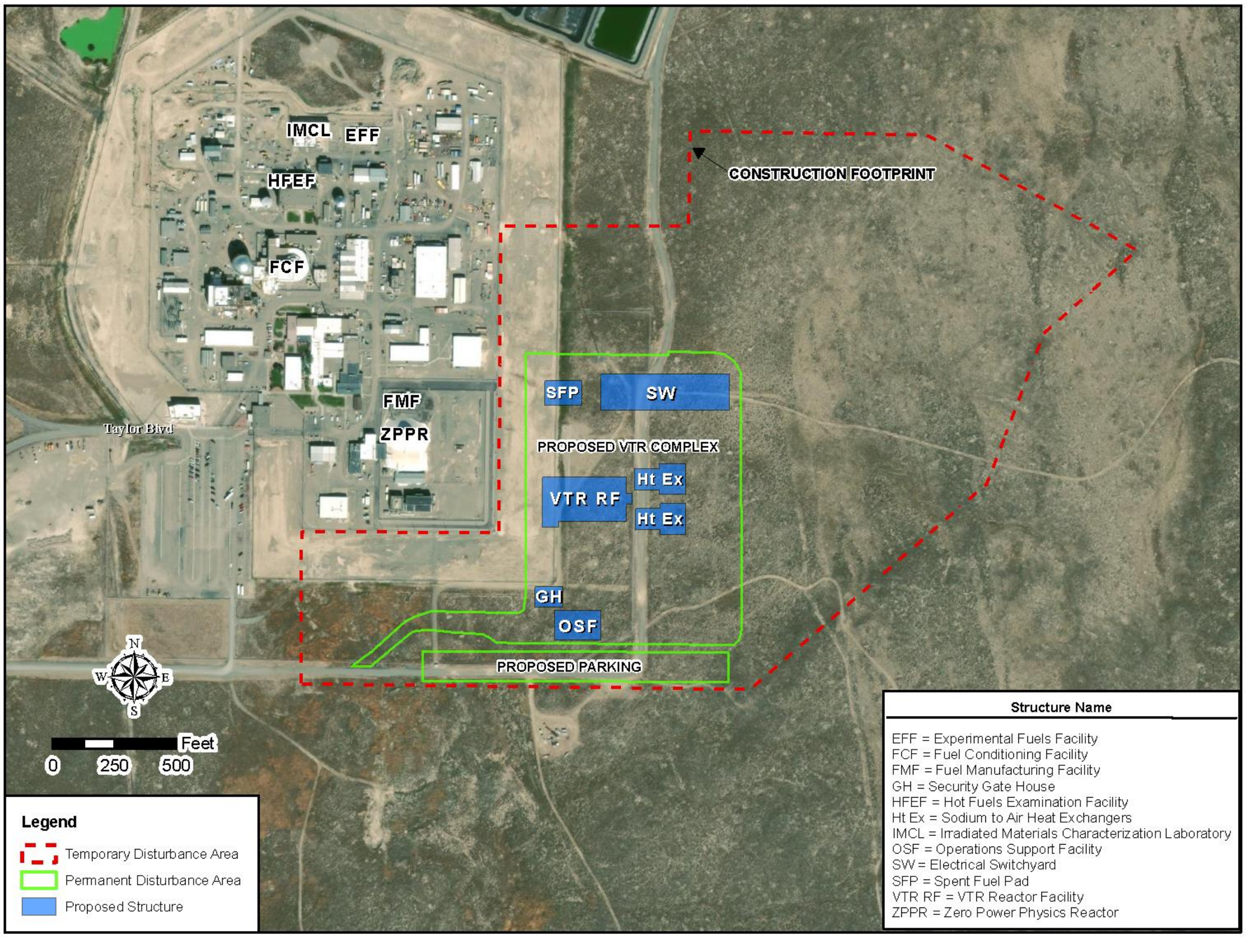

Figure 2–6. Versatile Test Reactor Facilities at the Materials and Fuel Complex at Idaho National Laboratory

Existing facilities would be used for post-irradiation examination of test and sample articles. Test and sample articles would be transferred to HFEF first. HFEF, a Hazard Category 2 nuclear facility[9] contains two large hot cells. The main cell is 70 feet by 30 feet with an inert argon atmosphere. This main cell employs 15 workstations. The second cell has an air atmosphere and includes five workstations. HFEF has the capability to handle fuel pins up to 13 feet long and the VTR test assemblies (excluding extensions removed prior to transfer to HFEF) would be less than 13 feet long. HFEF hot cells provide shielding and containment for remote examination (including destructive and non-destructive testing), processing, and handling of highly radioactive materials.

IMCL, a Hazard Category 2 nuclear facility, is the newest nuclear energy research facility at MFC, with a modular design that provides flexibility for future examination of nuclear fuel and materials. IMCL would be used for the study and characterization of radioactive fuels and materials at the micro- and nanoscale to assess irradiation damage processes. Shielded hot cell, glovebox, and hood capabilities are included in the facility. IMCL has free space for user-defined capability, such as the VTR project.

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[9] DOE defines hazard categories of nuclear facilities by the potential impacts identified by hazard analysis and has identified radiological limits (quantities of material present in a facility) corresponding to the hazard categories. Hazard Category 1 – Hazard Analysis shows the potential for significant offsite consequences (reactors are included in this category). Hazard Category 2 – Hazard Analysis shows the potential for significant onsite consequences beyond localized consequences. Hazard Category 3 – Hazard Analysis shows the potential for only significant localized consequences. Below (Less Than) Hazard Category 3 applies to a nuclear facility containing radiological materials with a final hazard categorization less than Hazard Category 3 facility thresholds (DOE 2018c).

> **Materials and Fuels Complex Facilities to Support the Versatile Test Reactor**
>
> *Fuel Fabrication*
>
> EFF – Experimental Fuels Facility
> FCF – Fuel Conditioning Facility
> FMF – Fuel Manufacturing Facility
> ZPPR – Zero Power Physics Reactor
>
> *Post-Irradiation Examination*
>
> HFEF – Hot Fuel Examination Facility
> IMCL – Irradiated Materials Characterization Laboratory
>
> *Fuel Treatment*
>
> FCF – Fuel Conditioning Facility

HFEF, IMCL, and EFF are not within a PIDAS, whereas FCF, FMF, and ZPPR are. The need for a PIDAS is determined by the type, quantity, and form of controlled material (e.g., plutonium) that a facility could contain at one time. HFEF, IMCL, and EFF are not expected to reach this threshold.

The existing facilities within MFC would not need to be modified to support fabrication of test articles or to support post-irradiation examination of irradiated test specimens withdrawn from the VTR. (HFEF would need new, in-cell handling equipment for experiment movement and examination.) These types of activities are ongoing within the MFC. These facilities and their associated operational staff provide an extensive capability to perform the anticipated post-irradiation examination activities that the VTR would create (INL 2020f).

Spent driver fuel would be temporarily stored at the VTR within the reactor vessel, followed by a period of storage on a spent fuel pad constructed to the east of ZPPR within the VTR complex. After the fuel cools sufficiently, it would be transported in a transfer cask to FCF. FCF contains two hot cell facilities: one with an air atmosphere and one with an inert argon atmosphere. Its primary mission is to support the treatment of DOE-owned, sodium-bonded metal fuel. DOE anticipates completing the processing of the current inventory of sodium-bonded driver fuel by the end of 2028. DOE also anticipates the identification and use of more efficient disposition options for the sodium-bonded EBR-II blanket material. Thus, FCF would be available and have the capacity to treat VTR fuel when the first fuel is available for treatment, no earlier than 2030. FCF is located within a PIDAS and is a Hazard Category 2 nuclear facility. It also supports DOE's Fuel Cycle Research and Development Program in the assessment of spent nuclear fuel treatment technologies involving high-temperature chemical and electrochemical methods for separation, purification, and recovery of fissile elements. DOE does not intend to separate, purify, or recover fissile material from VTR spent fuel.

Sodium would be removed from the driver fuel before packaging for storage and disposal. The process proposed for conditioning the fuel is a melt-distill-package process. The fuel would be chopped, using existing equipment at FCF. The chopped material would be consolidated, melted, and vacuum distilled to separate the sodium from the fuel. A diluent would be added to the spent driver fuel, most probably scrap HT-9 stainless steel from the driver fuel assembly. The mixture would be packaged in containers, placed in storage casks, and temporarily stored at a new spent fuel pad until shipped to an offsite location (either an interim storage facility or a permanent repository when either becomes available for spent VTR fuel). The sodium removed from the fuel would be converted into a nonreactive salt, stabilized (if necessary), and packaged in containers as low-level radioactive waste that would be stored at the Radioactive Waste Management Complex until it is shipped to a low-level radioactive waste disposal site (INL 2019e).

FCF would require modifications to support spent fuel treatment for the spent driver fuel. FCF would need new, in-cell handling equipment for spent fuel treatment and a hot cell window would need to be replaced to accommodate the transfer of driver fuel into the hot cells. Spent fuel treatment (EBR-II fuel) is an ongoing activity within MFC. These facilities and their associated operational staff would provide an extensive capability to perform the anticipated post-irradiation examination activities that the VTR would create (INL 2020f).

A new spent fuel pad would be constructed within the VTR site, adjacent to the VTR switchyard. A spent fuel pad would consist of a concrete slab of about 11,000 square feet with an approach pad of about 2,500 square feet.

Under the conceptual design, MFC's existing infrastructure, including utilities and waste management facilities, would be used to support construction and operation of the VTR. The current infrastructure is adequate to support the VTR with minor upgrades and modifications.

Driver fuel for the VTR would be fabricated at MFC or SRS, depending on multiple factors. Factors include the source of the nuclear material, as well as the availability and capabilities of DOE, commercial or foreign suppliers, and manufacturers (see Section 2.6).

2.5 Oak Ridge National Laboratory Versatile Test Reactor Alternative

Under the ORNL VTR Alternative, the VTR would be sited at ORNL at a site previously considered for other projects, about a mile east of the ORNL main campus (see **Figure 2–7** and **2–8**). The major structures for the VTR would be the same as those described for the INL VTR Alternative.

Although there are facilities with hot cells and other laboratories at ORNL that would be used for post-irradiation examination of test materials, none of the available hot cells operates with an inert atmosphere. All ORNL hot cells use an air atmosphere. A hot cell with an inert atmosphere would be needed for the VTR operation and for the treatment and conditioning of spent fuel. Converting existing hot cells at ORNL to operate with an inert atmosphere would require modifications that would interrupt their availability for ongoing mission work. Additionally, VTR-related operations in the hot cell(s) with an inert atmosphere have the potential to adversely impact the ongoing missions of these facilities. Based on these two considerations, conversion of an existing hot cell(s) to an inert atmosphere was not considered viable. Therefore, a new hot cell, a joint post-irradiation examination and spent fuel treatment facility, would be constructed adjacent to the VTR.

Additionally, a new spent fuel pad would be constructed as part of the VTR project to store treated fuel pending shipment to an offsite repository. All three facilities (the VTR facility, hot cell facility, and spent fuel pad) would be located within a single PIDAS.

The new hot cell facility would be approximately 172 feet by 154 feet and comprise four levels (including one level extending 19 feet below grade). The lower three levels would be constructed of concrete and brick masonry. The fourth level, a high bay area, would be of mostly steel construction and would rise to about 84 feet above grade. The facility would house four hot cells: two for post-irradiation examination and two for spent fuel treatment. Each pair of hot cells would include a decontamination hot cell and an inert atmosphere hot cell. Construction would occur in parallel with the construction of the VTR and be completed in the same 51-month period. Construction activities would result in disturbance of about 150 acres, with the completed VTR complex, including the hot cell facility and spent fuel storage pad, occupying fewer than 50 acres.

The new hot cell facility could be attached to the VTR and would support both spent fuel treatment and post-irradiation examination activities. In addition to this new hot cell facility, existing facilities at ORNL would be used for supplemental or advanced post-irradiation examination for materials that do not require an inert environment. Hot cells within the Irradiated Fuels Examination Laboratory (Building 3525) and the Irradiated Material Examination and Testing Facility (Building 3025E) would be used to supplement the capabilities of the new post-irradiation examination facility. In addition, the Low Activation Materials Design and Analysis Laboratory (LAMDA) would be used for testing of low dose samples that do not require the use of hot cells. The Irradiated Fuels Examination Laboratory is a Hazard Category 2 nuclear facility and contains hot cells that are currently used for examination of a wide variety of fuels. The Irradiated Material Examination and Testing Facility is a Hazard Category 3 nuclear facility and contains hot cells that are used for mechanical testing and examination of highly irradiated structural alloys and ceramics. LAMDA is a laboratory for the examination of materials with low radiological content that do not require remote manipulation. LAMDA supports the measurement of physical, chemical, and electric properties of samples.

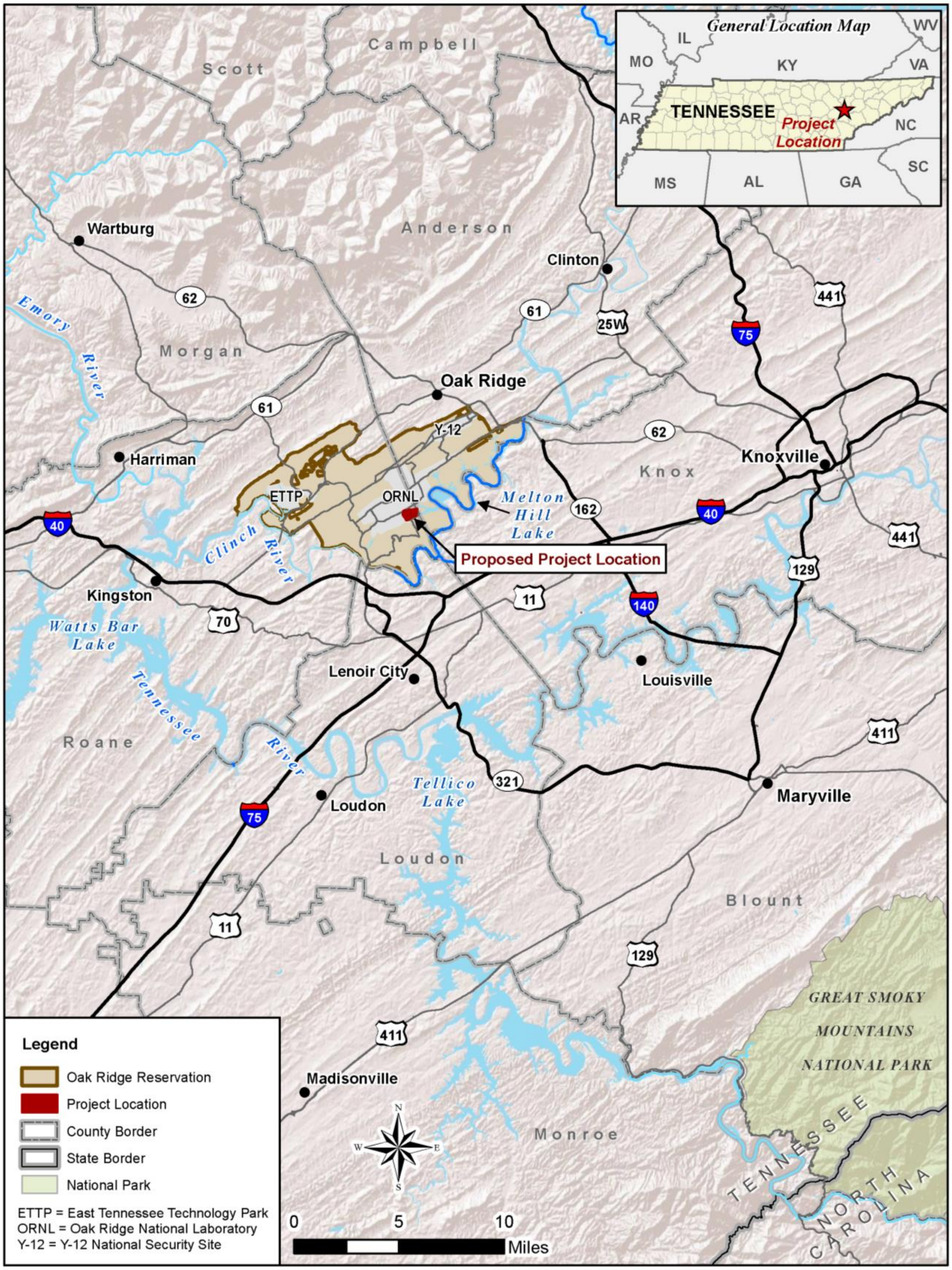

Figure 2–7. Proposed Versatile Test Reactor Facilities and Oak Ridge National Laboratory Location Map

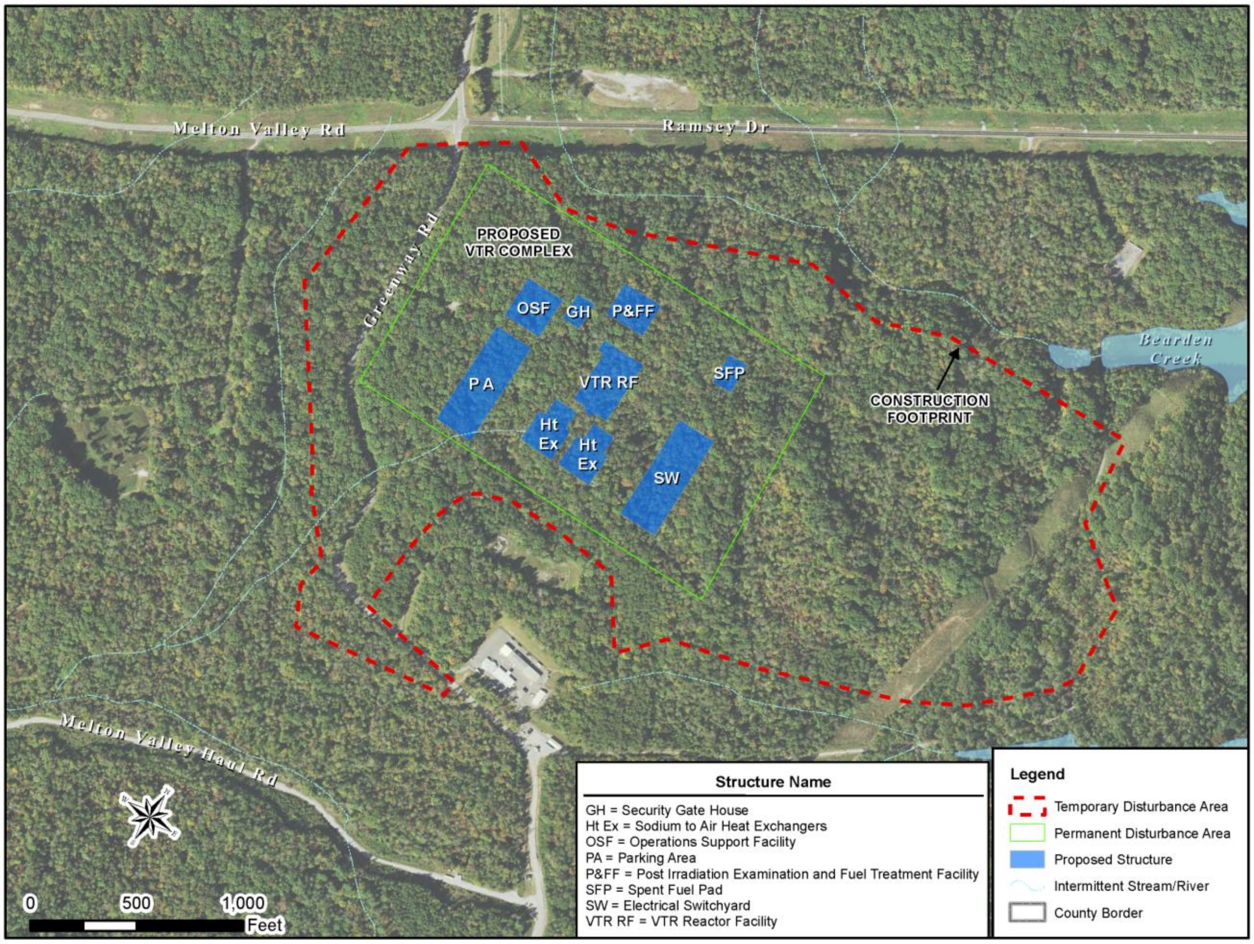

Figure 2–8. Proposed Versatile Test Reactor Site at Oak Ridge National Laboratory

Spent driver fuel would be temporarily stored, for at least a year, at the VTR, within the reactor vessel. Spent fuel would then be transferred to a storage pad for temporary storage (at least 3 years). At the end of this storage period, the fuel would be transferred to the spent fuel treatment facility. Treatment of the spent fuel would use the same processes described under the INL VTR Alternative, Section 2.4. Fuel treatment would occur in an inert atmosphere hot cell located in the new hot cell facility adjacent to VTR. Containerized spent fuel would be placed in storage casks and temporarily stored at a new spent fuel pad until shipped to an offsite location (either an interim storage facility or a permanent repository when either becomes available for VTR fuel). The sodium removed from the fuel would be low-level radioactive waste and would be packaged in containers, stored temporarily on site and transferred to a low-level waste disposal facility.

A new spent fuel pad would be constructed within the PIDAS for the VTR facility. It would consist of a concrete pad of about 11,000 square feet with an approach pad of about 2,500 square feet.

Under the conceptual design, the existing ORNL infrastructure would be extended to the VTR site. The location selected for the VTR is relatively undeveloped and does not have sufficient infrastructure (e.g., roads, utilities, security) to support construction and operation of the VTR. Existing waste management facilities within ORNL would be used to support waste management during construction and operation of the VTR.

Fuel for the VTR would be fabricated elsewhere, as determined by a number of factors. Factors include the source of the nuclear material, as well as the availability and capabilities of DOE, commercial or foreign suppliers and manufacturers (see Section 2.6.).

2.6 Reactor Fuel Production

The VTR design envisions the use of metallic fuel. DOE has conducted parametric studies to estimate the size of the reactor needed to obtain the desired experiment performance. Fuel compositions in the parametric study range from mixes of uranium, plutonium, and zirconium to mixes of only uranium and zirconium using high assay, low-enriched uranium (HALEU). The initial VTR core driver fuel would consist of a uranium/plutonium/zirconium alloy (U/Pu/Zr). Initially, the U/Pu/Zr fuel would be 70 percent uranium (enriched to 5 percent uranium-235[10]), 20 percent plutonium, and 10 percent zirconium, a blend identified as U-20Pu-10Zr. VTR driver fuel used in later operations could consist of these elements in different ratios and could use plutonium with uranium of varying enrichments, including depleted uranium or uranium enriched above 5 percent. After the completion of the parametric fuel study, DOE determined that HALEU fuel would not be available for use in the VTR. Current supplies of HALEU are insufficient to meet outstanding commitments and, despite projected increases in production, future supplies will not be sufficient to provide VTR fuel for its initial startup (DOE 2020h). Additionally, to meet the specifications for the VTR, a fast test reactor fueled with HALEU would need to be about a 700 megawatts thermal (MWth) reactor, which is beyond the size that is practical for a test reactor.

Annual heavy metal requirements would be approximately 1.8 metric tons of fuel material[11] (between about 1.3 metric tons and 1.4 metric tons of uranium and between 0.40 and 0.54 metric tons of plutonium, depending upon the ratio of uranium and plutonium in the fuel) (INL 2019e; Pasamehmetoglu 2019). The nuclear materials for the fuel could be acquired from several existing sources. Enriched uranium would be available from sources within the DOE complex and from commercial vendors. Existing sources of excess plutonium[12] within the DOE complex would be sufficient to meet the needs of the VTR project. Potential plutonium materials would include pit plutonium (metal), oxide, and plutonium from other sources (DOE 2015a). From a performance perspective, DOE's pit plutonium would be the technologically preferable source of plutonium for VTR fuel. However, should this material not be available for the VTR, sources of plutonium from Europe would be sought. Potential impacts from transportation of plutonium from Europe are evaluated in Appendix F of this EIS.

Uranium

Uranium enriched to 5 percent uranium-235 for use in fabricating VTR fuel could be provided from a number of sources. It could be supplied by purchase of commercially enriched uranium or by down-blending various DOE enriched uranium materials. DOE materials could include national security low-assay or scrap materials, unalloyed metals, oxides, or other uranium in various forms (DOE 2015c). All of this material could be down-blended (mixed with either natural or depleted uranium) to make 5 percent enriched uranium. (Depleted uranium is stored currently at two uranium enrichment sites in Paducah, Kentucky, and Portsmouth, Ohio). Low-enriched uranium and possibly depleted uranium, would be available through commercial sources.

The VTR project currently assumes that the 5 percent enriched uranium feed materials would come from commercial sources. DOE's plan for providing uranium for fabricating VTR fuel is to acquire metallic

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[10] Enriched refers to the concentration of the isotope uranium-235, usually expressed as a percentage, in a quantity of uranium. Low-enriched uranium, highly enriched uranium and high assay, low-enriched uranium are all enriched forms of uranium. Depleted uranium is a byproduct of the enrichment process and refers to uranium in which the percentage of uranium-235 is less than occurs naturally.

[11] The cited quantities are for finished fuel as it is placed in the reactor and corresponds to fuel that is from 20 to 27 percent plutonium. Allowing for the additional material that ends as waste during the reactor fuel production process, up to 34 metric tons of plutonium could be needed for startup and 60 years of VTR operation.

[12] Excess plutonium describes U.S. excess weapons-usable plutonium and includes pit (the central core of a primary assembly in a nuclear weapon that is typically composed of plutonium metal [mostly plutonium-239]) and non-pit plutonium that is no longer needed for U.S. national security purposes.

uranium from a domestic, U.S. Nuclear Regulatory Commission (NRC)-licensed, commercial supplier. Modifications needed to make metallic uranium, if necessary, at a commercial supplier may require NRC safety and environmental reviews. If another source of uranium were to be selected, DOE would conduct a review to determine if additional National Environmental Policy Act (NEPA) analysis would be needed.

Plutonium

As indicated above, there are various sources that could provide feedstock plutonium for the production of VTR driver fuel. In 1994 and 1995, the United States designated 38.2 metric tons of weapons-grade plutonium as excess to national security needs. DOE in 1996 identified an additional 14.3 metric tons and in 2006 another 9 metric tons (a total of 23.3 metric tons) of non-weapons-grade plutonium with no defined programmatic use. Since that time, DOE/National Nuclear Security Administration (NNSA) has had an ongoing program with the express purpose of effecting permanent disposition of certain inventories of excess plutonium. This material is stored at several locations within the DOE complex: the INL Site near Idaho Falls, Idaho; Los Alamos National Laboratory (LANL) near Los Alamos, New Mexico; the Pantex Plant near Amarillo, Texas; and SRS near Aiken, South Carolina.

> **Ingot** is an oblong block of metal (e.g., plutonium, uranium, zirconium, an alloy).
>
> **Fuel slug** is a cylindrical rod of alloyed fuel to be inserted into the fuel pin.
>
> **Fuel pin** is a single rod of fuel. The pin consists of a cladding tube, with top and bottom end plugs, containing fuel slugs, sodium-bonded to the cladding, and an inert gas plenum above the fuel.
>
> **Fuel assembly** (sometimes called a subassembly) is a hexagonal array of 217 fuel pins, top and bottom reflectors (shields), surrounded by an assembly duct with assorted mechanical components.
>
> Additional information is in Appendix B.

This plutonium exists in several forms and is of different isotopic mixes. Some of the more desirable forms include clean plutonium metal (e.g., unalloyed "buttons," billets, ingots, castings, finished machined weapon components, and miscellaneous small metal pieces), clean (low-impurity content) plutonium oxides, and alloy/oxide reactor fuels. For a number of technical reasons, the VTR would best be able to achieve the project's technical goals with the use of high-quality, excess pit plutonium as a component of the driver fuel. Less desirable material is in the form of impure metals and oxides, alloys, and uranium-plutonium oxides. Plutonium in spent nuclear fuel is not a candidate source for VTR fuel. DOE and NNSA have disposed of a portion of the excess inventory and continue to manage more than 50 metric tons of excess plutonium.

DOE/NNSA have evaluated the potential environmental impacts of disposition of excess plutonium in several NEPA documents prepared for the Surplus Plutonium Disposition Program (e.g., DOE 1999b, 2015a, and 2020d). Among other activities, these analyses included transportation of pits from storage at Pantex, disassembly of the pits, and various alternatives for dispositioning the plutonium. The analyses also addressed disposition of various other forms of excess plutonium. DOE/NNSA have issued Records of Decision regarding some of this material (81 FR 19588 and 85 FR 53350) and continue planning activities to ensure safe and secure disposition of additional material. DOE/NNSA could decide in the future to make a portion of the excess plutonium available as feedstock for VTR driver fuel. To the extent that excess plutonium becomes available, the VTR Program would be responsible for any technical activities and process changes that may be necessary to accept this source of feedstock. Any changes to allow use of excess plutonium as feedstock for VTR fuel production would be the subject of future NEPA analysis. That analysis would evaluate the different activities that would be required to make excess plutonium available as feedstock as opposed to preparing it for disposition in accordance with current planning.

This VTR EIS evaluates the potential environmental impacts of transporting excess plutonium that could be made available to the VTR project from LANL or SRS to the site where VTR fuel production would occur. It also evaluates the potential environmental impacts of performing the feedstock preparation activities necessary to remove contaminants from the plutonium and, if needed, convert it to metal for use in fuel fabrication. It does not evaluate the impacts of preparing disassembled pits, still in metal form, into a state suitable for packaging and transport to a site for use in VTR. These impacts would be evaluated in the future, if a decision is made to provide excess plutonium as feedstock material to the VTR project.

DOE is also exploring the possibility of acquiring plutonium from foreign stockpiles of plutonium. Both the United Kingdom and France have been reprocessing spent fuel from commercial power reactors and extracting plutonium from that spent fuel. Most of this material is reactor-grade plutonium and acceptable, though not preferable, for VTR fuel. The VTR would perform better with higher-grades of plutonium. In addition, use of reactor-grade plutonium may require more feedstock preparation to make it suitable for use in VTR fuel.[13] Both countries have adequate supplies of separated, reactor-grade plutonium to supply feedstock for the life of the VTR. Appendix F presents an assessment of the environmental consequences of transporting this material to the United States.

Feedstock Preparation

Depending on the impurities of the source material, a polishing process, or a combination of processes, would be required. Several processing options are available to chemically remove impurities from the plutonium prior to mixing with uranium and zirconium. These processes may require the conversion of the material from metal to oxide and oxide to metal and dissolution in acid solutions. Some of the processes must be performed at elevated temperatures to take advantage of the chemical properties of plutonium at different temperatures. These processes would be performed in a series of gloveboxes[14] in order to limit worker radiological exposure (see **Figure 2–9**).

Three potential feedstock preparation processes are under consideration: an aqueous capability, a pyrochemical capability, and a combination of the two. In the aqueous process, the plutonium feed (containing impurities) is dissolved in a nitric acid solution and through a series of extraction and precipitation steps a more polished plutonium oxide is produced. The oxide is converted to a metal in a direct oxide reduction process. In one form of the pyrochemical process (molten salt extraction), the metallic plutonium feed is combined with a salt, the mixture raised to the melting point. Impurities (americium) react with the salt, and the plutonium is collected at the bottom of the reaction crucible. If the pyrochemical process were selected, a direct oxide reduction process would also be required to convert plutonium dioxide feeds to plutonium metal. Either process (aqueous or pyrochemical) could be used to reclaim unusable fuel from the fuel fabrication process. If a combination of the two processes were to be selected, a smaller aqueous line to prepare this fuel could be incorporated into the pyrochemical process (SRNS 2020).

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[13] The source of plutonium impacts the ultimate disposal path for some of the waste generated during fuel production. Transuranic waste is eligible for disposal at the WIPP facility if it has been generated by atomic energy defense activities that meet the requirements of the WIPP Land Withdrawal Act (Public Law 102-579 as amended by Public law 104-201) and meets the WIPP Waste Acceptance Criteria. Transuranic waste resulting from activities using DOE excess plutonium could be eligible for disposal at the WIPP facility. Transuranic waste not eligible for disposal at the WIPP facility, would require disposal in a greater-than-Class-C low-level radioactive waste disposal facility. DOE evaluated potential environmental impacts of alternatives for the disposal of greater-than-Class-C low-level radioactive waste and DOE greater-than-Class-C-like waste in the *Final Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste* (DOE 2016a) and the *Environmental Assessment for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste at Waste Control Specialists, Andrews County, Texas* (DOE 2018d). If it is determined that the VTR Project waste is not eligible for disposal at the WIPP facility, additional National Environmental Policy Act analysis may be required as the EIS for GTCC disposal does not address VTR-generated waste. As of September 2020, DOE has not announced its decision on a disposal location for GTCC low-level waste and GTCC-like waste.

[14] Gloveboxes are sealed enclosures with gloves that allow an operator to manipulate materials and perform other tasks while keeping the enclosed material contained. In some cases, remote manipulators may be installed in place of gloves. The gloves, glass, and siding material of the glovebox are designed to protect workers from radiation contamination and exposure.

Figure 2–9. Representative Glovebox

Fuel Fabrication

Fuel fabrication would use an injection casting process to combine and convert the metallic ingots into fuel slugs. DOE has developed a conceptual design for this capability, based on existing equipment at INL's FMF. In a glovebox, a casting furnace would be used to melt and blend the three fuel components, uranium, plutonium, and zirconium. The molten alloy then would be injected into quartz fuel slug molds. After cooling, the molds would be broken, and the fuel slugs retrieved.

- 0.625 centimeters = 0.246 inches
- 80 centimeters = 31 inches
- 165 centimeters = 65 inches

Fuel pins would be created, using 0.625-centimeter-diameter, 165-centimeter-long, HT-9 stainless steel tubes (cladding) into which a slug of solid sodium would be inserted, followed by two or three of the alloy fuel slugs. The fuel slugs and sodium would occupy about half of the volume of the fuel pin with the remainder containing argon gas at near atmospheric pressure. The ends of the tubes would be closed with top and bottom end plugs. All of these activities would take place in gloveboxes with inert atmospheres. Once fully assembled, the fuel pins would be heated sufficiently to melt the sodium and create the sodium bond with the fuel. The sodium-bonded fuel would fill about half the length of the fuel pin (80 centimeters). Fuel pins would be assembled into a driver fuel assembly with each driver fuel assembly containing 217 fuel pins. Sodium bonding and producing the fuel assemblies would be performed in an open environment. No gloveboxes would be required (INL 2019e).

Fresh fuel assemblies would be kept in storage racks at the fuel fabrication facility until shipped to the VTR. At the VTR, fuel could be loaded directly into the core or temporarily placed in fuel cask pits.

This EIS evaluates the INL Site and SRS as potential locations for performing the activities necessary for reactor fuel production for the VTR. DOE would establish and operate feedstock preparation capabilities at either of the two sites. Independently, DOE would establish and operate all or part of the fuel fabrication capability at either site.

Operationally, the feedstock preparation and fuel fabrication capabilities would need to generate about 66 driver fuel assemblies for the initial VTR core. Thereafter, the capabilities would need to produce up to 45 driver fuel assemblies per year.

2.6.1 No Action Alternative

As discussed in Section 2.3, under the No Action Alternative, DOE would not pursue the construction and operation of the VTR nor the facilities required to support the VTR. Therefore, DOE would not construct, modify, nor operate any feedstock preparation or driver fuel fabrication capabilities to support VTR operation.

2.6.2 Idaho National Laboratory Reactor Fuel Production Options

The INL Site is a potential site for both feedstock preparation and for fuel fabrication. These activities, alone or together, could be located at INL. All activities would occur in existing facilities, but new equipment would need to be installed. As described in the following paragraphs, DOE has identified existing MFC facilities that would be capable of supporting all fuel production activities. All of these facilities are currently in use and some (e.g., the ZPPR cell) have been identified as possible locations for future programmatic missions other than VTR reactor fuel production. Based on DOE programmatic and scheduling priorities, use of these facilities by other programs may result in their being unavailable to the VTR Program. Should this happen, modifications to enlarge an existing facility or the use of other MFC or VTR facilities would be evaluated to assess their capability to support the VTR Program. Any changes to the facilities being considered to host VTR reactor fuel production would be subject to future review under NEPA.

Under the INL Feedstock Preparation Option, polishing and conversion capabilities would be located in the FCF operating floor/high bay, the mockup area, and workshop. FCF is located within a PIDAS and is a Hazard Category 2 nuclear facility. The primary feature of the FCF is its two hot cell facilities, one with an air atmosphere and one with an inert argon atmosphere. However, neither of these hot cells would be used to support feedstock preparation. These activities would be performed in space outside the hot cells converted for feedstock preparation (INL 2020d).

After removal of unneeded equipment (current activities within these areas would be relocated), DOE would install new equipment in glove box lines (a series of two or more related gloveboxes) to perform plutonium polishing and conversion. The number of glovebox lines required would depend upon the processes selected. As noted above, three process combinations are being considered for feedstock preparation. If the aqueous processing were to be selected an estimated 10 glovebox[15] lines may be necessary. Glovebox lines would be constructed for feed preparation, plutonium dissolution, plutonium extraction, oxide conversion, waste processing, and acid recycling. This scenario considers the most equipment-intensive process under consideration. Other processes would be expected to require fewer glovebox lines and less operational space. All feedstock preparation equipment would be newly installed equipment (INL 2020d).

Under the INL Fuel Fabrication Option, the VTR fuel fabrication process would be located in the existing FMF and ZPPR, both Hazard Category 2 nuclear facilities located within a PIDAS. FMF, adjacent to ZPPR, consists of multiple workrooms and a material storage vault. FMF has the ability to develop and store transuranic metallic and ceramic fuels and produce and purify transuranic and enriched uranium feedstock. The reactor and auxiliary systems portion of ZPPR have been removed, and the facility is now used, among other tasks, for the storage, inspection, and repackaging of transuranic elements and

[15] The feedstock preparation operations design uses gloveboxes. However, the design is at a conceptual stage and subject to change. Potential changes include the use of heavily shielded or highly automated gloveboxes or even the use of hot cells. Design considerations that might affect these decisions include limiting worker dose.

enriched uranium. The ZPPR facility includes a workroom, cell area, material storage vault, and the Material Control Building.

Fuel fabrication activities in FMF would occur in a series of gloveboxes. A representative glovebox located in the ZPPR facility and used in the handling of nuclear material is shown in Figure 2–9 (INL 2019e). As proposed, DOE would install gloveboxes for casting (two gloveboxes), demolding (two gloveboxes), and rod loading (one glovebox), to fabricate the fuel pins (see **Figure 2–10**). Additional gloveboxes would be required for slug and pin inspection and scrap recovery. Two gloveboxes are proposed for scrap recovery.

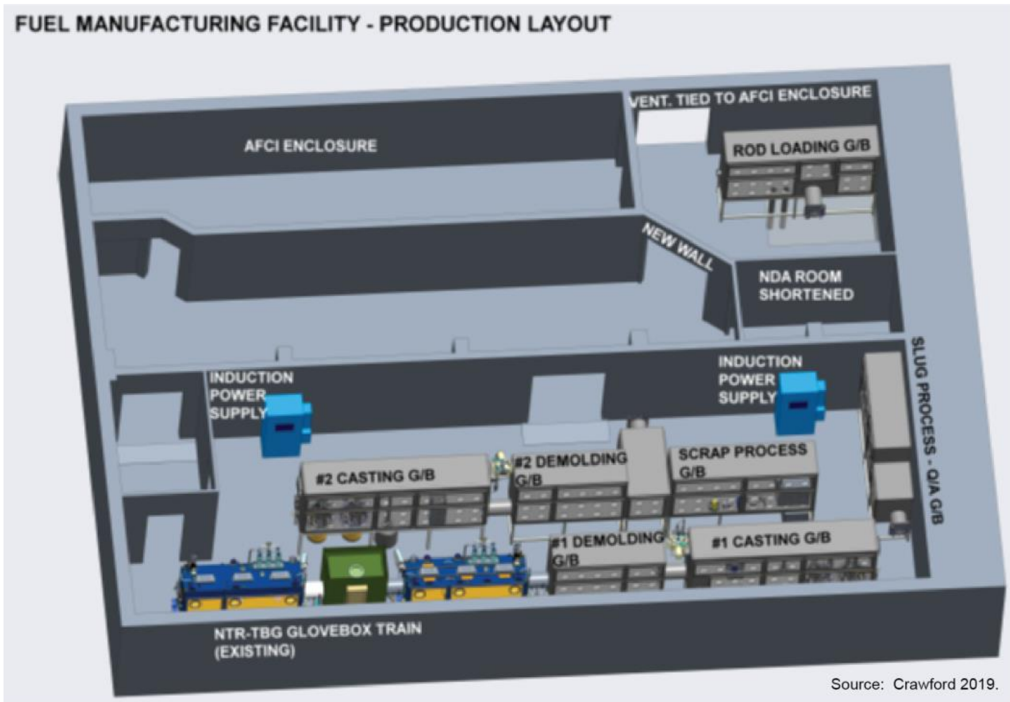

Figure 2–10. Proposed Fuel Fabrication Capability

One would be modified from an existing glovebox, and the second would be new. All of this activity would occur in FMF. After fabrication, fuel pins would be transferred to ZPPR. Bonding the sodium to the fuel (through heating) and assembling fuel pins into driver fuel assemblies would occur in the reactor cell room of ZPPR. This room is sufficiently high to allow fuel pins and driver fuel assemblies to be vertically raised into and out of the vertical assembly device used for driver fuel assembly fabrication.

Fuel fabrication at INL would require additional analytical chemistry capability. Sample analysis for process qualification and product quality assurance would require additional analytical workspace. DOE would install new equipment in existing space at FCF as an analytical chemistry laboratory to support VTR fuel fabrication (INL 2019e).

Driver fuel cladding would be tested in EFF. EFF, a less than Hazard Category 3 nuclear facility, is used to support both DOE and private industry customers. Basic uses of EFF include uranium and uranium alloy casting and extrusion, processing uranium metal and ceramics, and fabrication and handling of alloys and powders. Equipment available to support these activities include radiological fume hoods, metal-forming and machining equipment, equipment for high temperature applications (furnaces, molten salt baths, casting and annealing furnaces), and fuel experiment assembly equipment (INL 2016a).

2.6.3 Savannah River Site Reactor Fuel Production Options

SRS is a potential site for both feedstock preparation and for fuel fabrication. These activities, alone or together, could be located at SRS.[16]

The facilities and equipment required for reactor fuel production could be installed in either the K Area Complex or the similar L Area Complex. The reactor buildings in K Area and L Area are of the same design, and like the K-Reactor Building, the nuclear fuel and equipment needed for reactor operations have been removed from the L-Reactor Building. This EIS specifically evaluates the potential environmental impacts of using the K Area Complex in support of the VTR project, but the impacts would be similar if the L Area Complex were used. The reactor buildings are only 2.5 miles apart and each is within a PIDAS. At either location, activities would largely occur indoors with small (fewer than 3 acres), previously disturbed locations outside required for construction laydown areas or ancillary facilities (e.g., heating, ventilation, and air conditioning equipment). At L Area, space on the ground floor of the facility would be available, as well as space at minus-20- and minus-40-foot levels. A comparative analysis shows that the offsite impacts from radiological releases would be within 3 percent of each other, with those from L Area being slightly lower.

At K Area, all core process activities would occur on the minus-20- and minus-40-foot levels (floor levels 20 and 40 feet below grade) of the K-Reactor Building[17] or in the adjacent 108-K Buildings in the K Area Complex (see **Figure 2–11)**. Approximately 22,600 square feet and 13,500 square feet of space would be made available at the minus-20- and minus-40-foot levels, respectively for fuel fabrication. A minimum of 10,000 square feet of space would be made available for feedstock preparation. This space could be in either the K-Reactor Building or in the adjacent 108-K Buildings. To establish any new capabilities, DOE would install new hot cells, gloveboxes, and equipment.

Under the SRS Feedstock Preparation Option, capabilities would be located primarily on the minus-20-foot level in the K Area Complex, although a substantial portion of the minus-40-foot level would be used. The identified area would be suitable for pretreatment operations like molten salt removal of the americium from plutonium (polishing), electrorefining, and direct oxide reduction to convert fuel compounds (e.g., fuel oxides) into their metallic form. The facility floorplan has available space to install the gloveboxes required for these operations. All of the equipment for fuel processing and conversion (as described in Section 2.6.2) would be newly installed (SRNS 2020).

Under the SRS Fuel Fabrication Option, the fuel fabrication capability would be located on the minus-20- and minus-40-foot levels. A portion of this area is currently occupied by excess equipment and stored drums of heavy water. The heavy water would be removed to a new onsite storage location. The disposition path for the excess equipment would be determined by characterization of the material at the time of disposal. A portion of the space at the minus-20-foot level has a high bay area that would allow for the vertical assembly of driver fuel assemblies, or, provided some heat exchangers would be removed from the minus-20-foot level, space on the minus-40-foot level would be used for vertical assembly of driver fuel assemblies. Another option would be to locate vertical assembly of the driver fuel assemblies in the 108-K Buildings. The space in several additional pump rooms would also be used if necessary. The identified area would be suitable for the fuel fabrication glovebox processes being designed at INL (as described in Section 2.6.2). All of the enclosures and equipment for fuel fabrication would be newly installed (SRNS 2020).

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[16] The identified locations for process space allocation are notional and are intended to demonstrate that sufficient space would be available. The final location of equipment would be determined after additional review of facility use options.
[17] Due to its use as a special nuclear material storage facility, the K-Reactor Building is a Hazard Category 1 nuclear facility.

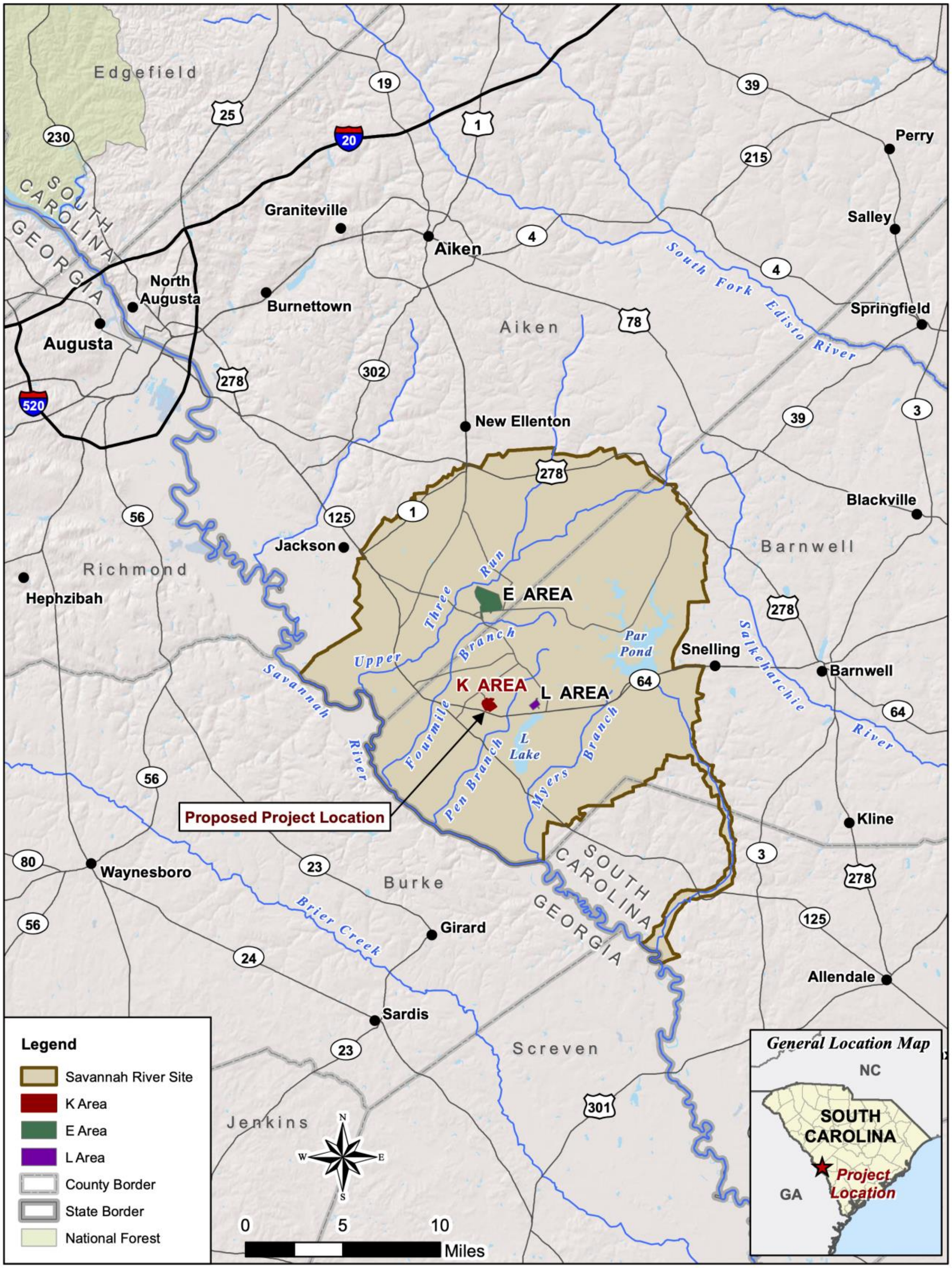

Figure 2–11. K Area Complex and Savannah River Site Location Map

The facility could support fuel manufacturing activities under all of the options being considered. But changes to the facility HVAC (heating, ventilation, and air conditioning) system and supporting equipment may be required. These changes could result in the construction of a new steel frame structure atop one of the 108-K Buildings or adjacent to the building to house the new HVAC equipment.

2.7 Alternatives Considered and Dismissed from Detailed Analysis

The Nuclear Energy Innovation Capabilities Act of 2017 amended the Energy Policy Act of 2005 and directed the Secretary of Energy to determine the need for a versatile reactor-based, fast-neutron source. If the need for such a reactor was identified, the Act directed the Secretary "to the maximum extent practicable, complete construction of, and approve the start of operations for, the user facility by not later than December 31, 2025." DOE considered several alternatives for different aspects of the VTR project. For the VTR design, DOE considered 16 concepts, primarily reactor concepts, but also some non-reactor concepts. The alternatives considered for the reactor design, but ultimately dismissed from detailed analysis, are discussed in Section 2.7.1. Two potential sites for locating the VTR and its associated post-irradiation examination facilities were discussed previously in this chapter. These two sites were selected after consideration of two additional sites. The two alternatives considered for facility site location but later dismissed from detailed analysis are discussed in Section 2.7.2. There were no alternative locations considered in this EIS for the fabrication of driver fuel required for VTR operation other than those discussed in Section 2.6.

2.7.1 Versatile Test Reactor Designs Considered but Dismissed from Detailed Analysis

In its *Analysis of Alternatives, Versatile Test Reactor Project* (AoA) (DOE 2019d), DOE evaluated 18 design concepts (including the sodium-cooled fast test reactor concept) for the VTR. The AoA also considered the status quo, which is effectively the No Action Alternative of this EIS. The concepts considered included retaining existing facilities (either with modification or by keeping the status quo of no new facilities and no modifications to existing facilities), building new fast test reactors, and establishing a new accelerator-driven system. (Although evaluated in the AoA, the sodium-cooled fast test reactor is not discussed in this section, because it is the proposed technology for the VTR.)

The AoA performed an initial screening of these concepts against six criteria based on the requirements of the Nuclear Energy Innovation Capabilities Act of 2017 and the *Mission Need Statement for the Versatile Test Reactor (VTR) Project* (DOE 2018a). Because they failed to meet one or more of these criteria, twelve concepts[18] were eliminated from further evaluation in the AoA. In particular, DOE determined that 10 of the 12 concepts failed to meet the criteria: "*Provides an intense, fast-neutron irradiation environment with prototypic spectrum to determine irradiation tolerance and chemical compatibility of reactor fuels, materials, and coolants, with the versatility to address diverse technology options and sustained and adaptable testing environments*". Six of the 12 concepts failed the criteria: "*The alternative shall become operational on an accelerated schedule to regain and sustain U.S. technology leadership and to enable the competitiveness of U.S.-based industry entities in the advanced reactor markets*" (DOE 2019d).

Three existing facilities and two new fast test reactors (in addition to the sodium-cooled reactor) passed the initial screening criteria. The three existing facilities that passed the initial screening criteria were ATR, HFIR, and FFTF. The two new reactor designs that passed the screening criteria were the molten-salt fast test reactor (MSFTR) and a lead/lead-bismuth-cooled fast test reactor (LFTR).

[18] The status quo alternative was evaluated in the AoA for completeness and as a comparison for the remaining alternatives evaluated. As noted above, this is the No Action Alternative of this EIS.

ATR is a light-water-cooled reactor located at the INL Site. The reactor's primary "customer" is the U.S. Navy, but over the past several years, the reactor has been used to irradiate a broad spectrum of fuels and cladding materials of interest for other customers. The reactor is typically operated at a power level in the range of 110 to 120 MWth [megawatts thermal]. It has a maximum thermal flux of 1×10^{15} neutrons per square centimeter per second, and maximum fast flux of 5×10^{14} neutrons per square centimeter per second. There has been interest in using the ATR to support the testing of fuels and materials for fast-spectrum systems. To respond to this need (which included a fast-neutron flux of 2×10^{15} neutrons per square centimeter per second), the Advanced Fuel Campaign developed and applied an irradiation capsule design with a "thermal flux absorber" (e.g., cadmium). The design minimized the thermal component of the flux to approximate a fast spectrum. The campaign also proposed a Boosted Fast Flux Loop to increase the fast flux into the required range.

HFIR is a light-water-cooled reactor located at ORNL. The reactor has a power level of 85 MWth and associated maximum thermal and fast fluxes of 3×10^{15} and 1×10^{15} neutrons per square centimeter per second, respectively. The primary application of the HFIR is isotope production and neutron generation for scientific applications via beam ports and a cold neutron source. HFIR has been used to irradiate fuels and cladding materials. Irradiations designed to approximate a fast spectrum also use a "thermal flux absorber" to minimize the thermal component of the flux. Options to boost the flux to the desired target may be feasible.

FFTF is a deactivated fast test reactor located at DOE's Hanford Site (Hanford) in Washington. This reactor was a 400 MWth sodium-cooled fast reactor that used mixed oxide driver fuel and operated from 1982 through 1992. FFTF was used to test fuels and materials for fast reactors. It is potentially capable of being reactivated to meet the fast-neutron irradiation requirements of the VTR project.

An MSFTR would be a fast-spectrum reactor cooled and possibly fueled by molten salt. Options include both a solid-fuel, salt-cooled concept or, more likely, a molten-salt fuel concept. Molten fuel allows greater flexibility in accommodating test assemblies due to the absence of solid fuel assemblies. Molten fuel can achieve high power density and high flux for irradiation. The reactor could be leveraged off of any one of several conceptual designs for molten-salt fast power reactors. MSFTRs would be modified to incorporate test irradiation locations in the core to accommodate both static and dynamic experiments. Fast-spectrum MSFTR designs are amenable to high power density cores and could achieve the desired irradiation conditions with a reactor in the 250 to 400-MWth range. A typical fuel/coolant would be chloride salt loaded with dissolved uranium or plutonium. A pool-type design could facilitate experiment access, with above-pool access to experimental channels. Molten salt fuel has advantages in thermal capacity, low-pressure operation, retention of actinides and fission products, high thermal margin to voiding, transparency, and low chemical reactivity. Challenges include new fuel and core materials and proliferation concerns. One thermal molten salt (test) reactor (MSR) has been built, and there is both foreign and domestic interest in both thermal and fast MSR concepts.

An LFTR would be a new fast-spectrum reactor, cooled by either lead or a lead-bismuth eutectic (an alloy with a comparatively low melting point). A test reactor could be based on any one of several conceptual designs for a lead/lead-bismuth-cooled power reactor. While none of the designs is for a test reactor, they could be modified to incorporate test irradiation locations. A pool-type design would be amenable to high power density cores and could achieve the desired irradiation conditions with a reactor in the 250- to 400-MWth range. Unlike sodium fast reactors, the preferred fuel would probably be a uranium/plutonium-nitride. A pool-type design could facilitate experiment access, with above-pool access to experimental channels. No heavy metal-cooled reactors have been built in the United States, but a number have been tested and fielded abroad.

The five designs (in addition to the sodium-cooled fast reactor evaluated in this EIS) that passed the initial screening were evaluated against the criteria shown in **Table 2–1**. These criteria are adapted from the 20 criteria[19] used in the AoA to assess designs that passed the screening evaluation. They have been aggregated here into a set of eight criteria that describe the reasons why the alternatives were not further analyzed as part of this EIS. (The AoA criteria were derived from the Mission Need Statement [DOE 2018a], and the Nuclear Energy Innovation Capabilities Act of 2017, with some added as part of the AoA evaluation.)

Table 2–1. Criteria for Evaluation of Alternatives Not Screened

Number	Criteria
1	**Provides an intense fast-neutron irradiation environment with prototypic spectrum that meets the specifications of the VTR program** • Provides a source of fast neutrons at a neutron flux sufficient to enable research for an optimal base of prospective users • Provides high neutron dose rate for materials testing [quantified as displacement per atom] • Provides capabilities for irradiation with neutrons of a lower energy spectrum
2	**Provides testing capacity that meets the specifications of the VTR program** • Provides a large irradiation volume within the core region • Provides an irradiation length that is typical of fast reactor designs – Expedites experiment life cycle by enabling easy access to existing support facilities for experiments fabrication and post-irradiation examination • Provides capabilities that support experimental high-temperature testing • Provides the ability to test advanced sensors and instrumentation for the core and test positions • Provides innovative testing capabilities through flexibility in testing configuration, testing closed-loop environments
3	**Capable of becoming operational on an accelerated schedule, compliant with the operational start date set in the Nuclear Energy Innovation Capabilities Act of 2017 (P.L. 115-248)** • High technical confidence with the facility so that the facility can be available for testing as soon as possible • Shortest schedule to initiate operations
4	**Availability of existing facilities and infrastructure to support the VTR mission** • The facility should have sufficient test capability to add the VTR mission to existing and continuing facility missions without impacting those missions
5	**Programmatic risk - Factors that could impact programmatic risks (primarily to schedule) include** • Maturity of design both for new reactor types and preferred fuel types • Required updates/modifications to existing facilities • Higher confidence in stakeholder acceptance • Greater ease and confidence of compliance with codes, standards, regulations
6	**Ability to regain and sustain U.S. technology leadership and to enable the competitiveness of U.S.-based industry entities in the advanced reactor markets**
7	**Costs associated with alternative development** • Present value of life-cycle costs • Capital investment (total project cost) • Annual operating and maintenance costs during operations
8	**Life cycle management** • Capability to manage test fuels and driver fuel while minimizing cost and schedule impacts, including management of discharged fuel

P.L. = Public Law; VTR =Versatile Test Reactor.

[19] One criterion included in the AoA was not considered in this evaluation: security. All options evaluated scored high on this criteria because existing facilities are located at sites with appropriate security capabilities, and new designs were assumed to be located at similarly secure sites.

Despite two existing operating facilities—ATR and HFIR—having favorable qualities for the VTR project (e.g., they have existing infrastructure and established fuel management), they are *primarily* thermal-spectrum reactors. Even with modification, neither reactor would fully meet the test capabilities required for the VTR. They could not provide the fast-neutron flux, the neutron dose rate, or the required experimental volume. Additionally, as operating facilities, both reactors support other programs and have prior test commitments. Use of either as the VTR could interfere with the current test capabilities of the reactors and could result in conflicts between tests and experiments requiring a fast flux and those requiring a thermal flux. This would result in the loss of thermal flux test capacity at the facilities. That capacity could not be replaced using existing U.S. test capabilities, nor could it provide the full fast flux testing capability identified for the VTR. Modifying either of these reactors would create some fast flux testing capability, but could compromise the United States' ability to regain and sustain a technology leadership position. Therefore, these two reactors were dismissed from further evaluation in this EIS.

FFTF operated for many years as a fast flux test reactor and, as a result, has a demonstrated history of performing the type of testing for which a VTR is proposed. Because the FFTF would be modified as part of a restart, appropriate testing capabilities could be factored into the design. However, there are uncertainties associated with modifying the design. These include required studies to determine the scope of modifications. For example, would the modified facility meet current codes and standards? Would it meet current seismic requirements? In addition, the support facilities originally constructed to support the FFTF would also need to be modified as they are either currently inactive or not fully constructed. A restart of the FFTF has been considered on several occasions since the last shutdown and has been a contentious issue in the region. Public opposition to a restart could introduce schedule risks to the VTR project. (In the ROD [66 FR 7877] for an earlier EIS [DOE 2000b], DOE decided that FFTF would be permanently deactivated.)

The DOE Office of Nuclear Energy reviewed the AoA results and determined that a further examination of the Modify and Restart FFTF Alternative was warranted given its evaluation score, technology-related risk score, site-specific risk score, and costs relative to the Sodium-Cooled Fast Spectrum Test Reactor Alternative. This examination included a facility walk down of FFTF conducted in October 2019 by a team composed of the VTR Program Director, DOE Richland Assistant Manager, VTR Project Manager, and industry experts. Based on the facility walk down, extensive pre and post-tour discussions and a review of a study by the Columbia Basin Consulting Group, the team had significant concerns about the viability of restarting FFTF. These concerns include:

- FFTF was operated for 10 of its 20-year design life with a potential for an additional 10 years;
- there are an extensive number of electrical and mechanical systems that would have to be replaced since last operated in the mid-1990s;
- the Columbia Basin Consulting Group study, conducted in 2007, based its cost estimate on a 2000 restart study when the systems were in relatively good condition;
- an extensive effort would be necessary to obtain a viable cost and schedule restart estimate; and
- FFTF would require extensive design changes to accommodate testing of alternate coolant technologies (lead, salt, or gas).

While it is believed that the entire suite of design documents exists, there is also a concern that an extensive design and safety-basis reconstitution effort, including seismic analysis, would be costly and time-consuming and has the potential to identify additional necessary upgrades. Subsequent discussions with the VTR Project Team concluded that these issues would result in a restart effort significantly longer and more costly than characterized in the AoA. The schedule and cost could increase further to accommodate upgrades to address the full suite of VTR test requirements and to respond to the current design-basis safety philosophy. Therefore, FFTF was removed from further analysis in this EIS.

The most significant shortcoming of the two new reactor designs (MSFTR and LFTR) is the current level of development and technical maturity for these reactor concepts. In an assessment of the technical readiness level of various reactor concepts, the *Advanced Demonstration and Test Reactor Options Study* concluded that salt-cooled reactors (e.g., a fluoride-cooled high-temperature reactor) and lead-cooled fast reactors are less mature than sodium-cooled fast reactors and require additional research and development (INL 2017d). There is considerably less knowledge base for these designs than for the sodium-cooled fast test reactor concept. Only one small thermal molten-salt test reactor has been built, and no molten salt fast reactors have been built in the United States. Experience with building and operating lead-cooled reactors is limited, not readily available, and related to submarine propulsion. For both reactor concepts, a demonstration reactor might be necessary, which would result in greater costs and unacceptable schedule delays for the construction and operation of the VTR. These reactor technologies were dismissed from further evaluation in this EIS because of the technical and schedule risk associated with their technical maturity.

Table 2–2 presents DOE's rationale for dismissing these alternatives from further consideration.

Table 2–2. Rationale for Dismissal of Alternative from Further Consideration

Alternative	*Rationale for Dismissal*
Modify Advanced Test Reactor (ATR)	• Does not meet VTR performance criteria, even with modifications – Primarily a thermal flux test reactor – Achievable fast flux is factor of 4 less than required VTR flux – Available test volume at the maximum fast flux would be less than 10% of VTR 7 liter requirement – Limited ability to support experimental high-temperature testing • Negative impact on thermal flux testing availability/competition for resource. Alternatives for current thermal flux test missions not readily available among existing facilities. Thermal flux capability required for – Main mission of Navy program support – Nuclear Science User Facility commitments – Plutonium-238 production for radioisotope thermoelectric generators (National Aeronautics and Space Administration support) • Operational efficiency would be less than that for other design concepts resulting in lowered testing capability, and fewer test cycles per year. • Adverse impacts between fast flux and thermal flux experiments. Use as a fast flux facility would adversely impact thermal flux experiments being performed at the same time. • Does not fully support regaining and sustaining U.S. technology leadership and enabling the competitiveness of U.S.-based industry entities in the advanced reactor markets
Modify High Flux Isotope Reactor (HFIR)	• Does not meet VTR performance criteria even with modifications – Primarily a thermal flux test reactor – Achievable fast flux is factor of 2 to 4 less than required VTR flux – Available test volume of 4.6 liters is less than the 7 liter VTR requirement – Limited ability to support experimental high-temperature testing • Negative impact on thermal flux testing availability/competition for resource. Alternatives for current missions are not readily available among existing facilities. Facility is heavily used for thermal flux testing with this capability required for – Main mission of isotope production and neutron science – Plutonium-238 production for radioisotope thermoelectric generators (National Aeronautics and Space Administration support) • Adverse impacts exist between fast flux and thermal flux experiments. Use as a fast flux facility could adversely impact thermal flux experiments being performed at the same time. • Does not fully support regaining and sustaining U.S. technology leadership and enabling the competitiveness of U.S.-based industry entities in advanced reactor markets

Alternative	***Rationale for Dismissal***
Modify and Restart the Fast Flux Test Facility (FFTF)	• Significant technical challenges to the restart of the FFTF exist: – FFTF is a deactivated facility. Studies are needed to determine the condition of the facility and the ability to refurbish it. Issues include system/component age-related material degradation; repair/replacement/certification of systems modified for deactivation; upgrades to meet current codes and standards. – Uncertainties of the cost and schedule to restart. Estimates have been generated, but additional study would be required to develop updated cost and schedule estimates for modifications needed to support VTR operations. – FFTF safety basis would require updating, potentially requiring modifications to the facility to meet current requirements. For example, the seismic design of the facility is not based on the current peak ground level acceleration for the Hanford area. Seismic reanalysis would be required and upgrades are likely. • FFTF was not designed for the 60-year mission of VTR. Only 10 years remain of the facility's original 20-year operational lifetime. • Post-irradiation examination facilities are either deactivated or construction was halted. (MASF has been repurposed to support cleanup operations and FMEF is a largely vacant structure.) • Legal considerations (agreements to deactivate FFTF) impose schedule risks on attempts to reactivate the reactor. • Reversing earlier decisions and agreements would require renegotiating deactivation milestones in the Tri-Party Agreement (with Washington State and the U.S. Environmental Protection Agency). • Minimally supports regaining and sustaining U.S. technology leadership and enabling the competitiveness of U.S.-based industry entities in advanced reactor markets
Molten-Salt-Cooled/Fueled Fast Test Reactor	• First-of-a-kind design for a fast flux test reactor; technology maturity is an issue – Could require construction of a technology demonstration facility – Lack of experience regulating this type of reactor – New codes, standards, and practices may need to be developed. • Potential programmatic risks to – Cost (large capital investment, including a demonstration prototype) – Schedule (Aggressive schedule is longer than other technologies. A more likely schedule is even longer) – Performance (little stakeholder support for using the VTR itself as a technology innovation experiment). • Reactor system and operational complexity. With molten fuel, additional systems would be required to handle heat removal and fuel; uncertainties in fuel cycle management (processing).
Lead-Cooled Fast Test Reactor	• First-of-a-kind design for a fast flux test reactor, limited U.S. experience in operating reactor of any design, limited technology maturity – Could require construction of a technology demonstration facility – Lack of experience regulating this type of reactor – new codes, standards, and practices may need to be developed. • Potential programmatic risks to – Cost (large capital investment, including a demonstration prototype) – Schedule (aggressive schedule is longer than other technologies, a more likely schedule is even longer) – Performance (little stakeholder support for using the VTR itself as a technology innovation experiment) • Preferred fuel (nitride) would require additional development/demonstration

ATR = Advanced Test Reactor; FFTF = Fast Flux Test Facility; FMEF = Fuels and Materials Examination Facility; MASF = Maintenance and Storage Facility; VTR = Versatile Test Reactor.

2.7.2 Site Selection

DOE used a variety of factors in narrowing down the potential VTR reactor and support sites for assessment in this EIS. Chief among the factors is the realistic and pragmatic assessment of whether the site had an adequate location and the technical infrastructure necessary to support the key VTR activities. Most importantly, the site needed to have established technical infrastructure to support construction and operation of a test reactor; to operate hot cells for post-irradiation examination of test items; to use hot cells for the disassembly of spent fuel and processing it to a form suitable for long-term disposal; and to manufacture VTR driver fuel, including feedstock preparation and fuel fabrication.

DOE recognized that choosing a site that has the human resources with the requisite experience to build and operate a test reactor like the VTR is essential to the success of the VTR mission. Only two DOE sites currently have a large enough technical staff (including scientists, engineers and operational and support staff), who have operated test reactors and conducted missions similar to VTR. Those sites are the INL Site with ATR and Transient Reactor Test Facility (TREAT) and ORNL with HFIR. Other DOE site staff have some past experience, but their current technical resources are limited. While it is expected that some technical resources might move to the chosen VTR site, it is not realistic to move to a site where personnel have limited or no experience specific to test reactors.

An equally important site selection consideration is that VTR support activities include operation of hot cells for two critical purposes: post-irradiation examination and spent fuel treatment. These critical VTR support activities require a substantial technical staff with direct experience in use of hot cells. While at one time DOE had hot cell facilities at multiple sites, most of those hot cells have been shut down. As such, most of the scientists, engineers, and technical staff (especially operators) have moved or retired. Hot cell operation is a highly specialized field and it requires years to train new staff and gain the experience necessary to conduct the operations. Most of the remaining experience is at the INL Site and ORNL, both of which have multiple operating hot cells and, to a lesser extent, at the Pacific Northwest National Laboratory (PNNL) and Savannah River National Laboratory (SRNL). While building new hot cell facilities is straightforward if needed to support the VTR mission, the key factor for success of the mission is having the technical staff to lead and conduct the research at the post-irradiation examination hot cells and to operate the spent fuel treatment hot cell activities.

VTR fuel manufacturing, including feedstock preparation and fuel fabrication, requires several key factors. Because of the quantities of plutonium handled each year, a site must be able to support DOE's security requirements. DOE has only a few remaining facilities that can securely handle the quantities of plutonium and fabricate fuels necessary to support the VTR's fuel needs. These facilities are principally at SRS and at the INL Site.

As with hot cell operation, fuel manufacturing success depends on having the technical staff to support feedstock preparation and fuel fabrication. These activities are highly specialized, and most of the past DOE activities of this nature have been closed. As such, the DOE personnel with expertise in these areas have moved or retired. The principal remaining facilities with expertise in plutonium fuels and processing are SRS, LANL, Lawrence Livermore National Laboratory (LLNL), PNNL, and INL. However, LANL, LLNL, and PNNL staff and facilities are fully dedicated to missions that preclude these sites from detailed analysis. The only practical, readily available locations for VTR fuel manufacturing are SRS and the INL Site.

The AoA performed a preliminary assessment of candidate sites for the location of VTR technology. Four DOE sites were considered. Three sites have operational test reactors: ATR and TREAT at INL, HFIR at ORNL, and the deactivated FFTF at Hanford. AoA selected the fourth site, SRS to represent a generic DOE site without a test reactor. Additionally, a generic non-government site was evaluated. Sites were assessed only to the degree to which they have the capability to meet the preliminary assessment criteria.

Unlike the assessment of VTR alternatives, no quantitative ranking of the sites against these criteria was performed.

No specific non-government sites were identified for the location of the VTR in the AoA (DOE 2019d); the AoA assessed a generic non-government site. Finding a non-government site with (1) available infrastructure (power, water, post-irradiation examination facilities, etc.); (2) staff experienced in preparation of test assemblies, test reactor operation, and post-irradiation examination; (3) spent fuel storage; and (4) security required for the VTR facilities would be unlikely. Additionally, any non-government site would fall under the regulatory authority of the NRC. While the NRC has extensive experience in licensing research and test reactors, NRC licensing of the VTR and its associated facilities would add activities (including NRC license application, NRC license review, licensing hearings, preparation of an NRC EIS, and review by the Advisory Committee on Reactor Safeguards) to the project timeline (NRC 1996). Many of these activities would have to be completed before beginning construction and do not have a fixed duration, adding programmatic risk to the project schedule. Stakeholder acceptance, ultimately, would have to be assessed if a non-government site were to be selected. Given the existence of DOE sites that have demonstrated capabilities to support the VTR and given the potential schedule impact of the added licensing activities, locating the VTR at a non-government site was not considered a viable alternative.

The AoA concluded that the INL Site "appears to be the best equipped to handle the new VTR mission." However, several of the assessment criteria did not provide any differentiation between the three remaining DOE sites considered: Hanford/PNNL, ORNL, and SRS. For example, all three sites were identified as having at least some hot cells (with air and, in the case of Hanford/PNNL and SRS, inert[20] atmospheres) and the associated infrastructure that could support post-irradiation examination of test specimens. The availability of facilities, staff, and infrastructure capable of supporting both existing missions and the VTR project is the major discriminator among the sites.

Hanford/Pacific Northwest National Laboratory

Although much of the site is in the process of environmental cleanup and closure, Hanford/PNNL has a full range of supporting infrastructure for potential VTR-related transportation, construction and operation, safety, security, nuclear material management, and regulatory compliance. Hanford, itself, has no operational post-irradiation examination facilities. Yet the deactivated Fuels and Materials Examination Facility and the Maintenance and Storage Facility could be reactivated, refurbished, and equipped to support pre- and post-irradiation examination of test fuels. Substantial support capabilities exist at PNNL, including hot cells (the Shielded Analytical Laboratory) for post-irradiation examination and laboratories for chemistry, materials, and instrumentation at the Radiochemical Processing Laboratory.

Additionally, the last of Hanford's test reactors, FFTF, has not operated since 1992 and is currently in a long-term surveillance and maintenance condition. This means that the organizational infrastructure needed to support operation of a test reactor no longer exists at Hanford. After nearly 30 years, experienced test reactor operational staff would not be available. Compared to ORNL, Hanford's PNNL has more limited capability to support experiment fabrication and fuel and experiment disassembly and inspection. ORNL currently performs these activities in association with the operation of HFIR.

[20] ORNL does not have operating hot cells with an inert atmosphere. However, the AoA identified dormant hot cells that could be refurbished for about $5 million.

Stakeholder support for a new operational mission at Hanford would be mixed. There would likely be pockets of community support for the restart of FFTF or another nuclear mission. However, there would be extensive State or regional opposition to anything that could potentially impact the environmental closure mission. At public meetings held during the Nuclear Infrastructure EIS[21] process, attendees declared opposition to any activity (for example, the restart of FFTF as considered in that EIS) that would change the Hanford mission from "clean up" back to "production." Stakeholders also called for DOE to continue to honor its commitment to clean up the site. Additionally, they raised concerns about the impact of new operations on the existing waste cleanup at Hanford. The prospect of even temporary storage of additional spent nuclear fuel at Hanford potentially faces public opposition, which could pose programmatic risks and schedule delays for the VTR project.

Savannah River Site/Savannah River National Laboratory

SRS and SRNL have extensive history in nuclear reactor operation and offer a full range of supporting infrastructure for potential VTR-related transportation, construction and operation, safety, security, nuclear material management, and regulatory compliance. There are also substantial support capabilities currently available at SRNL, including hot cells and laboratories for chemistry, materials, and instrumentation. SRNL has bench-scale hot cell capability. These hot cells, however, are currently used to support DOE's Office of Environmental Management missions at SRS.

SRS has no test reactor experience and the last of the onsite operating reactors shut down in 1992. This means that the organizational infrastructure needed to support operation of a test reactor does not exist at SRS. Compared to ORNL, SRS also has more limited capability (primarily located at SRNL) to support experiment fabrication and fuel and experiment disassembly and inspection. ORNL currently performs these activities in association with the operation of HFIR.

2.8 Preferred Alternative

DOE's Preferred Alternative is the INL VTR Alternative. DOE would build and operate the VTR at the INL Site adjacent to the existing MFC. Existing facilities within MFC would be used for post-irradiation examination of test assemblies. Post-irradiation examination would be performed in HFEF, IMCL, and other MFC facilities. Spent nuclear fuel (spent VTR driver fuel) would be treated to remove the sodium-bonded material at FCF. Modifications to FCF may be required to carry out this process. The intent of this treatment is to condition and transform the spent nuclear fuel into a form that would meet the acceptance criteria for a future permanent repository. This treated fuel would be temporarily stored at a new VTR spent fuel pad at MFC.

DOE has no preferred options at this time for where it would perform driver fuel production (i.e., feedstock preparation and driver fuel fabrication) for the VTR. This EIS evaluates options for both processes at the INL Site and at SRS. DOE could choose to use either site or a combination of both sites to implement either option. DOE will state its preferred options for feedstock preparation and driver fuel fabrication in the Final VTR EIS, if preferred options are identified before issuance.

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[21] *Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility*, DOE/EIS-0310, December 2000.

2.9 Summary of Environmental Consequences

This section summarizes the environmental impacts of the VTR alternatives and reactor fuel production options evaluated in this EIS. Section 2.9.1 presents the impacts for each alternative and option at each site. Section 2.9.2 discusses the cumulative impacts of the alternatives in the context of past, present, and reasonably foreseeable future actions at each site.

2.9.1 Comparison of Alternatives and Options

Under the No Action Alternative, DOE would make use of the limited capabilities available at existing facilities, both domestic and foreign, for testing in the fast-neutron-flux spectrum. DOE would not construct or modify any facilities or effect any substantial change in the level of operations for post-irradiation examination. There would be no need for new reactor fuel production nor would any VTR spent driver fuel be generated. Whereas the impacts presented in **Tables 2–3, 2–4,** and **2–5** represent potential incremental increases, under the No Action Alternative there would be no increase in environmental impacts at the INL Site, ORNL, and SRS above the existing conditions described in Chapter 3, Affected Environment.

Table 2–3 summarizes and allows side-by-side comparison of the potential environmental impacts of the INL VTR Alternative and the ORNL VTR Alternative. Impacts are analyzed for constructing the VTR, modifying existing facilities for post-irradiation examination and spent driver fuel treatment, and operating these facilities at the INL Site. Impacts for constructing and operating the VTR and a hot cell facility at ORNL are also given. The impacts, as presented, include the operation of the VTR, post-irradiation examination activities, and spent fuel management.

Table 2–4 summarizes and allows comparison of the impacts from establishing the capabilities for and performing feedstock preparation and fuel fabrication at the INL Site or SRS.

Table 2–5 summarizes the potential environmental consequences that could occur if DOE were to decide to implement all actions at the INL Site. This table presents the potential consequences if DOE selected the INL Site to: (1) construct and operate the VTR, which includes post-irradiation examination activities and spent fuel management; (2) modify and operate facilities to prepare feedstock for use in VTR fuel; and (3) modify and operate facilities for fabrication of VTR fuel.

Table 2–3. Summary of Versatile Test Reactor Alternative Environmental Consequences

<table>
<tr><th rowspan="2">Resource Area</th><th colspan="2">Alternatives</th></tr>
<tr><th>INL VTR</th><th>ORNL VTR</th></tr>
<tr><td colspan="3">Land Use and Aesthetics (Chapter 4, Section 4.1)</td></tr>
<tr><td rowspan="2">Land Use</td><td>Construction:
There would be minor impacts on land use from the disturbance of approximately 100 acres during construction activities.</td><td>Construction:
There would be minor impacts on land use from the disturbance of approximately 150 acres during construction activities.</td></tr>
<tr><td colspan="2">Operations:
Land use would be consistent with existing land use and activities currently occurring at each location. Approximately 25 acres of previously unused area would be converted permanently for industrial use at the INL Site. Approximately 50 acres of vegetated area at ORNL would be cleared and converted permanently for industrial use.</td></tr>
<tr><td rowspan="2">Aesthetics</td><td colspan="2">Construction:
There would be minimal impacts on aesthetics as newly constructed facilities would not dominate the local landscape and would be similar in design to existing facilities. Though not visible from offsite areas, approximately 150 acres of vegetated/forested area at ORNL would be cleared during construction.</td></tr>
<tr><td colspan="2">Operations:
There would be minimal impacts on aesthetics from operation of the newly constructed facilities that would be similar in design to existing facilities, but only from areas within line of sight of the new facilities. Impacts on International Dark Sky Park, Craters of the Moon National Monument would not be expected from additional exterior lighting required for the VTR at the INL Site.</td></tr>
<tr><td colspan="3">Geology and Soils (Chapter 4, Section 4.2)</td></tr>
<tr><td rowspan="2"></td><td>Construction:
Area disturbed would be 100 acres. Volume of excavated materials would be 135,000 cubic yards; backfill/soil needed would be 202,000 cubic yards; deficit fill volume of 67,000 cubic yards would be obtained from onsite borrow sources such as Rye Grass Flats. Rock/gravel needed would be 45,000 cubic yards. The total quantities of geologic and soil materials needed during construction would represent small percentages of regionally plentiful resources and are unlikely to adversely impact geology and soil resources.</td><td>Construction:
Area disturbed would be 150 acres. Volume of excavated material would be 886,000 cubic yards; backfill/soil needed would be 989,000 cubic yards; deficit fill volume of 103,000 cubic yards would be obtained from onsite borrow sources such as the Copper Ridge borrow area. Rock/gravel needed would be 74,000 cubic yards. The total quantities of geologic and soil materials needed during construction would represent small percentages of regionally plentiful resources and are unlikely to adversely impact geology and soil resources.</td></tr>
<tr><td>Operations:
Area occupied would be 25 acres. No additional land disturbance, no additional excavation, and little or no use of geologic and soil materials.</td><td>Operations:
Area occupied would be 50 acres. No additional land disturbance, no additional excavation, and little or no use of geologic and soil materials.</td></tr>
<tr><td colspan="3">Water Resources (Chapter 4, Section 4.3)</td></tr>
<tr><td></td><td>Construction:
All water required during the construction process would be drawn from existing wells that access the Snake River Plain Aquifer. Potable water would be treated through the existing Materials and Fuels Complex (MFC) system. The total water demand is estimated to be about 128 million gallons, including about 34 million gallons of potable water and about 94 million gallons for other construction activities. Water would be discharged to surface water (which could include MFC sewage lagoons or other surface discharges such as swales).</td><td>Construction:
All water required during the construction process would be drawn from the Clinch River. Potable water would be treated at a water treatment plant that is owned and operated by the City of Oak Ridge and located northeast of the Y-12 National Security Complex. The total water demand is estimated to be about 170 million gallons during the entire construction period, including about 46 million gallons of potable water and about 121 million gallons for construction activities. Water would be discharged to adjacent surface waters.</td></tr>
</table>

<table>
<tr><th rowspan="2">Resource Area</th><th colspan="2">Alternatives</th></tr>
<tr><th>INL VTR</th><th>ORNL VTR</th></tr>
<tr><td></td><td>Operations:
Water would be drawn from the Snake River Plain Aquifer and discharged as surface water to either the Industrial Waste Pond or active sewage lagoons. The total annual volume of water that would be discharged is estimated to be about 4.4 million gallons, which includes the volume required for personnel use and sanitation, firewater, and demineralized water. No water would be required for operation of the reactor itself.</td><td>Operations:
Water used during operations would be drawn from the Clinch River and discharged to Bearden Creek or Melton Branch. The total annual volume of water that would be discharged is estimated to be about 4.4 million gallons, which includes the volume required for personnel use and sanitation, firewater, and demineralized water. No water would be required for operation of the reactor itself.</td></tr>
<tr><td colspan="3">Air Quality (Chapter 4, Section 4.4)</td></tr>
<tr><td rowspan="2"></td><td>Construction:
Counties that encompass the INL Site currently are in attainment for all national ambient air quality standards (NAAQS) (i.e., for criteria pollutants). Annual nonradiological emissions estimated for construction of the VTR facilities would be well below the EPA prevention of significant deterioration (PSD) permitting threshold of 250 tons per year for a criteria pollutant. Construction at the INL Site would generate more fugitive dust compared to the effort at ORNL, as the INL Site has a more arid climate. Hazardous air pollutant (HAP) emissions from construction activities would not result in adverse air quality impacts on the public. Construction activities would not generate radiological air emissions.</td><td>Construction:
Counties that encompass ORNL currently are in attainment for all NAAQS. Annual nonradiological emissions estimated for construction of the VTR facilities would be well below the EPA PSD permitting threshold of 250 tons per year for a criteria pollutant. Construction at ORNL would result in higher emissions of most pollutants (compared to the INL Site), due to the larger area and more effort needed to clear and grade the project site. HAPs emissions from construction activities would not result in adverse air quality impacts on the public. Construction activities would not generate radiological air emissions.</td></tr>
<tr><td colspan="2">Operations:
Annual nonradiological emissions from operation of the VTR facilities would be similar and well below the annual indicator thresholds.
Impacts from radiological air emissions are addressed under Human Health – Normal Operations.</td></tr>
<tr><td colspan="3">Ecological Resources (Chapter 4, Section 4.5)</td></tr>
<tr><td></td><td>Construction:
Area disturbed: about 100 acres. Construction would result in a loss of sagebrush habitat. Losses to sagebrush habitat would be compensated for in accordance to the DOE's "no net loss of sagebrush habitat" policy on the INL Site under the Candidate Conservation Agreement (CCA) for the sage-grouse. Nesting bird surveys would occur prior to any ground disturbance or vegetation removal to confirm the absence of Migratory Bird Treaty Act-protected species, as well as sage-grouse, in the proposed project area. A 300-foot buffer would be established around active pygmy rabbit burrow systems to prevent direct impacts. Operational and administrative controls would be evaluated and implemented, if warranted, to reduce the potential for adverse effects on wildlife species and human-wildlife interactions.</td><td>Construction:
Area disturbed: about 150 acres. Construction would result in a loss of forested habitat, including up to thirty-seven hemlock trees, with potential for impacts on federally and state-listed species and aquatic resources. If the ORNL VTR alternative were selected, additional species-specific surveys would occur. Aquatic features (e.g., channels, tributaries, drainages, catchments, seeps, springs or wetlands) would be impacted. Potential impacts to aquatic resources would require wetland delineations, stream evaluations, and hydrologic determinations of currently unclassified channels and wet weather conveyances. Any potential Exceptional Tennessee Waterways would require additional assessment using the Tennessee Rapid Assessment Method.
In compliance with Section 404 of the Clean Water Act, a permit from U.S. Army Corps of Engineers would be obtained prior to any construction work within jurisdictional features and compensatory mitigation would be required for unavoidable impacts.</td></tr>
</table>

Resource Area	Alternatives	
	INL VTR	**ORNL VTR**
	Operations: Area occupied by new structures would be about 25 acres. Operations would take place in new and existing facilities. No additional land disturbance would occur, and therefore no additional impacts would occur on ecological resources.	*Operations*: Area occupied by new structures would be about 50 acres. Operations would take place in new and existing facilities. No additional land disturbance would occur, and therefore no additional impacts would occur on ecological resources.
Cultural and Paleontological Resources (Chapter 4, Section 4.6)		
	Construction: No impacts on significant cultural and paleontological resources would occur from facility construction and land disturbance.	
	Operations: No impacts on cultural and paleontological resources would occur from facility operations.	
Infrastructure (Chapter 4, Section 4.7)		
	Construction: Construction electricity usage would average 1,000 megawatt-hours per year with a peak annual use of 2,000 megawatt-hours. Diesel fuel usage would total 2.3 million gallons. Total water usage would be 128 million gallons.	*Construction:* Construction electricity usage would average 1,300 megawatt-hours per year with a peak annual use of 2,600 megawatt-hours. Diesel fuel usage would total 3.3 million gallons. Total water usage would be 170 million gallons.
	Operations: Operations at VTR would use 150,000 megawatt-hours per year of electricity, 4.7 million cubic feet of propane per year, and 4.4 million gallons of water per year.	*Operations*: Operations at VTR would use 180,000 megawatt-hours per year of electricity, 4.7 million cubic feet of propane per year, and 4.4 million gallons of water per year.
	Discussion: For construction, more resources would be used at ORNL because a new hot cell facility would be constructed in addition to the VTR. For operations, estimates for electrical usage differ because INL would primarily utilize two existing facilities for post-irradiation examination and spent fuel treatment and ORNL would use a new facility for most of these activities.	
Noise and Vibration (Chapter 4, Section 4.8)		
Noise	*Construction:* Due to the distance, estimated noise levels at the INL Site boundary (2.9 miles) and closest receptor (5.0 miles) would not be perceptible and would be consistent with ambient levels.	*Construction:* Estimated noise levels at the closest receptor (6,750 feet) would be approximately 47 dBA, which given the distance, would be minimal and remain below the noise standards at the closest receptor.
	Operations: Due to the distance, noise levels at the INL Site boundary (2.9 miles) and closest receptor (5.0 miles) would not be perceptible and would be consistent with ambient levels.	*Operations*: Noise levels would be similar to other existing equipment at ORNL and would not impact offsite receptors.
Vibration	*Construction:* Ground-borne vibration due to typical construction activities are expected to be below the threshold of human perception at offsite locations.	
	Operations: Ground-borne vibration due to typical operational activities are expected to be below the threshold of human perception at offsite locations.	

<table>
<tr><th rowspan="2">Resource Area</th><th colspan="2">Alternatives</th></tr>
<tr><th>INL VTR</th><th>ORNL VTR</th></tr>
<tr><td colspan="3">Waste Management and Spent Nuclear Fuel Management (Chapter 4, Section 4.9)</td></tr>
<tr><td rowspan="2">Waste Management</td><td>Construction:
About 9,900 cubic meters of construction waste would be generated during construction activities.</td><td>Construction:
About 13,000 cubic meters of construction waste would be generated during construction activities.</td></tr>
<tr><td colspan="2">Operations (annual impacts):
During operations, 540 cubic meters of LLW, 38 cubic meters of MLLW, 0.89 cubic meters of TRU waste, and 7.2 cubic meters of hazardous and TSCA wastes would be generated. The characteristics of these wastes would be similar to wastes currently generated by existing activities. All wastes would be packaged for shipment off site. Treatment and disposal of these wastes are well within the current capacities of existing offsite facilities.</td></tr>
<tr><td rowspan="2">Spent Nuclear Fuel</td><td colspan="2">Construction: No spent fuel is generated during construction.</td></tr>
<tr><td colspan="2">Operations:
The heavy metal from 45 spent driver fuel assemblies produced annually (66 for the final core at the end of the VTR's operational life) would be treated and packaged as spent nuclear fuel and placed on the VTR spent fuel pad pending offsite shipment. The total number of spent fuel assemblies over the lifetime of the project represent about 110 metric tons of heavy metal.</td></tr>
<tr><td colspan="3">Human Health – Normal Operations (Chapter 4, Section 4.10)</td></tr>
<tr><td rowspan="2"></td><td>Construction:
Offsite population
No impacts on the public; there would be no radiological releases during construction.
Worker population – workers would receive exposures from installing equipment in existing facilities.
Dose: 10 person-rem
LCFs: 0 (calculated: 6×10^{-3})
Industrial accidents: 79 injuries with no fatalities expected.</td><td>Construction:
Offsite population
Same as INL Alternative
Worker population
No radiological impacts; all work would be performed in area of the site with no known radioactive contamination.
Industrial accidents: 120 injuries with no fatalities expected.</td></tr>
<tr><td>Operations (annual impacts):
Offsite population
Dose: 0.044 person-rem
LCFs: 0 (calculated: 3×10^{-5})
Maximally exposed individual
Dose: 0.0068 millirem
LCF risk: 4×10^{-9}
Worker population
Dose: 53 person-rem
LCFs: 0 (calculated: 3×10^{-2})
Industrial accidents: 9 injuries with no fatalities expected.</td><td>Operations (annual impacts):
Offsite population
Dose: 0.58 person-rem
LCFs: 0 (calculated: 3×10^{-4})
Maximally exposed individual
Dose: 0.031 millirem
LCF risk: 2×10^{-8}
Worker population
Dose: 44 person-rem
LCFs: 0 (calculated: 3×10^{-2})
Industrial accidents: 9 injuries with no expected fatalities</td></tr>
</table>

<table>
<tr><th rowspan="2">Resource Area</th><th colspan="2">Alternatives</th></tr>
<tr><th>INL VTR</th><th>ORNL VTR</th></tr>
<tr><td></td><td colspan="2">Discussion:
For construction, a larger number of injuries is expected at ORNL due to the construction of a new hot cell facility in addition to the VTR. For operations, a lower worker population dose is expected at ORNL than INL because at INL additional MFC staff could be tasked to support VTR personnel. That same additional support was not assumed for ORNL as the post-irradiation examination and spent fuel treatment staff at ORNL would be new and dedicated to VTR operations only.</td></tr>
<tr><td colspan="3">Human Health – Facility Accidents (Chapter 4, Section 4.11)</td></tr>
<tr><td rowspan="3"></td><td colspan="2">Construction:
No impacts on the offsite public, maximally exposed individual, or noninvolved worker. No construction accidents are expected to release radiological or hazardous materials.</td></tr>
<tr><td>Operations (annual impacts):
Offsite population
Accident probability: less than one in 10,000 per year
Dose: 38 person-rem
LCFs: 0 (0.02)
Maximally exposed individual
Accident probability: less than one in 10,000 per year
Dose: 0.25 rem
LCF risk: 0.0001
Noninvolved worker
Accident probability: less than one in 10,000 per year
Dose: 160 rem
LCF risk: 0.2</td><td>Operations (annual impacts):
Offsite population
Accident probability: less than one in 10,000 per year
Dose: 1,400 person-rem
LCFs: 1
Maximally exposed individual
Accident probability: less than one in 10,000 per year
Dose: 14 rem
LCF risk: 0.009
Noninvolved worker
Accident probability: less than one in 10,000 per year
Dose: 400 rem
LCF risk: 0.5</td></tr>
<tr><td colspan="2">Discussion:
The risks to the maximally exposed individual and the general population from accidents at the INL Site and ORNL are very small, taking into account the very, very low probabilities (less than one in 10,000 per year) and consequences of the accidents. A fire involving VTR spent driver fuel subassemblies in the VTR Experiment Hall is the bounding operational accident at the VTR. Offsite impacts on the maximally exposed individual and general population from an accident at ORNL would be greater than impacts at the INL Site because of the proximity of the proposed VTR site to areas of public access and because the population near ORNL is larger and closer to the VTR. A hypothetical, beyond-design-basis event with an estimated frequency much less than 1 in 10 million is evaluated and discussed in Chapter 4, Section 4.11 and Appendix D.</td></tr>
</table>

Resource Area	Alternatives	
	INL VTR	**ORNL VTR**
Human Health – Transportation Impacts (Chapter 4, Section 4.12)		
	Construction: Shipments: 18,460, with 1 potential traffic accident fatality based on accident statistics.	*Construction*: Shipments: 23,790, with 1 potential traffic accident fatality, based on accident statistics.
	Operations (annual impacts): Radioactive waste shipments: 130 Population: Maximum dose: 8 person-rem with no LCFs. Individual doses from transportation would be well below DOE and regulatory limits. Worker population: Maximum dose: 7 person-rem with no LCFs. Individual worker doses from transportation would be limited to meet DOE administrative worker dose limits. Accidents: LCFs: None Nonradiological traffic fatalities: 1 potential traffic fatality over the 60-year life of the project	*Operations (annual impacts)*: Radioactive waste shipments: 130 Population: Maximum dose: 12 person-rem with no LCFs. Individual doses from transportation would be well below DOE and regulatory limits. Worker population: Maximum dose: 10 person-rem with no LCFs. Individual worker doses from transportation would be limited to meet DOE administrative worker dose limits. Accidents: LCFs: None Nonradiological traffic fatalities: 1 potential traffic fatality over the 60-year life of the of project
	Discussion: Radioactive wastes include contact-handled and remote-handled LLW, MLLW, TRU waste, and mixed TRU waste. For incident-free operations, the affected population includes individuals living within 0.5 miles of each side of the road. For accident conditions, the affected population includes individuals living within 50 miles of the accident.	
Traffic (Chapter 4, Section 4.13)		
	Construction: The average increases in daily traffic during construction are not expected to exceed existing level of service of offsite roads and no upgrades or improvements to onsite roads are anticipated.	
	Operations: Operations at each facility are expected to result in an increase in traffic from new employees. The changes would represent a minor increase in traffic at each facility (about 5 percent). Operations traffic is not expected to cause a change in the existing level of service of offsite roads and no upgrades or improvements to onsite roads are anticipated.	

Resource Area	***Alternatives***	
	INL VTR	***ORNL VTR***
Socioeconomics (Chapter 4, Section 4.14)		
	Construction: The increase in jobs and income from construction would have a short-term beneficial impact on the local and regional economy. The population influx associated with an in-migrating workforce and their families is considered relatively small and would have no major adverse impacts on the region in terms of population, employment, income levels, housing, or community services.	
	Operations: The increase of 218 jobs would have a beneficial impact on the local and regional economy. The population influx associated with an in-migrating workforce and their families is considered relatively small and would have no major adverse impacts on the region in terms of population, housing, or community services.	*Operations*: The increase of 300 jobs would have a beneficial impact on the local and regional economy. The population influx associated with an in-migrating workforce and their families is considered relatively small and would have no major adverse impacts on the region in terms of population, housing, or community services.
Environmental Justice (Chapter 4, Section 4.15)		
	Construction and Operations: No disproportionately high and adverse impacts on minority or low-income populations are expected. Increased health risks to minority or low-income individuals or populations exposed to radiation would be negligible.	

dBA = decibels, A-weighted; EPA = U.S. Environmental Protection Agency; INL = Idaho National Laboratory; LCF = latent cancer fatality; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; ORNL = Oak Ridge National Laboratory; TRU = transuranic; TSCA = Toxic Substances Control Act; VTR = Versatile Test Reactor.
Note: Sums and products presented in the table may differ from those calculated from individual entries due to rounding.

Table 2–4. Summary of Environmental Consequences for Reactor Fuel Production Options

Resource Area	***Options***			
	INL Feedstock Preparation	***INL Fuel Fabrication***	***SRS Feedstock Preparation***	***SRS Fuel Fabrication*** [a]
Land Use and Aesthetics (Chapter 4, Section 4.1)				
Land Use	*Construction and Operations*: No impacts on land use as modifications/construction and operations would occur in existing facilities and not require construction of new facilities or additional land use.		*Construction and Operations*: No impacts on land use as modifications/construction and operations would occur in existing facilities or adjacent to those facilities. Up to 3 acres of previously disturbed land would be used. No impacts on land use as activities would occur in existing facilities and not require additional land use.	
Aesthetics	*Construction and Operations*: No impacts on aesthetics as modifications/construction would occur in existing facilities. No impact on aesthetics as operations would occur in existing facilities.		*Construction and Operations*: Construction would occur in or adjacent to existing facilities and be compatible with the current industrial setting.	
Geology and Soils (Chapter 4, Section 4.2)				
	Construction and Operations: No additional land disturbance, no additional excavation, and little or no use of geologic and soil materials because modifications/construction and operations would occur in existing buildings.		*Construction and Operations*: Most modifications/construction and operations would occur in existing buildings. Up to 3 acres of land disturbance, a small amount of excavation, and small quantities of geologic and soil materials maybe associated with constructing ancillary facilities.	
Water Resources (Chapter 4, Section 4.3)				
	Construction: An estimated 230,000 gallons of potable water would be required by construction personnel and 5,000 gallons of water would be needed for cleaning. The water would be drawn from groundwater and discharged as surface water (which could include the Materials and Fuels Complex sewage lagoons or other surface discharges such as swales).		*Construction*: An estimated 3 million gallons of potable water would be needed. An additional volume of non-potable water required during construction is expected to total about 6 million gallons.	
	Operations: The addition of 300 new full-time employees would require about 1.4 million gallons of water per year. An additional 50,000 gallons would be needed for process operations. Water would be drawn from groundwater. Sanitary waste would be discharged as surface water. Process waters would be transported off site for treatment and disposal.	*Operations*: The addition of 70 new full-time employees would increase potable water use by about 880,000 gallons per year. In addition, about 1,000 gallons per year would be needed for mopping and cleaning. This water would be drawn from groundwater and discharged as surface water.	*Operations*: The addition of 300 new full-time employees would increase water use by about 1.4 million gallons of water per year. An additional 50,000 gallons would be needed for process operations. Water would be drawn from groundwater and discharged as surface water.	*Operations*: The addition of 300 new full-time employees would increase water use by about 1.4 million gallons of water per year. This water would be drawn from groundwater and discharged as surface water.

<table>
<tr><th rowspan="2">Resource Area</th><th colspan="4">Options</th></tr>
<tr><th>INL Feedstock Preparation</th><th>INL Fuel Fabrication</th><th>SRS Feedstock Preparation</th><th>SRS Fuel Fabrication [a]</th></tr>
<tr><td></td><td colspan="4">Discussion:
The higher estimate of water use for construction of the feedstock preparation capability at SRS is because a greater level of effort is expected to make the facility modifications. More interior modifications (removing and constructing walls) are expected at SRS than at INL. Under the Fuel Fabrication Options, all new staff would be required at SRS, whereas at INL, a portion of the staff is existing and would be augmented with new hires.</td></tr>
<tr><td colspan="5">Air Quality (Chapter 4, Section 4.4)</td></tr>
<tr><td></td><td colspan="4">Construction and Operation:
he counties that encompass the INL Site and SRS currently are in attainment for all NAAQS. Annual nonradiological emissions from construction and operation would be well below the EPA prevention of significant deterioration (PSD) permitting threshold of 250 tons per year for a criteria pollutant. Construction and operation of the options SRS would result in slightly higher emissions compared to activities at the INL Site. Construction activities would not generate radiological air emissions at the INL Site and would generate radiological emissions at SRS. Operations would generate small quantities of radiological air emissions. See Human Health – Normal Operations below for the estimated impacts from these emissions.</td></tr>
<tr><td colspan="5">Ecological Resources (Chapter 4, Section 4.5)</td></tr>
<tr><td></td><td colspan="4">Construction and Operations:
There would be no impacts on ecological resources as modifications/construction would occur in existing facilities or adjacent to those facilities on previously disturbed land. Operations would occur in existing or new facilities.</td></tr>
<tr><td colspan="5">Cultural and Paleontological Resources (Chapter 4, Section 4.6)</td></tr>
<tr><td></td><td colspan="2">Construction and Operations:
No impacts on significant cultural resources as changes to the internal configuration of active laboratories or other experimental or testing properties to accommodate new experiments or tests are exempt activities per the INL Cultural Resources Management Plan (INL 2016f). With proposed operations conducted within existing facilities, there would be no impacts to paleontological resources.</td><td colspan="2">Construction and Operations:
No impacts on cultural or paleontological resources as modifications or construction would occur in K Area Complex facilities or adjacent to those facilities on previously disturbed land.</td></tr>
<tr><td colspan="5">Infrastructure (Chapter 4, Section 4.7)</td></tr>
<tr><td rowspan="2"></td><td colspan="4">Construction:
Use of existing infrastructure would be at levels well below existing capacities.</td></tr>
<tr><td>Operations:
Use of existing infrastructure within the Fuel Conditioning Facility would be well below existing capacities. Electric demand would be 6,700 megawatt-hours per year and water usage would be 1.5 million gallons per year.</td><td>Operations:
Use of existing infrastructure within FCF, the Fuel Manufacturing Facility and Zero Power Physics Reactor would be well below existing capacities. Electric demand would be 8,300 to 13,300 megawatt-hours per year and water usage would be 0.88 million gallons per year.</td><td>Operations:
Use of existing infrastructure within the K-Reactor Building would be well below existing capacities. Electric demand would be 6,700 megawatt-hours per year and water usage would be 1.5 million gallons per year.</td><td>Operations:
Use of existing infrastructure within K-Reactor Building would be well below existing capacities. Electric demand would be 8,300 to 13,300 megawatt-hours per year and water usage would be 1.4 million gallons per year.</td></tr>
</table>

Resource Area	**Options**			
	INL Feedstock Preparation	***INL Fuel Fabrication***	***SRS Feedstock Preparation***	***SRS Fuel Fabrication*** [a]
Noise and Vibration (Chapter 4, Section 4.8)				
	Construction: Due to the distance, estimated noise and vibration levels at the INL Site boundary (2.9 miles) and closest receptor (5.0 miles) would not be perceptible and would be consistent with ambient levels.		*Construction*: Due to the large distance from the site and receptors, estimated noise and vibration levels at the SRS boundary (5.5 miles) would not be perceptible and would be consistent with ambient levels.	
	Operations: Operational noise and vibration would be contained within the building and not be perceptible at the boundary.			
Waste Management and Spent Nuclear Fuel Management (Chapter 4, Section 4.9)				
	Construction: Existing facilities would be modified and existing equipment reallocated, as necessary, to support both feedstock preparation and fuel fabrication activities. Equipment currently in this space would be relocated for use in other facilities. Small volumes of construction waste, LLW, MLLW, and hazardous and TSCA wastes would generated during the modifications of facilities and the relocation of existing equipment and the installation of the new equipment.			
	Operations (annual impacts): During operations, 170 to 340 cubic meters of LLW, 2 to 4 cubic meters of MLLW, and 1 to 2 cubic meters of hazardous and TSCA wastes would be generated. The characteristics of these wastes would be similar to wastes currently generated by existing activities. These wastes would be managed within the current waste management system and sent offsite for disposal. The proposed action would provide preparation and packaging capabilities for the 200 to 400 cubic meters of TRU waste that would be generated from fuel production; TRU waste would be shipped to the Waste Isolation Pilot Plant for disposal.			
Human Health – Normal Operations (Chapter 4, Section 4.10)				
	Construction: Offsite population No impacts on the public; no radiological releases expected during construction Worker population Work would occur in a clean area of an existing facility so there would be no worker dose. Due to the short duration and small number of workers, less than 1 industrial injury is calculated.	*Construction*: Offsite population No impacts on the public; no radiological releases expected during construction Worker population Dose: 21 person-rem LCFs: 0 (calculated: 1×10^{-2}) Due to the short duration and small number of workers, less than 1 industrial injury is calculated.	*Construction*: Offsite population Same as INL Feedstock Preparation Worker population Dose: 1.3 person-rem LCFs: 0 (calculated: 8×10^{-4}) Industrial accidents: 10 injuries with no fatalities expected.	*Construction*: Offsite population Same as INL Fuel Fabrication Worker population Dose: 0.8 person-rem LCFs: 0 (calculated: 5×10^{-4}) Industrial accidents: 10 injuries with no fatalities expected.
	Operations (annual impacts): Offsite population Dose: 0.012 person-rem LCFs: 0 (calculated: 7×10^{-6}) Maximally exposed individual Dose: 0.0012 millirem LCF risk: 7×10^{-10}	*Operations (annual impacts):* Offsite population Dose: 0.0053 person-rem LCFs: 0 (calculated: 3×10^{-6}) Maximally exposed individual Dose: 0.0016 millirem LCF risk: 1×10^{-9}	*Operations (annual impacts)*: Offsite population Dose: 0.042 person-rem LCFs: 0 (calculated: 2×10^{-5}) Maximally exposed individual Dose: 0.0015 millirem LCF risk: 9×10^{-10}	*Operations (annual impacts)*: Offsite population Dose: 0.020 person-rem LCFs: 0 (calculated: 1×10^{-5}) Maximally exposed individual Dose: 0.00071 millirem LCF risk: 4×10^{-10}

Resource Area	Options			
	INL Feedstock Preparation	***INL Fuel Fabrication***	***SRS Feedstock Preparation***	***SRS Fuel Fabrication*** [a]
	Worker population Dose: 51 person-rem LCFs: 0 (calculated: 3×10^{-2}) Industrial accidents: 9 injuries with no fatalities expected.	Worker population Dose: 51 person-rem LCFs: 0 (calculated: 3×10^{-2}) Industrial accidents: 9 injuries with no fatalities expected	Worker population Dose: 51 person-rem LCFs: 0 (calculated: 3×10^{-2}) Industrial accidents: 9 injuries with no fatalities expected.	Worker population Dose: 51 person-rem LCFs: 0 (calculated: 3×10^{-2}) Industrial accidents: 9 injuries with no fatalities expected.
Human Health – Facility Accidents (Chapter 4, Section 4.11)				
	Construction: No impacts on the offsite public, maximally exposed individual, or noninvolved worker. No construction accidents are expected to release radiological or hazardous materials. No impacts on the noninvolved worker. There are no radiological or hazardous material accident scenarios during construction.			
	Operations (annual impacts): Offsite population Probability less than 0.0001/year Dose: 0.034 person-rem LCF risk: 2×10^{-5} Maximally exposed individual Probability less than 0.0001/year Dose: 0.0002 rem LCF risk: 1×10^{-7} Noninvolved worker Probability less than 0.0001/year Dose: 0.00052 rem LCF risk: 3×10^{-7}	*Operations (annual impacts):* Offsite population Probability less than 0.0001/year Dose: 0.13 person-rem LCF risk: 8×10^{-5} Maximally exposed individual Probability less than 0.0001/year Dose: 0.0036 rem LCF risk: 2×10^{-6} Noninvolved worker Probability less than 0.0001/year Dose: 0.048 rem LCF risk: 3×10^{-5}	*Operations (annual impacts):* Offsite population Probability less than 0.0001/year Dose: 0.22 person-rem LCF risk: 1×10^{-4} Maximally exposed individual Probability less than 0.0001/year Dose: 7.9×10^{-5} rem LCF risk: 5×10^{-8} Noninvolved worker Probability less than 0.0001/year Dose: 0.015 rem LCF risk: 9×10^{-6}	*Operations (annual impacts):* Offsite population Probability less than 0.0001/year Dose: 0.81 person-rem LCF risk: 5×10^{-4} Maximally exposed individual Probability less than 0.0001/year Dose: 0.0016 rem LCF risk: 9×10^{-7} Noninvolved worker Probability less than 0.0001/year Dose: 0.18 rem LCF risk: 1×10^{-4}
	Discussion: The risks to the maximally exposed individual and the general population from accidents at the INL Site and SRS are very small, taking into account the very, very low probabilities (less than one in 10,000 per year) and consequences of the accidents. A criticality while melting plutonium metal and adding uranium and zirconium is the bounding operational accident during fuel fabrication; an aqueous/electrorefining accident is bounding during feedstock preparation. Offsite impacts on the public from an accident at SRS are up to six times greater than impacts at the INL Site because the population near SRS is larger and closer to the reactor fuel production facility.			

<table>
<tr><th rowspan="2">Resource Area</th><th colspan="4">Options</th></tr>
<tr><th>INL Feedstock Preparation</th><th>INL Fuel Fabrication</th><th>SRS Feedstock Preparation</th><th>SRS Fuel Fabrication [a]</th></tr>
<tr><td colspan="5">Human Health – Transportation Impacts (Chapter 4, Section 4.12)</td></tr>
<tr><td rowspan="2"></td><td colspan="2">Construction:
Shipments: None
Accidents: None</td><td colspan="2">Construction:
Shipments: 2,454 with no radiological impacts
Accidents: None</td></tr>
<tr><td colspan="2">Operations (annual impacts):
All transportation impacts associated with reactor fuel production are included. No distinction is made between impacts from feedstock preparation and those from fuel fabrication.
Radioactive waste shipments: 57 to 285 estimated shipments. Additionally, this option would include 15 VTR fuel shipments annually to ORNL for the ORNL VTR Alternative.
Population:
Maximum dose: 20 person-rem with no LCFs. Individual doses from operations would be well below DOE and regulatory limits.
Worker Population:
Maximum dose: 23 person-rem with no LCFs. Individual worker doses from operations would be limited to meet DOE administrative worker dose limits.
Accidents:
LCFs: None
Nonradiological traffic fatalities: Two potential traffic accident fatalities over the life of the project</td><td colspan="2">Operations (annual impacts):
All transportation impacts associated with reactor fuel production are included. No distinction is made between impacts from feedstock preparation and those from fuel fabrication.
Radioactive waste shipments: There would be 57 to 278 estimated shipments. Additionally, this option would include 15 VTR fuel shipments annually to the INL Site or ORNL, for the INL VTR or the ORNL VTR Alternative, respectively.
Population:
Maximum dose: 32 person-rem with no LCFs. Individual doses from operations would be well below DOE and regulatory limits.
Worker Population:
Maximum dose: 34 person-rem with no LCFs. Individual worker doses from operations would be limited to meet DOE administrative worker dose limits.
Accidents:
LCFs: None
Nonradiological traffic fatalities: Three potential traffic accident fatalities over the life of the project</td></tr>
<tr><td colspan="5">Traffic (Chapter 4, Section 4.13)</td></tr>
<tr><td></td><td colspan="4">Construction and Operations:
The increase in traffic from both material shipments and workers are not expected to cause a change in existing level of service of offsite roads and no upgrades or improvements to onsite roads are anticipated.</td></tr>
<tr><td colspan="5">Socioeconomics (Chapter 4, Section 4.14)</td></tr>
<tr><td rowspan="3"></td><td colspan="4">Construction:
Negligible adverse impact; small and beneficial short-term economic impact associated with construction activities.</td></tr>
<tr><td colspan="4">Operations: The increase in jobs and income would be considered a potential beneficial impact on the local and regional economy. The population influx associated with an in-migrating workforce and their families is considered relatively small and would have no major adverse impacts on the regional in terms of population, employment, income levels, housing, or community services.</td></tr>
<tr><td>300 new employees for operations</td><td>70 new employees for operations</td><td>300 new employees for operations</td><td>300 new employees for operations</td></tr>
</table>

Resource Area	Options			
	INL Feedstock Preparation	INL Fuel Fabrication	SRS Feedstock Preparation	SRS Fuel Fabrication [a]
Environmental Justice (Chapter 4, Section 4.15)				
	Construction and Operation: No disproportionately high and adverse impacts on minority or low-income populations are expected. Increased health risks to minority or low-income individuals or populations exposed to radiation would be negligible.			

EPA = U.S. Environmental Protection Agency; INL = Idaho National Laboratory; LCF = latent cancer fatality; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; NAAQS = National Ambient Air Quality Standards; SRS = Savannah River Site; TRU = transuranic; TSCA = Toxic Substances Control Act; VTR =Versatile Test Reactor.

[a] If the SRS Fuel Fabrication Option were selected, there would be a fuel fabrication development/demonstration capability established in the Fuel Manufacturing Facility at INL. The impacts of 3-to-4 years INL fuel development effort would approximate those of a single year of fuel fabrication under the INL Fuel Fabrication Option.

Note: Sums and products presented in the table may differ from those calculated from individual entries due to rounding.

Table 2–5. Summary of Combined Environmental Consequences for the Versatile Test Reactor, Feedstock Preparation, and Fuel Fabrication at Idaho National Laboratory

Resource Area	***Construction***	***Operations***
Land Use and Aesthetics (Chapter 4, Section 4.1)		
Land Use	Same as Table 2–3, INL VTR Alternative: There would be minor impacts on land use from the disturbance of approximately 100 acres during construction activities. The VTR complex would occupy approximately 25 acres after construction.	There would be no impact on land use since no additional land would be disturbed.
Aesthetics	Same as Table 2–3, INL VTR Alternative: There would be minimal impacts on aesthetics as newly constructed facilities would not dominate the local landscape and would be similar in design to existing facilities.	Same as Table 2–3, INL VTR Alternative: There would be minimal impacts on aesthetics from operation of the newly constructed facilities that would be similar in design to existing facilities.
Geology and Soils (Chapter 4, Section 4.2)		
	Same as Table 2–3, INL VTR Alternative: Area disturbed would be 100 acres. The total quantities of geologic and soil materials needed during construction would represent small percentages of regionally plentiful resources and are unlikely to adversely impact geology and soil resources.	Same as Table 2–3, INL VTR Alternative: Area occupied would be 25 acres. No additional land disturbance, no additional excavation, and little or no use of geologic and soil materials. Minimal impacts.
Water Resources (Chapter 4, Section 4.3)		
	Water would be drawn from existing wells that access the Snake River Plain Aquifer and treated through the existing Materials and Fuels Complex (MFC) potable water system. The total water estimated to be used is 128 million gallons. Discharges would be made to surface water (which could include the MFC sewage lagoons or other surface discharges such as swales).	Water use is estimated to be 6.8 million gallons per year. Water would be drawn from groundwater and most would be discharged as surface water to the Industrial Waste Pond or active sewage lagoons. About 50,000 gallons of potentially contaminated process water would be sent off site for treatment and disposal.
Air Quality (Chapter 4, Section 4.4)		
	Annual nonradiological emissions from construction of the VTR facilities would be well below the EPA prevention of significant deterioration (PSD) permitting threshold of 250 tons per year for a criteria pollutant. Hazardous air pollutant emissions generated by construction activities would not result in adverse air quality impacts on the public. Construction activities would not generate radiological air emissions.	Annual nonradiological emissions from operation of the VTR facilities would be well below the annual PSD indicator thresholds. Operations activities would generate small quantities of radiological air emissions. See Human Health – Normal Operations below for the estimated impacts from these emissions.

Resource Area	Construction	Operations
Ecological Resources (Chapter 4, Section 4.5)		
	Same as Table 2–3, INL VTR Alternative: Area disturbed: is about 100 acres. Construction would result in a loss of sagebrush habitat. Losses to sagebrush habitat would be compensated for in accordance to the DOE's 'no net loss of sagebrush habitat' policy on the INL Site under the Candidate Conservation Agreement (CCA) for the sage-grouse. Nesting bird surveys, as indicated in the MBTA permit, would occur prior to any ground disturbance or vegetation removal to confirm the absence of MBTA protected species, as well as sage-grouse, from the proposed project area. A 300-foot buffer would be established around active pygmy rabbit burrow systems to prevent direct impacts. Operational and administrative controls will be evaluated and implemented, if warranted, to reduce the potential for adverse effects to wildlife species and human-wildlife interactions.	Same as Table 2–3, INL VTR Alternative: Area occupied is about 25 acres. Operations would take place in new and existing facilities. No additional land disturbance would occur so there would be no impacts on ecological resources.
Cultural and Paleontological Resources (Chapter 4, Section 4.6)		
	No impacts on significant cultural and paleontological resources would occur from facility construction, land disturbance, and operations.	
Infrastructure (Chapter 4, Section 4.7)		
	Construction electricity usage would be 1,000 megawatt-hours average annual value with annual peak value of 2,000 megawatt-hours. Diesel fuel usage would total 2.3 million gallons. Total water usage would be 128 million gallons.	VTR operations and driver fuel production would use 170,000 megawatt-hours per year of electricity, 4.7 million cubic feet of propane per year, and 6.8 million gallons of water per year.
Noise & Vibration (Chapter 4, Section 4.8)		
Noise	Due to the distance, estimated construction and operations noise levels at the INL Site boundary (2.9 miles) and closest receptor (5.0 miles) would not be perceptible and would be consistent with ambient levels.	
Vibration	Ground-borne vibration due to typical construction and operation activities are expected to be below the threshold of human perception.	
Waste Management and Spent Nuclear Fuel Management (Chapter 4, Section 4.9)		
Waste Management	About 9,900 cubic meters of construction waste would be generated during VTR construction activities. For the Reactor Fuel Production, existing facilities would be modified and existing equipment reallocated, as necessary, to support feedstock preparation and fuel fabrication activities. Equipment currently in this space would be relocated for use in other facilities. Small volumes of construction waste, LLW, MLLW, and hazardous and TSCA wastes would be generated during the modifications of facilities and the relocation of existing equipment and the installation of the new equipment would be minimal.	Annually, about 710 to 880 cubic meters of LLW, 40 to 42 cubic meters of MLLW, 200 to 400 cubic meters of TRU waste, and 8.2 to 9.2 cubic meters of hazardous and TSCA wastes would be generated. The characteristics of most of these wastes would be similar to wastes currently generated from existing activities and would be managed within the current waste management system. The project would provide preparation and packaging capabilities for the 200 to 400 cubic meters of TRU waste that would be generated from fuel production. All wastes would be shipped off site for treatment and/or disposal. Treatment and disposal of these wastes are well within the current capacities of existing offsite facilities.

Resource Area	***Construction***	***Operations***
Spent Nuclear Fuel	*Construction:* No spent nuclear fuel would be generated during construction.	*Operations:* The heavy metal from 45 spent driver fuel assemblies produced annually (66 for the final core offload at the end of the VTR's operational lifetime) would be treated and packaged as spent nuclear fuel and placed on the VTR spent fuel pad pending offsite shipment. The total number of spent fuel assemblies over the lifetime of the project represent about 110 metric tons of heavy metal.
Human Health – Normal Operations (Chapter 4, Section 4.10)		
	Offsite population No population impacts. Maximally exposed individual No maximally exposed individual impacts. Worker population Dose: 32 person-rem LCFs: 0 (calculated: 2×10^{-2}) Industrial accidents: 80 injuries with no fatalities expected.	*Annual impacts:* Offsite population Dose: 0.06 person-rem LCFs: 0 (calculated: 4×10^{-5}) Maximally exposed individual Dose: 0.0096 millirem LCF risk: 6×10^{-9} Worker population Dose: 160 person-rem LCFs: 0 (calculated: 9×10^{-2}) Industrial accidents: 26 injuries with no fatalities expected.
Human Health – Facility Accidents (Chapter 4, Section 4.11)		
	Offsite population No impacts on the offsite public. There are no radiological or hazardous material accident scenarios during construction. Maximally exposed individual No impacts on the maximally exposed individual. There are no radiological or hazardous material accident scenarios during construction. Noninvolved worker No impacts on the noninvolved worker. There are no radiological or hazardous material accident scenarios during construction.	*Annual impacts*: Offsite population Accident probability: less than one in 10,000 per year Dose: 1,400 person-rem LCFs: 1 Maximally exposed individual Accident probability: less than one in 10,000 per year Dose: 0.25 rem LCF risk: 0.0001 Noninvolved worker Accident probability: less than one in 10,000 per year Dose: 160 rem LCF risk: 0.2

Resource Area	***Construction***	***Operations***
Human Health – Transportation Impacts (Chapter 4, Section 4.12)		
	Radioactive waste shipments: 18,460 total shipments with no radiological impacts Accidents: One potential traffic accident fatality.	Radioactive waste shipments: 187 to 415 shipments annually. Offsite Population: Maximum dose: 28 person-rem with no LCFs. Individual doses from operations would be well below DOE and regulatory limits. Worker Population: Maximum dose: 30 person-rem with no LCFs. Individual doses from operations would be well below DOE and regulatory limits. Accidents: LCFs: None Nonradiological traffic fatalities: Three potential traffic accident fatalities over the 60-year life of the project
Traffic (Chapter 4, Section 4.13)		
	The average increases in daily traffic during construction are not expected to exceed existing level of service of offsite roads, and no upgrades or improvements to onsite roads are anticipated.	Operations at each facility are expected to result in an increase of about 400 employees. This represents a negligible increase in traffic at each facility (about 5 percent). Operation traffic not expected to exceed existing level of service of offsite roads and no upgrades or improvements to onsite roads are anticipated.
Socioeconomics (Chapter 4, Section 4.14)		
	The increase in jobs and income would have a short-term beneficial impact on the local and regional economy. The population influx associated with an in-migrating workforce and their families is considered relatively small and would have no major adverse impacts on the regional area of influence in terms of population, employment, income levels, housing, or community services.	The increase in 588 jobs would have a beneficial impact on the local and regional economy. The population influx associated with an in-migrating workforce and their families is considered relatively small and would have no major adverse impacts on the regional area of influence in terms of population, housing, or community services.
Environmental Justice (Chapter 4, Section 4.15)		
	No disproportionately high and adverse impacts on minority or low-income populations are expected. Increased risks of minority or low-income individuals or populations exposed to radiation would be negligible.	

EPA = U.S. Environmental Protection Agency; INL = Idaho National Laboratory; LCF = latent cancer fatality; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; TRU = transuranic; TSCA = Toxic Substances Control Act; VTR =Versatile Test Reactor.
Note: Sums and products presented in the table may differ from those calculated from individual entries due to rounding.

2.9.2 Summary and Comparison of Cumulative Impacts

Council on Environmental Quality regulations define cumulative impacts as effects on the environment that result from implementing any of the alternatives when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such actions (40 CFR 1508.7). Cumulative impacts were assessed by combining the effects of activities at the INL Site, ORNL, and SRS for each of the alternatives and options assessed in this VTR EIS with the effects of other past, present, and reasonably foreseeable future actions. Many of these actions occur at different times and locations and may not be truly additive. However, the effects were combined irrespective of the time and location of the impact, to encompass any uncertainties in the projected activities and their effects. This approach produces a conservative estimate of cumulative impacts for the activities considered. **Table 2–6**, presents a summary and comparison of cumulative impacts at the INL Site, ORNL, and SRS. Cumulative impacts for issues of national and global concern (i.e., transportation, ozone depletion, and climate change) are presented below. For the full discussion of cumulative impacts, refer to Chapter 5.

Transportation – The assessment of cumulative transportation impacts for past, present, and reasonably foreseeable future actions concentrates on offsite transportation throughout the nation that would result in potential radiation exposure to the transportation workers and the general population. Cumulative radiological impacts from transportation are estimated using the dose to the workers and the general population, because dose can be directly related to latent cancer fatalities (LCFs) using a cancer risk coefficient.

When combined with past, present, and reasonably foreseeable future nation-wide transportation, the cumulative transportation worker dose was estimated to be about 430,000 person-rem (258 LCFs). The cumulative general population dose was estimated to be about 441,000 person-rem (265 LCFs). For the INL VTR and the ORNL VTR Alternatives evaluated in this EIS, doses to transportation workers and the general population would be less than 2,120 and 2,025 person-rem, respectively. Therefore, transportation worker and population doses from the proposed action would be less than 0.5 percent of the cumulative worker and population doses and would not substantially contribute to cumulative transportation impacts.

Ozone Depletion – The proposed action is not expected to use substantial quantities of ozone-depleting substances as regulated under 40 CFR Part 82, "Protection of Stratospheric Ozone." Emissions of ozone-depleting substances would be very small and would represent a negligible contribution to the destruction of the Earth's protective ozone layer.

Climate Change – Greenhouse gas (GHG) emissions from construction and operations at the INL Site, ORNL, and SRS of 65,000, 97,000, and 59,000 metric tons of carbon dioxide equivalents, respectively, would occur over a period of up to 65 years. These emissions would imperceptibly add to U.S. and global GHG emissions, which were estimated to be 6.7 billion metric tons and 36.6 billion metric tons of carbon dioxide equivalents, respectively, in 2018. Therefore, GHGs emitted from the proposed actions at the INL Site, ORNL, and SRS would be a negligible percentage of U.S. and global GHG emissions and would not substantially contribute to future climate change.

Table 2–6. Summary and Comparison of Cumulative Impacts

Resource Area	*INL VTR Alternative (including Reactor Fuel Production Option)*	*ORNL VTR Alternative*	*SRS Reactor Fuel Production Option*
Land Use and Aesthetics	Activities evaluated under the proposed action would disturb 100 acres, or approximately 0.2 percent of the 45,400 acres of currently developed land at the INL Site and approximately 0.02 percent of the 569,600 acres of land available at the INL Site, and would not substantially contribute to cumulative land use impacts. Because construction would disturb only 100 acres, would be located adjacent to industrial area at MFC, and would be geographically separated from most of the other activities at the INL Site, the proposed action would not substantially contribute to cumulative aesthetics impacts.	Activities evaluated under the proposed action would disturb 150 acres, or approximately 1.2 percent of the 12,250 to 12,450 acres of developed land at ORR and approximately 0.5 percent of the 32,867 acres of land available at ORR, and would not substantially contribute to cumulative land use impacts. Because construction would disturb only 150 acres and would be geographically and topographically separated from most of the other activities at ORR, the proposed action would not substantially contribute to cumulative aesthetics impacts.	Modification and operation activities would occur primarily within existing buildings with minimal additional land disturbance. Therefore, impacts of the proposed action on land use and aesthetics would be minimal and would not contribute substantially to cumulative impacts.
Geology and Soils	Based on the information presented above for Land Use, the amount of soil disturbed by the proposed action would be a small percentage of the total soil disturbed at the INL Site and would not substantially contribute to cumulative impacts. The amount of geologic and soils materials used by the proposed action would be 112,000 cubic yards or about 9 percent of the 1,230,000 cubic yards used by other activities at the INL Site.	Based on the information presented above for Land Use, the amount of soil disturbed by the proposed action would be a small percentage of the total soil disturbed at ORR and would not substantially contribute to cumulative impacts. The amount of geologic and soils materials used by the proposed action would be 187,000 cubic yards or approximately 13 percent of the 1,460,000 cubic yards used by other activities at ORR.	Modification and operation activities would occur primarily within existing buildings with minimal additional land disturbance. Therefore, impacts of the proposed action on geology and soils would be minimal and would not contribute substantially to cumulative impacts.
Water Resources	Under the proposed action, no effluent would be discharged directly to natural surface water bodies, and no surface water would be used. Therefore, the proposed action would not contribute to cumulative impacts on surface water. No effluent would be discharged directly to groundwater, and thus the proposed action would not contribute to cumulative impacts on groundwater quality. Groundwater withdrawal for the proposed action, would be less than 1 percent of the 872 million gallons per year cumulative groundwater use at the INL Site, and therefore, would not substantially contribute to cumulative impacts. The other past, present, and reasonably	Under the proposed action, no effluent would be discharged directly to groundwater, and no groundwater would be withdrawn, except shallow groundwater withdrawn during dewatering. Dewatering would be of short duration and localized extent. Therefore, the proposed action would not substantially contribute to cumulative groundwater impacts. Water use would be less than 0.1 percent of the 4.27 billion gallons per year cumulative surface water use at ORR, and would not substantially contribute to cumulative impacts on surface water availability. No contaminated effluent would be discharged directly to surface water	Under the proposed action, modification and operation activities would occur within existing buildings with no additional land disturbance and no effluent discharged directly to surface water or groundwater. Therefore, impacts on surface water and groundwater quality would be minimal and would not contribute to cumulative impacts. No surface water would be used, and thus, the proposed action would not contribute to cumulative impacts from surface water use. Groundwater withdrawal for the proposed action would be less than 1 percent of the 538 to 623 million gallons per year cumulative groundwater

Resource Area	***INL VTR Alternative (including Reactor Fuel Production Option)***	***ORNL VTR Alternative***	***SRS Reactor Fuel Production Option***
	foreseeable future actions would be located across the INL Site and would discharge wastewater to different discharge points. Therefore, there would be little or no cumulative impact of these discharges.	during operation, and thus, the proposed action would not contribute to cumulative impacts on surface water quality.	use at SRS, and therefore would not substantially contribute to cumulative impacts.
Air Quality	The minor increase in offsite air pollutant concentrations produced from construction and operation, in combination with emissions from other past, present, and reasonably foreseeable future actions, would result in air pollutant concentrations that would not exceed the State and national ambient air quality standards. Emissions from construction and operations activities would not substantially contribute to cumulative air quality impacts.		
Ecological Resources	Cumulative impacts on ecological resources would not be substantial because ground disturbance and land clearing for the proposed action and other past, present, and reasonably foreseeable future actions would occur at different locations and times, and appropriate best management practices (such as sagebrush replacement and invasive species management) would be enforced.	The proposed action and other past, present, and reasonably foreseeable future actions would occur at different locations and times, and appropriate best management practices (such as wetland protection) would be enforced. The loss of habitat associated with the proposed action would account for less than 1 percent of the 24,000 acres of forested-hardwood habitat and less than 1 percent of the 4,100 acres of interior forest available at ORR. Even though these impacts to vegetation would generally be considered minor due to the availability of forested-hardwood habitats within ORNL and intermountain regions of Appalachia, ongoing assessments of the ORNL's ecological resources suggest that in-kind mitigation (i.e., protection or enhancement of ecologically-similar resources) could be required due to impacts to vegetation and may entail greater acreage than available elsewhere on ORNL (ORNL 2020d).	Under the proposed action, modification and operation activities would occur primarily within existing buildings with minimal additional land disturbance. Therefore, impacts of the proposed action on ecological resources would be minimal and would not contribute substantially to cumulative impacts.
Cultural and Paleontological Resources	Cumulative impacts on cultural and paleontological resources within the regional area of influence would be negligible because no historic properties or paleontological resources were identified within the area of proposed new construction. The proposed new construction is consistent with the historic industrial character of the area and would not diminish the integrity of setting of any existing historic property within MFC.	Cumulative impacts on cultural and paleontological resources within the regional area of influence would be negligible because of the lack of significant resources within the area of potential effect and due to the necessity of following the NHPA Section 106 process for all activities.	Under the proposed action, modification and operation activities would occur primarily within existing buildings with minimal additional land disturbance. Therefore, impacts of the proposed action on cultural and paleontological resources would be minimal and would not contribute substantially to cumulative impacts.

Resource Area	***INL VTR Alternative (including Reactor Fuel Production Option)***	***ORNL VTR Alternative***	***SRS Reactor Fuel Production Option***
Infrastructure	Projected cumulative site activities would annually require 468,000 to 471,000 megawatt-hours of electricity which is below the site capacity of 481,800 megawatt-hours. Annual electricity use for the proposed action would be approximately 170,000 megawatt-hours of electricity, which represents about one third of the 481,800 megawatt-hours of site capacity. Operation of the proposed action would annually use about 6.8 million gallons of water, which represents a fraction of the 872 million gallons cumulative infrastructure use and an even smaller fraction of the 11.4 billion gallons total site capacity. Therefore, operation activities would not substantially contribute to cumulative water use impacts.	Projected cumulative site activities would annually require about 1,440,000 to 1,520,000 megawatt-hours of electricity, which is well within the total site-wide capacity of 13,880,000 megawatt-hours. Cumulative annual water usage would be about 4,270 million gallons, which is well within the site-wide capacity of 11,715 million gallons. Operation of the proposed action would annually use about 180,000 megawatt-hours of electricity and about 4.4 million gallons of water, which represents a fraction of cumulative infrastructure use and an even smaller fraction of total site capacity. Therefore, operation activities would not substantially contribute to cumulative infrastructure impacts.	Projected cumulative site activities would annually require about 851,000 to 1,000,000 megawatt-hours of electricity, which is well within the total site-wide capacity of 4,400,000 megawatt-hours. Cumulative annual water usage would range from about 538 million to 624 million gallons of water, which is well within the site-wide capacity of 2,950 million gallons. Operation of the proposed action activities would annually use about 13,300 megawatt-hours of electricity and 3.6 million gallons of water, which represents a fraction of the cumulative infrastructure use and an even smaller fraction of total site capacity. Therefore, operation activities would not substantially contribute to cumulative infrastructure impacts.
Noise	The closest offsite receptor is a home/farm site that is approximately 5.0 miles away. Given the large distance, cumulative noise from construction or operation of projects at MFC and other locations within the INL Site would be indistinguishable from background at the closest offsite noise-sensitive receptor.	The closest offsite receptors include residential homes more than 1.25 miles to the east and across the Clinch River. Given the large distance, cumulative noise from construction or operation of projects at ORNL would be indistinguishable from background at the closest offsite noise-sensitive receptors.	Under the proposed action, modification and operation activities would occur within existing buildings with no additional land disturbance. Therefore, impacts of the proposed action on noise would be minimal and would not contribute to cumulative impacts.
Waste Management	The waste management infrastructures at the INL Site, ORNL, and SRS were developed such that they would be able to accommodate the quantities of waste generated by the proposed action. Therefore, cumulative waste generation would be within site capacities. There are existing offsite DOE and commercial waste management facilities with sufficient capacities for the treatment and disposal needs associated with the relatively small volumes of LLW and MLLW wastes that would be generated by the proposed action. Therefore, substantial cumulative impacts on offsite LLW and MLLW treatment and disposal facilities would not be expected. The Waste Isolation Pilot Plant (WIPP) is currently the only disposal option for TRU waste. WIPP's Land Withdrawal Act total TRU waste volume limit is 175,564 cubic meters. As of the reporting date for the 2019 *Annual Transuranic Waste Inventory Report* (ATWIR), 67,400 cubic meters of TRU waste were disposed of at the WIPP facility. The alternatives and options evaluated in this EIS would generate an estimated 24,000 cubic meters of TRU waste. TRU waste volume estimates such as those provided in NEPA documents, cannot be used to determine compliance with the WIPP Land Withdrawal Act TRU waste volume capacity limit. These wastes and waste from other actions will be incorporated, as appropriate, into future ATWIR TRU waste inventory estimates. Any GTCC-like waste (e.g., non-defense TRU waste not eligible for disposal at WIPP) generated from the proposed action would be stored at the generator site in accordance with applicable requirements until a disposal capability is available.		

Resource Area	***INL VTR Alternative (including Reactor Fuel Production Option)***	***ORNL VTR Alternative***	***SRS Reactor Fuel Production Option***
Human Health – Normal Operations	The cumulative offsite population dose would be 0.13 person-rem per year with no expected LCFs (calculated value of 8×10^{-5}). Operation of the proposed action would result in a total population dose of 0.061 person-rem per year with no expected LCFs (calculated value of 4×10^{-5}). The proposed action would be 45 percent of the cumulative dose and LCFs. While the proposed action would be a significant portion of the cumulative impact, the absolute value would be low, and, therefore, would not substantially contribute to human health impacts. The cumulative MEI dose would be 1.8 millirem per year with an associated LCF risk of 1×10^{-6}. Operation of the proposed action would result in a total MEI dose of 0.0096 millirem per year with an associated LCF risk of 6×10^{-9}. The proposed action would be 0.05 percent of the cumulative MEI dose and LCFs and, thus, would not substantially contribute to cumulative human health impacts. The cumulative worker dose would be 220 person-rem per year with no expected LCFs (calculated value of 0.1). Operation of the proposed action would result in a total worker dose of 110 person-rem per year with no expected LCFs (calculated value of 0.07). The proposed action would be 51 percent of the cumulative dose and LCFs. The proposed action could result in 4 worker LCFs from 60 years of VTR operation. Some of the worker dose estimate is the result of using conservative dose estimates for some fuel fabrication workers. Additional worker protection could be incorporated into the final design to reduce potential worker doses.	The cumulative offsite population dose would be 94 person-rem per year with no expected LCFs (calculated value of 0.06). Operation of the proposed action would result in a total population dose of 0.58 person-rem per year with no expected LCFs (calculated value of 0.0004). The proposed action would be less than one percent of the cumulative dose and LCFs and therefore, would not substantially contribute to cumulative human health impacts. The cumulative MEI dose for ORR activities would be 3.8 millirem per year with an associated LCF risk of 2×10^{-6}. Operation of the proposed action would result in a total MEI dose of 0.031 millirem per year with an associated LCF risk of 2×10^{-8}. The proposed action would be about one percent of the cumulative MEI dose and LCFs and, thus, would not substantially contribute to cumulative human health impacts. The cumulative worker dose would be 110 person-rem per year with no expected LCFs (calculated value of 0.08). Operation of the proposed action would result in a total worker dose of 44 person-rem per year with no expected LCFs (calculated value of 0.03). The proposed action would be 39 percent of the cumulative dose and LCFs. This could result in 2 worker LCFs from 60 years of VTR operation. Additional worker protection could be incorporated into the final design potentially reducing worker doses.	The cumulative offsite population dose would be 35 person-rem per year with no expected LCFs (calculated value of 0.02). Operation of the proposed action would result in a total population dose of 0.062 person-rem per year with no expected LCFs (calculated value of 4×10^{-5}). The proposed action would be 0.2 percent of the cumulative dose and LCFs and, thus, would not substantially contribute to cumulative human health impacts. The cumulative MEI dose from SRS activities would be 0.82 millirem per year with an associated LCF risk of 5×10^{-7}. Operation of the proposed action would result in a total MEI dose of 0.0022 millirem per year with an associated LCF risk of 1×10^{-9}. The proposed action would be about 0.03 percent of the cumulative MEI dose and LCFs and therefore, would not substantially contribute to cumulative human health impacts. The cumulative worker dose would be about 1,000 person-rem per year with 1 expected LCFs (calculated value of 0.6). Operation of the proposed action would result in a total worker dose of 102 person-rem per year with no expected LCFs (calculated value of 0.06). The proposed action would be 10 percent of the cumulative dose and LCFs and therefore, would not substantially contribute to cumulative human health impacts. This could result in 4 worker LCFs from 60 years of VTR operation. Additional worker protection could be incorporated into the final design potentially reducing worker doses.
Traffic	The impacts on traffic from construction and operation activities are anticipated to be negligible to minor. As such, they would not substantially contribute to cumulative traffic impacts.		

Resource Area	INL VTR Alternative (including Reactor Fuel Production Option)	ORNL VTR Alternative	SRS Reactor Fuel Production Option
Socioeconomics	Cumulative employment at INL from present and reasonably foreseeable future actions could reach a peak of about 7,990 persons; this is about 5.1 percent of the 157,400 people employed in the INL Site region in 2018. Activities under the proposed action could produce direct employment of up to a peak of about 1,350 construction workers during the 51-month construction period, nearly 32 percent of the 4,120 cumulative workforce related to construction activities. The 588 operations staff (new workers) under the proposed action would be about 7.4 percent of the 7,990 cumulative workforce related to annual operations and a very small percentage of the about 157,400 people employed in the INL Site region in 2018. Note: That the total operations workforce under the proposed action would actually be close to 820, however, 230 of these workers would be pulled from the existing on-site workforce. The overall contribution to cumulative socioeconomic impacts (e.g., housing, schools, and community services) from the proposed action on the regional area of influence is expected to be small.	Cumulative employment at ORR from past, present, and reasonably foreseeable future actions could reach a peak of about 15,200 persons; this is about 4.7 percent of the 320,327 people employed in the ORR regional area of influence, including ORNL, in 2019. Activities under the proposed action could produce direct employment of up to a peak of 1,598 construction workers during the 51-month construction period, or 30 percent of the 5,380 cumulative workforce (peak) related to construction activities. The 300 operations staff under the proposed action would be about 2 percent of the 15,200 cumulative workforce related to operations and a very small percentage of the about 320,327 people employed in the ORR region in 2019. The overall contribution to cumulative socioeconomic impacts (e.g., housing, schools, and community services) from the proposed action on the regional area of influence is expected to be small.	Cumulative employment at SRS from past, present, and reasonably foreseeable future actions could reach a peak of about 15,600 persons; this is about 6.4 percent of the 243,863 people employed in the SRS regional area of influence in 2019. Activities under the proposed action could produce direct employment of up to a peak of 240 construction workers during the three-year construction period, or 3.2 percent of the 7,430 cumulative workforce (peak) related to construction activities. The 600 operations staff under the proposed action would be about 3.7 percent of the 16,410 cumulative workforce related to operations and a very small percentage of the about 243,863 people employed in the SRS region in 2019. The overall contribution to cumulative socioeconomic impacts (e.g., housing, schools, and community services) from the proposed action on the regional area of influence is expected to be small.
Environmental Justice	Because the doses from the proposed action would be small and there would be no disproportionate high and adverse impacts on minority and low-income populations, the proposed action would not substantially contribute to cumulative environmental justice impacts.		

Chapter 3
Affected Environment

3.0 AFFECTED ENVIRONMENT

In accordance with the Council on Environmental Quality's (CEQ) National Environmental Policy Act (NEPA) regulations (40 Code of Federal Regulations [CFR] Parts 1500 through 1508), this Versatile Test Reactor Environmental Impact Statement (VTR EIS) describes the resource areas that could be affected by the alternatives and options under consideration. The affected environment descriptions provide the context for understanding the environmental consequences described in Chapter 4 of this VTR EIS and serve as baselines from which any potential environmental impacts can be evaluated.

For this VTR EIS, each resource area that may be affected by the evaluated alternatives and options is described. The level of detail varies depending on the potential for impacts for each resource area. A number of site-specific and recent project-specific documents that are important sources of information for describing the existing environment are summarized and/or incorporated by reference in this chapter.

An important component in analyzing impacts is identifying or defining the region of influence (ROI) for each resource area. The ROIs are specific to the type of effect evaluated and encompass geographic areas within which potential impacts could be expected to occur. **Table 3–1** briefly describes the ROIs for each resource area evaluated in this VTR EIS. Definitions of the ROIs are further refined for each of the U.S. Department of Energy (DOE) sites included in the evaluations.

This chapter begins with descriptions of the affected environment for the Idaho National Laboratory (INL) in Section 3.1, followed by the Oak Ridge National Laboratory (ORNL) in Section 3.2, and the Savannah River Site (SRS) in Section 3.3.

Table 3–1. General Regions of Influence for Resource Areas

Resource Area	*Region of Influence*
Land Use and Aesthetics	INL, ORNL, and SRS and lands immediately adjacent, including county or counties where the site is located, neighboring communities, nearby tourist and recreation attractions, and other regional land uses that could be affected by the proposed action.
Geology and Soils	The boundaries of the INL, ORNL, and SRS.
Water Resources	INL, ORNL, and SRS surface waters where stormwater, industrial wastewater, or sanitary wastewater are discharged, including rivers, streams, tributaries, floodplains, swamps, lakes, ponds, bays, wetlands, and reservoirs; groundwater sources underlying the sites; and drinking water for the sites.
Air Quality	INL, ORNL, and SRS and nearby offsite areas within local air quality control regions and the transportation corridors that could be affected by air quality impacts from the proposed action.
Ecological Resources	INL, ORNL, and SRS and adjacent offsite areas where aquatic and terrestrial ecological communities exist, including non-sensitive and sensitive habitats and species that could be directly or indirectly affected by the proposed action.
Cultural and Paleontological Resources	INL, ORNL, and SRS and areas immediately adjacent to the sites where the proposed action would have the potential to affect cultural and paleontological resources
Infrastructure	INL, ORNL, and SRS power, fuel, and water supplies.
Noise	Proposed construction area at INL, ORNL, and SRS and 0.5-mile zone from the edge of the proposed construction areas.
Waste Management	INL, ORNL, and SRS waste treatment, storage, and disposal facilities.

Resource Area	Region of Influence
Human Health – Normal Operations	INL, ORNL, and SRS onsite project workers and the offsite public within 50 miles of the project location.
Human Health – Facility Accidents	INL, ORNL, and SRS noninvolved workers and the offsite public within 50 miles of the project location.
Traffic	INL, ORNL, and SRS onsite road systems, regional U.S. Interstate Highways, U.S. Highways, State Routes, major arterial roadways, and collector roads in the areas.
Socioeconomics	Counties where INL, ORNL, and SRS are located and surrounding counties
Environmental Justice	Minority and low-income populations within 50 miles of INL, ORNL, and SRS.

3.1 Idaho National Laboratory

3.1.1 Land Use and Aesthetics

The ROI for land use affected environment is composed of the INL Site and lands immediately adjacent, including portions of the five-county region where the INL Site is located. As the majority of the INL Site is located within Butte County, land use there, in neighboring communities, and nearby tourist and recreation attractions are generally described without a detailed account of specific land use in each respective area. Other regional land uses are described because they can be included in the ROI for other aspects of this affected environment. For example, areas potentially impacted by INL activities (e.g., Craters of the Moon National Monument and Preserve) are described as nearby land uses because these areas are considered in the ROI for aesthetics.

3.1.1.1 Land Use at Idaho National Laboratory

The INL Site is located on an 890-square mile parcel of land in the Eastern Snake River Plain (ESRP) in southeastern Idaho. The INL Site extends 39 miles from north to south and, at its broadest section, about 36 miles from east to west. INL's land holdings lie within five counties: Bingham, Bonneville, Butte, Clark, and Jefferson; however, the majority of the INL Site is located in Butte County. The INL Site is 45 miles northwest of the Fort Hall Indian Reservation, 132 miles southwest of Yellowstone National Park, 198 miles east of Boise, Idaho, and 234 miles north of Salt Lake City, Utah. The eastern boundary of the INL Site is 24 miles west of Idaho Falls, Idaho. INL also maintains a number of buildings within the city of Idaho Falls.

Congress authorized the Department of the Interior to "withdraw" public land to meet the needs of Federal agencies, such as DOE, using public land orders. The present-day boundary of the INL Site was created through several land transfers and land withdrawals beginning in the 1940s, resulting in the withdrawal of about 506,000 acres. INL lands were withdrawn from the public domain by way of Public Land Orders No. 318, 545, 637, and 1770. These public land orders have no specific time limitations. As such, DOE retains the authority to administer INL lands for the foreseeable future and is responsible for ensuring that future use and management of these lands are undertaken in accordance with these Public Land Orders. In addition to this federally withdrawn land, several parcels of land owned by the State of Idaho (21,308 acres) and private owners (43,275 acres) were transferred to the ownership of DOE's predecessor agencies from the 1940s to the 1960s. These transfers resulted in the completion of the intact land area of the current INL boundary (INL 2015c).

Approximately 94 percent of INL remains open and undeveloped. Pastures, foothills, and farmlands border much of the INL Site, with agricultural activity concentrated in areas to the northeast. The Bitterroot, Lemhi, and Lost River mountain ranges border the INL Site to the north and west; volcanic buttes and open plains are located near the southern boundary of the INL Site (INL 2017b). These surrounding mountain ranges are used for recreational activities and for livestock grazing; mining occurred in these mountains in the past, and the Bureau of Land Management (BLM) manages subsurface mineral rights on INL. At the INL Site, the Department of the Interior administers public land owned by the Federal government. As such, BLM has certain administrative responsibilities, including managing livestock grazing permits, granting utility rights-of-way across the land, and extracting materials (INL 2015c). INL's Fire Department provides wildland fire suppression services on the rangeland within the INL Site, as well as for a 1-mile perimeter outside the INL Site boundary (INL 2011b). Cooperative emergency policies and procedures have been established through agreements with Federal, State, local and Tribal agencies. The INL Emergency Plan/RCRA Contingency Plan defines agreements and communications links between the organizations in the event of emergencies (INL 2017e). Predator control at the INL Site is managed by the U.S. Department of Agriculture (USDA) Animal and Plant Health Inspection Service in coordination with other agencies. INL controls weeds and insects according to its Sitewide Noxious Weed Management Plan (INL 2013).

At the INL Site about 11,400 acres of the total land area has been developed at eight primary facility areas associated with energy research and waste management activities, which is surrounded by an about 45,000-acre security and safety buffer area. The developed area and buffer are located within an about 230,000-acre central core area of the INL Site. Another 34,000 acres at the INL Site have been developed for utility rights-of-way and public roads (DOE 2016k).

In 1975 the INL Site was designated a National Environmental Research Park (NERP) and is currently one of only seven in the United States. NERPs, which are situated on DOE land holdings, provide opportunities for researchers to study the compatibility of the environment with energy technology development. This designation opens the site to scientists from other government agencies, universities, and private foundations for use as a protected outdoor laboratory where long-term projects can be set up to answer questions about man's impact on the natural environment (SREL 2019).

In July 1999, the Secretary of Energy and representatives of the U.S. Fish and Wildlife Service (USFWS), BLM, and Idaho Department of Fish and Game designated a portion of the INL Site (then called the Idaho National Engineering and Environmental Laboratory) as a Sagebrush-Steppe Ecosystem Reserve. The reserve, located on 73,260 acres in the northwestern corner of the INL Site, was established to ensure this critically endangered ecosystem receives special consideration (DOE 2016k). A management plan for the INL Sagebrush-Steppe Ecosystem Reserve, prepared by the BLM and DOE, manages the reserve as a laboratory where all native ecosystem components, cultural resources, and Native American Tribal values are conserved in balance with opportunities for scientific investigation of the resources present on INL (INL 2015c).

Approximately 60 percent of the INL Site is available to livestock grazing (including on the Sagebrush-Steppe Ecosystem Reserve) with up to 340,000 acres leased for cattle and sheep grazing. However, grazing is not permitted within 0.5 miles of any primary facility boundary or within 2.0 miles of any nuclear facility. The U.S. Sheep Experiment Station uses about 900 acres of land at the junction of Idaho State Highways 28 and 33 as a winter feedlot for sheep.

The INL Site contains habitat suitable for big game. DOE cooperates with the Idaho Department of Fish and Game in allowing limited, controlled hunts for elk and antelope in a section of the northern half of the INL Site. These hunts, which are restricted to certain species and specific times and locations, are managed in accordance with an existing DOE/Idaho Department of Fish and Game memorandum of agreement. They are one of the few permitted public uses of the INL Site.

The INL Site is an administratively controlled area and in general, access to the INL Site and its facilities is permitted only on an official business basis. Public access is only allowed in rights-of-way associated with highways, the Big Lost River rest area, and at the Experimental Breeder Reactor-I (EBR-I) visitor center. There are no residential dwellings on INL property.

The INL Site is included within a large territory once inhabited by, and still of importance to, the Shoshone-Bannock Tribes. However, the INL Site does not lie within any of land boundaries established by the Fort Bridger Treaty of 1868. The Treaty provision that allows the Shoshone-Bannock Tribes to hunt on unoccupied lands of the United States does not apply to the INL lands because the entire site is considered to be occupied by DOE. DOE and the Shoshone-Bannock Tribes have an agreement-in-principle encouraging regular interactions between the DOE and the Tribes on issues of mutual concern. In addition, the Tribes have a memorandum of agreement that assures continued Tribal access to the Middle Butte Cave, which holds significant Tribal interest for ceremonial, cultural, and educational activities. For more information about the Fort Bridger Treaty and the Shoshone-Bannock Tribes, please refer to Section 3.1.6, Cultural and Paleontological Resources.

Land Use at Materials and Fuels Complex

The Materials and Fuels Complex (MFC) is located about 28 miles west of Idaho Falls and about 50 miles north of Pocatello, Idaho. U.S. Highway 20 is about 1.5 miles from MFC's southern boundary. MFC consists of a large developed area surrounded by an undeveloped security perimeter. Structures tend to be one- or two-story, block concrete buildings, with a handful of towers and other holding tank structures interspersed. The MFC operational area encompasses about 60 acres. MFC contains analytical laboratories and other facilities for nuclear research, including the Hot Fuel Examination Facility, the Irradiated Materials Characterization Laboratory, the Experimental Fuels Facility, the Fuel Conditioning Facility, and the decommissioned Zero Power Physics Reactor. Over the last few years, significant infrastructure investment has occurred and will continue in the next several years, including the construction of a Sample Preparation Laboratory (INL 2015c). The land outside the security fencing at MFC is similar to the other undeveloped land at INL.

Regional Land Use

Figure 3–1 depicts the regional location of INL and land ownership of surrounding areas. The INL Site is surrounded by a mixture of public and private land, about 75 percent of which is managed by the Federal government by way of BLM. Land uses in these federally administered areas include mineral and energy production, livestock grazing, and recreation. Approximately 1 percent of the adjacent land is owned by the State of Idaho and is used for the same purposes as the Federal land. The remaining 24 percent of the land adjacent to the INL Site is privately owned and primarily is used for grazing and crop production. In 2017, about 1,005,921 acres of total cropland was available for use, with 825,165 acres harvested within the 5-county area that encompasses INL (USDA 2019a).

Populated areas in proximity to the INL Site are relatively sparse, with the largest population centers of Idaho Falls and Pocatello to the east and south, respectively. Based on U.S. Census Bureau population estimates, total population of the 5-county area where the INL Site is situated is 195,952 with only 2,611 of those residing in Butte County (Census 2019a). The largest population centers within 50 miles of the INL Site include Idaho Falls (61,535), Pocatello (56,266), and Rexburg (28,687) (Census 2019a). Outside of such population centers, the remaining regional population resides in small towns and rural communities. There are no permanent residents on the INL Site.

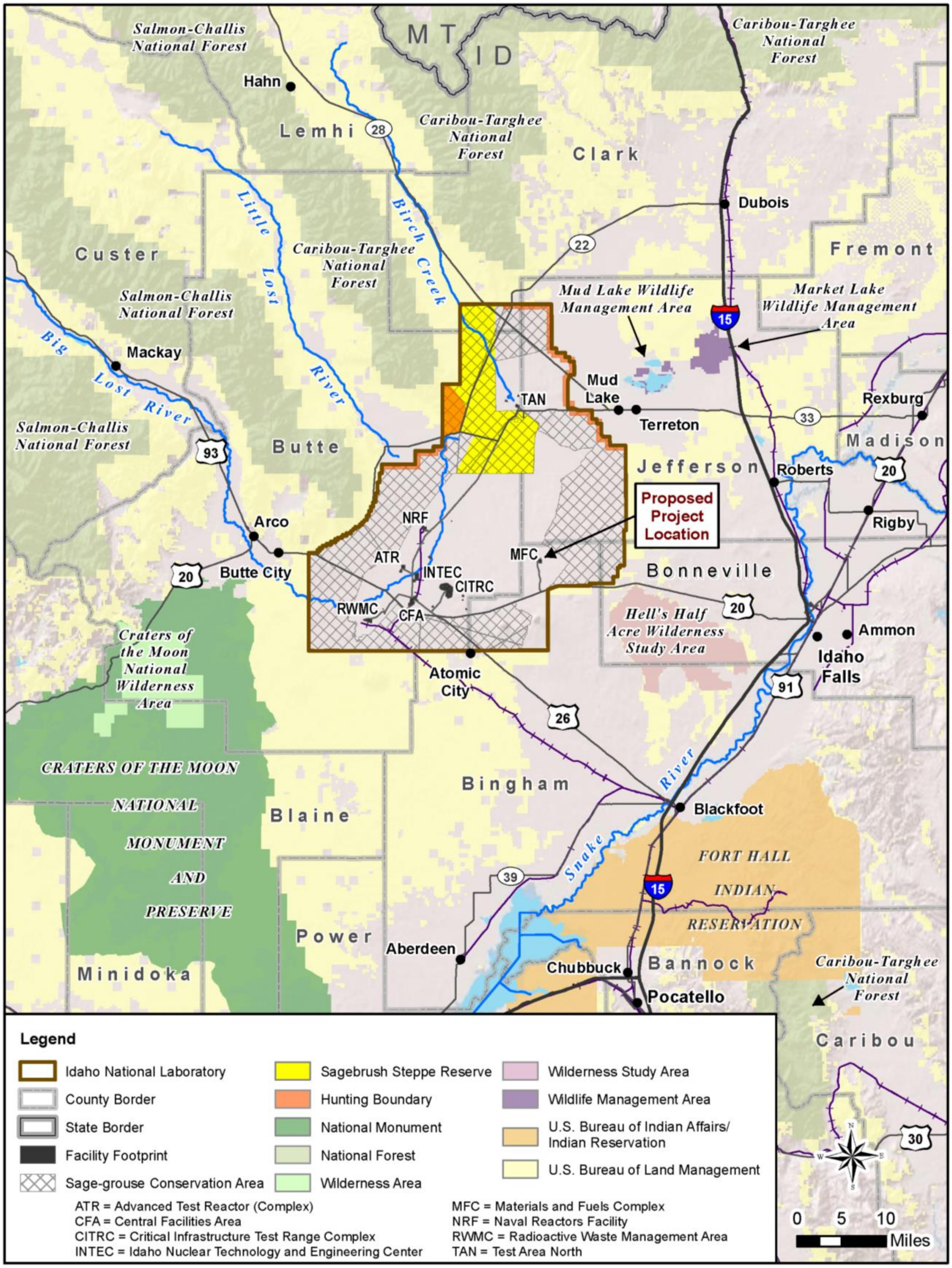

Figure 3–1. Idaho National Laboratory Regional Location and Land Ownership

The Idaho Local Land Use Planning Act of 1975 guided land-use planning in the State of Idaho. Currently, Idaho does not have a statewide land use agency or any State-based funding for cities and counties to carry out their land-use planning work. Therefore, the Idaho legislature requires that each county adopt its own land-use planning and zoning guidelines. At present, most of the counties around the INL Site have implemented guidelines to focus development adjacent to previously developed areas. Because of INL's remote location and existing adjacent land uses (BLM, U.S. Forest Service [USFS], private cultivated and non-cultivated land), areas near the site are not likely to experience residential and commercial development; however, increased recreational and agricultural use can be expected to increase in the surrounding area.

There are several areas adjacent to INL used for recreational purposes, including the Big Southern Butte and Hell's Half Acre Lava Field National Natural Landmark south of the INL Site border, and Mud Lake Wildlife Management Area and Market Lake Wildlife Management Area to the northeast of INL. Other tourist and recreational attractions in the vicinity of INL include Craters of the Moon National Monument and Preserve, Challis National Forest, Targhee National Forest, Beaverhead-Deerlodge National Forest, Camas National Wildlife Refuge, and Black Canyon Wilderness Study Area. Yellowstone National Park and Grand Teton National Park are within a few hours' drive east of the INL Site.

3.1.1.2 Aesthetics at Idaho National Laboratory

Aesthetics includes natural and manmade features that provide a particular landscape its character and aesthetic quality. The ROI for aesthetics are comprised of the INL Site, the ESRP, Fort Hall Reservation, the Bitterroot, Lemhi, and Lost River mountain ranges, the Big Southern Butte, East Butte, Middle Butte, Circular Butte, Antelope Butte, Hell's Half Acre National Natural Landmark, and Hell's Half Acre Wilderness Study Area.

The INL Site is located in a large, relatively undisturbed expanse of sagebrush steppe, but small volcanic buttes dot the natural landscape. Topographic features, such as volcanic cones, domes, and mountain ranges, are visible from most areas on the INL Site. Several mountain ranges (Bitterroot, Lemhi, and Lost River) are visible to the north and west of the INL Site. The Big Southern Butte, East Butte, and Middle Butte are visible from the southern boundary of the INL Site; Circular and Antelope Buttes are visible to the northeast. In general, the viewscape at the INL Site consists of sagebrush-dominated terrain with an understory of grasses. Juniper is common near the buttes and foothills of the Lemhi range; crested wheatgrass is scattered throughout the INL Site.

Features of the natural landscape at the INL Site have a special importance to the Shoshone-Bannock Tribes. Some prominent features of the INL Site landscape are within visual range of the Fort Hall Reservation, about 45 miles to the southeast.

There are eight primary facility areas present on the INL Site, each of which resembles a low-density commercial or industrial complex area. Structures generally range in height from 10 to 100 feet, some with emission stacks that tower up to 250 feet in height. While several facilities on the INL Site are visible from public highways (particularly U.S. Highways 20 and 26, and Idaho State Road 33), most buildings are located more than 0.5 mile from public roads.

Lands within and adjacent to the INL Site follow the BLM Visual Resource Management (VRM) guidelines. While the VRM system is officially applicable only to BLM land, it provides a useful tool for making inventory and managing visual resources on land owned by other agencies. This system relies on two main components: visual resource inventories and visual resource management. Visual resource inventories attempt to establish the visual qualities of an area, assess whether the public has any concerns related to scenic quality for a location, and determine if sensitivity exists at the location for visual intrusions. Sensitivity is evaluated by considering the types of users that would view the location (e.g., recreational users, commuters, or workers), the amount of use, public interest, and adjacent land uses. There are four levels of VRM rating, designated as VRM Classes I to IV, with Class I being the most restrictive and protective of the visual landscape and Class IV being the least restrictive (BLM 1986):

> *Class I* – Preserve the existing character of the landscape. This class provides for natural ecological changes and does not preclude limited management activity. The level of change to the characteristic landscape should be very low and must not attract attention.
>
> *Class II* – Retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.
>
> *Class III* – Partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
>
> *Class IV* – Provide for management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements.

Lands adjacent to the INL Site have been designated visual resource Class II areas; lands within the INL Site have been designated as Class III and Class IV.

In 2017, the International Dark-Sky Association (IDA) designated Craters of the Moon National Monument an International Dark Sky Park (IDA 2019). An International Dark Sky Park is a land area possessing an exceptional or distinguished quality of starry nights and a nocturnal environment specifically protected for its scientific, natural, educational, cultural heritage, and/or public enjoyment. The IDA only designates International Dark Sky Places following a rigorous application process requiring applicants to demonstrate robust community support for dark sky protection and a documentation of designation-specific program requirements. While Craters of the Moon National Monument is host to some of the darkest night skies of any national park unit, light pollution from far-off cities such as Idaho Falls and Twin Falls, Idaho, can influence views of the night sky. The park is considered to be located on the edge of one of the largest remaining pools of natural nighttime darkness in the lower 48 States, which serves as a natural defense against development that could bring significant new sources of artificial light (IDA 2019).

3.1.2 Geology and Soils

The ROI for geology and soils includes the INL Site and MFC. The INL Site is located on a relatively flat area along the northwestern edge of the ESRP Physiographic Province (DOE 2016b). The Snake River Plain (SRP) is about 50 to 62 miles wide and over 348 miles long and extends in a broad arc from the Yellowstone Plateau on the east to the Idaho-Oregon border on the west (INL 2010b). The ESRP extends from the Yellowstone Plateau to Shoshone, Idaho, and represents the track of volcanic activity associated with movement of the North American crustal plate over the Yellowstone hotspot (Hackett et al. 2002:462).

The land surface at the INL Site is gently sloping, with elevations ranging from 4,790 feet in the south to 5,912 feet in the northeast (Mattson et al. 2004). The INL Site is relatively flat but includes volcanic buttes jutting from the desert floor, uneven surfaced basalt flows, and flow vents and fissures. The INL Site is bordered on the north and west by mountain ranges of the geologic Basin and Range Province and on the south by volcanic buttes and open plain (INL 2010c).

3.1.2.1 Geology

Regional Geology

The surface of the ESRP is covered by basaltic lava, aged between 4 million and 2,100 years ago (DOE 2005b), and overlying older tertiary rhyolites. Most of the visible ESRP was shaped during the last 1.2 million years by volcanic eruptions that resulted in gentle sloping basaltic shield volcanoes and 3, steep-sided silicic domes (NRC 2004). Basaltic volcanic centers have been grouped into four volcanic rift zones, each with a northwestern trend that cut across the ESRP. Three of these volcanic rift zones cut across the INL Site. The volcanic rift zone orientations appear to be the result of basalt dikes, which primarily intruded perpendicular to the northeast-southwest direction of extension associated with the physiographic region of the Basin and Range province. The Axial Volcanic Zone extends along the axis of the ESRP and has a higher concentration of basaltic volcanic vents (DOE 2005b; Payne 2006).

The INL Site is underlain by about 0.6 to 1.2 miles of Quaternary age basaltic lava flows interbedded with poorly consolidated sedimentary materials. Interbedded sediments consist of materials deposited by streams and the Big Lost River (silts, sands, and gravels), historic lakes (clays, silts, and sands), and wind (silts) that accumulated between volcanic events. The interbedded basalt flow and sediment sequences are collectively known as the Snake River Group (DOE 2005b). The Snake River Group is composed of sedimentary deposits of thicknesses up to 197 feet interbedded with basalts that are 16 to 82 feet in thickness (NRC 2011).

The Quaternary Yellowstone Group and Plateau Rhyolite, which is composed of rhyolite ash-flow tuff, ash and pumice beds, is found in some areas of the ESRP. Below the Snake River Group, in the northeast and southeast area of the ESRP, lies the upper part of the Idaho Group, which is in the Tertiary geologic period and consists of basalts and poorly consolidated sediment beds. The lower part of the Idaho Group (Tertiary) is composed of basalt exhibiting columnar jointing and is ubiquitous throughout the entire Snake River Plain. The Tertiary Idavada Volcanics are found in the northeast and southwest areas of the ESRP (NRC 2011).

The most recent basalt flow at the INL Site is the Cerro Grande flow, which occurred about 13,000 years ago and originated from a vent south of the INL Site (Kuntz et al. 1994). In contrast, the Hell’s Half-Acre flow immediately southeast of the INL Site is only about 5,200 years old and flows at the nearby Craters of the Moon National Monument and Preserve are as recent as 2,100 years old. The much older basalt lava flows characteristic of the southern portion of the INL Site are between 200,000 and 730,000 years old (Hackett and Smith 1992). Basalt on the northern portion of the INL Site is at least a million years old (INL 2015c).

Overlying the basalts are thin, discontinuous deposits of wind-blown sand (loess composed of calcareous silt), floodplain sediments, and riverbed and lake sediments (clays, silts, sands, and gravels) (NRC 2004). These surficial sediments range in thickness from 0 to over 310 feet (Anderson et al. 1996; DOE 2005b).

The subsurface geology beneath MFC is somewhat different from the rest of the INL Site because it is closer to basaltic volcanic vents and is isolated from receiving sediment deposits from the Big Lost River. Because of this difference, MFC lacks thick sedimentary interbeds. The sedimentary interbeds are discontinuous stringers, deposited in low areas on basalt surfaces from wind and localized drainages. They are generally composed of calcareous silt, sand, or cinders. Rubble layers between individual basalt flows are composed of sand and gravel to boulder-sized material. The interbeds range in thickness from less than 1 inch to 15 feet. The thickness and texture of individual basalt lava flows are quite variable and range in thickness from 10 to 100 feet. The upper surfaces of the basalt flows are often irregular and contain many fractures and joints that may be filled with sediment. The outer portions of a flow (both top and bottom) tend to be highly vesicular. The middle portions of the flow typically have few vesicles and are dominated by vertical fractures formed during cooling (INL 2010b).

3.1.2.2 Soils

Four basic soilscapes exist at the INL Site: river-transported sediments deposited on alluvial plains, fine-grained sediments deposited into lake or playa basins, colluvial sediments originating from bordering mountains, and windblown sediments (silt and sand) over lava flows. The alluvial deposits follow the courses of the modern Big Lost River and Birch Creek. The playa soils are found in the north-central part of the site; the colluvial sediments, along the western edge of the INL Site; and the windblown sediments, throughout the rest of the site (DOE 2002c).

Although a comprehensive survey of the soils at the INL Site has not been conducted, information from county surveys and other sources has been compiled (Olson et al. 1995). This compendium indicates that most soils at the INL Site are Aridisols, with Calciorthids being the most common great group; Entisols, namely Torriorthents and Torrifluvents; and Mollisols, including Calcixerolls and Haploxerolls (INL 2020f). No soils have been designated as prime farmland within the INL Site boundaries (DOE 2005b).

Soils in the MFC area generally consist of light, well-drained, brown-gray, silty loams to brown, extremely stony loams. Soils are highly disturbed within developed areas of MFC (DOE 2002c). The thickness of surficial soils and sediment near MFC range from 0.5 to 26 feet, with two locations in MFC that have deposits of 31.5 and 46 feet (INL 2006:56). The two primary types of soils at MFC are classified as 425-Bondfarm-Rock outcrop-Grassy Butte complex and 432-Maim-Bondfarm-Matheson complex (DOE-ID 1998). The permeability of these soils is moderately rapid to rapid. The hazard of erosion is slight or moderate (INL 2010b).

Radiological Monitoring

To determine the need for soil sampling, potential releases from INL Site facilities with significant air emissions in 2013 were modeled using CALPUFF, a non-steady state air dispersion model (Rood and Sondrup 2014) and estimated particulate deposition rates (INL 2016e). The results showed that for the onsite facilities only the Radioactive Waste Management Complex had the potential for soil accumulations to be detectable in less than a decade. Results for the other facilities, including MFC showed the potential for surface accumulations to be detectable only after hundreds to thousands of years (INL 2016e).

The INL contractor currently completes soil sampling on a 5-year rotation at the INL Site to evaluate long-term accumulation trends and to estimate environmental radionuclide inventories. Data from previous years of soil sampling and analysis on the INL Site show slowly declining concentrations of short-lived, manmade radionuclides (e.g., cesium-137), with no evidence of detectable concentrations depositing onto surface soil from ongoing INL releases. The Environmental Surveillance, Education, and Research (ESER) program contractor collects soil samples at offsite locations first established by Radiological and Environmental Sciences Laboratory (RESL) every 2 years (in even-numbered years). Results to date indicate that the source of detected radionuclides is not from INL operations and is most likely derived from worldwide fallout activity (DOE-ID 2014).

3.1.2.3 Geologic and Soil Resources

Mineral resources that are inside the INL Site boundary are limited to several quarries, or "borrow sources," which supply sand, gravel, pumice, silt, clay, and aggregate for road construction and maintenance; new facility construction and maintenance; waste burial activities; and landscaping on site. Onsite topsoil is a very limited commodity. The INL Site contains six active gravel/borrow pits that support onsite maintenance operations, new construction, and environmental restoration and waste management activities (DOE-ID 2019b). The Rye Grass Flats Borrow Source, the nearest borrow source to MFC, is about 11 miles to the southwest.

The geologic history of the ESRP makes the potential for petroleum production at the INL Site very low (NRC 2004). The potential for geothermal energy development exists at the INL Site; however, a study conducted in 1979 found no economic geothermal resources (Mitchell et al. 1980). Outside of the INL Site and within about 100 miles of the boundary, mineral resources include sand, gravel, pumice, phosphate, and base and precious metals (NRC 2004).

3.1.2.4 Geologic Hazards

Seismic Hazards

The seismic characteristics of the ESRP and the adjacent Basin and Range Province are different. The ESRP has historically experienced infrequent, small-magnitude earthquakes (DOE 2002a). In contrast, the majority of contemporary seismicity is associated with the major episode of Basin and Range Province faulting that began about 16 million years ago and continues today (Rodgers et al. 2002).

Most earthquakes with the potential to affect the INL Site occur along normal faults (type of fault associated with Basin and Range tectonics) in the Basin and Range Province. The faults closest to the INL Site are the Quaternary Lost River, Lemhi, and Beaverhead faults. They are normal faults located along the base of the mountains to the north and west of the INL Site (INL 2010a). The nearest capable faults to MFC are the southernmost segments along the Lost River and Lemhi faults. Their southernmost terminations are near the western and northwestern INL Site boundary about 20 miles from MFC. A capable fault is one that has had movement at or near the surface at least once within the past 35,000 years or recurrent movement within the past 500,000 years (10 CFR Part 100). **Figure 3–2** shows the locations of faults and volcanic rift zones near the INL Site (DOE 2016b: 3-11).

The mountains and valleys of southeastern Idaho lie within the Intermountain Seismic Belt and tectonic belts II and III of the Yellowstone Tectonic Parabola (INL 2020c). As shown in **Figure 3–3**, the compilation of seismicity from 1850 to 2014 from the INL seismic network and surrounding networks documents that earthquakes of magnitude 2.0 and greater occurred outside the ESRP with the exception of the 1905 Shoshone, Idaho earthquake.[1] During this time period, there were 23 documented earthquakes of magnitude 5.5 and greater within the parabolic zone of seismicity and nearby regions (Payne and Bockholt 2017). The closest large event (Borah Peak earthquake) occurred on October 28, 1983, with an epicenter about 68 miles northwest of MFC and an estimated moment magnitude of 6.9 (USGS 2019c).

The historical earthquake record shows the ESRP has a remarkably low rate of seismicity compared to the surrounding Basin and Range Province. The basalt layers interbedded with ancient stream and lakebed sediments under the INL Site may dampen or attenuate ground motions generated by earthquakes (Payne 2006). Due to the large distances from the INL Site, the 1959 Hebgen Lake earthquake (moment magnitude 7.3), 1983 Borah Peak earthquake (moment magnitude 6.9), and recent March 2020 Central Idaho earthquake (moment magnitude 6.5) were felt at MFC but did not cause any damage (BMPC 2011; DNFSB 2020). Earthquake-produced ground motion is expressed in units of percent *g* (acceleration relative to that of the Earth's gravity). The Borah Peak earthquake produced horizontal peak accelerations ranging from 0.022 *g* to 0.078 *g* across the INL Site (INEEL 2005; Jackson and Boatwright 1985). At MFC, recorded peak accelerations in the basement of two facilities ranged from 0.032 *g* to 0.048 *g* (Jackson and Boatwright 1985).

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[1] With no instrumental recordings, the epicenter for the 1905 magnitude 5.7 earthquake was placed in the ESRP at Shoshone, Idaho; however, damage reports indicate the earthquake epicenter was south of the ESRP.

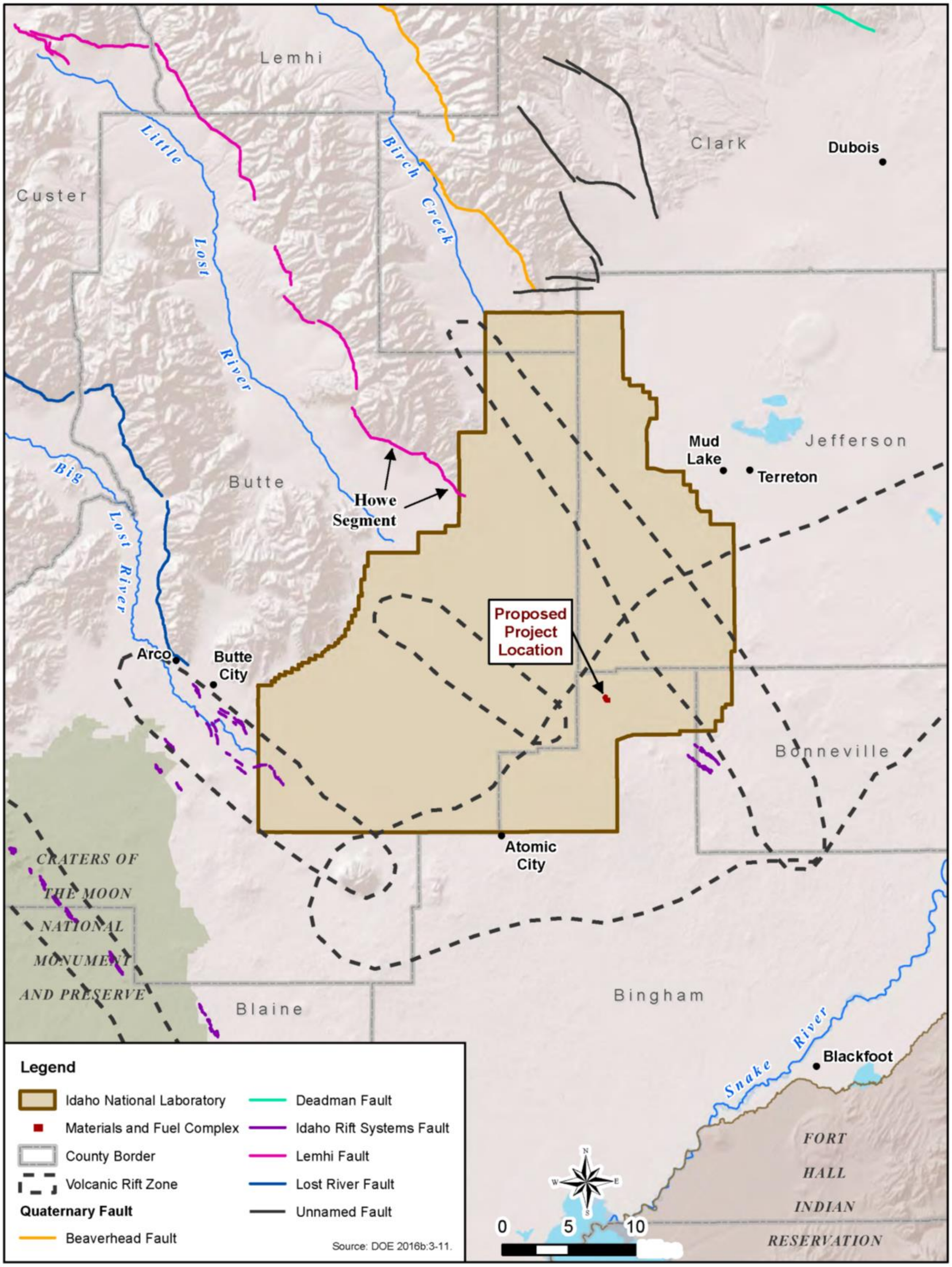
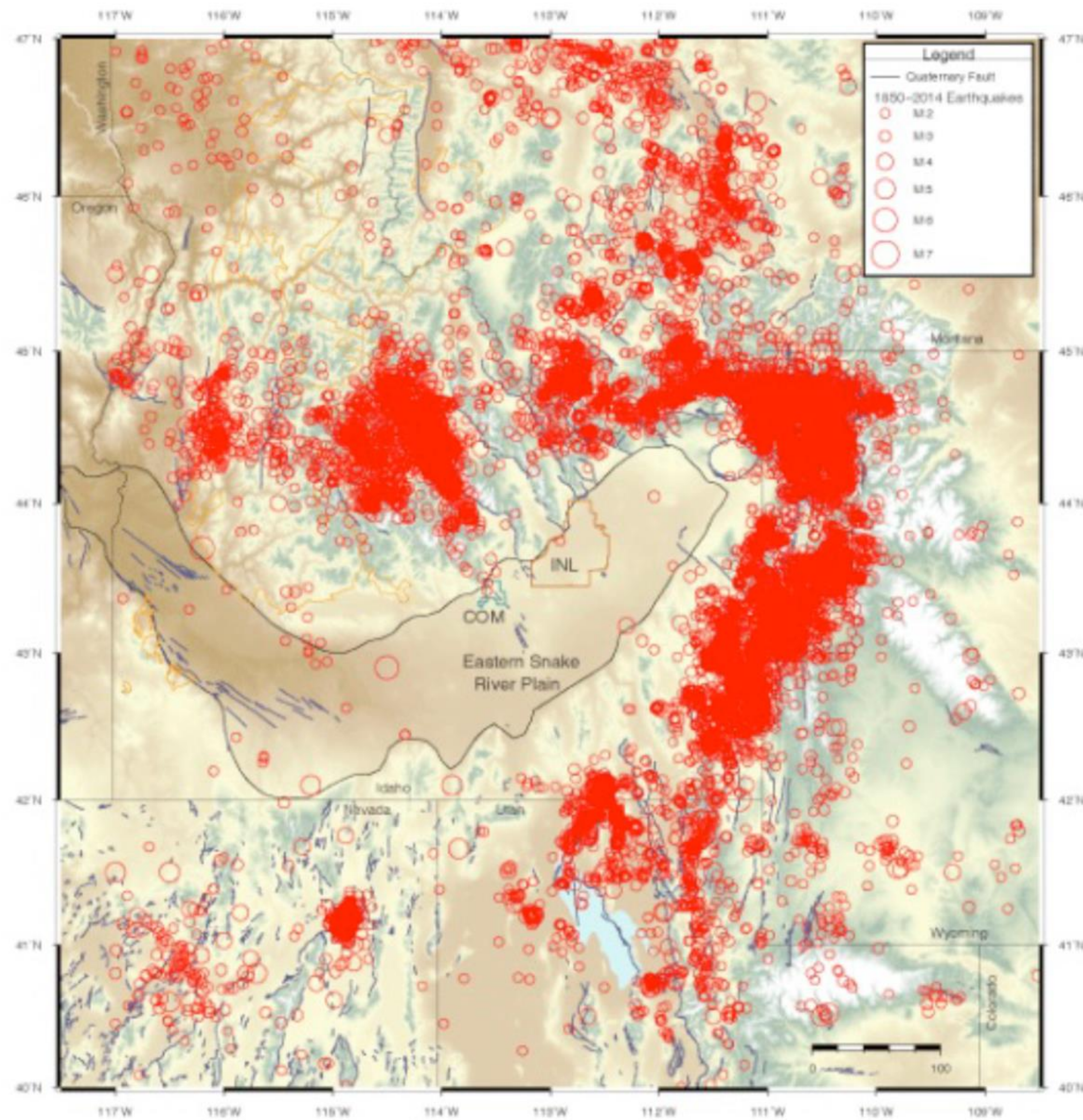


Figure 3–2. Locations of the Faults and Volcanic Zones



Source: Payne and Bockholt 2017.

Figure 3–3. Map Showing Epicenters of More than 20,000 Magnitudes 2.0 or Greater Earthquakes from 1850 to 2014 Form a Parabolic Distribution around the Eastern Snake River Plain

The INL Seismic Monitoring Program has 35 permanent seismic stations to determine the time, location, and size of earthquakes occurring near the INL Site. The program also operates 32 sites with accelerometers near and within INL facilities and at seismic stations to record strong ground motions from local moderate or major earthquakes. Seismic monitoring provides data for validating current ground motion models, and serves as an early detection system for future volcanism, because low-magnitude earthquake swarms typically accompany the upward movement of magma. Two permanent seismic stations with accelerometers are located at MFC (INL 2020c).

Seismic history and geologic conditions indicate that earthquakes with a magnitude of more than 5.5 and the associated strong ground shaking and surface rupture are more likely to occur in the Basin and Range

Province outside the ESRP. However, moderate to strong ground shaking from future large magnitude earthquakes in the Basin and Range Province could be felt at INL (DOE 2016a).

Volcanic Hazards

The potential for future volcanism and associated volcanic hazards at the INL Site are a consequence of the volcanic history of the ESRP. Eruptions of silica- and iron-rich (mafic) magmas have occurred in the ESRP as a result of the Yellowstone hotspot in conjunction with crustal thinning associated with Basin and Range Province extension of the crust. Explosive silica-rich, caldera-forming eruptions began about 16 million years ago, in association with the hotspot's initial position centered on the common borders of Idaho, Oregon, and Nevada. The hotspot is now located beneath the Yellowstone Plateau, which has had three major caldera eruptions over the last 2 million years. Following cessation of hotspot-related caldera-forming eruptions, mild effusive eruptions of predominantly iron-rich magmas from relatively recent basaltic volcanoes have covered the ESRP. Basaltic volcanic activity on the ESRP dates from 4 million years ago to as recently as 2,100 years ago (DOE 2011a). Recent eruptions produced basalt lava flows from 2,100 to 15,000 years ago at Craters of the Moon National Monument and Preserve (INL 2010a) and at other locations south of the INL Site.

Volcanic hazards at the INL Site have been evaluated for possible hazard phenomena associated with the different types of silica- and iron-rich eruptions. Hazards associated with explosive, silica-rich caldera-forming eruptions, similar to those that have occurred at the Yellowstone Plateau, are considered to be negligible for the INL Site since the locus of this activity is now in the Yellowstone Plateau. Volcanic ash-falls could occur at the INL Site from eruptions as far away as the Cascade Mountains. A 0.001 annual probability was calculated for a 0.4-inch thick ash deposit forming at the INL Site from a Cascade volcano eruption (NRC 2004). Rhyolite dome volcanoes, such as Big Southern Butte or East Butte, also have the potential to produce ash-fall deposits. The estimated recurrence of silicic volcanism within the volcanic axial zone is 4.5×10^{-6} per year (NRC 2011:3-42). In addition, eruptions from the Yellowstone Volcanic Zone could produce appreciable ash-fall deposits at the INL Site, in the unlikely event that regional winds were directed to the southwest during a potential small-volume eruption (INL 2010a) or the size of the eruption overwhelmed prevailing winds (Mastin et al. 2014).

Basaltic volcanism has occurred as recently as 2,100 years ago in the Great Rift, southwest of the INL Site. Other basaltic lava flows near the southern INL Site boundary erupted about 5,000 and 13,000 years ago (INL 2010a). Based on the probability analysis of the volcanic history in the Axial Volcanic Zone and volcanic rift zones, the conditional probabilities that MFC and the south-eastern INL Site would be affected by basaltic volcanism would be once in 16,000 and 40,000 years or longer, respectively (Hackett et al. 2002:Figure 4). The estimated probability of volcanic impact is less than once every million years or longer for the northern INL Site because past volcanism was older and less frequent (DOE 1995).

A recent study (Gallant et al. 2018) shows a 30 percent probability of partial inundation of the INL Site given an eruption on ESRP, with an annual inundation probability of 8.4×10^{-5} to 1.8×10^{-4}. An annual probability of 6.2×10^{-5} to 1.2×10^{-4} is estimated for the opening of a new eruptive center within the INL Site boundaries.

Slope Stability, Subsidence, and Liquefaction

No natural factors at MFC that would produce slope instability, subsidence, or liquefaction have been reported. As described in Section 3.1.2.2, slopes are very gradual and soils are generally thin.

3.1.3 Water Resources

The ROI for water resources includes surface waters of the INL Site where stormwater, industrial wastewater, or sanitary wastewater are discharged (e.g., Industrial Waste Pond and active sewage lagoons), and the Snake River Plain Aquifer (SRPA) beneath and downstream of the INL Site.

This section describes the INL Site's surface and groundwater resources in general and provides specific information regarding current levels of nonradiological and radiological contaminant concentrations in surface water effluent and groundwater due to operations at MFC. Wastewater, stormwater, and flooding potential are discussed.

The U.S. Environmental Protection Agency (EPA) has established, under authority of the Safe Drinking Water Act (SDWA), National Primary Drinking Water Regulations known as primary standards. Primary standards limit the levels of contaminants in drinking water. Maximum Contaminant Levels (MCLs), as contained in 40 CFR Part 141, are the highest levels of contaminants allowed in drinking water and are legally enforceable. National Secondary Drinking Water Regulations, or secondary standards, are non-enforceable guidelines regulating contaminants that may cause cosmetic or aesthetic effects in drinking water (40 CFR Part 143). Idaho Administrative Procedures Act (IDAPA) 58.01.08 establishes State drinking water standards that are enforced by the Idaho Department of Environmental Quality (IDEQ).

The State of Idaho has established primary and secondary constituent standards for groundwater per IDAPA 58.01.11. These standards essentially mirror the Federal primary and secondary standards established by EPA for drinking water and apply to any activity with the potential to substantially degrade groundwater (aquifer) quality. Unlike the Federal secondary standards, State secondary constituent standards may be enforced.

3.1.3.1 Surface Water

3.1.3.1.1 Natural Water Features

The INL Site is in the Mud Lake – Lost River Drainage Basin. This is a closed basin that includes the Big Lost River, Little Lost River, and Birch Creek. IDEQ regulates protection of bodies of water in Idaho for existing or designated uses. Big Lost River, Little Lost River, and Birch Creek have been designated for cold-water aquatic communities, salmonid spawning, and primary recreation (IDAPA 58.01.02). The Big Lost River channel and sinks and lowermost Birch Creek are classified for domestic water supply and as special resource waters. In general, Big Lost River, Little Lost River, and Birch Creek are similar with respect to water quality. Chemical compositions reflect the carbonate mineral compositions of the mountain ranges drained by the streams and the quality of irrigation water return flows. None of the rivers or streams on or near the INL Site has been classified as wild and scenic per the Wild and Scenic Rivers Act, 16 *United States Code* (U.S.C.) Section 1274. Surface waters are not used for drinking water at the INL Site, nor are effluents discharged directly to them; therefore, no surface water rights are issued to INL.

The Big Lost River, Little Lost River, and Birch Creek are intermittent on the INL Site. During the summer months, most flow from these streams is diverted for irrigation before it reaches the INL Site's boundaries. During fall and winter, seasonal changes in climate (e.g., precipitation and temperature) reduce stream flow enough that streams do not generally reach the INL Site. Big Lost River, Little Lost River, and Birch Creek flow year-round off the INL Site and drain the mountain areas to the north and west of the site. Flow that reaches the INL Site seeps into the ground surface along the length of the streambeds and in the Big Lost River spreading areas and sinks. The spreading areas are natural, low elevation, closed basins associated with the INL Site's diversion dam. The sinks are the lowest elevation in the closed drainage basin where the Big Lost River terminates in a series of playas where seasonal wetlands have formed.

Surface water on the INL Site that does not infiltrate the ground surface is lost from the system through evapotranspiration processes. No surface water flows off the INL Site.

The Big Lost River flows southeast from Mackay Dam, past Arco, and onto the Snake River Plain. The INL Site's diversion dam, near the southwestern boundary, prevents flooding of downstream areas during periods of heavy runoff by diverting water to a series of natural depressions or spreading areas. During periods of high flow or low irrigation demand, the Big Lost River continues to the northeast past the diversion dam, passes between the Idaho Nuclear Technology and Engineering Center (INTEC) and the Advanced Test Reactor (ATR) Complex, and ends in a series of playas, where the water infiltrates the ground surface.

National Wetland Inventory maps prepared by the USFWS indicate wetland areas are associated with the Big Lost River, the Big Lost River spreading areas, and the Big Lost River Sinks. These wetlands are classified as riverine/intermittent, indicating a defined stream channel with flowing water during only part of the year. The only U.S. Army Corps of Engineers jurisdictional wetlands are the Big Lost River Sinks.

Materials and Fuels Complex

MFC's watershed contains natural drainage channels, which can concentrate overland water flow during periods of high precipitation or heavy spring runoff. However, the watershed contains no perennial, natural surface water features. The Transient Reactor Test (TREAT) Facility is located in an adjacent local topographically closed watershed, which also contains no identifiable perennial, natural surface water features.

The closest natural surface water feature to MFC is an unnamed intermittent stream located about 7.8 miles to the south. This about 12-mile-long waterway extends west before sinking into the ground about 1.6 miles northeast of the intersection of U.S. Routes 20 and 26. At its most proximate point, the Big Lost River is located 16 miles west of MFC.

3.1.3.1.2 Surface Water Quality

Surface water locations outside of the INL Site's boundaries are sampled quarterly. When the Big Lost River is flowing, locations along this surface water within the INL Site are also sampled for gross alpha activity, gross beta activity, tritium, and cesium-137. The Big Lost River was flowing enough to collect samples in April and June of 2018. Samples were collected at five locations, plus one control sample from Birch Creek. During the June 2018 sampling event, gross alpha activity was detected in four of these samples (the highest concentration was 3.6 picocuries per liter (pCi/L) found in the samples collected from INTEC and the Experimental Field Station in June). Gross beta activity was detected in all five (the highest concentration was 9.1 pCi/L found at INTEC and the Experimental Field Station). Tritium was also detected in five samples, with the highest concentration being 119 pCi/L at the rest area (ESER 2019b). For reference, the EPA MCL for gross alpha is 15 pCi/L, the EPA screening level for gross beta activity is 50 pCi/L, and the EPA MCL for tritium is 20,000 pCi/L. Thus, all concentrations detected in June 2018 fell well below regulatory levels. All concentrations detected this quarter were similar to those found in atmospheric moisture and precipitation samples and were consistent with the findings from sampling events occurring in prior years. No manmade, gamma-emitting radionuclides (e.g., cesium-137) were found during this sampling effort (ESER 2019b).

3.1.3.1.3 Wastewater

Other surface water bodies on the INL Site include manmade percolation and evaporation ponds, sewage lagoons, and industrial waste ditches. These ponds, lagoons, and ditches are used for wastewater management at the INL Site and include the INTEC New Percolation Ponds, Test Area North/Technical Support Facility Sewage Treatment Plant Disposal Pond, ATR Complex Code Waste Pond, MFC Industrial

Waste Pond, MFC Sanitary Lagoons, and the Naval Reactors Facility Industrial Waste Ditch. The Naval Reactors Facility also has sewage lagoons.

INL Wastewater Discharge

Discharge of industrial wastewater to the land surface at the INL Site is regulated by IDAPA 58.01.16 and IDAPA 58.01.17 and may require an industrial reuse permit (referred to in general terms as a wastewater reuse permit throughout the rest of this section). Wastewater reuse permits specify annual discharge volumes, application rates, and effluent primary and secondary constituent standards. Monitoring of nonradioactive parameters is required to demonstrate compliance with the permits. Annual reports are prepared and submitted to IDEQ, as required, and IDEQ inspects facilities for permit compliance on a regular basis. Some facilities also monitor specified radiological parameters for surveillance purposes, even though this may not be required by the different wastewater reuse permits. Compliance with Idaho groundwater quality primary constituent standards and secondary constituent standards in specified groundwater monitoring wells is generally required.

Currently, permitted INL facilities include the ATR Complex Cold Waste Pond, INTEC New Percolation Ponds, and MFC Industrial Waste Pond. These facilities were sampled for parameters required by facility-specific permits, and no limits were exceeded in 2017 (INL 2018a).

Materials and Fuels Complex

Wastewater features within the MFC boundary include an Industrial Waste Pond and new evaporative sewage lagoons (constructed in 2012). The Industrial Waste Pond has a design capacity of 285 million gallons and receives wastewater from the industrial waste pipeline and stormwater runoff (INL 2018a). The Industrial Waste Pond appears in the USFWS National Wetland Inventory and is classified as PUBHx. PUBHx means the pond is a palustrine, permanently flooded wetland with an unconsolidated bottom that was excavated by humans (USFWS 2019b).

Effluent carried through the industrial waste pipeline includes non-contact cooling water, boiler blowdown, cooling tower blowdown and drain, air wash flows, steam condensate, intermittent reverse osmosis effluent, and laboratory sink discharge from the MFC-768 Power Plant. Effluent discharged to the Industrial Waste Pond from the industrial waste pipeline is sampled monthly in accordance with Reuse Permit I-160-02, issued January 26, 2017 and modified March 7, 2017. In 2017, gross alpha, gross beta, potassium-40, and uranium isotopes were detected at levels below applicable derived concentration standards (INL 2018a). **Figure 3–4** illustrates wastewater and groundwater sampling locations at MFC.

3.1.3.1.4 Stormwater

Stormwater from onsite INL facilities, including MFC, is generally discharged to industrial waste ditches, sewage lagoons, or infiltration ponds. Stormwater may result in minor overland flow that infiltrates into the ground. Stormwater that is discharged to sewage lagoons is contained, and stormwater discharged to infiltration ponds or trenches evaporates or infiltrates the ground surface. Because stormwater from INL facilities is not discharged to regulated waters (i.e., the Big Lost River), the National Pollutant Discharge Elimination System (NPDES) permit provisions for discharges into regulated surface waters do not apply to MFC operations.

For construction stormwater discharges, INL facilities maintain compliance with INL's NPDES General Permit for Discharges from Construction Activities, updated June 2019, initially issued by EPA in June 1993. INL contractors obtain coverage under the general permit and develop stormwater pollution prevention plans for individual construction projects if it is determined there is reasonable potential to discharge pollutants to regulated surface waters. The general permit and plan provide best management practices to prevent pollution of stormwater from construction activities at the INL Site.

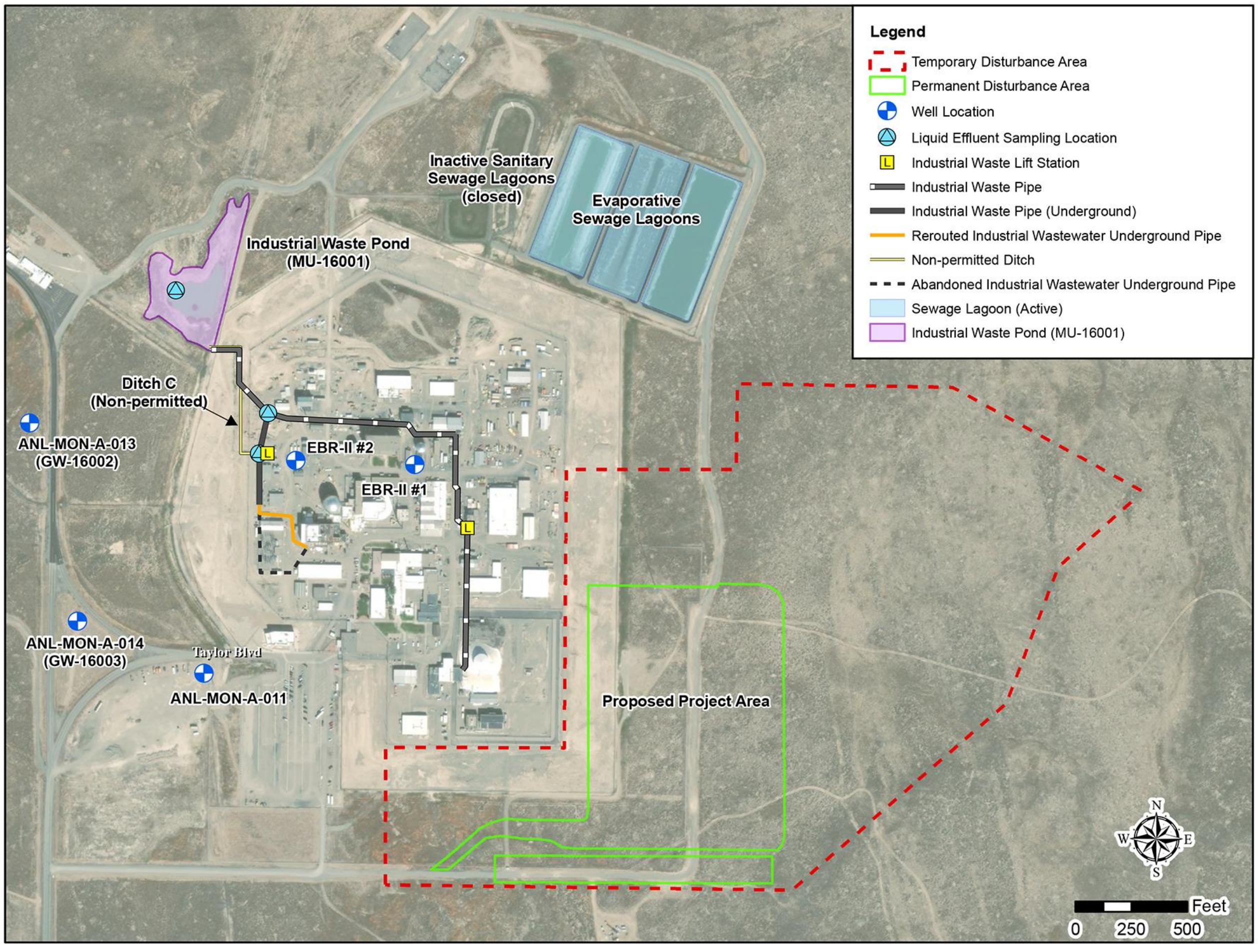


Figure 3–4. Wastewater and Groundwater Sampling Locations at the Materials and Fuels Complex

3.1.3.1.5 Floodplains

Flood frequency is typically characterized by the recurrence interval of a flood. The recurrence interval is the average period of time that elapses between floods of a given size. Larger floods are less frequent and, therefore, have a greater recurrence interval. Recurrence intervals are calculated based on historical measurements of flow and on geologic evidence of flooding. The 100-year flood does not necessarily occur once every 100 years, but rather has a 1 in 100 (1 percent) probability of occurring in any given year. The 500-year flood may occur more or less than once in a 500-year period but has only a 1 in 500 (0.2 percent) probability of occurring in any given year. A probable maximum flood is a hypothetical flow scenario that is used to place an upper bound on the impacts of flooding and is usually several times larger than the maximum-recorded flood. Probable maximum flood is not assigned a probability, but it is intended to represent the combination of events (snowmelt, precipitation, and dam failure) that could lead to maximum streamflow.

The INL Site's diversion dam, constructed in 1958 and enlarged in 1984, was designed to secure that portion of the INL Site located on the Big Lost River floodplain from the 300-year flood of the Big Lost River by directing flow through a diversion channel into four spreading areas. The estimated flood hazard area for a probable maximum flood due to a failure of the Mackay Dam includes the west-central portion of the INL Site along the Big Lost River drainage. Because the ground surface at the INL Site is relatively flat, floodwaters outside the banks of the Big Lost River would spread over a large area and pond in the lower lying areas. Although predicted flood velocities would be relatively slow with shallow water depths, some facilities could be impacted. However, MFC is not located within the probable maximum flood hazard area.

A flood control system was constructed for MFC around 1963. This system, which has been improved over time, now consists of drainage ditches, culverts, an interceptor canal, a diversion dam, and the Industrial Waste Pond. The flood control system is intended to "control and collect water from intermittent surface water runoff events" (Sehlke and Wichlacz 2010). The interceptor canal is located along the western side of MFC and transports water into the Industrial Waste Pond. MFC's diversion dam was constructed in 1968 in response to a flood event and is located 0.5 mile south of MFC. During a flood, the dam's gate can be closed and water diverted into a drainage channel toward the interceptor canal and the Industrial Waste Pond (Sehlke and Wichlacz 2010).

According to the Federal Emergency Management Agency (FEMA), MFC is located within an area designated as Zone C, or an area of minimal flooding. While the only potential source of this minimal flooding is anticipated to be from intermittent overland flow, flood events have occurred at MFC in the past, including 1963, 1969, and 1995. All three of these past flood events involved precipitation or snowmelt over frozen ground (Sehlke and Wichlacz 2010).

Figure 3–5 illustrates flood hazard areas, wetlands, and other surface water features near the INL Site.

3.1.3.2 Groundwater

3.1.3.2.1 Local Hydrology

Snake River Plain Aquifer

Groundwater in the ESRP is contained primarily in one major unit known as the SRPA. The SRPA underlies about 9,600 square miles in southeastern Idaho, including the INL Site. Aquifer boundaries are formed by contact of the aquifer with less-permeable rocks at the margins of the ESRP. These boundaries correspond to the mountains on the west and north and the Snake River on the east.

The SRPA is the major source of drinking water and crop irrigation for southeastern Idaho and has been designated a Sole Source Aquifer by EPA (EPA 2019a). Water storage in the uppermost 500 feet of the aquifer is estimated to equal that of Lake Erie, or about 200 to 300 million acre-feet (De Grey and Link 2020; Idaho Conservation League 2019). The aquifer is composed of numerous relatively thin basalt flows with interbedded sediments extending to depths of more than 5,000 feet. The interbeds accumulated over time, as some basalt flows were exposed at the surface long enough to collect sediment. The fractured basalt allows for the flow of groundwater (De Grey and Link 2020; Idaho Conservation League 2019).

Transmissivity is a measure of the rate at which water is transmitted through a unit width of aquifer to hydraulically downgradient areas and to pumping wells. Transmissivity in the SRPA ranges from about 1.1 to 760,000 square feet per day and averages about 93,000 square feet per day. Groundwater flow rates in the aquifer have been reported to range from about 2 to 20 feet per day (INL 2011a). Regionally, water in the aquifer moves horizontally, mainly through fractures in the basalts and basalt interflow zones. Interflow zones are comprised of highly permeable rubble zones between basalt flows. Groundwater flow in the SRPA is primarily toward the southwest.

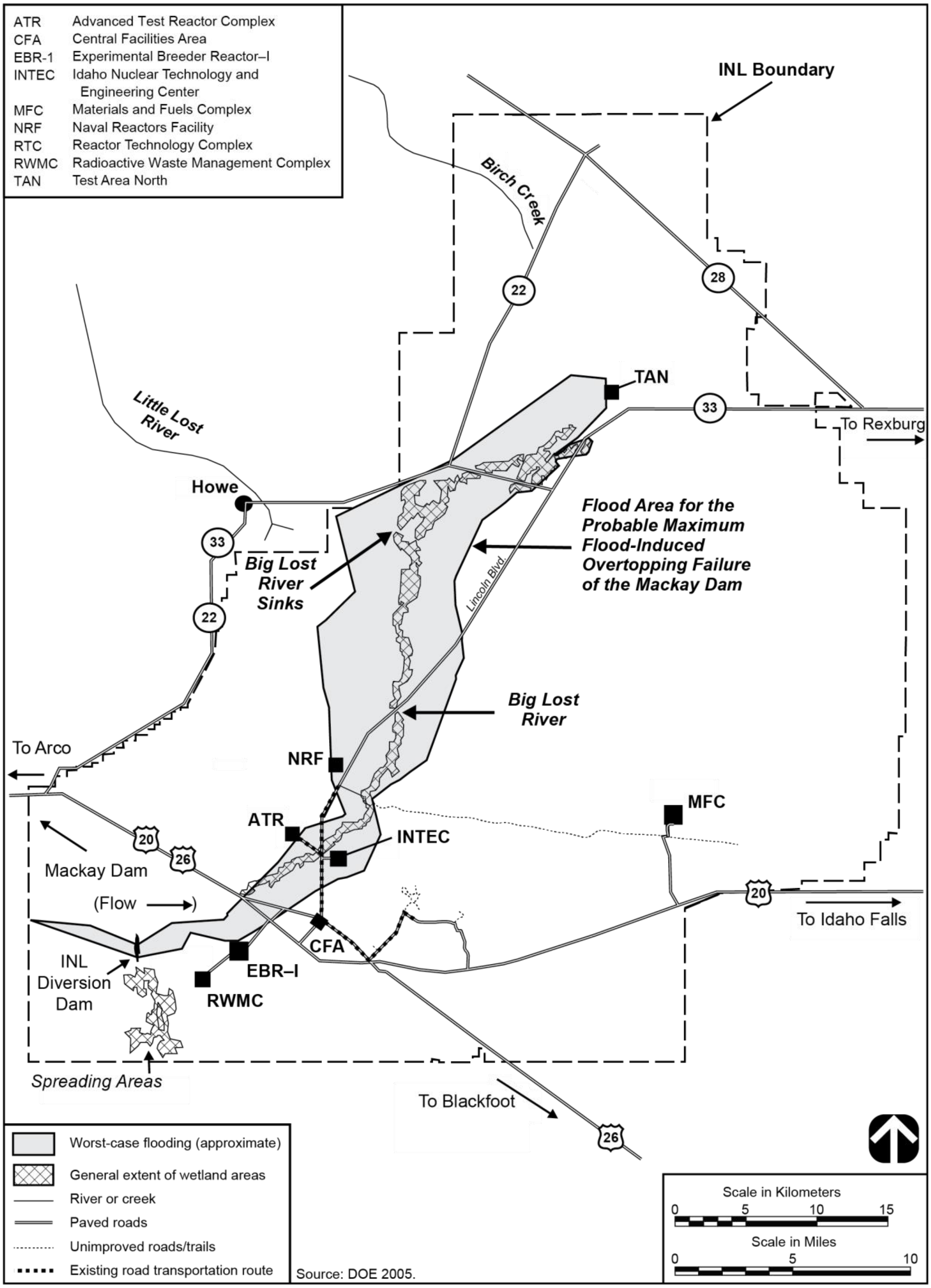


Figure 3–5. Surface Water Features, Wetlands, and Flood Hazard Areas at the Idaho National Laboratory Site

The Big Lost River, Little Lost River, and Birch Creek terminate at sinks on or near the INL Site and recharge the aquifer (when flow is present). Recharge occurs when water infiltrates through the surface of the ESRP from flow in the channel of the Big Lost River, the sinks, Little Lost River, Birch Creek, and Mud Lake. Additionally, recharge may occur from melting of local snowpacks, during years in which snowfall accumulates on the ESRP, and from local agricultural irrigation activities. Valley underflow from the mountains to the north and northeast of the ESRP has been cited as a source of recharge. Water is discharged from the SRPA through large springs to the Snake River at locations near American Falls, Idaho and Hagerman, Idaho. The aquifer discharges about 311 billion cubic feet of water annually to springs and rivers.

The USGS estimates that the thickness of the active portion of the SRPA at the INL Site ranges from 250 to 820 feet. Depth to the water table ranges from about 200 feet below land surface in the northern part of the INL Site to about 1,000 feet in the southern part. At MFC, the distance to the water table was measured at three locations in September 2016 and ranged between 649 to 662 feet below land surface (INL 2017a). From these findings, the direction of groundwater flow was estimated to be from the northeast to the southwest.

3.1.3.2.2 Subsurface Water Quality

Groundwater Monitoring Network

The USGS INL Project Office and INL contractors perform groundwater monitoring, analyses, and studies of the SRPA under and adjacent to the INL Site. Groundwater monitoring is required by a variety of permits and by Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Records of Decision (RODs) related to remedial action requirements for Waste Area Groups (WAGs) established on the INL Site. The INL Site has an extensive groundwater quality monitoring network maintained by the USGS and INL contractors. This network includes monitoring or production wells in the SRPA, from which samples are collected and analyzed for selected organic, inorganic, and radioactive constituents. The specific number of wells sampled each year varies. However, between 1949 and 2017, 143 wells have been sampled for water quality and water levels have been monitored at 213 wells (USGS 2017).

CERCLA activities at the INL Site are divided into 10 WAGs. Each WAG monitors specific groundwater contaminants associated with remedial actions implemented according to the requirements of the associated ROD (INL 2011a). DOE has designated WAG 10 as INL-wide and addresses the combined impact of the individual contaminant plumes. MFC is covered by WAG 9.

Groundwater Quality

Localized areas of radiochemical and chemical contamination are present in the SRPA beneath the INL Site. These areas, or plumes, are considered to be the result of past disposal practices. Of principal concern at the INL Site over the years has been the movement of the tritium, strontium-90, and iodine-129 plumes. Groundwater monitoring has generally shown long-term trends of decreasing concentrations for these radionuclides and current concentrations are near or below EPA MCLs for drinking water (INL 2018a). The decreases in concentrations are attributed to discontinued disposal to the aquifer, radioactive decay, and dilution within the aquifer.

USGS collects samples annually from select wells at the INL Site for analysis of gross alpha activity, gross beta activity, gramma spectroscopy, and plutonium and americium isotopes. Between 2012 and 2015, sampled wells showed exceedances of reporting levels for gross alpha activity, gross beta activity, and cesium-137 in at least one sampling location (INL 2018a).

USGS also collects samples annually from select wells at the INL Site for analysis of chloride, sulfate, sodium, fluoride, nitrate, chromium, selected other trace elements, total organic carbon, and volatile organic compounds (VOCs). Concentrations of chloride, nitrate, sodium, and sulfate historically have been above background concentrations in many wells at the INL Site, but concentrations were below established MCLs or secondary MCLs in all wells during 2015 (INL 2018a).

In 2017, samples from 26 groundwater monitoring wells across the INL Site were analyzed for 61 VOCs; 10 of these compounds were detected above the minimum detection limit of 0.2 or 0.1 microgram per liter (µg/L), depending on the compound, in at least one well (INL 2018a).

In 2017, samples at five wells in WAG-9 (which encompasses MFC) were collected and tested for radionuclides, metals, anions, cations, and other water quality parameters. Per the 2017 Annual Site Environmental Report, "Overall, the data show no discernable impacts [to groundwater quality] from activities at the MFC" (INL 2018a).

3.1.3.3 Drinking Water

Drinking water at the INL Site is routinely monitored to ensure it is safe for human consumption and to demonstrate that it meets Federal and State regulations. Drinking water parameters are regulated by the State of Idaho under authority of the SDWA. Parameters with primary MCLs must be monitored at least once every 3 years. Parameters with secondary MCLs are monitored every 3 years based on a recommendation by EPA. Sampling is generally more frequent when establishing a baseline, and subsequent sampling parameters/frequency are determined from the baseline result. Currently, the INL Site has 11 drinking water systems. Drinking water samples collected from these systems in 2017 were well below drinking water limits for all regulatory parameters. Specifically regarding MFC, concentrations of gross alpha activity, gross beta activity, nitrate, total trihalomethanes (TTHM), lead, and copper were detected, but all at levels well below the applicable MCL (INL 2018a).

3.1.3.4 Water Use and Rights

The SRPA is the only source of water for INL facilities. The INL's Federal Reserved Water Right permits a maximum water consumption of 11.4 billion gallons per year from the SRPA. In 2019, the INL Site's production well system withdrew a total of about 755 million gallons of water, which represents about 6.6 percent of the Federal Reserved Water Right for the INL Site (Nelson 2020).

3.1.4 Air Quality

This section describes the existing air quality and climate change conditions of the INL Site. The following five counties that encompass the INL Site comprise the immediate ROI for the project air quality analysis: Bingham, Bonneville, Butte, Clark, and Jefferson.

3.1.4.1 Meteorology and Climatology

The altitude, latitude, and intermountain setting of the INL Site combine to produce a continental and semi-arid climate for the region. This climate is characterized by relatively low precipitation, warm summers, cold winters, and wide fluctuations in diurnal and seasonal temperatures.

A prevailing westerly flow transports Polar storm systems and moisture from the Pacific Ocean into the INL region for much of the year. The Cascade Mountains, Coastal Ranges, and northern extension of Sierra Nevada mountain range block much of this moisture flow, which produces a rain shadow effect in the region and contributes to its aridity. This westerly flow regime provides the majority of annual precipitation to the region. From roughly July through September, weak westerly flow can be replaced by southerly flow that is part of the North American monsoon. This regime produces widely scattered rain shower and thunderstorm activity.

Climate and meteorological data collected at the Central Facilities Area (CFA) (14 miles west-southwest of MFC) and MFC are used to describe the climatic conditions of the INL Site and the MFC location (NOAA 2018). The average high and low temperatures at the INL Site in July are about 88 and 50 degrees Fahrenheit, respectively. January's average high and low temperatures are about 28 and 5 degrees Fahrenheit, respectively. Annual precipitation averages about 8.4 inches per year. The wettest and driest seasons are spring and summer, respectively. An average of 26 inches of snow falls annually at the INL Site. Thunderstorms occur mainly during the warmest months of the year and peak monthly activities occur in August.

Figure 3–6 shows a graphic of wind speed and wind direction data (wind rose) recorded at MFC for years 1994 through 2015. These data show that winds at MFC prevail from the southwest and northeast quadrants. This wind direction pattern is largely due to the regional geography, which frequently forces winds to flow up and down the southwest to northeast axis of the ESRP. The annual average wind speed is 9.4 miles per hour. May and June are the windiest months, when wind speeds average 11 miles per hour.

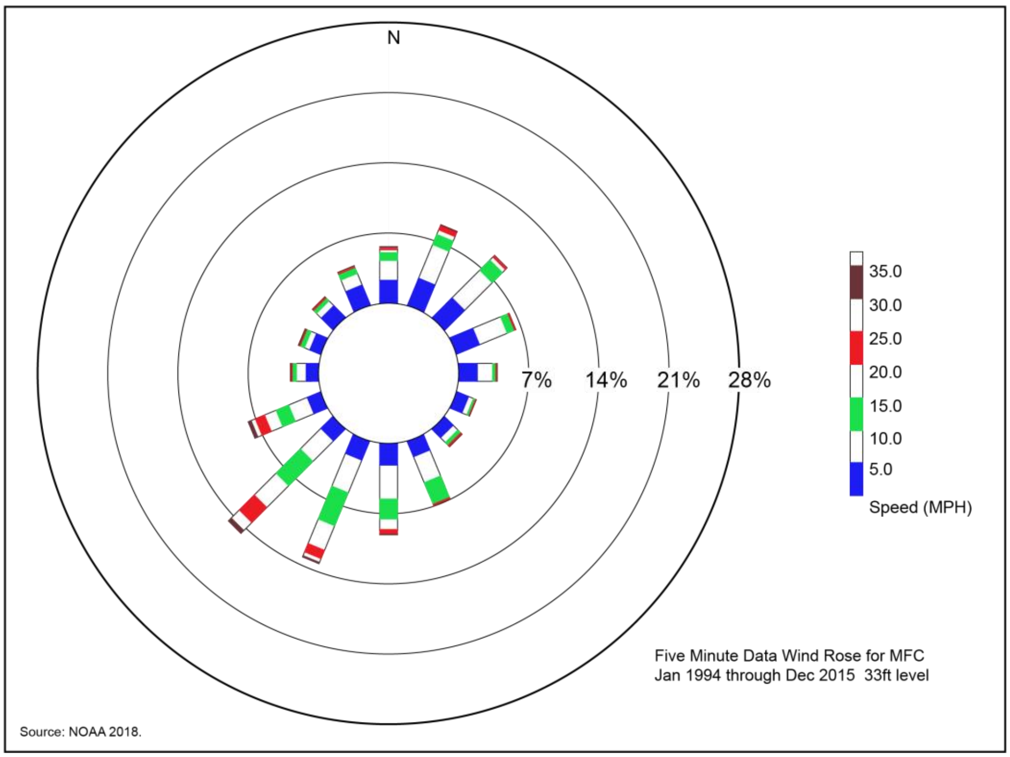


Figure 3–6. Wind Rose for the Materials and Fuels Complex – Years 1994 through 2015

3.1.4.2 Air Quality Standards and Regulations

The Clean Air Act (CAA) and its subsequent amendments establish air quality regulations and the National Ambient Air Quality Standards (NAAQS). In Idaho, the EPA has delegated authority to the IDEQ to enforce air quality regulations. The CAA establishes air quality planning processes and requires States to develop a State Implementation Plan that details how they will maintain the NAAQS or attain a standard in nonattainment within mandated timeframes. The requirements and compliance dates for attainment are based on the severity of the nonattainment classification of the area. The following summarizes the air quality rules and regulations that apply to the proposed action at the INL Site.

3.1.4.2.1 Nonradiological Air Emission Standards

Air quality at a given location can be described by the concentrations of various air pollutants in the atmosphere. Air pollutants are defined as two general types: (1) criteria pollutants and (2) hazardous air pollutants (HAPs). EPA establishes the NAAQS to regulate the following criteria pollutants: ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter less than or equal to 10 microns in diameter (PM_{10}), particulate matter less than or equal to 2.5 microns in diameter ($PM_{2.5}$), and lead. These standards represent atmospheric concentrations to protect public health and welfare and include a reasonable margin of safety to protect the most sensitive individuals in the population. The IDEQ implements the NAAQS and a State ambient standard for fluoride for purposes of regulating air quality in Idaho. The NAAQS are shown in **Table 3–2**.

Table 3–2. National Ambient Air Quality Standards

Pollutant	*Averaging Time*	*National Standards* [a]	
		Primary [b]	*Secondary* [c]
O_3	8-hour	0.070 ppm (137 μg/m³)	Same as primary
CO	8-hour	9 ppm (10 mg/m³)	Not applicable
	1-hour	35 ppm (40 mg/m³)	Not applicable
NO_2	Annual	0.053 ppm (100 μg/m³)	Same as primary
	1-hour	0.10 ppm (188 μg/m³)	Not applicable
SO_2	3-hour	Not applicable	0.5 ppm (1,300 μg/m³)
	1-hour	0.075 ppm (196 μg/m³)	Not applicable
PM_{10}	24-hour	150 μg/m³	Same as primary
$PM_{2.5}$	Annual	12 μg/m³	15 μg/m³
	24-hour	35 μg/m³	Same as primary
Lead	Rolling 3-month period	0.15 μg/m³	Same as primary

ppm = parts per million; μg/m³ = micrograms per cubic meter.
[a] Concentrations are expressed first in units in which they were promulgated. Equivalent units are included in parentheses.
[b] Primary Standards: The levels of air quality necessary, with an adequate margin of safety to protect the public health.
[c] Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.
Source: EPA 2016.

Ozone is formed in the atmosphere by photochemical reactions of previously emitted pollutants called precursors. Ozone precursors are mainly nitrogen oxides and photochemically reactive VOCs. In the presence of sunlight, the maximum effect of precursor emissions on ozone levels usually occurs several hours after they have been emitted and many miles from their source. Ozone concentrations are highest during the warmer months of the year and coincide with the period of maximum exposure to sun rays. Inert pollutants, such as carbon monoxide, tend to have the highest concentrations during the colder months of the year when light winds and nighttime/early morning surface-based temperature inversions inhibit atmospheric dispersion. Maximum inert pollutant concentrations usually are found near an emission source. Maximum PM_{10} concentrations in the vicinity of the INL Site occur in combination with fugitive dust generated by ground-disturbing activities (such as the operation of vehicles on unpaved surfaces and agricultural activities) and high wind events.

EPA designates all areas of the United States as having air quality better than (attainment) or worse than (nonattainment) the NAAQS. Former nonattainment areas that have attained the NAAQS are designated as maintenance areas. Presently, EPA categorizes the five counties that encompass the INL Site as in attainment of all NAAQS. The nonattainment area nearest to the INL Site is the Fort Hall Indian Reservation PM_{10} nonattainment area, which is in northeastern Power County and northwestern Bannock

County. Directly east of this area and centered in Pocatello is the Portneuf Valley PM_{10} maintenance area, which is the nearest maintenance area to the INL Site.

EPA also regulates HAPs that are known or are suspected to cause serious health effects or adverse environmental effects. The CAA identifies 187 substances as HAPs (e.g., benzene, formaldehyde, mercury, and toluene). HAPs are emitted from a range of industrial facilities and vehicles. EPA sets Federal regulations to reduce HAP emissions from stationary sources in the National Emission Standards for Hazardous Air Pollutants (NESHAP). A "major" source of HAPs is defined as any stationary facility or source that directly emits or has the potential to emit 10 tons per year or more of any HAP or 25 tons per year or more of combined HAPs. In Idaho, the IDEQ regulates HAPs and about 350 toxic air pollutants (TAPs), as the Idaho TAP program preceded the Federal program. Both programs set ambient levels of concern for HAPs and TAPs.

As part of the Prevention of Significant Deterioration (PSD) Regulation, the CAA provides special protection for air quality and air quality-related values (including visibility and pollutant deposition) in select National Parks, National Wilderness Areas, and National Monuments in the United States. These Class I areas are areas in which any appreciable deterioration of air quality is considered significant. In 1999, EPA promulgated a regional haze regulation that requires States to establish goals and emission reduction strategies to make initial improvements in visibility within their respective Class I areas. Visibility impairment is defined as a reduction in the visual range and atmospheric discoloration. Criteria to determine the significance of air quality impacts in Class I areas usually pertain to stationary emission sources, because mobile sources are generally exempt from permit review by regulatory agencies. However, Section 169A of the CAA states the national goal of prevention of any future impairment of visibility within Class I areas from manmade sources of air pollution. Craters of the Moon National Monument and Preserve is the closest PSD Class I area to the INL Site. Its nearest border is about 45 miles southwest of MFC. Therefore, this EIS provides qualitative analyses of the potential for emissions generated by the project alternatives to affect visibility within this pristine area.

The IDEQ Air Quality Division (AQD) is responsible for enforcing air pollution regulations in Idaho. The AQD enforces the NAAQS by monitoring air quality, developing rules to regulate and to permit stationary sources of air emissions, and managing the air quality attainment planning processes in Idaho. The IDEQ air quality regulations, "Rules for the Control of Air Pollution in Idaho," are found in the IDAPA Section 58.01.01 (IDEQ 2019). The operation of the INL Site includes sources that emit criteria and hazardous air pollutants and require a permit to construct (PTC), as outlined in IDAPA 58.01.01.200 through 228. These sources currently operate under a PTC (PTC #P-2015.0023) with a facility emissions cap. This PTC limits facility-wide emissions to below levels that would require a Title V operating permit and it rescinds the previous Title V permit that regulated emission sources at the INL Site (IDEQ 2018).

3.1.4.2.2 Greenhouse Gases and Climate Change

It is well documented that the Earth's climate has fluctuated throughout its history. However, recent scientific evidence indicates a correlation between increasing global temperatures over the past century and the worldwide proliferation of greenhouse gas (GHG) emissions by mankind. Climate change associated with global warming is predicted to produce negative environmental, economic, and social consequences across the globe.

GHGs are gases that trap heat in the atmosphere by absorbing infrared radiation. GHG emissions occur from natural processes and human activities. Water vapor is the most important and abundant GHG in the atmosphere. The most common GHGs emitted from natural processes and human activities include carbon dioxide (CO_2), methane, and nitrous oxide. The main source of GHGs from human activities is the combustion of fossil fuels, such as natural gas, crude oil (including gasoline, diesel fuel, and heating oil), and coal. Examples of GHGs created and emitted primarily through human activities include fluorinated gases (hydrofluorocarbons and perfluorocarbons) and sulfur hexafluoride. The main sources of manmade GHGs include refrigerants and electrical transformers.

Each GHG is assigned a global warming potential (GWP). The GWP is the ability of a gas or aerosol to trap heat in the atmosphere over a given period of time. The GWP rating system is normalized to CO_2, which has a value of one. For example, methane has a GWP of 28 over 100 years, which means that it has a global warming effect 28 times greater than CO_2 on an equal-mass basis (IPCC 2014). To simplify GHG analyses, total GHG emissions from a source are often expressed as a CO_2 equivalent (CO_2e), which is calculated by multiplying the emissions of each GHG by its GWP and adding the results together to produce a single, combined emission rate representing all GHGs. While methane and nitrous oxide have much higher GWPs than CO_2, CO_2 is emitted in such greater quantities that it is the overwhelming contributor to global CO_2e emissions from both natural processes and human activities.

Numerous studies document the recent trend of rising atmospheric concentrations of CO_2. The longest continuous record of CO_2 monitoring extends back to 1958 (Keeling 1960; Scripps Institution of Oceanography 2019). These data show that atmospheric CO_2 levels have risen an average of 1.6 parts per million per year over the last 60 years (NOAA 2019). As of 2018, CO_2 levels are about 40 percent higher than the highest levels estimated for the 800,000 years preceding the industrial revolution, as determined from CO_2 concentrations analyzed from air bubbles in Antarctic ice core samples (USGCRP 2018).

This section defines GHGs and the concept of CO_2e and discusses the link between the worldwide proliferation of GHG emissions by humankind and global warming. Global climate change has already had observable negative effects on the environment (IPCC 2014; USGCRP 2018). The potential future effects of global climate change include more worldwide environmental, economic, and social consequences. Predictions of long-term negative environmental impacts due to global warming include an increase in the rate of sea level rise; changing weather patterns, including increases in the severity of storms and droughts; changes to local and regional ecosystems, including the potential loss of species; and a substantial reduction in winter snowpack. In Idaho, the USGCRP predicts that annual average temperatures will increase between four and eight degrees Fahrenheit by 2100, based on both low and high global GHG emission scenarios (USGCRP 2018). In addition, average winter precipitation will increase over the long-term, but with an increase in annual variability. Predictions of the impacts of these changes to Idaho include (1) an increase in flooding, drought, and heat waves; (2) compromises to water supplies and hydropower; (3) an increase in wild fires; (4) damage to aquatic and terrestrial ecosystems; (5) an increase in the incidence of infectious diseases and other human health problems; and (6) stresses to agricultural productivity.

Federal agencies address emissions of GHGs by reporting and meeting reductions mandated in Federal laws, Executive orders, and agency policies. Some of these requirements include Executive Order 13834 and EPA *Final Mandatory Reporting of Greenhouse Gases Rule*. Executive Order 13834 identifies requirements for Federal agencies to increase efficiency and to report GHG emissions. Under the *Mandatory Reporting of Greenhouse Gases Rule*, stationary sources that emit 25,000 metric tons or more per year of CO_2e are required to report their annual GHG emissions to EPA. The INL Site emitted greater than 25,000 metric tons CO_2e emissions from stationary combustion sources in 2010 and therefore was subject to the mandatory reporting requirements. INL developed a GHG monitoring plan for stationary combustion and other regulated sources to meet the mandatory reporting requirements (DOE 2010a). From 2011 through 2015, the INL Site emitted less than 25,000 metric tons CO_2e emissions and is no longer subject to the mandatory reporting requirements.

The potential effects of GHG emissions from the project alternatives are by nature global and cumulative. Given the global nature of climate change and the current state of the science, it is not useful at this time to attempt to link the emissions quantified for local actions to any specific climatological change or resulting environmental impact. Nonetheless, GHG emissions from the project alternatives are quantified in this EIS for use as indicators of their potential cumulative contributions to climate change effects and for making reasoned choices among alternatives.

3.1.4.2.3 Radiological Air Emission Standards

Facilities at the INL Site have the potential to emit radioactive materials and, therefore, are subject to NESHAP, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities." This regulation limits the radionuclide dose to a member of the public to 10 millirem per year. Subpart H also establishes requirements for monitoring emissions from facility operations and analyzing and reporting of radionuclide doses. Airborne radiological effluents are monitored at individual facilities at the INL Site (including MFC) to comply with the requirements of NESHAP and DOE Order 458.1, "Radiation Protection of the Public and the Environment."

3.1.4.3 Nonradiological Air Emissions

Sources of nonradiological air emissions at the INL Site include oil-fired boilers, diesel engines, emergency diesel generators; small gasoline, diesel, and propane combustion sources; and chemical and solvent usages. Boilers generate steam for heating facilities and are the main source of nonradiological air emissions at the INL Site. Diesel engines are mainly used to generate electricity for facility operations. All facilities at the INL Site use emergency diesel generators for emergency electrical power and emissions from these sources occur from periodic testing. Miscellaneous non-vehicle sources include small portable generators, air compressors, and welders. The main combustive sources at MFC are emergency diesel generators and diesel-powered emergency firewater pumps.

Table 3–3 presents a summary of the nonradiological air emissions that occurred in 2018 from stationary sources at the INL Site (including MFC) that are regulated under PTC P-2015.0023 (INL 2019a). These data show that regulated emissions in 2018 were below the facility emissions cap (FEC) limits. INL has applied to the AQD to modify PTC, and most of the FEC limits identified in Table 3–3 would change because of this process.

Table 3–3. Idaho National Laboratory Facility-Wide Emissions – Calendar Year 2018

Source	*Air Pollutant (tons per year)*							
	VOC	*CO*	*NO_x*	*SO_2*	*PM_{10}*	*$PM_{2.5}$*	*Single HAP*	*Total HAPS*
INL Facility Wide	2.66	11.58	35.65	2.16	3.51	3.51	1.26	1.49
FEC Emission Limits [a]	**3.7**	**17.7**	**95.0**	**16.9**	**5.6**	**5.6**	**10**	**25**

CO = carbon monoxide; FEC = facility emissions cap; HAP = hazardous air pollutant (Single HAP = hydrochloric acid); NOx = nitrogen oxides; $PM_{2.5}$ = particulate matter less than 2.5 microns in diameter; PM_{10} = particulate matter less than 10 microns in diameter; SO_2 = sulfur dioxide; VOC = volatile organic compound.

[a] IDEQ 2018.

Source: INL 2019a.

3.1.4.4 Radiological Air Emissions

Radionuclide emissions at the INL Site occur from (1) point sources, such as process stacks and vents; and (2) fugitive sources, such as waste ponds, buried waste, contaminated soil areas, and decontamination and decommissioning (D&D) operations. During 2018, an estimated 1,477 curies of radioactivity were released to the atmosphere from all INL Site sources (INL 2019c). This level of release is within the range of releases from recent years and is consistent with the general downward trend observed over the past 10 years. For example, reported releases for 2010 and 2015 were 4,320 curies and 1,870 curies, respectively.

Radiological air emissions from MFC primarily occur from spent fuel treatment at the Fuel Conditioning Facility, waste characterization and fuel research and development at the Hot Fuel Examination Facility, fuel research and development at the Fuel Manufacturing Facility, and post-irradiation examination at the Irradiated Materials Characterization Laboratory. These facilities are equipped with continuous emission monitoring (CEM) systems and all radionuclide sources are controlled with high-efficiency particulate air (HEPA) filters. MFC released about 93 curies in 2018, which equate to about 12.9 percent of total the INL Site source term (INL 2019c).

For calendar year 2018, the effective dose equivalent from combined INL Site emissions to the maximally exposed individual (MEI) member of the public was 0.01 millirem per year, which is 0.1 percent of the 10 millirem-per-year standard (INL 2019c). Subpart H defines the MEI as any member of the public at any offsite location where there is a residence, school, business, or office. Radionuclide emissions from MFC contributed to about 18.7 percent of this impact. See Section 3.1.10 Human Health – Normal Operations, for additional discussion of the radiological impacts from site operations.

3.1.5 Ecological Resources

Ecological resources include the plant and animal species, habitats, and ecological relationships of the land and water areas within the ROI, which is the area directly or indirectly affected by the proposed action. Particular consideration is given in the ROI to sensitive species, which are those species protected under Federal or State law, including threatened and endangered species, migratory birds, and bald and golden eagles. For the purposes of this EIS, sensitive and protected ecological resources include plant and animal species that are federally (USFWS) or State- (Idaho Department of Fish and Game [IDFG]) listed for protection.

Ecological resources at the INL Site are monitored by the ESER Program. The program implements comprehensive species monitoring via routine plant and animal inventories. These include focused surveys (including, but not limited to, sensitive species, breeding birds, pygmy rabbits, greater sage-grouse, and bats), and vegetation classification efforts. Revegetation and weed management are also supervised through the program as needed. Historical reports and further information on ecological resources available on the INL Site are identified on the Idaho ESER website (INL 2019b).

3.1.5.1 Vegetation

The INL Site covers about 569,135 acres (or about 890 square miles), supports over 420 plant species, and occupies one of the largest tracts of relatively undisturbed sagebrush steppe habitat (INL 2020e). Vegetation communities within the site are dominated by various sagebrush species (*Artemisia* spp.). A diversity of other native shrubs, grasses, and herbaceous plants also thrive there. The INL sagebrush communities are dominated by Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), basin big sagebrush (*Artemisia tridentate* ssp. *tridentat*a), or a combination of both. Prevailing shrubs in non-big sagebrush communities may include green rabbitbrush (*Chrysothamnus viscidiflorus*), sickle saltbush (*Atriplex falcata*), black sagebrush (*Artemisia nova*), three-tip sagebrush (*Artemisia tripartita*), low sagebrush (*Artemisia arbuscul*a), spiny hopsage (*Grayia spinosa*), and shadscale (*Atriplex confertifolia*) (ESER 2019a).

BLM and DOE work in partnership to manage sagebrush resources at the INL Site. Together the agencies employ the INL Sagebrush-Steppe Ecosystem Reserve plan with input from IDFG, USFWS, and Native American Tribes. The Sagebrush-Steppe Ecosystem Reserve, which covers about 115 square miles (73,600 acres) in the northwest corner of the INL Site, was designated to ensure that this portion of the ecosystem receives special consideration and remains undisturbed (INL 2020e).

Vegetation communities within the 100-acre proposed project area were assessed during three field survey days in 2019 and 2020 to confirm the vascular plant resources within the area (Veolia 2019; VNSFS 2020). A total of 73 species and 5 vegetation communities were documented within the proposed project area. **Table 3–4** presents these communities. Nearly 60 percent of vegetation within the proposed project area is comprised of shrublands, 38 percent is disturbed, and 1 percent is grasslands. Vegetation class distribution within the proposed project area is also presented in **Figure 3–7**.

Table 3–4. Vegetation Communities within the Proposed Project Area

Vegetation Community	***Acres within the Proposed Project Area***
Crested Wheatgrass Ruderal Grassland	0.07 acres
Cheatgrass Ruderal Grassland	1.14 acres
Green Rabbitbrush/Thickspike Wheatgrass Shrub Grassland and Needle and Thread Grassland	24.9 acres
Big Sagebrush – Green Rabbitbrush (Threetip Sagebrush) Shrubland	35.0 acres
Previously disturbed/facilities	38.4 acres
	Total: ~100 acres

Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: Veolia 2019; VNSFS 2020.

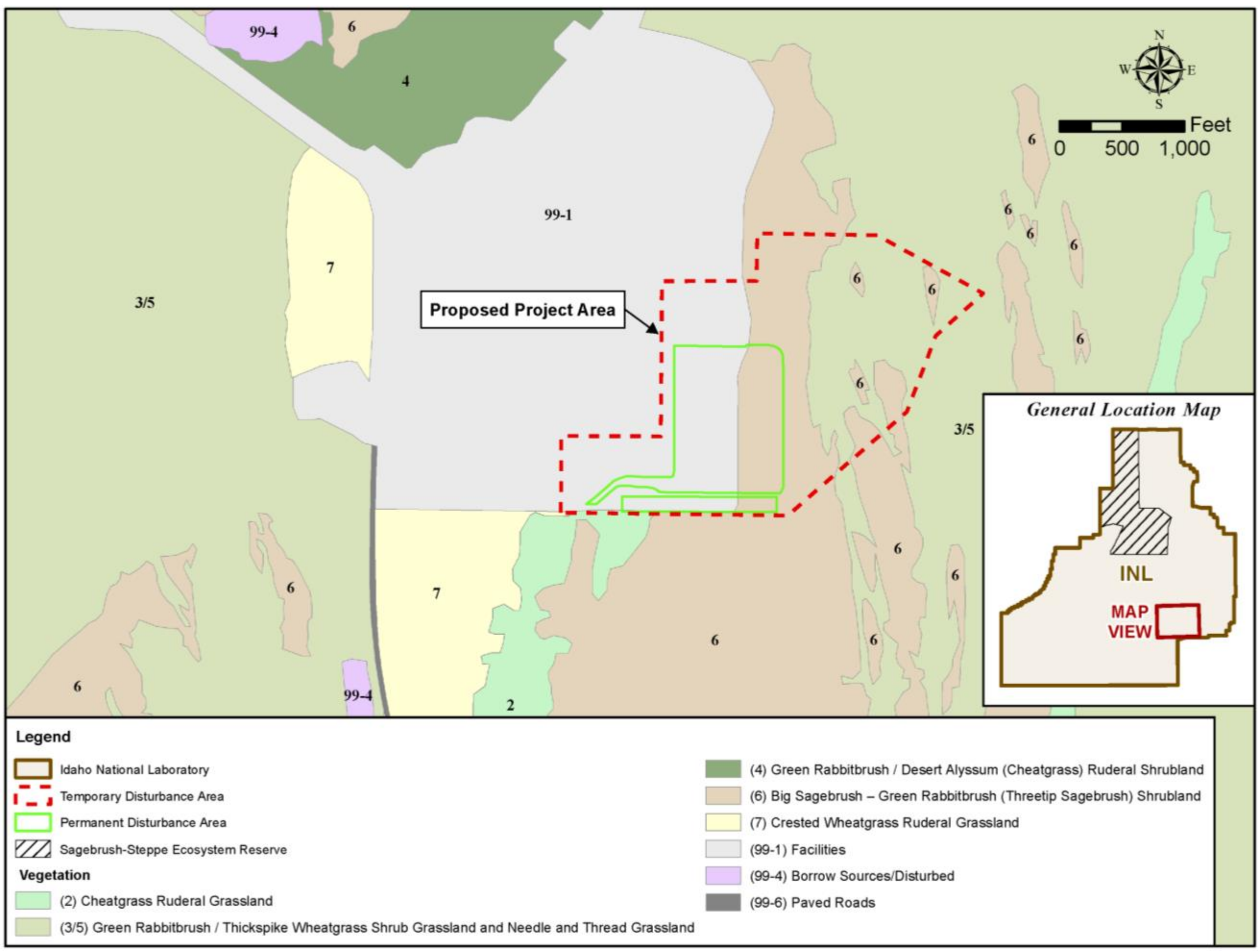


Figure 3–7. INL Vegetation Class Distribution within the Proposed Project Area

3.1.5.2 Invasive Plant Species

Invasive plants are those species whose introduction does or is likely to cause economic or environmental harm or harm to human health. Per the *Invasive Species Executive Order 13112*, the Idaho Department of Agriculture mandates the official noxious weed list of introduced, invasive, and harmful plants. At the INL Site, invasive species management and noxious weed control is monitored and managed throughout the site. According to *Weeds of the Idaho National Engineering and Environmental Laboratory* report, a total of 13 Idaho invasive weeds have been identified on the INL Site (INL 2020e). Battelle Energy Alliance (BEA) administers invasive plant species control, with support from the ESER program.

Within the proposed project area, field surveys documented 16 non-native species and 4 Idaho State-listed noxious weeds, including whitetop (*Cardaria draba*), Canada thistle (*Cirsium arvense*), musk thistle (*Carduus nutans*), and bull thistle (*Carduus nutans*) (VNSFS 2020; USDA 2020). These species are relatively sparse in intact vegetation communities but become more frequent in highly disturbed areas, such as along fence lines and roadways (VNSFS 2020).

3.1.5.3 Wildlife

Sagebrush steppe ecosystems provide habitat for a variety of terrestrial wildlife species. Common small mammals observed at the INL Site include bushy-tailed woodrat (*Neotoma cinerea*), black-tail jackrabbit (*Lepus californicus*), mountain cottontail (*Sylvilagus nuttallii*), sagebrush voles (*Lemmiscus curtatus*), North American deer mice (*Peromyscus maniculatus*), Merriam's shrew (*Sorex merriami*), and American badgers (*Taxidea taxus*). Large mammal species include coyote (*Canis latrans*), bobcat (*Lynx rufus*), pronghorn (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), moose (*Alces americanus*), mountain lion (*Puma concolor*), and elk (*Cervus canadensis*) (INL 2020e). A complete list of mammal species documented on the INL Site in 2001 is available on the ESER website (INL 2001).

Additionally, the sagebrush steppe ecosystem provides foraging and roosting habitat for a variety of resident and transient bat species. Eleven bat species have been recorded on the INL Site, including several species with heightened conservation concern (refer to *Special Status Species* below) (INL 2018c). Bats are known to frequent the proposed project area to forage and roost, and there is a potential for maternity roosts to occur within close proximity because there are caves distributed around the INL Site (Veolia 2019). For additional information on bats' use of the INL Site, refer to the *Idaho National Laboratory Bat Protection Plan* (2018) (DOE-ID 2018).

Common reptiles observed at the INL Site include the Great Basin spadefoot toad (*Spea intermontana*), sagebrush lizard (*Sceloporus graciosus*), short-horned lizard (*Phrynosoma douglassii*), Great Basin rattlesnake (*Crotalus oreganus lutosus*), western terrestrial garter snake (*Thamnophis elegans*), and gopher snake (*Pituophis catenifer*) (INL 2020e; VNSFS 2020). Fish species reported on the INL Site are limited to the Big Lost River during years when water flow is sufficient. However, there is no aquatic habitat to support fish species within the proposed project area.

In an effort to monitor bird populations on the INL Site, breeding bird surveys have been conducted almost annually since 1985. Surveys occur along five breeding bird survey (BBS) routes that are part of a nationwide survey administered by the U.S. Geological Survey and eight additional routes near INL Site facilities (ESER 2019c). In 2018, about 2,840 birds representing 53 species were documented during the BBSs across the INL Site. The most commonly identified bird species observed were horned lark (*Eremophila alpestris*), western meadowlark (*Sturnella neglecta*), sage thrasher (*Oreoscoptes montanus*), sagebrush sparrow (*Artemisiospiza nevadensis*), Brewer's sparrow (*Spizella breweri*), common raven (*Corvus corax*), and mourning dove (*Zenaida macroura*) (ESER 2019c). The 2018 breeding bird surveyors observed eight species considered by the IDFG to be Species of Greatest Conservation Need (SGCN) on the INL Site. These birds are the sage thrasher, sagebrush sparrow, Franklin's gull (*Larus pipixcan*), common nighthawk (*Chordeiles minor*), ferruginous hawk (*Buteo regalis*), grasshopper sparrow (*Ammodramus savannarum*), burrowing owl (*Athene cunicularia*), and long-billed curlew (*Numenius americanus*) (ESER 2019c). Within the proposed project area, field surveys conducted in May 2020 documented a bobolink (*Dolichonyx oryzivorus*), which is also listed as a SGCN (VNSFS 2020). Additionally, one BBS INL facility route, Route M, occurs within the proposed project area (see **Figure 3–8**).

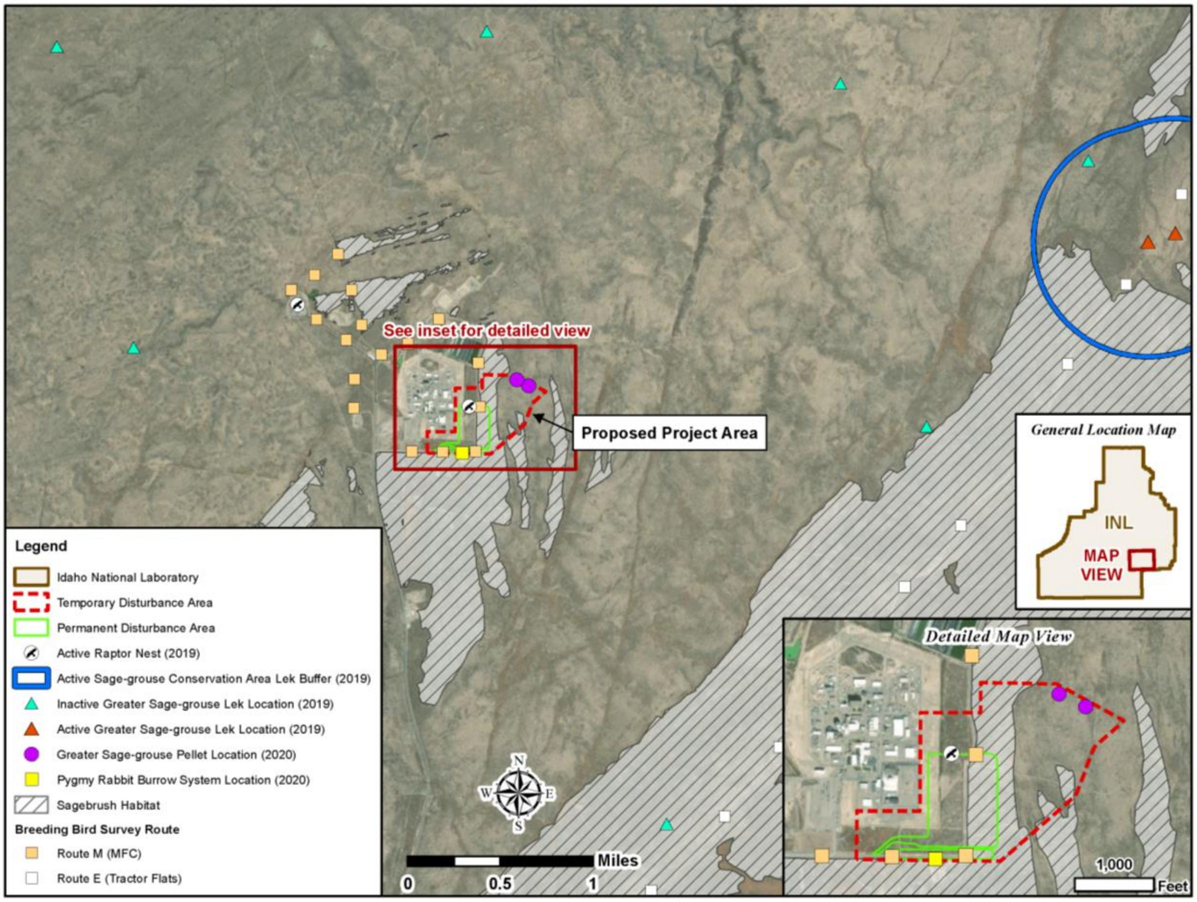


Figure 3–8. Sensitive Species Occurrences and/or Known Habitat Distribution within the Proposed Project Area

3.1.5.4 Special Status Species

Special status species include federally listed (USFWS) threatened, endangered, and State-designated (IDFG) sensitive species and their habitats. Applicable laws include the Endangered Species Act (ESA) (16 U.S.C. 1532 et seq.), the Migratory Bird Treaty Act (MBTA) (16 U.S.C. 703-712), the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668c), and the Idaho Fish and Game statutes (Title 36).

The USFWS's Information for Planning and Consultation (IPaC) online system was accessed to identify current USFWS trust resources with potential to occur within the proposed project area. On January 23, 2020, the Idaho Fish and Wildlife Office provided an automated Official Species List via Section 7 letter (USFWS 2019a). No federally listed species under the ESA have been observed or documented within the INL Site, and there is no designated critical habitat. According to the USFWS IPaC report, no federally listed species were identified as known to occur or have potential to occur within the proposed project area (USFWS 2020a).

The INL Site has no documented federally listed plant species. However, there are five rare and/or sensitive species (i.e., those that have a global or State ranking identified by the Idaho Natural Heritage Program) that are known to occur and 29 species have the potential to occur. Within the proposed project area, no sensitive plant species were recorded during the vegetation surveys. However, focused surveys that target peak identification periods have not been conducted (Veolia 2019; VNSFS 2020).

The IDFG *Idaho State Wildlife Action Plan* (SWAP) (IDFG 2017) prioritizes SGCN by three tiers (1, 2, and 3) based on relative conservation priority. Tier 1 SGCN are species of the highest priority for the SWAP and represent species with the most critical conservation needs. The plan includes an early warning list of taxa that have a highest probability of being listed under ESA in the near future. Tier 2 SGCN are species with high conservation needs and longer-term vulnerabilities or patterns suggesting management intervention is needed, but the species is not necessarily facing imminent extinction or having the highest management profile. Tier 3 SGCN are relatively common, yet long-term monitoring surveys indicate they are rapidly declining throughout the species' range. Sensitive species occurrences and known habitat distribution within the proposed project area is presented in Figure 3–8.

A number of SGCN wildlife have been reported on the INL Site. One SGCN Tier 1 bird (greater sage-grouse [*Centrocercus urophasianus]*), two SGCN Tier 2 bats (the hoary bat [*Lasiurus cinereus*] and silver-haired bat [*Lasionycteris noctivagans*]), and three SGCN Tier 3 bats (Townsend's big-eared bat [*Corynorhinus townsendii*], western small-footed myotis [*Myotis ciliolabrum*], and little brown myotis [*M. lucifugus]*) are known to occur on the INL Site (IDFG 2017). Habitat for these species includes lava tube caves, fractured rock outcrops, talus-flanked buttes, and juniper uplands (INL 2018c). Bats are known to use the proposed project area, and MFC provides an abundance of roost sites and foraging habitat (VNSFS 2020). Additionally, pygmy rabbits (*Brachylagus idahoensis*), a SGCN Tier 2, have been observed throughout the INL Site as well as within the proposed project area (ESER 2007). An active burrow system was identified on the southern boundary of the proposed project area during recent ecological surveys and several positive pygmy rabbit sightings were caught on wildlife cameras, confirming their presence within the site (see Figure 3–8) (VNSFS 2020). Pygmy rabbits are dependent on sagebrush for food and shelter throughout the year. They use the dense stands of big sagebrush growing in deep loose soils to dig burrows (NatureServe 2019).

The greater sage-grouse is a widespread, sagebrush-obligate species that has become an icon and symbol for conserving sagebrush across the western United States. Sage-grouse is known to occupy various areas at the INL Site (ESER 2019d). In 2014, DOE voluntarily entered into a *Candidate Conservation Agreement* with USFWS to protect the greater sage-grouse and its habitats on the INL Site, while allowing DOE flexibility in conducting its current and future missions (DOE-ID & USFWS 2014). Although the sage-grouse does not warrant protection under the ESA, DOE, and USFWS continue to collaborate on sage-grouse protection at the INL Site.

The INL Site establishes a Sage-grouse Conservation Area (SGCA) that limits infrastructure development and human disturbance in remaining sagebrush-dominated communities. The INL Site conservation framework protects lands within a 0.6-mile radius of all known active leks (sage-grouse communal breeding ground). Leks are categorized as historical, active, or inactive. Historical leks have not been surveyed since 2009. Active leks are part of established IDFG survey route or have been surveyed elsewhere using the protocol from the IDFG guidelines. (Guidelines require a lek survey to be conducted at least four times per year.) Inactive leks were not found to have an active breeding ground for at least 4 years within a 5-year period. (No sage-grouse activity was observed within the survey period [DOE-ID & USFWS 2014].) The INL Site sage-grouse population is assessed according to baseline conditions from 2011. As of 2019, 40 active leks were recorded (VNSFS 2020).

The proposed project area is not within the established SGCA, and there are no documented active or inactive leks. The closest known documented lek site is categorized as inactive, and it is located about 1.7 miles northwest. The closest active lek is located about 2.7 miles east of the proposed project area. During recent 2020 surveys sage-grouse signs (fecal pellets) were observed at two separate locations, indicating current sage-grouse use of the proposed project area (Figure 3–8) (VNSFS 2020). The proposed project area is subject to DOE's no net loss of sagebrush habitat policy on the INL Site.

Additionally, several species identified as Birds of Conservation Concern (BCCs) under the MBTA or as SGCN under State of Idaho regulations occur at the INL Site. The USFWS maintains a regional list of designated migratory birds known to occur in the United States. BCCs are a subset of MBTA-protected species identified by the USFWS as those in the greatest need of additional conservation action to avoid future listing under the ESA. BCCs have been identified at three geographic scales: National, USFWS Regions, and Bird Conservation Regions (BCRs). The INL Site is located within BCR 9 (Great Basin) and there are 28 BCCs listed (USFWS 2008). Additionally, the USFWS IPaC system identified five migratory bird species with potential to occur in the proposed project area: bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos*), Brewer's sparrow, sage thrasher, and willow flycatcher (*Empidonax traillii*) (USFWS 2020a). SGCN on the INL Site include bald eagle, golden eagle, Brewer's sparrow, burrowing owl, common nighthawk, grasshopper sparrow, greater sage-grouse, long-billed curlew, ferruginous hawk, Franklin's gull, loggerhead shrike (*Lanius ludovicianus*), peregrine falcon (*Falco mexicanus*), sage thrasher, sagebrush sparrow, and short-eared owl (*Asio flammeus*) (ESER 2019c).

3.1.5.5 Aquatic Resources

The nearest aquatic resources are within 1 mile of the proposed project area and include manmade ponds and sporadic riverine wetlands (see Figure 3–5). Riverine wetlands in Idaho typically occur in broad valleys and have fine-textured sediments, deposited by peak flows in the spring and early summer (IIFA 1999). In general, water flow patterns are typically intermittent within the shallow creeks. The sagebrush steppe terrain is typically flat or gently rolling (NWL 2019). There are no aquatic resources located within the proposed project area (VNSFS 2020).

3.1.5.6 Wildfire

Wildfire in Idaho is fairly common due to the landscape's arid conditions and dry vegetation. Wildland fire management is employed at the INL Site to prevent the loss of big sagebrush habitat and to protect sensitive species unique to the area (ESER 2019a). Fires on the INL Site pose heightened risks because of the potential to burn through radiologically contaminated areas. Restrictions are in place to minimize the potential for human-caused fires when vegetation is most susceptible to fire (INL 2020e). For more information on recent wildfires and past fire scars, refer to the *Wildfire Recovery Reports* available on the ESER website (INL 2001).

Decade old fire scars cover about 13.5 acres of the proposed project area. These fires have resulted in the loss of sagebrush habitat and increased the abundance of other native shrublands (such as green rabbitbrush) and native grasses (bluebunch wheatgrass [*Pseudoroegneria spicata*], bottlebrush squirreltail [*Elymus elymoides*], and Sandberg bluegrass [*Poa secunda*]) (Veolia 2019).

3.1.6 Cultural and Paleontological Resources

The area of potential effect (APE) was determined by the scope of the current undertaking, including all potential direct and indirect impacts associated with project activities. The project area encompasses about 100 acres east of MFC and extends east and south into currently undeveloped areas. Development in the far western section of the project area, a new Spent Fuel Storage Area (SFSA), will occur within the existing MFC security fence within an area already disturbed by MFC activities. Accounting for this disturbance, the APE was established as a 200-foot buffer surrounding all but the western perimeter of the project area to allow for new building construction, laydown areas, defensible security buffers, and egress during construction. The APE for new construction totals 138 acres.

In determining the APE, consideration was given to visual, auditory, and atmospheric effects that may be imposed by the proposed undertaking on architectural properties within the MFC facility. MFC consists of a 90-acre developed area, which includes an undeveloped security perimeter. Structures include analytical laboratories and other facilities that tend to be one- or two-story, block concrete buildings with towers and holding tank structures interspersed.

3.1.6.1 Ethnographic Resources

The Shoshone-Bannock Tribes have a long and traditional association with the area of the proposed action, as detailed in the following sections.

Native American Cultures

Native American cultural resources have been identified within the 138-acre APE that encompasses the proposed VTR facility construction area. Coupled with numerous recorded and yet to be identified properties within MFC and across the INL Site, the Shoshone-Bannock Tribes document the past, long-term use of the area. Representatives from the Shoshone-Bannock Tribes Heritage Tribal Office have indicated to DOE that pre-contact archaeological sites, native plants and animals, water, and other natural landscape features across the INL Site continue to fill important roles in Tribal heritage and ongoing cultural traditions.

Pre-contact sites, located throughout the INL Site, and oral histories establish the importance of the area in the seasonal round of the Shoshone and Bannock people. Much of the area now encompassing the INL Site served as a travel route within their traditional territory, providing access to the Birch Creek and Little Lost River valleys as well as the Camas Prairie and beyond. The Big Lost River, Big Southern Butte, and Howe Point served as seasonal base camps providing fresh water, food, and obsidian (volcanic glass) for tool making and trade. The Shoshone and Bannock people depended on a variety of plants and animals for food, medicines, clothing, tools, and building materials (NRC 2004).

The importance of plants, animals, water, air, and land resources on the ESRP to the Shoshone and Bannock peoples is reflected in the sacred reverence in which they hold the resources. Specific places in the ESRP have sacred and traditional importance to the Shoshone and Bannock people, including buttes, caves, and other natural landforms on or near the INL Site (NRC 2004).

Native American and Euro-American Interactions

The influence of Euro-American culture and loss of aboriginal territory and reservation land severely impacted the aboriginal subsistence cultures of the Shoshone and Bannock people. Settlers began establishing homesteads in the valleys of southeastern Idaho in the 1860s, increasing the conflicts with aboriginal people and providing the motivation for treaty-making by the Federal government. The Fort Bridger Treaty of 1868 and associated Executive orders designated the Fort Hall Reservation for mixed bands of Shoshone and Bannock people. A separate reservation established for the Lemhi Shoshone was closed in 1907, and the Native Americans were forced to migrate to the Fort Hall Reservation across the area now occupied by the INL Site.

The original Fort Hall Reservation, consisting of 1.8 million acres, has been reduced to about 544,000 acres through a series of cessions to accommodate the Union Pacific Railroad and the growing city of Pocatello. Other developments, including the flooding of portions of the Snake River bottoms by the construction of the American Falls Reservoir, have also reduced the Shoshone-Bannock Tribes' land base.

The creation of the INL Site had an impact on the Shoshone and Bannock subsistence culture. Land withdrawals initiated by the U.S. Navy during World War II and continued by the Atomic Energy Commission during the Cold War restricted access to authorized personnel. In addition, initial construction of facilities on the INL Site may have impacted cultural resources of importance to the Tribes, including traditional and sacred areas and artifacts (NRC 2004).

Contemporary Cultural Practices and Resource Management

The efforts of the Shoshone-Bannock Tribes to maintain and revitalize their traditional cultures are dependent on having continual access to aboriginal lands, including some areas on the INL Site. DOE accommodates Tribal member access to areas on the INL Site for subsistence and religious uses. Also, Tribal members continue to hunt big game, gather plant materials, and practice religious ceremonies in traditional areas that are accessible on public lands adjacent to the INL Site. The historical record described in the *INL Cultural Resources Management Plan* (INL 2016f) supports the conclusion that the INL Site is located within a large, traditional territory of the Shoshone and Bannock people and there are archaeological and other cultural resources that reflect the importance of the INL Site area to the Tribes. DOE recognizes the unique interest the Shoshone-Bannock Tribes have in the management of resources on the INL Site and continues to consult with the Tribes concerning Federal undertakings and management of cultural and natural resources.

The maintenance of pristine environmental conditions, including native plant communities and habitats, natural topography, and undisturbed vistas, is critical to continued viability of the Shoshone and Bannock culture. Contamination from past and ongoing operations at the INL Site has the potential to affect plants, animals, and other resources that Tribal members continue to use and deem significant (NRC 2004). Due to the lack of nearby permanent water sources, the archaeological evidence within the proposed VTR construction location is limited to single, short-term events. The area has been disturbed by fire and the subsequent planting of crested wheatgrass, a non-native bunchgrass that occurs on the INL Site and was planted in areas around MFC that were burned by wildland fires. It is unlikely that any sensitive Tribal resources are present within the project area (Lee 2020).

3.1.6.2 Cultural Resources

The INL Site and surrounding areas are rich in cultural resources, including pre-contact and early historic archaeological artifacts and features left by the Shoshone and Bannock people, as well as artifacts and features left by early pioneers, homesteaders, and ranchers who also frequented the area. Historic uses of the area include attempts at homesteading and as a route for cattle drives and settlers traveling west. The most recent use of the area facilitated the nuclear technology age with research and development of nuclear power. Descendants of pioneers who crossed the INL Site on Goodale's Cutoff or homesteaders who attempted to scrape an existence from the desert soils or employees who participated in the initial operations on the INL Site retain a special connection to the land.

To date, numerous cultural resource surveys have been conducted at the INL Site. These surveys have identified many archaeological properties and properties associated with the historic built environment. The archaeological record on the INL Site represents nearly 13,500 years of human occupation and land use. Many archaeological sites, buildings, and structures are significant and are either potentially eligible for or eligible for listing on the National Register of Historic Places (NRHP).

Archaeological Resources

Archaeological resources encompass Native American occupation sites and late 19th and early 20th century Euro-American cultural resources associated with mining, canal and railroad construction, emigration and homesteading, agriculture, and ranching. Archaeological surveys and investigations conducted in southeastern Idaho have provided evidence of human use of the ESRP for at least 12,500 years, which is supported by radiocarbon dates on excavated materials from Owl Cave at the Wasden site located on private land near the INL Site. Numerous collapsed lava tubes and caves on the INL Site provide evidence of pre-contact occupation. Recognizing the importance of these resources, Aviator's Cave was listed on the NRHP in 2010.

Southeastern Idaho is also rich with cultural resources that reflect the settlement and development of the region by Euro-American explorers and settlers. As the westward expansion entered the region, artifacts and features were left behind that provide a record of historic uses and development of the area. Many of these cultural resources exist within the INL Site boundaries. The region is etched with historic trails used by emigrants on their way to Oregon and California, prospectors headed to the gold fields, and settlers who attempted to homestead the area. Many of these trails were also used for cattle drives and, in the late 1800s, as stage and freight routes, to support mining towns in central Idaho. Encouraged by the Carey Act, homesteaders attempted to settle and farm the area along the Big Lost River in the late 1800s and early 1900s, but irrigation efforts in the high desert climate failed. Subsequently, homesteads were abandoned, and Euro-American settlement and development of the region ceased (DOE 2002a).

The area of the proposed VTR facility construction was subject to intensive pedestrian archaeological survey. The investigation identified five pre-contact cultural resources, but none of the resources were determined to meet the threshold of significance to be recommended as eligible for listing on the NRHP (Lee 2020).

Historic Resources

Resources within the built environment consist of modern roads, railroad tracks, irrigation canals, and transmission and telephone lines, along with buildings and landscape features associated with the Arco Naval Proving Ground and the National Reactor Testing Station's nuclear energy research beginning in 1949. MFC was initially established as Argonne National Laboratory – West (ANL-W) and was operated by the University of Chicago from 1949 to 2005. Prior to the development of the second Experimental Breeder Reactor (EBR-II) at ANL-W, researchers and operators successfully demonstrated the creation of usable quantities of electricity at EBR-I for the Atomic Energy Commission (AEC). EBR-I, located over 18 miles west of MFC, was designated as a National Historic Landmark by President Lyndon B. Johnson in 1966 for its outstanding historical significance in reactor development and design. Following decontamination, in 1975 the Reactor Building and associated Office Annex were opened as a public Visitor Center.

MFC, which is located about 38 miles west of Idaho Falls in Bingham County, is in the southeastern corner of the INL Site. MFC is about 100 acres (inside the MFC fence) and about 2.7 miles from the southern INL Site boundary. MFC is engaged in advanced nuclear power research and development, spent fuel and waste treatment technologies, national security programs, and projects to support space exploration. Since it was established in 1949, MFC's primary mission has been to take nuclear power systems through the steps from design to demonstration.

Five buildings within MFC have been proposed for modification to support fabrication of VTR driver fuel: the Hot Fuels Examination Facility (HFEF), the Irradiated Materials Characterization Laboratory (IMCL), the Fuel Conditioning Facility (FCF), the Zero Power Physics Reactor (ZPPR), and the Fuel Manufacturing Facility (FMF). Internal reconfiguration activities within these existing MFC facilities, in which additional equipment would be installed for proposed post-irradiation testing, spent fuel treatment, and fuel fabrication, are exempt from cultural resource review by agreement among the INL Site, the Idaho State Historic Preservation Officer, the Advisory Council on Historic Preservation, and the Shoshone-Bannock Tribes (INL 2016f:51). Construction of the SFSA will require the removal of the existing guardhouse, MFC-

1741. The guardhouse was constructed in 2016 and does not meet the standard 50-year age requirement for historic significance. Another facility, the Experimental Fuels Facility may also be used for testing VTR Fuel cladding. However, no modifications are anticipated.

Table 3–5 lists the NRHP status of the seven existing facilities within the MFC that are proposed for use or removal in operations of the VTR, including post-irradiation testing and spent fuel treatment.

Table 3–5. Materials and Fuels Complex Facilities Proposed for Use in Operations of the VTR

Facility Name	*Facility Number*	*Year Built*	*NRHP Eligibility*	*Proposed Action*
Fuel Manufacturing Facility (FMF)	MFC-704	1986	Not Eligible	Internal Modification
Fuel Conditioning Facility (FCF)	MFC-765	1963	Eligible	Internal Modification
Zero Power Physics Reactor (ZPPR)	MFC-776	1968	Eligible	Internal Modification
Hot Fuels Examination Facility (HFEF)	MFC-785	1972	Eligible	Internal Modification
Experimental Fuel Facility (EFF)	MFC-794	1975	Not Eligible	No Modification [a]
Irradiated Materials Characterization Laboratory (IMCL)	MFC-1729	2012	Not Eligible	Internal Modification
Guardhouse	MFC-1741	2016	Not Eligible	Demolition

[a] The Experimental Fuels Facility may be used for testing VTR Fuel cladding but no modifications are anticipated.
Source: INL 2016f.

3.1.6.3 Paleontological Resources

Paleontological resources are fossils of plants or animals from a former geologic age used to investigate prehistoric biology and ecology. Survey and evaluation for paleontological remains within the INL Site boundaries have identified several fossils that suggest that the region contains varied paleontological resources. Analyses of these materials and site locations suggest that these types of resources are found in areas of basalt flows, particularly in sedimentary interbeds or lava tubes within local lava flows, and in some wind and sand deposits. Other and more specific areas in which these resources are likely to occur are in the deposits of the Big Lost River, Little Lost River, Birch Creek, and Lake Terreton and playas. Vertebrate and invertebrate animals, pollen, and plant fossils have been discovered in caves, in lake sediments, and in alluvial gravels along the Big Lost River. Twenty-four paleontological localities have been identified in published data. Vertebrate fossils include mammoth and camel remains, and a horse fossil identified in a borrow source near the CFA (NRC 2004). Paleontological resources are not governed by the same set of laws that apply to cultural resources, but are managed in the same way under the *INL Cultural Resources Management Plan* (INL 2016f).

3.1.7 Infrastructure

Site infrastructure includes those basic resources and services required to support planned construction and operations activities and the continued operations of existing facilities. For the purposes of this EIS, infrastructure is defined as electricity, fuel, water, and sewage. The ROI for infrastructure includes those items at MFC. Waste management and transportation infrastructure are addressed separately in Sections 3.1.9 and 3.1.12, respectively.

Capacities and characteristics of INL's utility infrastructure are summarized in **Table 3–6**. Section 3.1.12, Traffic, addresses local and regional transportation, infrastructure, and waste and material shipments.

Table 3–6. Idaho National Laboratory Site-Wide Infrastructure Characteristics

Resource	*Site Usage*	*Site Capacity*
Electricity		
Energy Consumption (megawatt-hours per year)	186,255	481,800 [a]
Peak Load (megawatts)	36	55
Fuel		
Natural Gas (cubic feet per year)	902,001	Not applicable
Fuel Oil for Heating (gallons per year)	571,028	Not limited [b]
Diesel Fuel (gallons per year)	262,909	Not limited [b]
Gasoline (gallons per year)	627,007	Not limited [b]
Propane (gallons per year)	754,699,070	Not limited [b]
Water (gallons per year)	902,001	11.400,000,000 [c]

[a] Limited by contract with the Idaho Power Company.
[b] Capacity is limited only by the ability to ship resources to the site.
[c] Water right allocation.
Source: Nelson 2020.

3.1.7.1 Electricity

Commercial electric power is delivered by contract with Idaho Power Company to supply the operating areas of the INL Site by way of an extensive power transmission and distribution system (see **Figure 3–9**). Offsite power feeds into the INL Site power transmission system through the Scoville substation. Power to the Scoville substation and the INL Site is provided via two 230-kilovolt (kV) transmission lines from Rocky Mountain Power's Antelope substation. At the Antelope substation, the voltage is stepped down to 138 kV, then transmitted to the DOE-owned Scoville substation via two redundant feeders. The Antelope substation feeds the Scoville substation via three different transformers, a pair of 161kV-138kV transformers, and a single 230kV-161kV transformer, fed from three local utilities. The Scoville substation is the end and the beginning of the 138kV INL loop (Nelson 2020).

The current contract allows for a total power demand of up to 50,000 kilowatts (50 megawatts [MW]), but can be increased to 55,000 kilowatts (55 MW) if advance notice is provided to Idaho Power. Power demand above this transmission would need to be negotiated with Idaho Power.

The INL Site power system consists of eight substations, with two more under construction, and nearly 70 miles of aboveground 138-kV-rated high-voltage transmission lines. Much of the system is looped, which provides a reliable and redundant source of power (Wayment et al. 2019). A separate 6.2-mile, 138-kV line feeds the INL Radioactive Waste Management Complex with capacity in excess of 20 MW. The distribution system ranges in voltage from 13.8 to 2.4 kV and is composed of about 60 miles of overhead lines and several miles of underground lines. The transmission loop capacity is 50 MW.

Electrical energy available to the INL Site is about 481,800 MW-hours per year based on the contract load limit of 55,000 kilowatts (55 MWs) for 8,760 hours per year. Current electrical energy consumption at the INL Site is 186,255 MW-hours annually. The recorded peak load was about 39 MWs; current electrical usage at MFC is about 28,700 MW-hours per year (Nelson 2020).

The current power transmission system is over 50 years old and is limited by available contractual supply capacity and voltage-drop problems directly related to the location where loads are applied on the loop. The current system can only support an approximate increase in peak demand of 20 MW to 30 MW and still maintain acceptable power quality (Wayment et al. 2019).

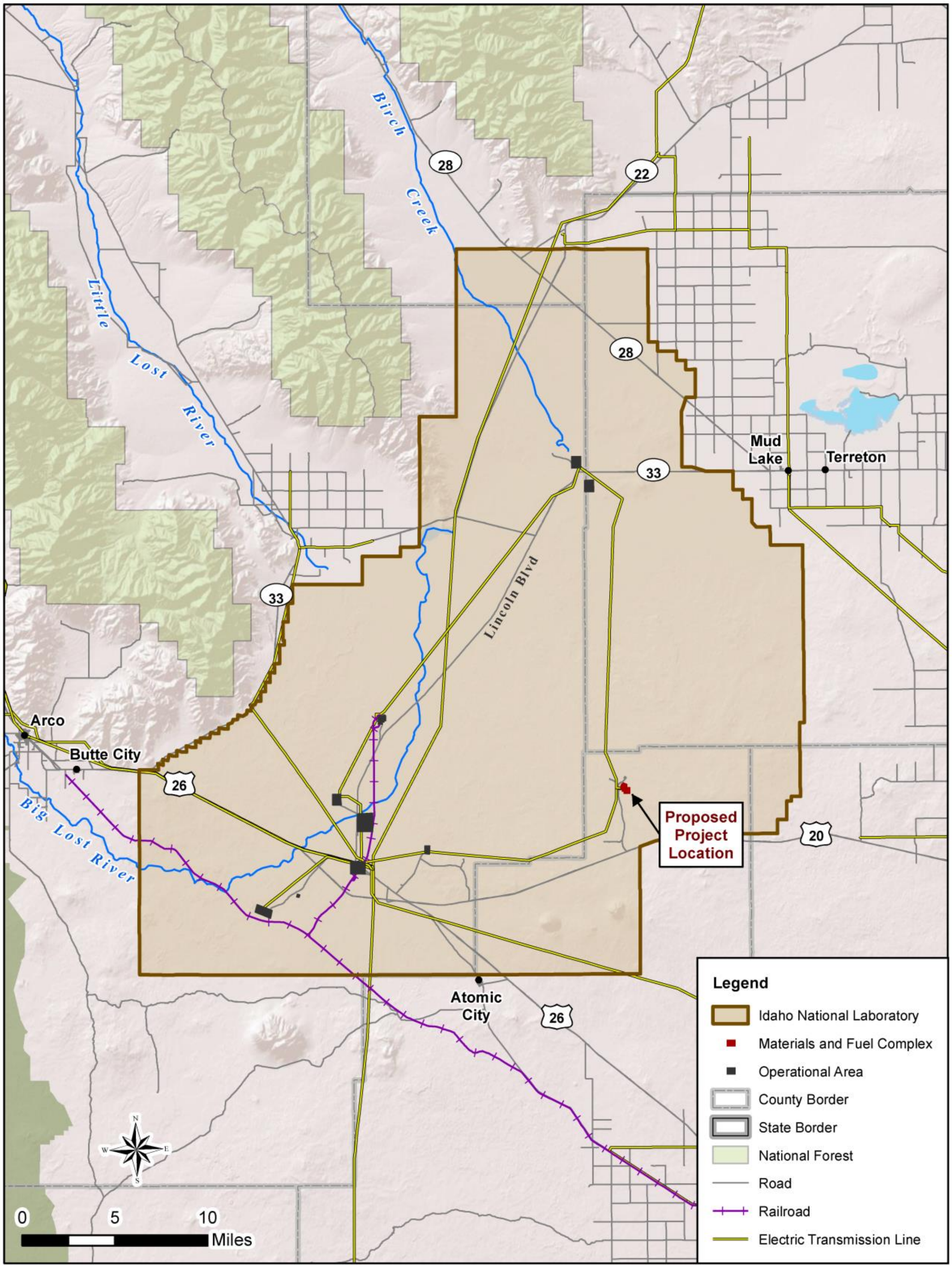


Figure 3–9. Idaho National Laboratory Infrastructure (includes electrical distribution, roads, and rail lines)

Electricity at MFC is supplied by the INL Site's transmission loop system. Annual electric consumption at MFC is just over 35.4 megawatt-hours (MWh). Annual electric usage for selected facilities at MFC is indicated in **Table 3–7**.

Table 3–7. Electrical Usage for Facilities on the Materials and Fuels Complex (kilowatt-hour)

Building Number	*FY 2015*	*FY 2016*	*FY 2017*	*FY 2018*	*FY 2019*	*Average*
MFC-704 Fuel Manufacturing Facility	697,566	812,552	833,029	769,870	835,376	789,679
MFC-765 Fuel Conditioning Facility	NA	NA	NA	2,071,180	2,064,979	2,068,080
MFC-768 Power Plant	1,996,422	1,423,303	106,363	1,200,155	1,303,763	1,206,001
MFC-774 Electron Microscopy Laboratory	NA	984,247	1,182,244	1,068,566	933,242	1,042,075
MFC-784 Advanced Fuels Facility	68,707	87,448	119,504	103,902	99,299	95,772
MFC-785 Hot Fuel Examination Facility (HFEF)	NA	2,542,919	2,607,832	2,219,233	2,365,578	2,433,891

NA = data not available.
Source: Nelson 2020.

3.1.7.2 Fuel

Fuel consumed at INL includes natural gas, fuel oil (for heating), diesel fuel, gasoline, and propane. All fuels are transported to the site for use and storage. There are no gas or oil lines on the INL Site, although individual facilities may have propane or fuel storage tanks (INL 2015b). Fuel storage is provided for each facility and inventories are restocked as needed. INL site-wide fuel oil consumption was about 902,000 gallons in 2019 (Nelson 2020). In 2019, natural gas consumption was about 3,149,200 cubic feet, total diesel fuel consumption was about 571,000 gallons, total gasoline consumption was about 262,900 gallons, and total propane consumption was about 627,000 gallons (see Table 3–5) (Nelson 2020).

3.1.7.3 Water

The SRPA supplies all water used at the INL Site. Water is provided to the INL Site by a system of about 30 wells, pumps, and storage tanks. DOE holds the Federal Reserved Water Right of 11.4 billion gallons per year for the site. In 2019, INL's production well system withdrew a total of about 755 million gallons of water, which represents about 6.6 percent of the Federal Reserved Water Right for the INL Site (Nelson 2020).

The MFC water supply and distribution system is a combination fire-protection, potable, and service water supplied from an underground aquifer via two onsite deep production wells. The two deep wells (EBR-II #1 and EBR-II #2) have a pumping capacity of 800 gallons per minute or 420 million gallons annually. These wells can be connected with control valves to either a storage tank or directly to the distribution system, as necessary. The two wells at MFC withdrew 26,754,578 gallons, or about 3.5 percent of the total water withdrawn across INL (INL 2018b). Typically, well water is pumped to a 400,000-gallon primary storage tank and then through the distribution system for potable, service, and fire-protection use. A second 400,000-gallon water storage tank, reserved for fire protection, is maintained at full capacity. Currently, MFC water demand and usage from its two production wells is about 48 million gallons annually. Accurate potable water flow information is difficult to determine. MFC's water supply demands average 50-60 gallons per minute and the system flows from 20-225 gallons per minute throughout the year. Water demand spikes are most likely due to fire water testing (INL 2019h).

The existing firewater supply system for MFC consists of a looped network of buried 6-, 8-, 10-, 12-, and 14-inch diameter fire mains. The lead-ins to the buildings are typically 6 inches in diameter. Piping materials differ depending on the era of installation and includes cast iron, ductile iron, cement-lined ductile iron, and polyvinyl chloride. The system is designed so that if any segment of the firewater main is isolated, water can be supplied through an alternate flow path (INL 2019h).

3.1.7.4 Sanitary Sewer

MFC has an existing sanitary sewer system to collect and treat domestic wastewater from the facilities. The majority of the facilities are served by a collection system consisting of gravity sewers and several lift stations and force mains. Collected wastewater is conveyed to one of two lift stations that pump the wastewater through a 4-inch high-density polyethylene force main to three total containment sewage lagoons for final disposal and evaporation. Some small areas of MFC are served by local onsite subsurface disposal systems and are independent from the primary collection system. The existing MFC wastewater lagoons were designed for flows of about 14,950 gallons per day. Based on information provided by MFC staff in 2017, the average daily flow to the lagoons was about 7,840 gallons per day (INL 2019h).

3.1.7.5 Industrial Wastewater

MFC industrial wastewater operates using a collection system consisting of gravity pipelines, ditches, and structures located throughout the MFC site. Collected wastewater is conveyed to an industrial wastewater pond, permitted by IDEQ, located outside the perimeter security fence near the northwest corner of the facility. MFC currently generates 7 to 8 million gallons of industrial wastewater per year; the permit from the IDEQ for the existing industrial wastewater pond allows 17 million gallons per year (INL 2019h).

3.1.7.6 Telecommunications

MFC uses existing INL Site telecommunications services for telephone and business and research data network needs. Services are provided to buildings via fiber optic and copper cabling from MFC-1728 where telephone, INL Site data network, Private Facility Controls Network, security systems, and life safety systems are housed. The existing MFC telecommunications infrastructure system is comprised of a main dial room, an auxiliary dial room, and telecommunications manhole/duct system (INL 2019h).

3.1.8 Noise and Vibration

The ROI for noise extends 0.5 mile from the edge of the construction area, and is the area that could be susceptible to noise impacts.

This EIS considers the following data sources for characterizing the noise environment and vibration:

- Aerial photography to identify potential noise-sensitive receptors near the project area, including the Google Earth™ imagery for counties within the project area.
- The 2018 U.S. Department of Transportation (DOT) Federal Transit Administration Transit Noise and Vibration Impact Assessment methodology to estimate ambient, construction, and operational noise levels and to evaluate general noise and vibration concepts (DOT 2018).
- EPA methodology for noise concepts and limits (EPA 1978).
- 2018 Idaho National Laboratory Site Environmental Report (INL 2019c).

3.1.8.1 Noise and Vibration Overview

Sound is a physical phenomenon consisting of vibrations that travel through a medium, such as air, and are sensed by the human ear. Noise is defined as any sound that is undesirable because it interferes with communication, is intense enough to damage hearing, or is otherwise intrusive. Human response to noise varies, depending on the type and characteristics of the noise, distance between noise source and receptor, receptor sensitivity, and time of day. Noise is often generated by activities essential to a community's quality of life, such as construction or vehicular traffic.

Sound varies by both intensity and frequency. Sound also can be quantified in terms of its amplitude (loudness) and frequency (pitch). The physical intensity or loudness level of noise is expressed quantitatively as the sound pressure level. Sound pressure levels are defined in terms of decibels (dB), which are measured on a logarithmic scale. Frequency is measured in hertz, which is the number of cycles per second. The typical human ear can hear frequencies ranging from about 20 hertz to 20,000 hertz. Typically, the human ear is most sensitive to sounds in the middle frequencies where speech is found and is less sensitive to sounds in the low and high frequencies.

> **Sound** is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air. The human ear experiences sound as a result of these pressure variations in the air.
>
> **Noise** is defined as any unwanted sound.

Because the human ear cannot perceive all pitches or frequencies equally, measured noise levels in dB will not reflect the actual human perception of the loudness of the noise. Thus, the sound measures can be adjusted or weighted to correspond to a scale appropriate for human hearing. The common sound descriptors used to evaluate the way the human ear interprets dB from various sources are as follows:

- **Decibel (dB)**: Sound intensity is measured by sound pressure in levels known as decibels. The decibel is a logarithmic unit that expresses the ratio of a sound pressure level to a standard reference level.
- **A-Weighted Decibel Scale (dBA):** Often used to describe the sound pressure levels that account for how the human ear responds to different frequencies and perceives sound.
- **Hertz**: Measurement of frequency or pitch.
- **Equivalent Sound Level (L_{eq}):** The L_{eq} represents the average sound energy over a given period, presented in decibels.
- **Day-Night Average Sound Level (L_{dn}):** The L_{dn} is the 24-hour L_{eq}, but with a 10-dB penalty added to nighttime noise levels (10 p.m. to 7 a.m.) to reflect the greater intrusiveness of noise experienced during this time.
- **Sensitive Receptors**: Locations or land uses associated with indoor or outdoor areas inhabited by humans that may be subject to significant interference from noise (i.e., nearby residences, schools, hospitals, nursing home facilities, and recreational areas).

Table 3–8 presents a list of sounds encountered in daily life and their approximate levels in dBA. **Table 3–9** presents the typical sound levels associated with residential communities.

Table 3–8. Examples of Common Sound Levels

Noise Level (dBA)	Description	Typical Sources
140	Threshold of pain	–
120	Uncomfortably loud	Jet aircraft
100	Very loud	Diesel truck
80	Moderately loud	Motor bus
60	Moderate	Low conversation
40	Quiet	Quiet room
20	Very quiet	Leaves rustling

dBA = A-weighted decibel.
Source: Liu and Lipták 1997.

Table 3–9. Typical L_{90} Sound Levels in Residential Communities

Description	Typical Range (dBA)	Average (dBA)
Very Quiet Rural or Remote Area	26 to 30	28
Very Quiet Suburban or Rural Area	31 to 35	33
Quiet Suburban Residential	36 to 40	38
Normal Suburban Residential	41 to 45	43
Urban Residential	46 to 50	48
Noisy Urban Residential	51 to 55	53
Very Noisy Urban Residential	56 to 60	58

dBA = A-weighted decibel.
Note: L_{90} is the level exceeded for 90 percent of the time. For 90 percent of the time, the noise level is above this level. It is generally considered to be representing the background or ambient level of a noise environment.
Source: EPA 1974.

Ambient or background noise is a combination of various sources heard simultaneously. Calculating noise levels for combinations of sounds does not involve simple addition, but instead uses a logarithmic scale (HUD 1985). As a result, the addition of two noises, such as a garbage truck (100 dBA) and a lawn mower (95 dBA) would result in a cumulative sound level of 101.2 dBA, not 195 dBA.

Noise levels decrease (attenuate) with distance from the source. The decrease in sound level from any single noise source normally follows the "inverse square law." That is, the sound level change is inversely proportional to the square of the distance from the sound source (DOT 2018). Barriers, both manmade (e.g., sound walls, buildings) and natural (e.g., forested areas, hills) may reduce noise levels, as may other natural factors, such as temperature, humidity, and wind direction (EPA 1978). Persistent and escalating sources of sound are often considered annoyances and can interfere with normal activities, such as sleeping or conversation, so that these sounds could disrupt or diminish quality of life.

Vibration refers to the oscillations or rapid linear motion of parts of a fluid or elastic solid. Vibration is often expressed in terms of the peak particle velocity, as inches per second or millimeters per second, when used to evaluate human annoyance and building damage impacts. Common sources of ground-borne vibration are trains, heavy construction machinery, and groundbreaking construction activities such as blasting, drilling, and operating heavy earth-moving equipment. The impacts of ground-borne vibration include perceptible movement of the building floors, rattling of windows, shaking of items on shelves or hanging on walls, and rumbling sounds. In severe cases, the vibration can cause damage to buildings (DOT 2018).

While there are no Federal standards for vibration, various researchers and organizations have published guidelines. The human response to vibration involves barely perceptible vibration levels (in peak particle velocity) of 0.01 inches per second, distinctly perceptible levels of 0.04 inches per second, and strongly perceptible levels of 0.10 inches per second (Jones and Stokes 2004). Continuous, frequent, or intermittent vibration sources are typical of construction activities. Additionally, 0.2 inches per second is the threshold at which there is a risk of architectural damage to normal structures, such as dwellings (Jones and Stokes 2004).

3.1.8.2 Noise Regulations

The Noise Control Act of 1972 (42 U.S.C. 4901) directs Federal agencies to comply with applicable Federal, State, interstate, and local noise control regulations. The primary responsibility of addressing noise pollution has shifted to State and local governments. In 1974, EPA published its document entitled *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*, which evaluated the effects of environmental noise with respect to health and safety (EPA 1974). The document provides information for State and local agencies to use in developing their ambient noise standards. As set forth in the publication, an L_{dn} of 55 dBA outdoors and 45 dBA indoors is the threshold above which noise could cause interference or annoyance (EPA 1974).

Aside from the Noise Control Act of 1972, the noise levels associated with the construction and operation of VTR would be regulated by 40 CFR Part 204, Noise Emissions Standards for Construction Equipment.

Except for the prohibition of nuisance noise, neither the State of Idaho nor local governments have established any regulations that specify acceptable community noise levels applicable to the INL Site. In the absence of standardized criteria for a detailed assessment of construction noise, the Federal Transit Administration recommends construction noise levels for the sensitive receptor in residential areas should not exceed the following levels:

- An 8-hour L_{eq} of 80 dBA during daytime (7 a.m. to 10 p.m.),
- An 8-hour L_{eq} of 70 dBA during nighttime (10 p.m. to 7 a.m.), or
- A 30-day average L_{dn} of 75 dBA (DOT 2018).

3.1.8.3 Existing Noise Environment

The major noise sources within the INL Site include industrial facilities, equipment, and machines (e.g., cooling systems, transformers, engines, pumps, boilers, steam vents, intercom paging systems, construction and materials-handling equipment, and vehicles). Most INL industrial facilities are far enough from the site boundary that noise levels from these sources are not measurable or are barely distinguishable from background levels at the boundary.

The primary existing noise at the INL Site results from transportation-related activities including transportation of people and materials to and from the site and in-town facilities via buses, trucks, private vehicles, and freight trains. During a typical workweek, the majority of the employees are transported to various work areas at the INL Site by buses covering about 70 routes. Approximately 1,200 private vehicles also travel to and from the INL Site daily. Rail transport for the INL Site typically occurs no more than one train per day and usually less than one train per week (NRC 2004). Homeland Security's occasional explosive tests at the INL Site and detonation of unexploded ordnance also contribute to the noise at the INL Site.

The proposed VTR site would be located on the east side of MFC, which includes a number of noise-generating sources such as industrial heating, ventilation, and air conditioning equipment, blowers, moving equipment, and forklifts. Nearly all of this equipment is housed inside existing buildings. Noise measurements were obtained in Spring 2020 at 23 different locations outside existing facilities that could provide support for VTR operations, fuel fabrication, and post-irradiation examination. Noise readings ranged from 42.3 dBA to 65.9 dBA and are relatively consistent throughout the day.

Historical noise measurement data obtained from sites within 50 feet of U.S. Highway 20 indicate traffic noise ranges from about 64 to 86 dBA, with buses identified as the primary source, contributing from 71 to 80 dBA (NRC 2011). Buses operate off the INL Site but are part of the normal levels of traffic noise in the community. Industrial activities (i.e., shredding paper documents) at the CFA produce the highest noise levels measured at 104 dBA. Noise generated at the INL Site is not detectable off site because all existing primary facilities are at least 3 miles from site boundaries. In addition, previous studies on effects of noise on wildlife indicate that even high intermittent noise levels at the INL Site (more than 100 dBA) would not affect wildlife productivity (NRC 2004).

The proposed VTR site is about 2.9 miles from the INL Site boundary. The Bingham County parcel data identified the land directly adjacent to this portion of the INL Site border as zoned as a natural resource area and owned by the State of Idaho and BLM. The closest noise-sensitive receptor is an agricultural homestead that is about 5.0 miles from the VTR site and about 1.9 miles from U.S. Highway 20, which is expected to be the primary noise at this location.

The existing noise levels in a particular area are generally based on its proximity to nearby major roadways or railroads or on population density (DOT 2018). The land surrounding the proposed VTR site and existing MFC is uninhabited and the location of the closest sensitive receptor is rural. U.S. Highway 20 accounts for the majority of potential noise for the closest sensitive receptor, but since it is more than 800 feet away, it is not considered a major source. Therefore, ambient noise levels were estimated based on the population density of the affected county using the methodology described in the DOT *Transit Noise and Vibration Impact Assessment* (DOT 2018).

According to the U.S. Census Bureau, the population density of the Bingham County is about 22 people per square mile (Census 2010a). As a result, the existing L_{dn} in the vicinity of the proposed VTR site is estimated to be 35 dBA, and the existing ambient equivalent continuous sound levels (in L_{eq}) during daytime and nighttime are estimated to be about 35 and 25 dBA, respectively (DOT 2018). Ambient (background) noise levels could occur from roadway traffic, farm machinery, pets, and various other household noises. The closest Federal and State parks to the proposed VTR site are Craters of the Moon National Monument and Preserve, Harriman State Park, and Massacre Rocks State Park, which are about 40 miles southwest, 62 miles northeast, and 67 miles southwest of the proposed VTR site, respectively. Other nearby recreation areas include the Hells Half Acre Lava Field, about 10 miles southeast, and Middle Butte, about 7.5 miles southwest of the proposed VTR site. The INL Site is designated as a NERP to provide protected lands that act as buffers around DOE facilities and provide environmental research and education (see Section 3.1.1.1 for additional details).

3.1.9 Waste and Spent Nuclear Fuel Management

This section describes the current average annual "baseline" generation rates and management practices for the waste categories that will be generated if the VTR alternative and a fuel fabrication scenario are implemented at the INL Site (INL 2020a). The ROI for waste management activities includes everything within the INL Site boundaries. Offsite locations (together with other DOE and commercial facilities) are not included in the waste management ROI. The potential impacts at these non-INL Site disposition facilities were considered as part of the licensing/permitting/approval process for these sites and are not detailed in this document. There would be no additional impacts, including exposure to the offsite public or onsite workers. All waste disposition actions would comply with the licenses, permits, and/or approvals applicable to the facilities described in this document. Those waste categories are: (1) low-level radioactive waste (LLW), mixed low-level radioactive waste (MLLW), and transuranic (TRU) waste, (2) Resource Conservation and Recovery Act (RCRA) Hazardous and Toxic Substances Control Act (TSCA) wastes, (3) and nonhazardous solid waste and recyclable materials. High-level radioactive waste (HLW) is also managed at the INL Site; however, no HLW would be generated under the VTR alternative or the fuel fabrication scenario and therefore will not be discussed further in the section. Additionally, while not a waste, spent nuclear fuel also would be generated and is discussed in this section. **Table 3–10** presents the latest available 5-year annual generation by waste category.

Table 3–10. 5-Year Annual "Baseline" Generation by Waste Category in Cubic Meters

	2015		*2016*		*2017*		*2018*		*2019*		*Average*	
Waste Type	***INL***	***MFC***	***INL***	***MFC***	***INL***	***MFC***	***INL***	***MFC***	***INL***	***MFC***	***INL***	***MFC***
LLW	9,900	460	12,000	710	4,300	400	6,900	720	10,000	800	8,600	620
MLLW	2,800	20	3,300	36	8,700	47	4,700	19	3,700	38	4,600	32
TRU	1,700	0.18	1,600	0	870	0	740	0	650	9.0	1,100	1.8
Hazardous and TSCA	59	22	35	9.0	13	8.3	35	9.3	83	32	45	16
C&D	520	53	310	8.5	650	33	670	14	790	10	590	24

C&D = construction and demolition and industrial waste; INL = Idaho National Laboratory; LLW = low-level radioactive waste; MFC = Materials and Fuels Complex; MLLW = mixed low-level radioactive waste; TRU = transuranic waste.
Note: All numbers are rounded to two significant figures. Due to rounding, sums and products may not equal those calculated from table entries.
Source: INL 2020a.

3.1.9.1 Low-Level Waste, Mixed Low-Level Waste, and Transuranic Waste

Low-Level Waste

DOE Order 435.1, "Radioactive Waste Management" was issued to ensure that all DOE radioactive waste is managed in a manner that protects the environment, worker, public safety, and health. This order, effective July 1, 1999, includes the requirements that must be met by DOE in managing radioactive waste. LLW is generated as a result of current routine and D&D activities. LLW is transported to the INL Site's Radioactive Waste Management Complex (RWMC) where it is characterized and packaged consistent with the applicable waste acceptance criteria and shipped in accordance with DOT requirements. LLW scrap from the Naval Reactor Facility (NRF) is placed in the subsurface disposal area at the RWMC. Newly generated remote-handled LLW is disposed of at the Remote Handled Low-Level Waste Facility near the ATR Complex. Other LLW is sent off site.

Mixed Low-Level Waste

The Federal Facilities Compliance Act (FFCA) requires the preparation of site treatment plans for the treatment of mixed waste stored or generated at DOE facilities. Mixed waste contains both hazardous and radioactive components. The INL Site's FFCA Site Treatment Plan was signed by the State of Idaho on November 1, 1995, and is updated annually. This plan outlines DOE's proposed treatment strategy for the INL Site's mixed-waste streams. The Mixed Waste Management Plan specifies the requirements for management of MLLW in accordance with the State of Idaho requirements for RCRA hazardous constituents and DOE requirements for the radiological constituents. MLLW is transported to the INL Site's RWMC where it is characterized and packaged consistent with the applicable waste acceptance criteria and shipped in accordance with DOT requirements. MLLW is shipped off site for disposal at the Nevada National Security Site (NNSS) or treatment, disposal, or both through commercial waste processing vendors.

Transuranic Waste

On October 16, 1995, DOE, the U.S. Navy, and the State of Idaho entered into an agreement (the Idaho Settlement Agreement) that guides management of spent nuclear fuel and radioactive waste at the INL Site (DOE/Navy/ID 1995). The Agreement limits shipments of DOE and Naval spent nuclear fuel into the State and sets milestones for shipments of spent nuclear fuel and radioactive waste out of the State. The FFCA Site Treatment Plan and the Idaho Settlement Agreement require DOE to process and ship all waste stored as TRU waste on the INL Site in 1995. When the agreements were signed, all of these wastes were to be shipped out of Idaho by December 31, 2018. In February 2014, the shipment of TRU waste was curtailed due to the suspension of the Waste Isolation Pilot Plant (WIPP) operations in Carlsbad, New Mexico. However, during that time INL continued to characterize and package TRU waste for shipment and disposal. In April of 2017, shipments resumed to the WIPP facility. The Idaho Cleanup Project Core manages and operates a number of projects to facilitate the disposition of radioactive waste as required by the Idaho Settlement Agreement and Site Treatment Plan. The Idaho Cleanup Project performs retrieval, characterization, treatment, packaging, and shipment of TRU waste currently stored at the INL Site. The vast majority of the waste processed at the INL Site resulted from the manufacture of nuclear components at DOE's Rocky Flats Plant in Colorado. This waste is contaminated with TRU radioactive elements (primarily plutonium).

3.1.9.2 Resource Conservation and Recovery Act Hazardous and Toxic Substances Control Act/Mixed Toxic Substances Control Act Wastes

Resource Conservation and Recovery Act Hazardous Wastes

RCRA established regulatory standards for generation, transportation, storage, treatment, and disposal of hazardous waste. The IDEQ is authorized by EPA to regulate hazardous waste and the hazardous components of mixed waste at the INL Site. Mixed waste contains both radioactive and hazardous materials. The Atomic Energy Act, as administered through DOE orders, regulates radioactive wastes and the radioactive part of mixed wastes. Radioactive waste management is discussed above in Section 3.1.9.1. The INL Site's RCRA hazardous waste permit contains two parts: Part A and Part B. The INL Site currently has two RCRA Part A permit volumes and seven Part B permit volumes. Parts A and B are considered a single RCRA permit that comprises several volumes. As required by the State of Idaho, the INL Site annually submits the Hazardous Waste Generator Annual Report on the types and quantities of hazardous wastes generated, shipped for treatment and disposal, and remaining in storage. The predominant source of RCRA hazardous wastes are from D&D activities. RCRA hazardous waste is treated and disposed at offsite facilities and transported by a commercial transport contractor.

Toxic Substance Control Act Wastes/Mixed Toxic Substance Control Act Wastes

The TSCA, which is administered by EPA, requires regulation of the production, use, and/or disposal of chemicals. TSCA supplements sections of the CAA, the Clean Water Act, and the Occupational Safety and Health Act. Because the INL Site does not produce chemicals, compliance with the TSCA is primarily directed toward use and management of certain chemicals, particularly polychlorinated biphenyls. For example, polychlorinated biphenyls-containing light ballasts are being removed at buildings undergoing demolition. The ballasts are disposed of off the INL Site at a TSCA-approved disposal facility. TSCA/mixed TSCA wastes are treated and disposed at offsite facilities and transported by a commercial transport contractor.

3.1.9.3 Nonhazardous Solid Waste and Recyclable Materials

Nonhazardous solid waste and recyclable materials are routinely generated as a result of current routine and D&D activities. Nonhazardous solid waste is primarily disposed of at the INL Site's CFA Landfill

Complex. The INL Site's CFA Landfill Complex is operated in accordance with State of Idaho regulations. The remaining capacity of the INL Site's CFA Landfill Complex is about 3.4 million cubic meters. Nonhazardous solid waste items that cannot be disposed at the INL Site's CFA Landfill Complex are sent off site to a commercial disposer. As much as possible, recyclable materials are segregated from the solid waste stream in accordance with waste minimization and pollution prevention protocols. Most solid metal waste is accumulated and sold to a scrap salvage vendor. In addition, batteries, plastic and aluminum beverage containers, tin cans, paper, and cardboard materials are collected for recycling. Scrap wood is sent to the INL Site's CFA Landfill Complex to be chipped and reused for mulch.

3.1.9.4 Spent Nuclear Fuel

Spent nuclear fuel is nuclear fuel that has been withdrawn from a nuclear reactor following irradiation and the constituent elements have not been separated. Spent nuclear fuel contains unreacted uranium and radioactive fission products. Because of its radioactivity (primarily from gamma rays), it must be properly shielded. DOE's inventory of spent nuclear fuel is from development of nuclear energy technology (including foreign and domestic research reactors), national defense, and other programmatic missions. At the INL Site, spent nuclear fuel is managed by Fluor Idaho, the Idaho Cleanup Project Core contractor at INTEC, the Naval Nuclear Propulsion Program at the Naval Reactors Facility, and BEA, the INL Site's contractor at the ATR Complex and MFC. The 1995 Idaho Settlement Agreement (DOE/Navy/ID 1995) put into place milestones for the management of radioactive waste and spent nuclear fuel at the INL Site.

In order to resume shipments of spent nuclear fuel to Idaho, including spent nuclear fuel rods for research purposes from the Byron Nuclear Generating Station in Illinois, DOE and the State of Idaho developed the 2019 Supplemental Agreement (DOE-ID & Idaho 2019) to the 1995 Settlement Agreement.

To resolve uncertainty about how commitments made in the 1995 Settlement Agreement to eliminate wet storage of spent nuclear fuel apply to operations of ATR, DOE and the State of Idaho entered into the 2020 Advanced Test Reactor Spent Nuclear Fuel Agreement (DOE-ID & Idaho 2020).

3.1.10 Human Health – Normal Operations

The impact on human health during normal facility operations addresses the potential impacts from exposure to ionizing radiation and chemicals. Potential human health impacts from exposure to radiation from normal operational conditions is considered for both an individual and the population as a whole for both the public and site workers; this constitutes the ROI. For the existing environment, the public population is considered to be all people living within 50 miles of the operational areas at the INL Site. The maximally exposed individual is considered to be a hypothetical person who could receive the maximum possible dose from releases at the INL Site. In addition, for workers the potential human health impacts associated with exposure to workplace chemicals are considered.

3.1.10.1 Radiation Exposure and Risk

DOE monitors radiation in the environment and exposure of workers and calculates the radiation doses of members of the offsite general public and onsite workers from operation at the INL Site. **Table 3–11** presents data on radiation doses to the public for the years 2014 through 2018. The maximum radiation dose to an offsite member of the public during this period as a result of onsite facility operations was estimated to be 0.53 millirem per year (INL 2016b). The risk of developing a latent cancer fatality (LCF) from this dose is extremely small, much less than 1 in a million. The calculation of this total dose considers the maximum dose to an individual from air emissions and from the consumption of wildlife harvested in the vicinity of the INL Site. The maximum dose to an offsite individual does not include a contribution from drinking water. Although tritium has been detected in three USGS monitoring wells along the southern INL Site boundary, there are no drinking water wells near this location. This groundwater contamination does not contribute to a public dose, either individually or collectively. The average annual dose to an individual from INL Site operations is much less than one percent of the average dose of 383 millirem per year from exposure to natural background radiation (e.g., cosmic gamma, internal, and terrestrial radiation) for someone living on the Snake River Plain (INL 2018a).

There are two dose limits relevant to the exposure of an individual member of the public near a DOE site. As shown in Table 3–11, all of the doses to the maximally exposed individual from the operations at the INL Site are well below the DOE dose limit for a member the general public, which is 100 millirem per year from all pathways, as prescribed in DOE Order 458.1 (DOE 2011b). The table also shows that the dose from the air pathway is well below the NESHAPs dose limit for emissions from DOE facilities of 10 millirem per year (40 CFR Part 61, Subpart H).

Table 3–11. Annual Radiation Doses to the Public from Idaho National Laboratory Operations 2014–2018

Year	*Maximally Exposed Individual*				*Population*		
	Dose (millirem per year)			*LCF Risk*	*Estimated Population Dose (person-rem)*	*LCFs* [b]	*Estimated Dose from Background (person-rem)*
	Airborne Radionuclides [a]	*Consumption of Waterfowl*	*Total*	*Total* [b]			
2018	0.01	0.016	0.026	c	0.0075	0 (5×10^{-6})	129,000
2017	0.008	0.046	0.054	c	0.011	0 (7×10^{-6})	127,000
2016	0.014	NA [d]	0.014	c	0.044	0 (3×10^{-5})	126,000
2015	0.033	0.49	0.53	c	0.61	0 (4×10^{-4})	125,000
2014	0.037	0.032	0.069	c	0.61	0 (4×10^{-4})	124,000
Average	**0.022**	**0.15** [e]	**0.17** [e]	c	f	f	

LCF = latent cancer fatality; NA = not available.

[a] DOE (DOE 2011b) and the EPA (40 CFR Part 61 Subpart H) limit the dose to a member of the public from airborne radionuclides to 10 millirem per year.

[b] Calculated using a dose conversion factor of 6×10^{-4} LCF per rem.

[c] The probability of this individual contracting a fatal cancer is less than 1 in a million.

[d] No data was collected for waterfowl in 2016.

[e] The average is calculated without year 2016 data because consumption of waterfowl was not included in that year.

[f] An average is not presented because the results for individual years are not all calculated on the same basis.

Notes:

The population within 50 miles of the INL Site was assumed to be 314,069 in 2013, increasing to 332,665 in 2017.

Due to rounding, sums and products may not equal those calculated from table entries.

Sources: INL 2015a, 2016b, 2017b, 2018a, 2019c.

The population dose is the sum of average individual doses to the entire population within 50 miles of the INL Site. Table 3–11 shows that over the years 2014 through 2018, the population dose from operations at the INL Site ranged from 0.011 to 0.61 person-rem. No latent cancer fatalities would be expected from these doses. The decrease in population dose between 2015 and 2016 is primarily due to a change in the way population doses were estimated. Prior to 2016, the highest dose to an individual within an area (a census division) was applied to all individuals within the area. From 2016 on, the average dose to a person within an area was applied to the total population of the area. Population doses from background sources of radiation are also presented in Table 3–11. The doses from INL Site operations are a small fraction of the background doses. Changes in the estimated dose from background are the result of the population growth within 50 miles of the INL Site, from an estimated 318,528 in 2014 to 337,643 in 2018 (INL 2015a, 2019c).

Worker doses at the INL Site result from:

- Maintenance activities,
- Routine test reactor operations,
- Research and development activities,
- Waste handling, treatment, and storage,
- Fuel handling,
- Benchtop analyses,
- Decontamination work, and
- Radiography operations.

Of the workers at the INL Site (6,836 in April of 2020), about 20 percent received a measurable (detectable) dose during the period of 2014 through 2018 (DOE 2015g, 2018b, 2019g). The average collective worker dose during this time was 93.5 person-rem per year with no LCFs expected (calculated value of 0.06). Considering only the workers who received a measurable dose (on average 1,265 per year and ranging between 1,114 and 1,368 workers each year), the average annual dose to a worker was 74 millirem. No single worker received a dose greater than 750 millirem during this period (DOE 2015g, 2016j, 2017g, 2018b, 2019g). To protect workers from impacts from radiological exposure, 10 CFR Part 835 imposes an individual dose limit of 5,000 millirem in a year. In addition, worker doses must be monitored and controlled below the regulatory limit to ensure that individual doses are less than an administrative limit of 2,000 millirem per year (DOE 2017f), and maintained as low as reasonably achievable. **Table 3–12** presents the INL Site worker dose information for the years 2014 to 2018.

Table 3–12. Annual Radiation Doses to Idaho National Laboratory Workers from Operations 2014–2018

Year	*Collective Dose (person-rem)*	*Workers with a Measurable Dose*	*Exposed Worker Population LCF Risk* [a]	*Average Dose Among Workers with a Dose (rem)*
2018	86.3	1,368	0 (0.05)	0.063
2017	78.9	1,177	0 (0.05)	0.067
2016	92.7	1,273	0 (0.06)	0.073
2015	123.2	1,331	0 (0.07)	0.093
2014	86.2	1,174	0 (0.05)	0.073
Average	**93.5**	**1,265**	**0 (0.06)**	**0.074**

LCF = latent cancer fatality, rem = roentgen equivalent man.

[a] Calculated using a dose conversion factor of 6×10^{-4} LCF per rem. Values in parentheses are calculated values. A value of less than 0.5 is considered to result in no LCFs.

Note: Due to rounding, sums and products may not equal those calculated from table entries.

Sources: DOE 2015g, 2018b, 2019g.

Some INL Site workers potentially receive a dose from consumption of drinking water from wells supporting the CFA. These wells are contaminated from past wastewater injection directly into the aquifer. Each of the 500 CFA workers served by these wells could receive a dose of 0.154 millirem (INL 2017b), which is well below the EPA standard of 4 millirem per year from drinking water systems.

3.1.10.2 Nonradiological Health and Safety

Nonradiological exposures at the INL Site are controlled through programs intended to protect workers from normal industrial hazards. These programs are controlled by the safety and health regulations for DOE contractor workers governed by 10 CFR Part 851, which establishes requirements for worker safety and health programs to ensure that DOE contractor workers have a safe work environment. Included are provisions to protect against occupational injuries and illnesses, accidents, and hazardous chemicals.

DOE monitors worker safety through the Computerized Accident Incident Reporting System (CAIRS). The CAIRS is a computerized database used to collect and analyze DOE reports of injuries, illnesses, and accidents that occur during facility operations. Two metrics generated for the tracking of injury, illness, and accident rates are the Days Away, Restricted or on-the-job Transfer (DART) rate and the Total Reportable Cases (TRC) rate. The DART rate is an indication of the instances of injuries, illnesses, and accidents that result in, at worst, lost work days or days lost due to transfer or worker job restrictions. The TRC rate is an indication of the total number of work-related injuries or illnesses that resulted in death, days away from work, job transfer or restriction, or recordable case as identified in the Occupational Safety and Health Administration Form 300. For the years 2015 through 2019 the INL DART and TRC rates (incidents per 200,000 work hours or the equivalent of 100 full-time workers) were 0.54 and 1.08, respectively. For the years 2015 through 2019, the DART and TRC rates for all DOE facilities combined average 0.39 and 0.86, respectively (DOE 2019a).

3.1.10.3 Regional Cancer Rates

The National Cancer Institute publishes national, State, and county incidence rates of various types of cancer (NCI 2018). However, the published information does not provide an association of these rates with their causes, e.g., specific facility operations and human lifestyles. **Table 3–13** presents incidence rates for the United States, Idaho, and the counties that account for most of the population within 50 miles of the INL Site. Additional information about cancer profiles in the vicinity of the INL Site is available in State Cancer Profiles, Incidence Rates Tables (NCI 2018). Not all types of cancer are presented in this table; totals for individual cancers will not sum to the all cancer values.

Table 3–13. Cancer Incidence Rates for the United States, Idaho, and Counties Adjacent to Idaho National Laboratory, 2012–2016

	Cancer Incidence Rates [a]						
Region	***All Cancers***	***Thyroid***	***Breast (female)***	***Lung and Bronchus***	***Leukemia***	***Prostate***	***Colon and Rectum***
United States	448.0	14.5	125.2	59.2	14.1	104.1	38.7
Idaho	440.5	15.9	124.2	50.3	16.2	105.7	35.5
Bannock County	368.5	11.1	105	36.1	14.6	92.5	29.6
Bingham County b	403.2	28.6	115.7	35.6	12.1	97.3	41
Blaine County	421.8	(c)	139.7	31.7	19.6	122	19.5
Bonneville County b	426.5	30.9	107.5	34.8	16.2	115.4	35.2
Butte County b	456.6	(c)	(c)	(c)	(c)	(c)	(c)
Clark County b	(c)	(c)	(c)	(c)	(c)	(c)	(c)
Jefferson County b	405.1	28.9	85.1	35	14.3	123.3	36.2
Madison County	358	29.3	81.4	(c)	19.2	101.1	36.7
Power	363	(c)	117.6	41.2	(c)	84.8	(c)

[a] Age-adjusted incidence rates; cases per 100,000 persons per year.
[b] Portions of the INL Site are located in Bingham, Bonneville, Butte, Clark, and Jefferson Counties. MFC is in Bingham County.
[c] Data have been suppressed by the National Cancer Institute to ensure the confidentiality and stability of rate estimates when the annual average count is three or fewer cases.
Source: NCI 2018.

3.1.11 Human Health – Emergency Preparedness

Every site in the DOE complex has an established emergency management program that is activated in the event of an accident. These programs have been developed and maintained to ensure adequate response to most accident conditions and to provide response efforts for accidents not specifically considered. Emergency management programs address emergency planning, training, preparedness, and response for both on- and offsite personnel.

DOE Order 151.1D, *Comprehensive Emergency Management System,* (DOE 2016i) describes detailed requirements for emergency management that all DOE sites must implement. Each DOE site, facility, and activity, including the INL Site, establishes and maintains a documented emergency management program that implements the requirements of applicable Federal, State, and local laws, regulations, and ordinances for fundamental worker safety programs (e.g., fire, safety, and security). This is the Emergency Management Core Program. In addition, each DOE site, facility, and activity containing hazardous materials, such as radioactive materials or certain chemicals that do not fall under the purview of fundamental worker safety programs, establishes and maintains an Emergency Management Hazardous Materials Program. Finally, each site that receives or initiates shipments managed by the Office of Secure Transportation must be prepared to manage an emergency involving such a shipment, should that emergency occur on site.

These programs involve providing specialized training and equipment for local fire departments and hospitals, State public safety organizations, and other government entities that may participate in response actions, as well as specialized assistance teams. These programs also provide for notification of local governments whose constituencies could be threatened in the event of an accident. Broad ranges of drills and exercises are conducted to ensure the systems are working properly, from facility-specific exercises to regional responses. In addition, there are internal and external audits. Lessons learned from exercises and audits are used to continuously strengthen INL's emergency management program – see, for example, *Idaho National Laboratory Emergency Readiness Assurance Plan-Fiscal Year 2016* (INL 2016d) and the Office of Enterprise Assessments January 2018 *Assessment of the Emergency Management Exercise Program at the Idaho Site* (DOE 2018h).

A recent example of an exercise is INL's 2019 annual emergency exercise (INL 2019f). This exercise simulated a crash between a dump truck and a bus. The simulation tested the effectiveness of the response and coordination between numerous entities: INL fire department; INL Emergency Operations Center in Idaho Falls; INL heavy equipment operators; three helicopter ambulances from three separate outside agencies; Butte County coroner and dispatch; a local towing company; DOE-Idaho Operations Office; Idaho State Emergency Medical Services communications center (known as StateComm); and Eastern Idaho Regional Medical Center. The INL Site also made offsite notifications to all contiguous counties, Federal agencies, State of Idaho agencies, and Tribal authorities. This emergency exercise successfully tested and verified communication among all parties.

In summary, the emergency management system at the INL Site includes emergency response facilities and equipment, trained staff, and effective interface and integration with offsite emergency response authorities and organizations. INL personnel maintain the necessary apparatus, equipment, and a state-of-the-art Emergency Operations Center in Idaho Falls to respond effectively to virtually any type of emergency, not only at the INL Site, but throughout the local community.

3.1.12 Traffic

3.1.12.1 Transportation Infrastructure

The ROI for the transportation infrastructure includes two U.S. Interstate Highways, two U.S. Routes, three Idaho State Highways, and the INL onsite road systems.

Road performance is measured using level of service (LOS) ratings. LOSs are qualitative measures used to relate the quality of motor vehicle traffic services. LOS analyzes roadways and intersections by categorizing traffic flow and assigning quality levels of traffic based on performance measures like vehicle speed, density, and congestion. LOS ratings range from "A" to "F," with "A" being the best travel conditions and "F" being the worst. For example, U.S. Highways consider the following conditions when determining LOS:

- *A*: Traffic flows freely at or above the posted speed limit and motorists have complete mobility between lanes. Motorists have a high level of physical and psychological comfort. The effects of incidents or point breakdowns are easily absorbed. A rating of LOS A generally occurs late at night in urban areas and frequently in rural areas.
- *B*: Traffic flows freely. Speeds are maintained, maneuverability within the traffic stream is slightly restricted. Motorists still have a high level of physical and psychological comfort.
- *C*: Traffic flow is stable, at or near free flow. Ability to maneuver through lanes is noticeably restricted and lane changes require more driver awareness. Most experienced drivers are comfortable, roads remain safely below but efficiently close to capacity, and posted speed is maintained. Minor incidents may still have no effect, but localized service will have noticeable effects and traffic delays will form behind the incident. A rating of LOS C is considered acceptable for local roads and highways.
- *D*: Traffic flow is approaching unstable. Speeds slightly decrease as traffic volumes slightly increase. Freedom to maneuver within the traffic stream is much more limited and driver comfort levels decrease. Minor incidents create delays. A rating of LOS D is commonly considered acceptable for urban streets during peak hours since societal impacts and costs of construction (bypasses and lane additions) to attain a LOS C rating would be prohibitive.
- *E*: Traffic flow is unstable and operating at capacity. Flow becomes irregular, speeds vary rapidly, and there are virtually no usable gaps to maneuver in the traffic stream. Speeds rarely reach the posted limit. Any disruption to traffic flow, such as merging ramp traffic or lane changes, will create a shock wave affecting traffic upstream. Any incident will create serious delays. Drivers' level of comfort becomes poor. A rating of LOS E is a common standard in larger urban areas, where some roadway congestion is inevitable.
- *F*: Traffic is forced or there is a breakdown in flow. Every vehicle moves in lockstep with the vehicle in front of it. Frequent slowing is required. Travel time cannot be predicted, with generally more demand than capacity. A road in a constant traffic jam is at this LOS.

LOS is an average or typical service rather than a constant state. For example, a highway might be at LOS D for the AM peak hour, but have traffic consistent with LOS C some days, LOS E or F others, and come to a halt once every few weeks (Papacostas and Prevedouros 2001).

Regional

- U.S. Interstate 15, a north-south route connects several cities along the Snake River and is located about 25 miles east of the INL Site.
- U.S. Interstate 86 intersects Interstate 15 about 40 miles south of the INL Site and provides a primary linkage from Interstate 15 to points west.
- U.S. Route 20 is one of two main access routes to the southern portion of the INL Site and MFC.
- U.S. Route 26 is the second of two main access routes to the southern portion of the INL Site.
- Idaho State Highways 22, 28, and 33 pass through the northern portion of INL, with State Route 33 providing access to the northern INL Site facilities (DOE 2016b).

The majority of road segments in the vicinity of the INL Site operate at LOS D or better. However, the I-15 and US-20 interchange and a portion of US-26 (north of E Street in Idaho Falls) exceed LOS D threshold at certain times.

INL Onsite Road Systems

The INL Site contains an onsite road system of about 170 miles of paved roads. The onsite road system also includes 18 miles of service roads that are closed to the public. Some of the paved roads are highways that pass through the INL Site and are used by the public; however, security personnel and fencing strictly control public access to facilities at the INL Site. Most of the roads are adequate for the current level of normal transportation activity and could handle an increase in traffic volume.

The Multipurpose Haul Road is a 13-mile-long nonpublic road connecting MFC and other developed areas at the INL Site. It provides a road for limited year-round use with the ability for trucks traveling in opposite directions to pass.

The INL Site contains an onsite railroad system of about 22 miles of rail. Union Pacific Railroad's main line to the Pacific Northwest follows the Snake River across southern Idaho. This line handles as many as 30 trains per day. Union Pacific Railroad provides service to the INL Site from Blackfoot into the southern portion of the INL Site where it terminates. This branch connects with a DOE-owned spur line that extends to the CRF and the NRF (DOE 2016b). The rail does not extend to MFC. Rail shipments to and from the INL Site are usually limited to bulk commodities, Naval spent nuclear fuel, and radioactive waste.

MFC, where the proposed action would be located, is in the southeastern corner of the INL Site, about 38 miles west of Idaho Falls in Bingham County. MFC is about 2.7 miles from the southern INL Site boundary and is accessed via Taylor Boulevard from U.S. Highway 20 (INL 2015b).

Table 3–14 provides average daily traffic data for selected segments of routes in the vicinity of the INL Site. The daily weighted average of each route is the annual average daily traffic on the route. Each route is made up of segments that vary in distance and annual average daily traffic. The weighted average of each route is calculated by taking each segment of road from the beginning to the end (the total mileage of the segment) and dividing it by the total mileage of the total route.

Table 3–14. Annual Average Daily Traffic on Routes in the Vicinity of Idaho National Laboratory

Route	***Daily Traffic Number of Vehicles (weighted average)***
U.S. Highway 20 – Idaho Falls to the INL Site	2,500
U.S. Highway 26 – Blackfoot to the INL Site	1,200
State Route 33 – West from Mud Lake	1,600

Source: ITD 2020.

3.1.12.2 Waste and Material Shipments

The INL Site manages the following types of waste: HLW, TRU, LLW, MLLW, TSCA-regulated, RCRA-regulated hazardous, and industrial nonhazardous solid waste. See Section 3.1.9 for a detailed discussion of Waste and Spent Nuclear Fuel Management.

Average Shipments to and from the Materials and Fuels Complex

RCRA hazardous waste (including nonradioactive TSCA waste), recyclable material, LLW, MLLW, and radioactive TSCA wastes are transported from MFC to offsite facilities. Nonhazardous waste is typically shipped to the INL CFA Landfill Complex, while solid LLW is shipped to either the Radioactive Waste Management Complex at the INL Site or to offsite facilities. RCRA hazardous waste, radioactive TSCA waste, and MLLW are shipped on average 1.4 times per month, while routine solid[2]LLW is shipped 24.7 times on average per year. Nonhazardous waste is shipped less than once per year, on average.

The frequency of material shipments necessary to support MFC operations ranges from about one shipment per day to one shipment per week, depending on the amount of supplies ordered across MFC.

Traffic

The most recent employment data at the INL Site, as of Spring 2020, is 6,836 workers, including 4,998 at BEA and 1,838 at Fluor (DOE 2020c); these include full-time, part-time, and temporary employees. During a typical workweek, the majority of employees take buses to various work areas at the INL Site, covering about 70 bus routes. For MFC, about 13 percent of employees commute via carpool, while slightly less than 30 percent report taking the bus.

Approximately 1,200 private vehicles also travel to and from the INL Site daily, including an average of 250 to 300 to and from MFC. Rail transport for the INL Site typically occurs no more than one train per day and usually less than one train per week (NRC 2004).

3.1.13 Socioeconomics

This section describes current socioeconomic conditions and local community services within the seven-county ROI (or region) associated with the INL Site: Bannock, Bingham, Bonneville, Butte, Clark, Jefferson, and Madison Counties. Five of these counties border the INL Site: Bingham, Bonneville, Butte, Clark, and Jefferson. Also included are the Fort Hall Reservation and Off-Reservation Trust Land, home of the Shoshone Bannock Tribes, which lie largely within Bingham and Bannock Counties. Bannock County also includes Pocatello, one of the two largest cities within 50 miles of the INL Site; the other is Idaho Falls, located in Bonneville County. Because most of the population surrounding the INL Site lies to the east, including Madison County where nearly 2 percent of the INL Site workforce resides, this county is also included in the ROI. Figure 3–1 shows the counties in the ROI, surrounding towns, and major transportation routes.

3.1.13.1 Population and Housing

The main population surrounding the INL Site lies to the east, along Interstate Highway I-15 and U.S. Highway 20 corridors, which generally run north and south. Most of the population is concentrated in communities to the east and southeast. Idaho Falls with a population of about 61,535, and Pocatello with a population of about 56,266 are the 2 largest cities in the ROI and located about 40 and 50 miles, respectively, from MFC (Census 2020c).

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[2] The Integrated Waste Tracking System data did not consistently include information regarding solid, liquid, or mixed solid and liquid shipments. To ensure a bounding calculation of the number of shipments, all shipments were counted as solid.

From 2000 to 2010, State population grew by 21.2 percent, compared to the ROI population growth of 20.7 percent or an average of 2.1 percent per year for both the ROI and the State (Census 2011). Population growth in the region between 2000 and 2018 was slightly lower than the State average, with growth rates for the region and State at 7.4 percent and 11.9 percent, respectively.

Table 3–15 contains population estimates from the U.S. Census Bureau for 2018 and actual census results for 2000 and 2010. U.S. Census Bureau estimates are not certain due to variability in times of birth and death, emigration and immigration rates, and other unanticipated factors in the region. Population projections were also developed for 2050 (lifetime of proposed project), based on an extrapolation of a 1.1 percent annual growth rate projected for the State out to 2026 (Idaho Department of Labor 2020); and for an extrapolation of the growth rate from 2010 to 2018 for each individual county).

Table 3–15. Population of the Idaho National Laboratory Region of Influence and Idaho: 2000–2018

County	Year				Projected Population 2050
	2000	2010	2018	Population Change 2010-2018 (percent)	
Bannock	75,565	82,839	87,138	5.2	105,263
Bingham	41,735	45,607	46,236	1.4	48,825
Bonneville	82,522	104,234	116,854	12	172,944
Butte	2,899	2,891	2,611	-9.7	1,598
Clark	1,092	982	852	-13.2	402
Jefferson	19,155	26,140	29,439	12.6	44,276
Madison	27,467	37,536	39,304	4.7	46,693
ROI	**250,434**	**300,229**	**322,434**	**7.4**	**420,001**
Idaho	1,293,953	1,567,582	1,754,208	11.9	2,371,689

ROI = region of influence
Source: Census 2020a, 2020b, 2020c, 2020d; Idaho Department of Labor 2020.

Housing

The most recent housing stock statistics from the Census report estimated 2017 housing occupancy by type (owned or rented) (Census 2017c). Of interest for impact analysis is the capacity of the ROI to absorb any new housing demand projected by the project. Of the 116,264 housing units available in the region during 2017, the Renter Vacancy Rate was 8.2 percent, and the Homeowner Vacancy Rate was 1.9 percent. Rental units made up 31 percent of the occupied housing units in the ROI. A total of 11,706 vacant units were in the ROI. Housing characteristics for the ROI in 2017 are shown in **Table 3–16**.

Table 3–16. Region of Influence Housing Characteristics (2017)

County	2017 Housing Units	Occupied Housing Units	Vacant Housing Units	Owner-Occupied Units	Renter-Occupied Units	Vacant Homeowner Housing Units (percent)	Vacant Rental Units (percent)
Bannock	33,870	30,790	3,080	21,200	9,590	711 (2.1)	2,337 (6.9)
Bingham	16,513	14,903	1,610	11,147	3,756	396 (2.4)	991 (6.0)
Bonneville	41,593	38,400	3,193	27,120	11,280	582 (1.4)	3,286 (7.9)
Butte	1,338	1,049	289	870	179	25 (1.9)	356 (26.6)
Clark	553	313	240	173	140	49 (8.9)	0 (0.0)
Jefferson	9,105	8,470	635	6,861	1,609	155 (1.7)	346 (3.8)
Madison	13,292	10,633	2,659	4,930	5,703	66 (0.5)	3,376 (25.4)

County	2017 Housing Units	Occupied Housing Units	Vacant Housing Units	Owner-Occupied Units	Renter-Occupied Units	Vacant Homeowner Housing Units (percent)	Vacant Rental Units (percent)
ROI	**116,264**	**104,558**	**11,706**	**72,301**	**32,257**	**1,984 (1.7)**	**10,692 (9.2)**
Idaho	701,196	609,124	92,072	421,439	187,685	12,620 (1.8)	37,163 (5.3)

ROI = region of influence.
Notes:
Homeowner and rental vacancy units do not add to total vacant housing units because the vacancy rates only include vacant housing units (i.e., proportion of total inventory) that are on the market for rent or for sale only.
Due to rounding, sums and products may not equal those calculated from table entries.
Source: Census 2017c.

3.1.13.2 Employment and Income

From 2010 to 2018, the ROI experienced an average annual growth rate in the labor force of just over 1 percent (from 145,027 to 157,232 jobs), while the State of Idaho's labor force grew at an average annual rate of 2.5 percent. The unemployment rate has dropped significantly since 2010. In 2018, the ROI experienced the lowest unemployment rate (2.4 percent) in decades, where the unemployment rate ranged from 1.7 percent in Madison County, to 3.2 percent in Butte County. **Table 3–17** presents employment statistics in the ROI and Idaho for 2010 and 2018. In 2018, there were 153,766 people employed in the INL ROI.

Table 3–17. Employment Statistics in the INL ROI and Idaho in 2010 and 2018

Area	Civilian Labor Force		Employment		Unemployment		Unemployment Rate	
	2010	2018	2010	2018	2010	2018	2010	2018
Bannock	41,095	41,733	37,813	40,564	3282	1169	8.0	2.8
Bingham	22,848	23,303	21,201	22,657	1647	646	7.2	2.8
Bonneville	49,099	55,200	45,683	53,842	3416	1358	7.0	2.5
Butte	1,352	1,363	1,254	1,318	98	45	7.2	3.3
Clark	537	381	487	370	50	11	9.3	2.9
Jefferson	12,611	13,611	11,721	13,297	890	314	7.1	2.3
Madison	17,485	21,641	16,546	21,262	939	379	5.4	1.8
ROI	**145,027**	**157,232**	**134,705**	**153,310**	**10,322**	**3,922**	**7.7**	**2.5**
Idaho	761,120	856,795	692,918	832,500	71,000	24,000	9.0	2.8

ROI = region of influence.
Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: BLS 2020a, 2020b, 2020c.

INL Employment

The prime contractors at the INL Site include BEA, the management and operations contractor for the INL Site, and Fluor Idaho, which manages ongoing cleanup operations under the ICP Core and operates the Advanced Mixed Waste Treatment Project. The most recent employment data at the INL Site, as of Spring 2020, is 6,836 workers, including 4,998 at BEA and 1,838 at Fluor (DOE 2020c); these include full-time, part-time, and temporary employees. **Figure 3–10** shows the distribution of INL employees' residences in 2010 (DOE 2016b); the current distribution is expected to be essentially the same. The largest percentage (60.4 percent) resides within Bonneville County. Another 1.5 percent live outside of the ROI.

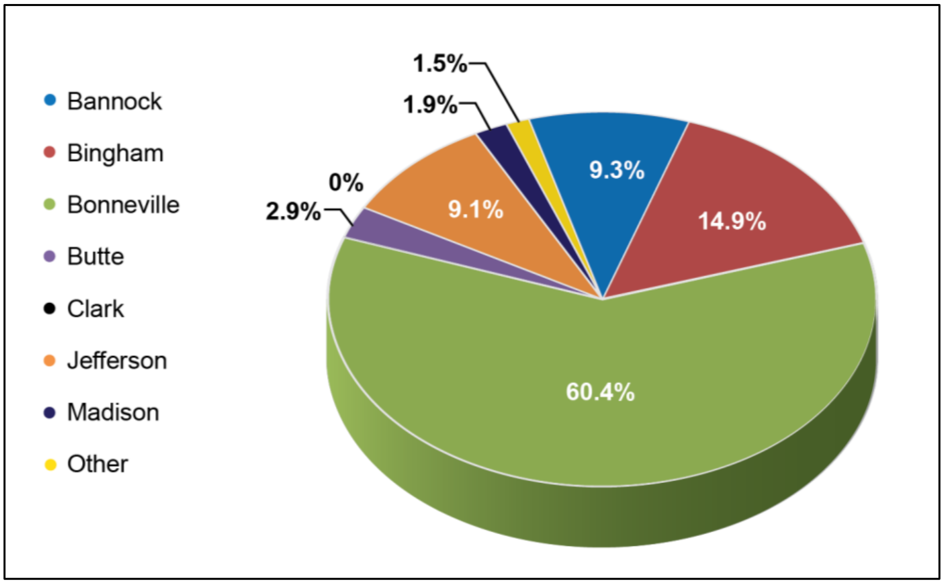

Figure 3–10. Distribution where Idaho National Laboratory Employees Live in the Region of Influence

In fiscal year (FY) 2018, the INL Site accounted for nearly 12,000 jobs (11,789), including direct, indirect, and induced employment (INL 2019d), where direct jobs include those employed directly at the INL Site , indirect jobs include jobs relating to suppliers (provide materials and supplies), and induced jobs include jobs in goods and services where workers spend their money. This total direct and indirect employment constituted about 1.4 percent of the total workforce in the State and nearly 8 percent of employment in the ROI. The INL Site is among the top 10 employers in the State – the sixth largest private employer and the ninth largest employer compared to all public and private businesses in the State; it is the largest in southeast Idaho (INL 2019d).

MFC Employment

MFC hosts the core of U.S. nuclear research and development with a wide array of facilities designed for remote work on highly irradiated fuels and materials. Areas of expertise include nuclear fuels, radiation-tolerant materials, fuel recycling, focused basic research, nuclear nonproliferation and nuclear forensics, and space nuclear power and isotope technologies. Approximately 1,094 employees currently work at MFC including government employees, subcontractors, contractors, and service employees, part-time seasonal, temporary, and occasional workers.

Local Income

The INL Site is a major economic contributor to the southeastern Idaho economy. In FY 2018, total labor income (wages and salaries, employee benefits, and payroll taxes) for INL (direct) employees totaled about $685.3 million with 98.5 percent of that distributed within the 7-county ROI, assuming a similar distribution of employee residences. The annual average wage of an INL Site employee was $97,893 in 2018 (INL 2019d).

In comparison, the per capita personal income for the ROI in 2018 was $37,494, a 27.2 percent increase from the 2010 level of $29,482, as shown in **Table 3–18**. Per capita income in 2018 in the ROI ranged from a low of $26,407 in Madison County to a high of $48,207 in Bonneville County. The per capita income in Idaho was $43,901 in 2018 (BEA 2019a).

Table 3–18. Per Capita Annual Personal Income

County	Per Capita Income ($)	
	2010	2018
Bannock	28,589	38,160
Bingham	26,299	36,335
Bonneville	34,667	48,287
Butte	32,199	38,961
Clark	39,726	39,408
Jefferson	26,241	34,900
Madison	18,651	26,407
ROI (Average)	**29,482**	**37,494**
Idaho	31,897	43,901

BEA 2019a, 2019b.
Note: Due to rounding, sums and products may not equal those calculated from table entries.

3.1.13.3 Community Services

Key community services in the ROI include education, law enforcement, fire protection, and medical services. Public school districts (29) and private schools (12) served 65,268 schoolchildren in the region in the 2018 to 2019 school year (NCES 2020). Idaho State University (Pocatello), University of Idaho Center for Higher Education (Idaho Falls), Brigham Young University-Idaho (Rexburg), and the Eastern Idaho Technical College (Idaho Falls) are institutions of higher education within the ROI.

The number of full-time law enforcement employees and firefighters by county are shown in **Table 3–19**. Data for 2016 showed the 7-county ROI having 307 law enforcement officers, including 200 sworn police officers and 107 civilians associated with the county sheriff's departments (FBI 2020a). Data are also available for law enforcement employees by city, representing the municipal police departments. Law enforcement staffing levels for the 2 largest cities in the ROI are as follows: Idaho Falls has 132 employees (including 87 sworn officers) and Pocatello has 127 employees (including 88 sworn officers) (FBI 2020b). There was a total of 318 full-time firefighters within 23 fire departments in the ROI in the period 2014 to 2015; many of the fire stations are volunteer (e.g., Clark County, all volunteer) or are staffed mostly by part-time firefighters (Jefferson and Madison Counties (80 and 50 part-time firefighters, respectively) (Fire Department 2020). In addition to these staffing levels, the INL Fire Department provides 24-hour coverage for the site. Its staff includes 68 firefighters, 11 lead firefighters, and 7 division chiefs, with no less than 16 on each shift (INL 2020f).

Table 3–19. Police and Firefighter Full-Time Employees within the Region of Influence

County	Law Enforcement	Sworn Officers	Civilians	Fire Departments	Firefighters
Bannock	66	52	14	7	76 (71 in Pocatello)
Bingham	53	34	19	5	39
Bonneville	102	67	35	5	98 (94 in Idaho Falls)
Butte	11	4	7	3	87 (all INL)
Clark	7	3	4	1	0 (all volunteer)
Jefferson	33	19	14	1	2
Madison	35	21	14	1	16
ROI	307	200	107	23	318

Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: FBI 2020a, 2020b; Fire Department 2020.

There are 58 hospital-based practices in the ROI. Approximately 84 percent of these are in Bannock and Bonneville Counties. Hospitals in the region include Eastern Idaho Regional Hospital in Idaho Falls (246 beds), Portneuf Medical Center in Pocatello (165 beds), Bingham Memorial Hospital in Blackfoot (85 beds), and Madison Memorial Hospital in Rexburg (67 beds). There are additional healthcare facilities (e.g., urgent medical care, surgical centers, community care) in Idaho Fall and Pocatello (Idaho Medical Association 2019; AHD 2020).

3.1.13.4 Public Finance

As one of the largest employers in the State, the INL Site provides a significant economic impact on Idaho's economy. In 2010, Boise State University conducted an analysis of the impacts of the INL Site on the economy of Idaho (Boise State University 2010). The analysis showed that the annual impacts of the INL Site's operations on employment, output, and income in Idaho are large by any measure, and especially significant in Idaho's largely rural economy and crucial to the economy of eastern Idaho (Boise State University 2010). INL employees spend their income on goods and services provided by residents and businesses in the area surrounding the INL Site. Total taxes and fees attributed to the INL Site and its employees amounted to more than $135 million of Idaho's total tax receipts in 2009. This represented 5.2 percent of Idaho's FY 2009 general fund revenues. These taxes and fees help fund public schools, libraries, emergency services (ambulance, police, and fire protection), road and bridge repairs, recreational opportunities, and waste disposal.

The INL Site's continued importance to the State economy is confirmed in more recent economic summaries prepared for the INL Site in 2017 and 2018 (INL 2018d, 2019d). The INL Site's total economic impact on Idaho in FY 2018 was over $2.058 billion, an increase of $123 million, or a 6.4 percent increase, from FY 2017 (INL 2019d). Updated and relevant statistics from the 2017 INL Economic Summary Report includes the following:

- The INL Site accounted for nearly 2.9 percent of statewide economic output. The INL Site's total output impact increased by $27.6 million between FY 2016 and FY 2017. This is a 1.4 percent increase.
- The INL Site generated nearly $935 million of economic output through INL Site suppliers and employee household spending.
- The INL Site increased personal income in the State by $862 million. The INL Site's economic impacts accounted for 1.3 percent of all personal income in the State.
- The INL Site impacts resulted in an estimated $69 million in State and local tax revenues.

Taxes generated by the INL Site operations account for 1.7 percent of total State and local tax revenue (based on FY 2016 State tax revenues).

3.1.14 Environmental Justice

The ROI for environmental justice is the area within a 50-mile radius of the proposed location of the VTR facilities at the MFC. The 50-mile radius was selected because it is consistent with the ROI for radiological emissions. The potentially affected area includes parts of 14 counties throughout Idaho.

Executive Order 12898 directs Federal agencies to make the achievement of environmental justice part of their mission. This goal is accomplished by identifying and addressing disproportionately high and adverse human health or environmental effects of Federal programs, policies, and activities on minority and low-income populations. The following discussion is consistent with the guidelines and procedures for compliance with the Executive order promulgated by the Council on Environmental Quality (CEQ 1997).

The definitions of minority, low-income, and minority and low-income populations are presented below.

- **Minority** – Individual(s) who are members of one or more of the following population groups as designated in the U.S. Census Bureau data: Black or African-American, American Indian and Alaska Native, Asian, Native Hawaiian and Other Pacific Islander, Some Other Race, as well as Hispanic or Latino of any race.
- **Low income** – The U.S. Census Bureau uses a set of money income thresholds that vary by family size and composition to determine who is in poverty (i.e., classified as "low income"). If a family's total income is less than the family's threshold, then that family and every individual in it is considered in poverty. The official poverty thresholds do not vary geographically but are updated for inflation using the U.S. Consumer Price Index. The official poverty definition uses money income before taxes and does not include capital gains or noncash benefits (such as public housing, Medicaid, and food stamps) (Census 2016).
- **Minority or low-income population** – Populations where either: (a) the total number of minority or low-income individuals of the affected area exceeds 50 percent of the overall population in the same area, or (b) the total number of minority or low-income individuals within the affected area is meaningfully greater (e.g., 120 percent greater) than the minority or low-income population percentage in an appropriate comparison unit of geographic analysis. A minority population also exists if there is more than one minority group present and the minority percentage, as calculated by aggregating all minority persons, meets one of the above stated thresholds.

  In identifying minority or low-income populations, agencies may consider as a community either a group of individuals living in geographic proximity to one another, or a geographically dispersed/transient set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect.

  The selection of the appropriate unit of geographic analysis may be a governing body's jurisdiction, a neighborhood, census tract, or other similar unit that is to be chosen so as to not artificially dilute or inflate the affected minority population.
- **Meaningfully Greater** – A meaningfully greater minority or low-income population within a geographic unit affected by a Federal action is determined by comparing the minority or low-income composition of the geographic unit to the minority or low-income composition of the general population. Similar to selecting the appropriate unit of geographic analysis, a comparison population should be selected so as to not artificially dilute or inflate the affected minority populations. For this analysis, the comparison population is the total population of the 14 counties that fall within the 50-mile radius of the proposed location of the VTR facilities at the MFC.

Minority and Low-Income Populations

The analysis of minority and low-income populations focuses on census data for geographic units (i.e., block groups) that represent, as closely as possible, the potentially affected areas. A census block group is the smallest geographic area for which the U.S. Census Bureau provides consistent sample data, and generally contains a population between 600 and 3,000 individuals. In order to evaluate the potential impacts on populations in closer proximity to the MFC, radial distances of 5, 10, and 20 miles are analyzed. **Table 3–20** shows the minority and low-income composition of the potentially affected area surrounding the proposed MFC facilities at each of these distances.

Table 3–20. Minority and Low-Income Populations within the 50-Mile Radius of the Materials and Fuels Complex

Population Group	Within 5 Miles		Within 10 Miles		Within 20 Miles		Within 50 Miles	
	Population	Percent of Total	Population	Percent of Total	Population	Percent of Total	Population	Percent of Total
Total Population	36	100.0	364	100.0	2,721	100.0	265,779	100.0
Nonminority	33	91.7	302	83.0	2,100	77.2	219,887	82.7
Total Minority	3	8.3	62	17.0	621	22.8	45,892	17.3
White - Hispanic/ Latino	3	8.3	27	7.4	255	9.4	16,355	6.2
Black/African American [a]	0	0.0	0	0.0	14	0.5	1,172	0.4
American Indian or Alaska Native [b]	0	0.0	0	0.0	4	0.1	5,313	2.0
Other Minority [a, b]	0	0.0	35	9.6	348	12.8	23,052	8.7
Low Income	0	0.0	33	9.1	239	8.8	39,055	14.7

[a] Includes persons who also indicated Hispanic or Latino origin.

[b] Other Minority includes all combined individuals of Asian, Native Hawaiian and Other Pacific Islander, Some Other Race, or Two or More Races.

Source: Census 2017a, 2017b.

Minority populations were evaluated using the absolute 50 percent and the relative 120 percent or greater criteria for potentially affected block groups within 50 miles of the MFC. If a block group's percentage of minority individuals met the 50 percent criterion or was more than 120 percent of the percentage of the total minority population within the 14-county comparison population, then the block group was identified as having a minority population. The total population residing in the 14-county comparison population is 390,550, of which 18 percent would be considered members of a minority population; therefore, the meaningfully greater criterion for minority populations is 21.5 percent. Of the 188 block groups within the ROI, 10 block groups have individual racial group minority populations or aggregate minority populations that meet the 50 percent criterion, and 55 block groups meet the meaningfully greater criterion for one or more racial groups.

The overall composition of the projected populations within every radial distance is predominantly nonminority. Minority populations in the ROI are predominantly White Hispanic and Other Minority. The concentration of minority populations is greatest within the 20-mile radius. American Indian or Alaska Native populations comprise 2 percent of the population within the 50-mile radius, because the Fort Hall Reservation of the Shoshone-Bannock Tribes lies largely within the ROI. **Figure 3–11** displays the block groups identified as meeting the criteria for environmental justice minority populations surrounding the MFC, as well as population density of minority populations within each block group.

As with minority populations, low-income populations were evaluated using the absolute 50 percent and the relative 120 percent or greater criteria for potentially affected block groups within 50 miles of the MFC. If a block group's percentage of low-income individuals met the 50 percent criterion or was more than 120 percent of the percentage of the total low-income population within the 14-county comparison population, then the area was identified as having a low-income population. Of the total population living in the 14-county MFC comparison population, about 15.5 percent are identified as living below the poverty line. Therefore, the meaningfully greater criterion for low-income populations is 18.5 percent. Of the 188 block groups within the ROI, 5 block groups have a low-income population that exceeds the 50 percent criterion, and a total of 62 block groups meet the 120 percent criterion for low-income populations. **Figure 3–12** displays the block groups identified as meeting the criteria for environmental justice low-income populations surrounding the MFC, as well as population density of low-income populations within each block group.

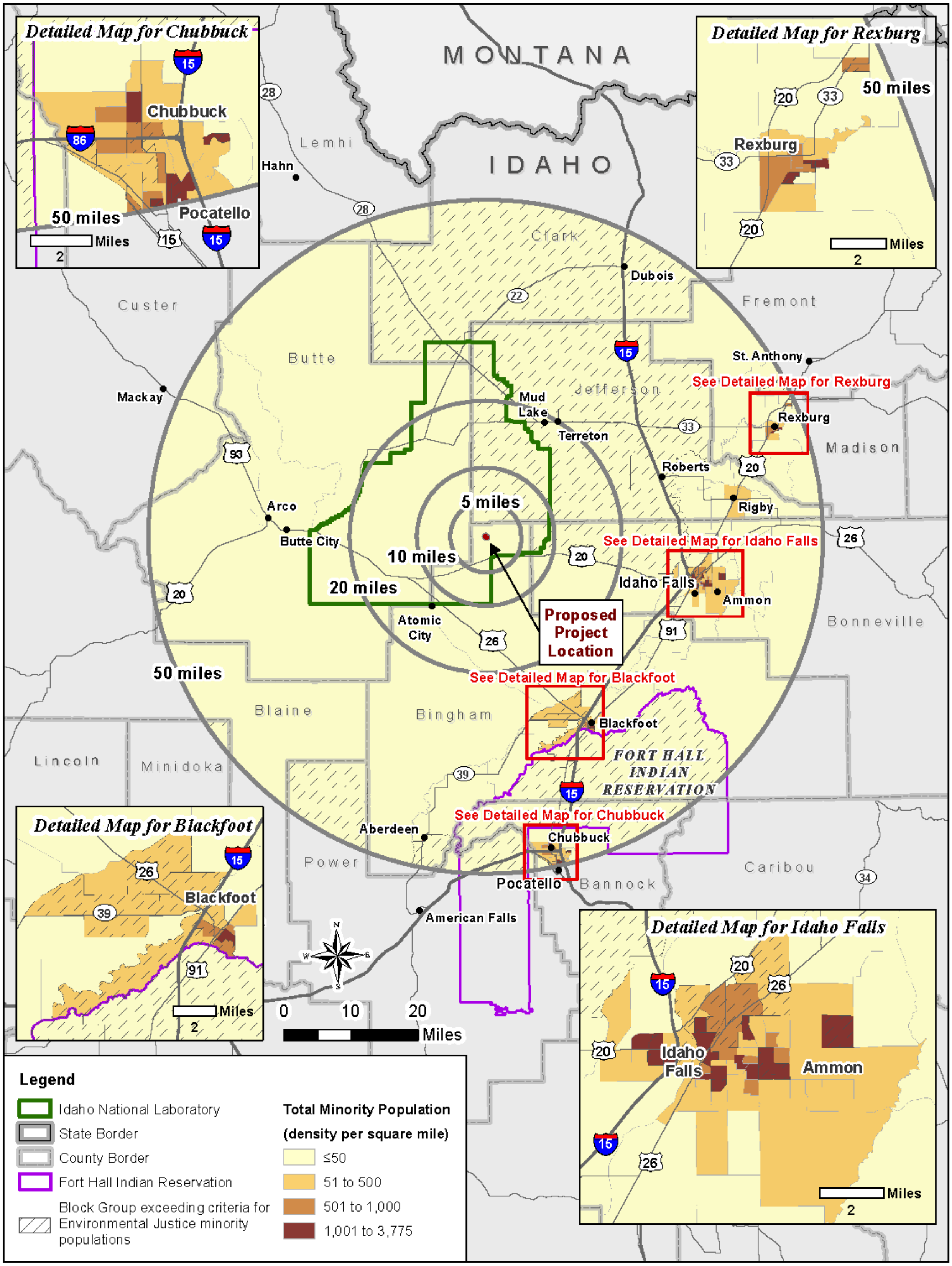

Figure 3–11. Locations of Block Groups Meeting the Criteria for Environmental Justice Minority Populations

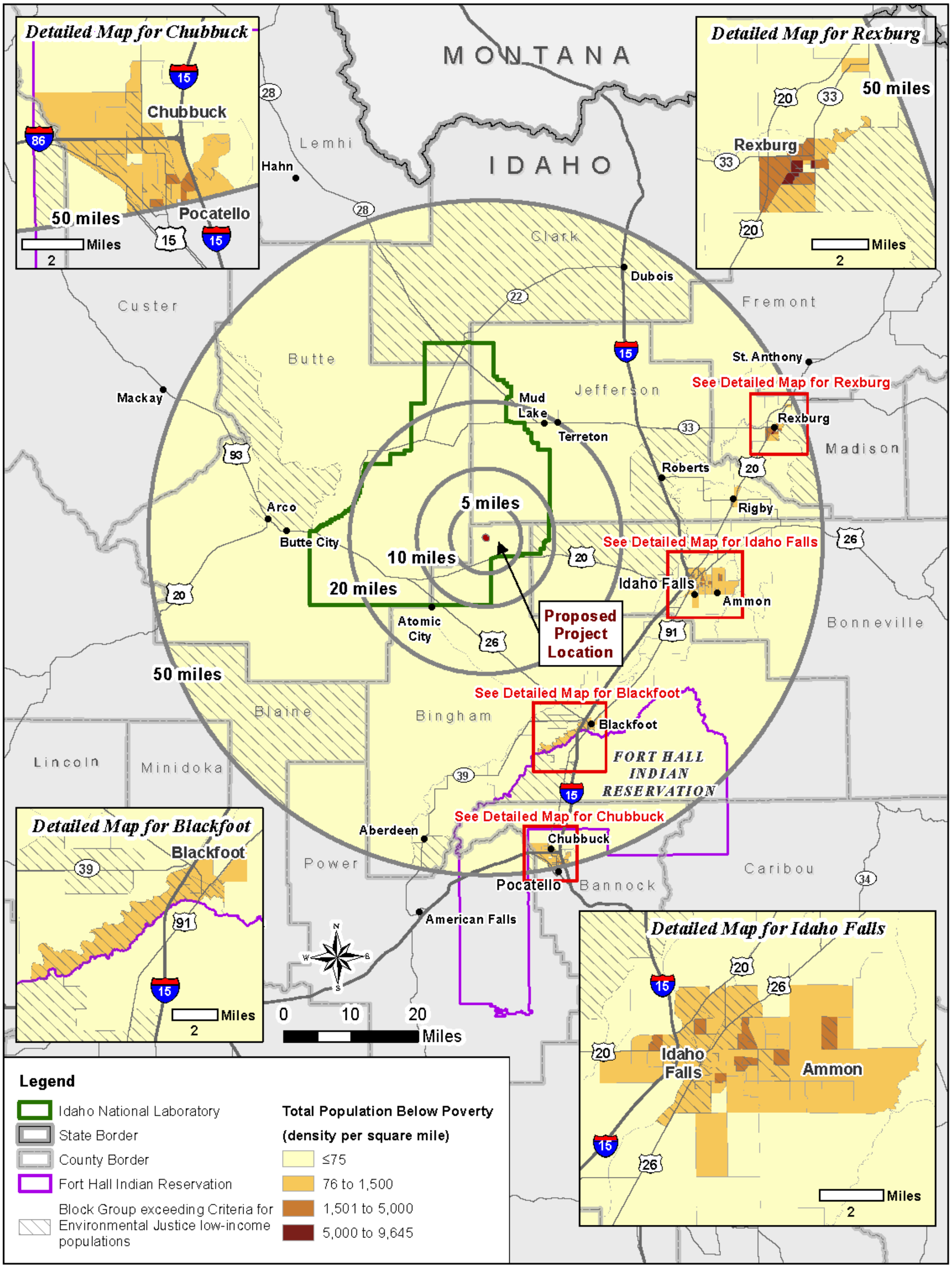

Figure 3–12. Locations of Block Groups Tracts Meeting the Criteria for Environmental Justice Low-Income Populations

3.2 Oak Ridge National Laboratory

3.2.1 Land Use and Aesthetics

This section describes the land use and aesthetics of the Oak Ridge Reservation (ORR) and the proposed project area. The ROI for land use is composed of ORNL, which resides within the ORR. Specific areas within ORNL include the proposed Melton Valley site and lands immediately adjacent. Other regional land uses are described because they can be included in the ROI for other aspects of this affected environment. The ROI for aesthetics would include any areas within line of sight of the proposed project area (near the Melton Valley site[3]) and nearby developed or industrialized areas.

Land use generally refers to human modification of land, often for residential or economic purposes. It also refers to the use of land for preservation or protection of natural resources, such as wildlife habitat, vegetation, or unique geographic features. Attributes of land use include general land use and ownership, land management plans, and special use areas.

3.2.1.1 Land Use at Oak Ridge Reservation

Situated in the Great Appalachian Valley of East Tennessee between the Cumberland Plateau and Great Smoky Mountains, the ORR encompasses about 32,867 acres of mostly contiguous land in Anderson and Roane Counties, owned by the Federal government and under the management of DOE (ORO 2019:1-3). The area is characterized by a succession of east−west-trending narrow ridges and flat-bottomed valleys. Trending northeast to southwest, the major valleys of ORR include the East Fork Valley, Bear Creek Valley, Bethel Valley, and Melton Valley. Major ridges of ORR include Black Oak Ridge, East Fork Ridge, Pine Ridge, Chestnut Ridge, Haw Ridge, and Copper Ridge. With the exception of the East Fork Ridge, these ridges and their intervening valleys extend beyond the limits of ORR. Topographic relief between valley floors and ridge crests on ORR is generally 300 to 350 feet (CROET 2007:2-1).

DOE classifies land use on ORR into five categories: institutional/research, industrial, mixed industrial, institutional/environmental laboratory, and mixed research/future initiatives. Development on ORR accounts for about 35 percent of the total acreage, leaving about 65 percent of ORR undeveloped. Industrial and mixed industrial areas of the ORR include ORNL (historically called X-10), Y-12 National Security Complex (Y-12), and East Tennessee Technology Park (ETTP). The institutional/research category applies to land occupied by central research facilities at ORNL and the Natural and Accelerated Bioremediation Field Research Center in Bear Creek Valley near Y-12. The institutional/environmental laboratory category includes the Oak Ridge Institute for Science and Education. Land within the mixed research/future initiative category includes land that is used or available for use in field research and land reserved for future DOE initiatives. Undeveloped forested lands on ORR are managed for multiple uses, habitat management, watershed protection, wildfire risk reduction, and forest health maintenance (DOE 2011c:4-2, 4-4).

The largest of the mixed industrial uses is biological and ecological research in the 20,000-acre Oak Ridge NERP. The NERP, established in 1980, is used by the nation’s scientific community as an outdoor laboratory for research and education, especially in the environmental sciences (ORNL 2020a). The Oak Ridge NERP was designated an international biosphere reserve in 1989, making it one of the five units of the Southern Appalachian Biosphere Reserve. It is also part of a Tennessee Wildlife Management Area

[3] The Melton Valley site is an area at the ORNL between the High Flux Isotope Reactor and the Clinch River to the east that previously was studied for siting under the Global Nuclear Energy Partnership (CROET 2007). The proposed location of the VTR complex at ORNL is within the Melton Valley site.

(Oak Ridge Wildlife Management Area) and part of the Southern Appalachian Man and the Biosphere Cooperative (ORNL 2020a).

In 1999, the Three Bend Scenic and Wildlife Management Refuge was created in an agreement between DOE and Tennessee Wildlife Resources Agency (TWRA). The Three Bend Scenic and Wildlife Management Refuge Area consists of 2,920 acres located in the ORR buffer zone on Freels, Gallaher, and Solway bends on the north shore of Melton Hill Lake in Anderson County. The cooperative agreement establishes general guidelines for managing the area to preserve and enhance its natural attributes (ORNL 2002:2-43).

In 2005, DOE and the State of Tennessee completed arrangements to place about 3,000 acres of land on ORR into a conservation easement (the Black Oak Ridge Conservation Easement) that is managed by the State of Tennessee in accordance with State laws regarding natural areas and wildlife management areas. The agreement preserves both East and West Black Oak Ridge and McKinney Ridge for conservation and public recreation (DOE 2011c: 4-4). **Figure 3–13** shows the current land use at ORR.

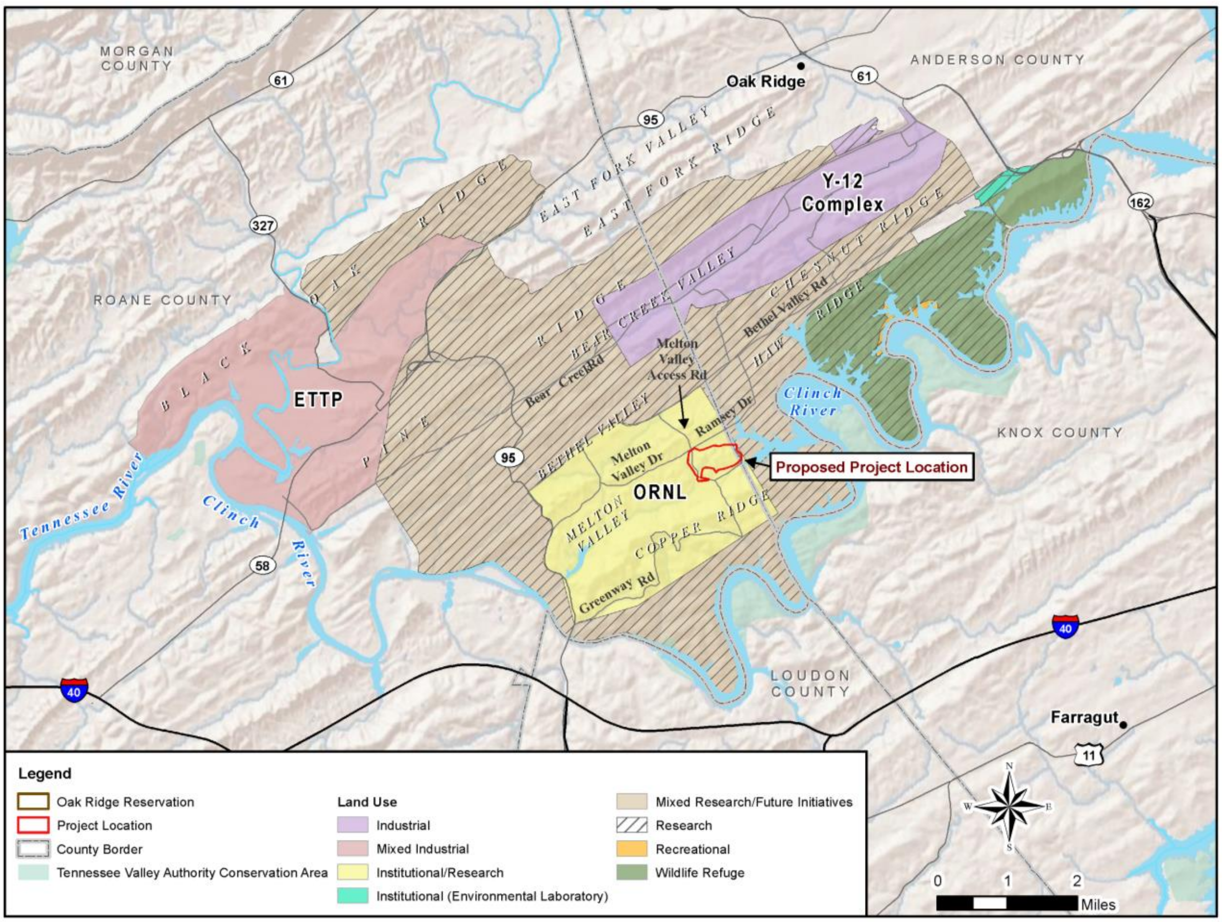

Figure 3–13. Current Land Use at Oak Ridge Reservation

The main ORNL site encompasses facilities in two valleys (Bethel and Melton Valleys) on 1,100 acres of land within the ORR. Within the main area of ORNL, the DOE land use designation is "institutional and research." ORNL supports research and development mission activities in science and technology, energy resources, environmental quality, and national security (DOE 2008a:3-1). The main campus is generally divided into three research campuses, each of which contains a mix of facilities by research type. The west campus primarily contains facilities dedicated to biological and environmental sciences. The heavily industrialized central campus contains a mix of facilities used for administration and support, energy and engineering sciences, physical sciences, and management and integration. The east campus also contains a mix of research facilities (DOE 2008a:3-2).

Land Use at Melton Valley Site

Melton Valley is a prominent northeast-southwest trending valley, typical of landforms in the Valley and Ridge Physiographic Province. The Melton Valley site is located within a relatively undeveloped area of ORNL. As described above, the zoning classification for the majority of the ORR, including the Melton Valley site, is Federal Industry and Research. The DOE designation for the Melton Valley site is institutional/research and mixed research/future initiatives. The area designated as institutional/research is primarily associated with ORNL activities. This includes DOE mission initiatives, research and education, cleanup and remediation, compliance monitoring, utilities, security, and wildlife management (CROET 2007:2-4, 2-5).

Melton Valley is also part of the TWRA Oak Ridge Wildlife Management Area through an agreement between DOE and TWRA, which provides for protection of wildlife habitat and species and restoration of other wildlife habitat and species. Land use in this area is primarily associated with research and education although utilities and some cleanup and remediation activities are present. Portions of Melton Valley are also within the Oak Ridge NERP (DOE 2008a:3-2). The Melton Valley Watershed, situated on about 1,000 acres just south of ORNL contains multiple closed remediation sites as implemented through decisions documented in the Melton Valley Watershed ROD after having been reviewed by the public and approved by DOE, EPA, and the State of Tennessee. The site under consideration for the VTR is not located in the immediate area that was addressed in the Melton Valley Watershed ROD (DOE 2000a) and as such, the Melton Valley site is not subject to the land use controls or remediation activities indicated in the Melton Valley Watershed ROD (CROET 2007:2-4).

Most of the 150-acre Melton Valley site is forested land. Several specific areas within the Melton Valley site currently are designated for other uses (CROET 2007:2-5). These include:

- Park City Road
- Potable water pipeline
- Lichen Research Site
- Explosive and Shock-Sensitive Waste Detonation Area

Regional Land Use

The City of Oak Ridge, Tennessee, forms the northern boundary of ORR and has a typical urban mix of residential, public, commercial, and industrial land uses. There are four residential areas along the northern boundary of ORR, several of which have houses located within 98 feet of the site boundary (DOE 2011c:4-2).

Except for the City of Oak Ridge, the land within 5 miles of ORR is semirural and used primarily for residences, small farms, forest land, and cattle pasture. Fishing, hunting, boating, water skiing, and swimming are popular recreational activities in the area. Other municipalities within about 20 miles of the reservation include Oliver Springs, Clinton, Rocky Top, Lenoir City, Farragut, Kingston, and Harriman. Knoxville, the major metropolitan area nearest Oak Ridge, is about 25 miles to the east (ORO 2019:1-3).

3.2.1.2 Aesthetics at Oak Ridge Reservation

The landscape at ORR is characterized by a series of ridges and valleys that trend in a northeast to-southwest direction. Areas on ORR that are not developed consist primarily of rural land. The City of Oak Ridge is the only adjoining urban area. Viewpoints affected by facilities at ORR are primarily associated with the public access roadways, the Clinch River/Melton Hill Lake, and the bluffs on the opposite side of the Clinch River. However, viewsheds from outside the ORR are often limited by hilly terrain, heavy vegetation, and generally hazy atmospheric conditions (DOE 2011c:4-7).

The level of development of ORNL, ETTP, and Y-12 is consistent with Bureau of Land Management's VRM Class IV, which is used to describe a highly developed area. Most of the ORR land surrounding ORNL, ETTP, and Y-12 would be consistent with the VRM Classes II and III (i.e., left to its natural state with little to moderate changes).

Facilities at ORNL are brightly lit at night, making them especially visible. Structures are mostly low profile, reaching heights of three stories or less. The tallest structures are exhaust stacks on buildings, water towers, and communication and meteorological towers.

Aesthetics at Melton Valley Site

The Melton Valley site would have a VRM Class II rating. Nearby developed areas, such as the High Flux Isotope Reactor (HFIR)/Radiochemical Engineering Development Center (REDC) complex at ORNL, would have a VRM Class IV rating.

There is no public access to the Melton Valley site. The closest viewpoints for the public are located on Melton Hill Lake. Boaters outside the DOE site boundary could get within about 1 mile of the Melton Valley site boundary. The closest viewpoint from an offsite residence is located about 1.5 miles from the site boundary. Hilly terrain, heavy vegetation, and generally hazy atmospheric conditions restrict the view from most publicly accessible areas.

There are currently no lighted facilities on the 150-acre Melton Valley site. Facilities at the nearby HFIR and REDC are brightly lit at night. The tallest structure at the HFIR/REDC complex is a 250-foot exhaust stack.

3.2.2 Geology and Soils

The ROI for geology and soils includes the 150-acre proposed project area at ORNL within the ORR. ORR is located within the Valley and Ridge Physiographic Province, part of the Appalachian fold and thrust belt. The area is characterized by a succession of northeast-southwest-trending narrow ridges and flat-bottomed valleys, which formed as a result of differential erosion of the southeast dipping rocks. Topographic relief between valley floors and ridge crests on ORR is generally 300 to 350 feet (CROET 2007:2-1).

Melton Valley, the location of the 150-acre proposed project area, is a prominent northeast-southwest-trending valley typical of landforms in this type of physiographic province. Haw Ridge borders Melton Valley to the northwest with crest elevations of about 1,000 feet. Copper Ridge lies southeast of Melton Valley with a high crest of 1,356 feet. The valley is about 1.2 miles wide from ridgetop to ridgetop. A line of low knobs with crest elevations of about 940 feet occurs near the center of Melton Valley. The lowest topography in Melton Valley is at the mouth of White Oak Creek at its confluence with the Clinch River. Elevations in the proposed project area range from about 820 to 940 feet (CROET 2007:2-1, 2-2, 2-4).

3.2.2.1 Geology

Bedrock underlying Melton Valley is composed of the calcareous shales and interbedded shaley to silty limestones of the Cambrian Period Conasauga Group. Several individual geologic formations that make up this group are represented, including from north to south (ascending order): the Pumpkin Valley Shale, Rutledge Limestone (also known as the Friendship Formation), Rogersville Shale, Maryville Limestone (also known as the Dismal Gap Formation), and the Nolichucky Shale (see **Figure 3–14**) (CROET 2007:3-2). The geologic units are described in detail in ORNL 1992 and ORNL 2005.

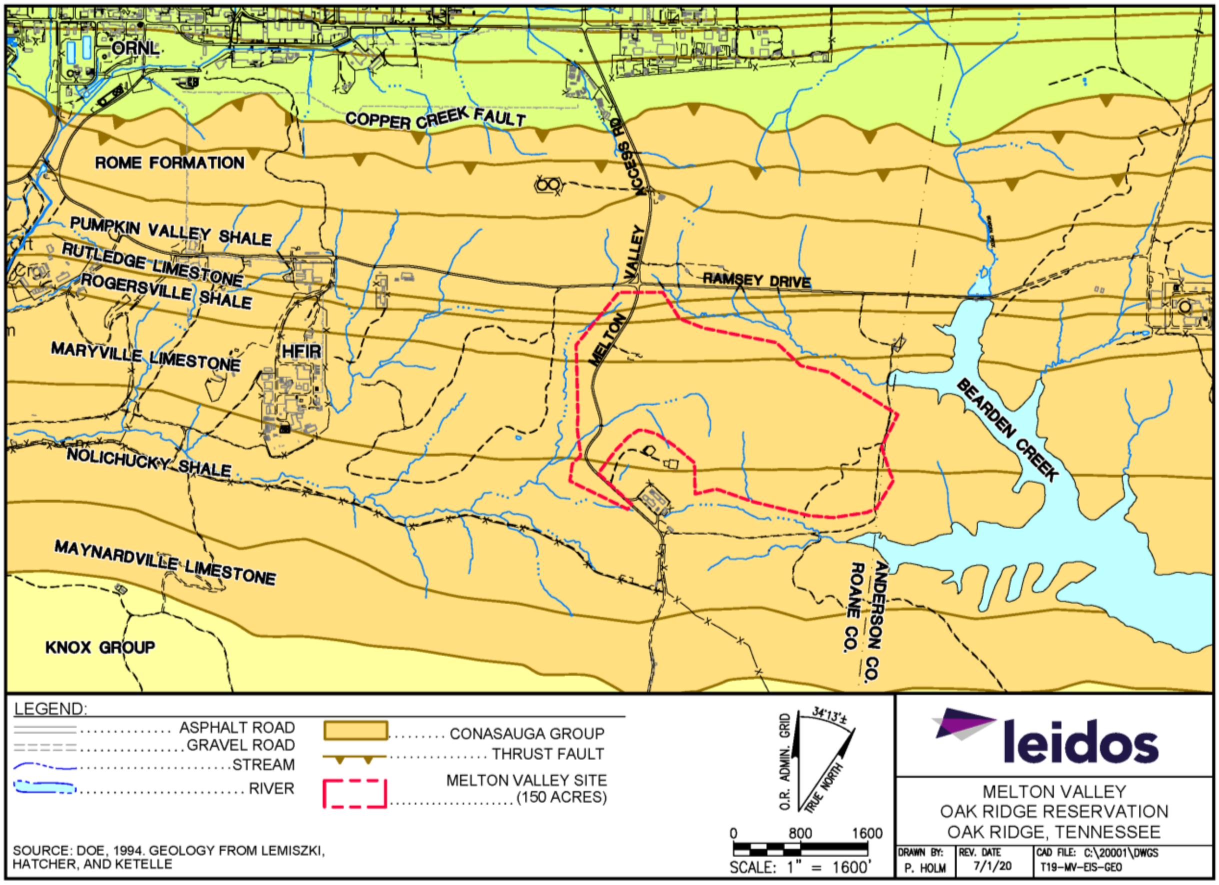

Figure 3–14. Geology of the Proposed Project Area in Melton Valley

A relatively thick zone of bedrock residuum (saprolite) immediately overlies the rocks of the Conasauga Group in Melton Valley. Rock units of the Conasauga Group generally have a low permeability and the residuum zone is highly adsorptive to radionuclides. Because the Conasauga Group has historically been the primary geologic unit for radioactive waste disposal activities, it is the most thoroughly studied rock unit on the ORR (CROET 2007:3-2).

The structural geology of ORR is dominated by two regional thrust faults: White Oak Mountain and Copper Creek faults. There is no geologic evidence indicating that these thrust faults are active or capable. As defined in 10 CFR Part 100, Appendix A, a capable fault is one that has had movement at or near the ground surface at least once within the past 35,000 years, or recurrent movement within the past 500,000 years. The final episode of movement along these fault systems occurred during the Pennsylvanian or Permian Period, at least 230 million years ago (CROET 2007:3-2, 3-4). These faults are no longer active, but stress stored up at depth in these rocks is periodically released as minor earthquakes (DOE 2016d:3-29).

Haw Ridge, Melton Valley, and Copper Ridge are underlain by the Copper Creek Fault, with Melton Valley located south of the surface trace of this fault along Haw Ridge (see Figure 3–14). The Copper Creek Fault underlies Melton Valley at a depth of about 800 feet. Folds, offsets, and dislocations, prevalent in the rocks above the Copper Creek Fault, are believed to be localized in extent and related to the regional thrust faulting. Displacements on these features are generally measured in inches (CROET 2007:3-2, 3-4).

3.2.2.2 Soils

Soils across Melton Valley are generally thin and developed from residual, alluvial (stream-laid), and colluvial (material transported downslope) materials derived from parent bedrock. These soils are underlain by a thick zone of saprolite. Saprolite represents a transition zone between soil and bedrock materials. Saprolite is a soft, clay-rich material derived from decomposed rock that has been leached of cementing materials but which may retain some of the physical characteristics of the parent rock from which it formed. Based on studies performed for the characterization of the former Advanced Neutron Source (ANS) site, bedrock in Melton Valley generally weathers to a clayey residual soil that varies from a true clay at the top to a thick "saprolitic zone" commonly termed "rotten rock." While the saprolite zone is likely to vary spatially across Melton Valley, it was observed during excavation for the adjacent HFIR/REDC complex that the residuum over bedrock averaged about 20 feet in thickness and was overlain by only a thin (less than 1 foot) layer of topsoil (CROET 2007:3-6).

Surficial (geomorphic) material and derived soil types have been mapped across the ORR and Melton Valley. General surficial material types in Melton Valley include residuum, Conasauga Alluvium, Conasauga Colluvium, Pleistocene-Tertiary Alluvium, and Rome Alluvium. Detailed mapping of soil units was previously conducted as part of the ANS site characterization and provides the basis for the following discussion (CROET 2007:3-6).

Residuum. The vast majority of Melton Valley is mapped as residuum. Soils that developed as residuum (saprolite) reflect the variability and degree of weathering of the underlying bedrock formations (see Figure 3–14). Pumpkin Valley residual soils are extensive clayey or fine-loamy soils greater than 20 inches in depth to the horizon underlain by soft bedrock. Rutledge Residuum soils are described as "clayey argillic and loamy-skeletal" residual soils that formed in shale-siltstone-derived, low-glauconitic saprolite weathered from calcareous rocks. Where the saprolite was derived from shale, the material has low permeability, allowing water to perch. Rogersville Residuum soils generally are clayey, clayey argillic, and loamy-skeletal soils on summits and sideslopes. Maryville Residuum soils arose under varying degrees of weathering. Most of these soils are clayey and loamy-skeletal-type soils that formed in saprolite from less weathered but highly interbedded siltstone and claystone, with thin strata of limestone and sandstone. The depth to the horizons underlain by soft bedrock is highly variable ranging from less than 4 inches to more than 40 inches over short distances. Nolichucky Residuum consists of clayey argillic and loamy-skeletal-type soils. Due to the relatively impermeable nature of the saprolite, the upper soil becomes readily saturated (CROET 2007:3-6).

Conasauga Alluvium. This unit comprises coarse to fine, silty soils that formed in modern alluvium along surface water drainages and contributes high silt-content sediment to their drainages. Modern or recent alluvium is less than 300 years old and is the product of accelerated erosion from human settlement and related land uses, such as agriculture. Because of its age, the alluvium lacks any diagnostic soil horizons in the subsurface. Most of the soils are well to moderately well drained, but some soils grade to somewhat poorly to poorly drained, particularly along the larger drainages to Melton Branch in the central portion of Melton Valley. Most of these mapped areas contain a buried soil at depths ranging from 20 to 40 inches (CROET 2007:3-6, 3-8).

Conasauga Colluvium. These colluvial materials include fine, loamy soils that developed from parent materials from the Pumpkin Valley, Rogersville, and Maryville Limestone formations. Derived soils include rock fragment assemblages reflecting their source, including shale and siltstone fragments. Associated soils occur on toeslopes and fan terraces near first-order drainage ways (CROET 2007:3-8).

Pleistocene-Tertiary Alluvium. These alluvial materials are limited in extent and reflect older terraces of stream-deposited alluvium (CROET 2007:3-8).

No current soil surveys prepared by the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) are available for Roane County. Nevertheless, maps of areas to the east of the site in Anderson County indicate that soils of the Armuchee and Montevallo Series would be representative of some soil units on the proposed project area. Armuchee soils are moderately deep and well-drained soils that occur on rolling to very steep uplands. Montevallo-Series soils consist of shallow, well-drained, moderately permeable soils on gently sloping to steep, narrow ridgetops and side slopes. Armuchee- and Montevallo-Series soils are classified as having specific limitations affecting excavation work that may be difficult to overcome without adequate engineering design and planning. Specific limitations identified for these soils include shallow depth to soft bedrock, presence of clayey strata, slope, and the tendency for cut slopes to cave (CROET 2007:3-8). More finely textured soils of the Armuchee-Montevallo-Hamblen association have been designated as prime farmland when drained (DOE 2011c:4-19).

No widespread areas of soil contamination have been identified within the proposed project area (CROET 2007:3-8).

3.2.2.3 Geologic and Soil Resources

The known geologic and soil resources exposed on the ORR are limited to quarry rock (limestone and dolomite) and clay (soils). Quarry rock was mined at several locations on ORR, but no quarries are currently in operation (DOE 1995:3.4-20–21). A number of active borrow pits at ORR have been identified for use in providing a supply of borrow materials for ongoing and future activities. The Copper Ridge Borrow Area, the nearest borrow source, is about 0.5 mile southeast of the proposed project area. No other economically viable geologic resources have been identified at ORR (DOE 1996c:3-200).

3.2.2.4 Geologic Hazards

Seismic Hazards

There is no evidence of capable faults in the immediate area of ORR, as defined by 10 CFR Part 100 (surface movement within the past 35,000 years or movement of a recurring nature within the past 500,000 years). The nearest capable faults are about 300 miles west of ORR in the New Madrid Fault zone (DOE 2011c:4-17). Historical earthquakes occurring in the Valley and Ridge Province of Tennessee are not attributable to faults in underlying sedimentary rocks but instead occur at depth in basement rock (DOE 2011d:3-156).

Seismic-hazard assessments in the Central and Eastern United States generally rely on historical seismicity to quantify seismic hazard, rather than geologic evidence of active faulting at or near the surface. ORNL is located within the Southern Appalachian Seismic Zone, which extends from western Virginia to central Alabama, subparallel to the Valley-and-Ridge and Blue Ridge physiographic provinces. While minor earthquakes are relatively common in the Southern Appalachian Region within about 60 miles of ORNL, no earthquakes above magnitude 6.0 have been documented in the region (CROET 2007:3-4).

The USGS reported 179 earthquakes greater than magnitude 2.5 occurred within 100 miles of the proposed project area between January 1973 and September 2019. Only one of the 179 earthquakes had a magnitude greater than 4.5. A magnitude 4.7 event occurred on November 30, 1973 (USGS 2019b).

The November 30, 1973, earthquake occurred in Blount County, Tennessee (in the Maryville/Alcoa area), about 21 miles from ORNL. Although this earthquake caused minor damage in eastern Tennessee, there were no earthquake-related damage reports for DOE facilities at ORR (CROET 2007:3-5).

On August 9, 2020, a magnitude 5.1 earthquake occurred near Sparta, North Carolina, over 175 miles from ORR. The earthquake was generally weakly to lightly felt in the Oak Ridge, Tennessee area, with no damage reported (USGS 2020).

Within the larger southern portion of the Appalachian Basin Tectonic Province in which the ORR is located, the strongest documented earthquake occurred in Giles County, Virginia, on May 31, 1897. Located about 220 miles from ORNL, it had an estimated magnitude of 5.8 and produced slight damage in eastern Tennessee. The strongest earthquakes to affect the ORR region were the New Madrid, Missouri, earthquakes (with estimated magnitudes ranging from 7.0 to 7.9) that occurred in 1811 and 1812 at distances of 310 to 370 miles from ORNL. It is believed that this series of earthquakes led to low-level shaking at ORR for several minutes. Second to the New Madrid earthquakes in intensity, the Charleston, South Carolina, earthquake of 1886, located about 320 miles from ORNL, produced minor damage in East Tennessee (CROET 2007:3-5).

Earthquake-produced ground motion is expressed in units of "g." (acceleration relative to that of the Earth's gravity.) PGA data from the USGS are used to indicate seismic hazard. At the proposed project area, the calculated PGA based on an earthquake with a 2 percent probability of exceedance in 50 years (or an annual occurrence probability of 1 in 2,500) is about 0.35 g (USGS 2014a, 2014b).

Current standards, including DOE Orders and prescribed standards applicable to the ORR, require the use of probabilistic seismic analysis to establish the seismic hazard curve of postulated earthquake ground motions for the site. Probabilistic seismic analysis considers all possible tectonic events that could impact the site and attempts to account for both the likelihood of occurrence, and the uncertainty in such input parameters as seismic source, seismicity, or attenuation factors. For HFIR, adjacent to the proposed VTR site, the current established peak horizontal ground acceleration for the design-basis earthquake is 0.15 g (CROET 2007:3-5).

Volcanic Hazards

The area near ORR has not experienced volcanic activity within the last 230 million years and future volcanic activity is not anticipated (DOE 1996c:3-200).

Slope Stability, Subsidence, and Liquefaction

Topographic relief and slope classifications across Melton Valley are shown in **Figure 3–15**. Slopes less than 5 percent (Class 2) cover most of Melton Valley. The steepest slopes (Class 5) generally occur along the major surface drainages like those of Bearden Creek (CROET 2007:2-2).

Karst terrain is characterized by dissolution of carbonate bedrock and development of diagnostic karst features such as sinking streams, karst springs, caves, and sinkholes. Strata of the Conasauga Group, especially the shaley members, do not pose a significant hazard for karst development, and no sinkholes or other karst features have been identified in the proposed project area. On the ORR, carbonate bedrock formations of the Knox Group have the greatest potential for karst development. The proposed project area is situated north of subcrops of the Knox Group (CROET 2007:3-2) (see Figure 3–14). Therefore, subsidence is not likely to be an issue in the proposed project area.

There is no potential for liquefaction beneath facilities constructed on firm rock. Overall, DOE's experience on the ORR has been that depths to bedrock are sufficiently shallow that any location can be expected to provide a competent bedrock foundation for major structures. The highest liquefaction potential exists for shallow foundation materials that are saturated, uniformly graded, cohesionless, fine-grained sands at low-relative density. Drilling data from the geotechnical investigation of the HFIR site in Melton Valley have shown that the soil materials above continuous rock are residual clays of relatively high density (CROET 2007:3-4, 3-5).

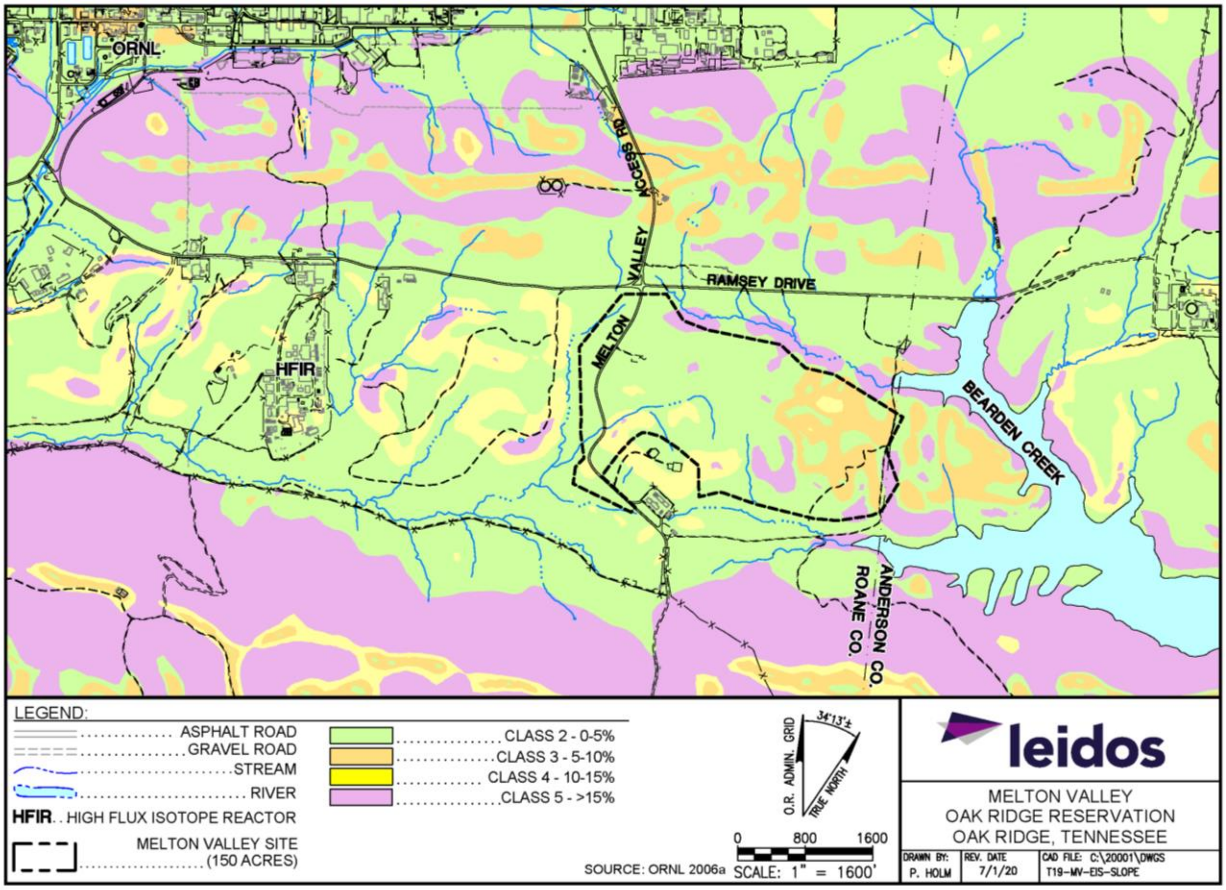

Figure 3–15. Surface Topography (Slopes) of the Proposed Project Area in Melton Valley

3.2.3 Water Resources

The ROI for water resources includes surface waters, wetlands, and groundwater present within and downstream of ORR in general and the 150-acre proposed project site within the ORNL in particular. This section describes surface and groundwater resources that drain the site and serve as sources of onsite drinking water and provides specific information regarding water availability and quality. Wastewater, stormwater, wetlands, and flooding potential are also discussed.

Chapter 0400-45-01 (Public Water Systems) of the Tennessee Department of Environment and Conservation (TDEC) outlines rules and regulations issued under the Tennessee Safe Drinking Water Act of 1983. These rules include State drinking water standards and primary and secondary constituent standards for groundwater.

3.2.3.1 Surface Water

ORR surface water drainage eventually reaches the Tennessee River via the Clinch River, which forms the southern and eastern boundaries of the ORR. There are four major subdrainage basins on ORR that flow into the Clinch River and are affected by site operations: Poplar Creek, East Fork Poplar Creek, Bear Creek, and White Oak Creek. Several smaller drainage basins — including Ish Creek, Grassy Creek, Bearden Creek, McCoy Branch, Kerr Hollow Branch, and Raccoon Creek — drain directly into the Clinch River. Each drainage basin takes the name of the major stream flowing through the area. The southwest corner of the project site drains to Melton Branch, while the remainder drains toward Bearden Creek. All surface water drainage from the project site eventually reaches the Clinch River.

The Clinch River water levels in the vicinity of ORR are regulated by a system of dams operated by the Tennessee Valley Authority. Watts Bar Dam on the Tennessee River near the lower end of the Clinch River controls the flow of the Clinch River along the southwest side of ORR. Melton Hill Dam controls the flow of the Clinch River along the northeast and southeast boundaries of ORR, including those sections of the river nearest the project site. The Melton Hill Dam on the Clinch River creates Melton Hill Reservoir, which extends about 57 miles upstream to Norris Dam (TVA 2020e).

None of the rivers or streams on or near ORR have been classified as wild and scenic per the Wild and Scenic Rivers Act, 16 U.S.C. Section 1274.

National Wetland Inventory maps prepared by the USFWS indicate wetland areas are associated with the Melton Hill Reservoir (on the Clinch River) and other drainages toward White Oak Creek, including Melton Branch. These wetlands are classified as open water, riverine, or freshwater forested/shrub wetlands.

Figure 3–16 presents water resources in the vicinity of the Melton Valley site, including surface water and wetlands.

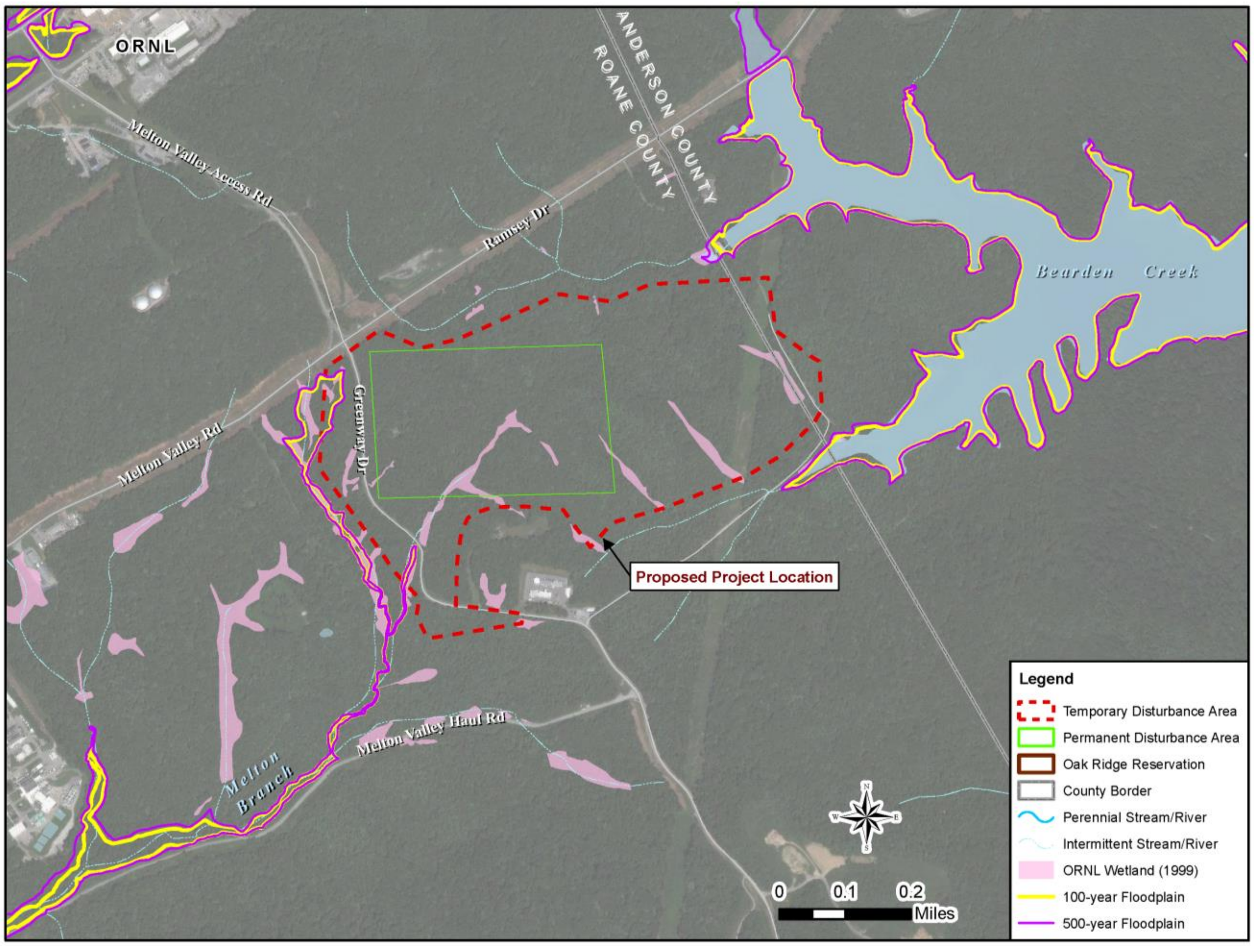

Figure 3–16. Water Resources in the Vicinity of the Melton Valley Site

3.2.3.1.1 Surface Water Quality

The surface streams of Tennessee are classified by the TDEC based on water quality, beneficial uses, and resident aquatic biota. Unless otherwise specified in Chapter 0400-40-04 of TDEC's rules, all streams in Tennessee are classified for use for fish and aquatic life, irrigation, and for livestock watering and wildlife. White Oak Creek and Melton Branch are the only streams not classified for irrigation. The Clinch River is classified for domestic water supply and for industrial water supply use. Melton Hill Reservoir (on the Clinch River) has been designated as impaired due to polychlorinated biphenyls (PCBs) and chlordane arising from contaminated sediment (TDEC 2019b).

Wastewater treatment facilities are located throughout ORR, including six treatment facilities at Y-12 that discharge to East Fork Poplar Creek and three treatment facilities at ORNL that discharge into White Oak Creek Basin. These discharge points are included in existing NPDES permit provisions. There are about 400 NPDES-permitted outfalls at ORR; many of these are stormwater outfalls. About 150 of these NPDES outfalls are located within ORNL (ORNL 2008). In 2018, the NPDES permit limit compliance rate for all discharge points was 100 percent (ORO 2019).

3.2.3.2 Groundwater

3.2.3.2.1 Local Hydrology

Groundwater in the vicinity of ORNL, including near the project site, occurs both in the unsaturated zone as transient, shallow subsurface stormwater and within the deeper saturated zone. An unsaturated zone of variable thickness separates the stormflow zone and water table. Adjacent to surface water features or in valley floors, the water table is found at shallow depths, and the unsaturated zone is thin. Along the ridge tops or near other high topographic areas, the unsaturated zone is thick, and the water table often lies at considerable depth (50 to 175 feet deep). In low-lying areas where the water table occurs near the surface, the stormflow zone and saturated zone are indistinguishable. It is estimated that in undisturbed, naturally vegetated areas at ORR, about 90 percent of the infiltrating precipitation does not reach the water table but travels through the 3- to 7-foot-stormwater zone, which about corresponds to the root zone. This condition exists because of the permeability contrast between the shallow stormflow zone and the underlying unsaturated zone (ORO 2004).

Two broad hydrologic groupings have been characterized at ORR, each having fundamentally different characteristics. The Knox Group and the Maynardville Limestone of the Conasauga Group constitute the Knox Aquifer, in which the groundwater flow is dominated by a combination of solution conduits and weathered permeable fractures. The less permeable ORR aquitard units constitute the second regime, in which the groundwater flow is dominated by fractures. The combination of fractures and solution conduits in the dolostones and limestones of the Knox Aquifer control flow over substantial areas, and rather large quantities of water may move relatively long distances. Active groundwater flow can occur at substantial depths in the Knox Aquifer (300 to 400 feet deep). The Knox Aquifer is the primary source of groundwater to many streams, and most large springs on ORR receive discharge from the Knox Aquifer. Yields of some wells penetrating larger solution conduits are reported to exceed 1,000 gallons per minute (ORO 2018).

Units constituting the ORR aquitards include the Rome Formation, the Conasauga Group below the Maynardville Limestone, and the Chickamauga Group. The units consist mainly of siltstone, shale, sandstone, and thinly bedded limestone of low to very low permeability. The typical yield of a well in the aquitards is less than 1 gallon per minute, and the base flow of streams draining areas underlain by the aquitards are poorly sustained because of such low flow rates (DOE 2000b). Most water in the saturated zone in the ORR aquitards is transmitted through a 3- to 20-foot layer of closely spaced, well-connected fractures near the water table. Modeling by the USGS indicates that 95 percent of all groundwater flow occurs in the upper 50 to 100 feet of the saturated zone in the ORR aquitards. As a result, flow paths in the active flow zones of the aquitards are relatively short, and nearly all groundwater discharges to local surface water drainages on the ORR (DOE 2000b; ORO 2004).

3.2.3.2.2 Subsurface Water Quality

Background groundwater quality at ORR is generally good in the near-surface saturated zone and the Knox Aquifer. It is poor in the deep saturated zone (particularly in the aquitards) at depths greater than 1,000 feet due to high total dissolved solids (ORO 2004).

Groundwater near ORNL has been locally contaminated by hazardous chemicals and radionuclides from past process activities. The contaminated sites include past waste disposal sites, waste storage tanks, spill sites, and contaminated inactive facilities (DOE 2000b). In general, contaminant plumes in groundwater at ORNL are relatively small in areal extent, as contaminant sources are discretely located and flow paths to surface water outlets are short (ORO 2004).

3.2.3.3 Drinking Water

Water for ORNL is obtained from the Clinch River south of the eastern end of Y-12 and pumped to the water treatment plant located on the ridge northeast of Y-12. The treatment plant is owned and operated by the City of Oak Ridge. The water treatment plant can deliver water to two water storage reservoirs at a potential rate of 24 million gallons per day. Water from the two reservoirs is distributed to Y-12, ORNL, and the City of Oak Ridge. Water use at ORNL is discussed in Section 3.2.7, Infrastructure.

3.2.3.4 Water Use and Rights

State laws and statutes relating to water rights have continuously developed over the past century and a half. Groundwater rights in the State of Tennessee have evolved to be aligned with the Reasonable Use doctrine. Under this doctrine, landowners can withdraw groundwater as long as they exercise their rights reasonably in relation to the rights of others (DOE 2000b).

3.2.4 Air Quality

This section describes the existing air quality and climatic conditions of ORNL. Roane and Anderson Counties encompass ORNL and, therefore, comprise the immediate ROI for the project air quality analysis. However, the counties of Knox and Loudon are adjacent to portions of the southern boundary of ORR and also are part of a regional ROI for the project.

3.2.4.1 Meteorology and Climatology

Due to its latitude and location on the eastern side of North America, ORNL experiences a humid subtropical climate. This climate of the ORNL region is characterized by hot and humid summers, relatively mild winters, abundant precipitation, and minor differences in precipitation between seasons.

Moisture from the Gulf of Mexico is the main source of precipitation in the region. During the warmer months of the year, this moisture produces rain showers and thunderstorms. The occasional passage of weak polar storm systems through the region during this time of year can enhance precipitation. The remnants of tropical storms also can move into the region from the Gulf of Mexico and can augment rainfall in the late summer and early fall. During the colder months of the year, the occurrence of polar storms increases and produces occasional snow and ice.

Climate and meteorological data collected within ORNL are used to describe the climatic conditions of ORNL (ORO 2019:1.4, Appendix B). The average high and low temperatures at ORNL in July are about 89 and 68 degrees Fahrenheit, respectively. January’s average high and low temperatures are about 47 and 28 degrees Fahrenheit, respectively. Annual precipitation averages about 53 inches per year. July and October are the wettest and driest months of the year, respectively. An average of 6 inches of snow falls annually at ORNL.

Thunderstorms at ORNL occur an average of 48 days per year and are most common during the months of April through October. Hailstorms can occur with these storms, although the potential for large hail (greater than 0.75 inch in diameter) is low. As an example, hail was reported only 6 times within 25 miles of ORNL from 1961 to 1990. However, in 2011, large hail was observed about 9 miles southeast of ORNL. Tornadoes are rare in the region; only six have been observed in Roane County since 1950 (National Weather Service 2019b). In February 1993, a moderately strong tornado struck the Bear Creek Valley near the Y-12 Complex. This event is the only known occurrence of a tornado on ORR.

Figure 3–17 shows a graphic of wind speed and wind direction frequencies (wind rose) for data recorded at ORNL for period 2014 through 2018 at Tower A (MT4), which is located near the HFIR and about 1 mile west of the project site (ORNL 2020c). These data show that winds at ORNL prevail from the west-southwest and east-northeast directions. This wind direction pattern is largely due to the orientation of the Clinch River valley and its paralleling mountain ridges, which forces winds up and down their axes.

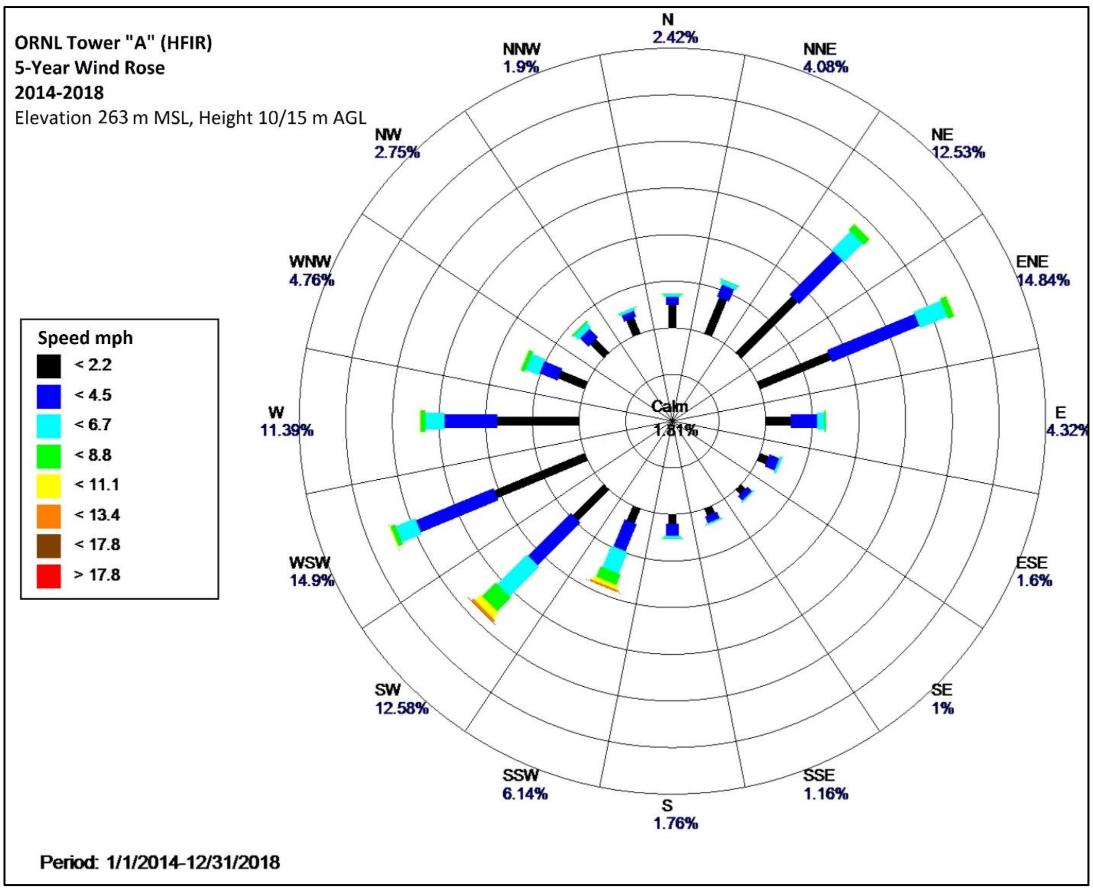

Figure 3–17. Wind Rose for Oak Ridge National Laboratory – Years 2014–2018

3.2.4.2 Air Quality Standards and Regulations

The CAA and its subsequent amendments establish air quality regulations and the NAAQS and delegate the enforcement of these standards to the States. In Tennessee, TDEC has the authority to regulate air quality. The CAA establishes air quality planning processes and requires States to develop a State Implementation Plan that details how they will maintain the NAAQS or attain a standard in nonattainment within mandated timeframes. The requirements and compliance dates for attainment are based on the severity of the nonattainment classification of the area. The following summarizes the air quality rules and regulations that apply to the proposed action at ORNL.

3.2.4.3 Nonradiological Air Emission Standards

Air quality at a given location can be described by the concentrations of various air pollutants in the atmosphere. Air pollutants are defined as two general types: (1) criteria pollutants and (2) HAPs. EPA establishes the NAAQS to regulate the following criteria pollutants: O_3, CO, NO_2, SO2, PM_{10}, $PM_{2.5}$, and lead. These standards represent atmospheric concentrations to protect public health and welfare and include a reasonable margin of safety to protect the more sensitive individuals in the population. TDEC implements the NAAQS and State ambient standards for total suspended particulates (TSP), hydrogen chloride, and fluoride for purposes of regulating air quality in Tennessee. The Tennessee standards and NAAQS are shown in **Table 3–21**.

EPA designates all areas of the United States as having air quality better than (attainment) or worse than (nonattainment) the NAAQS. Former nonattainment areas that have attained the NAAQS are designated as maintenance areas. Presently, EPA categorizes Roane County that encompasses ORNL as in attainment of all NAAQS. The nearest nonattainment area to ORNL is an SO_2 nonattainment area in Sullivan County, about 120 miles to the east-northeast. The nearest maintenance area to ORNL is a lead maintenance area in Bristol, Sullivan County, about 140 miles to the east-northeast.

Table 3–21. Tennessee and National Ambient Air Quality Standards

Pollutant	Averaging Time	Tennessee Standards [a]		National Standards	
		Primary [b]	Secondary [c]	Primary [b]	Secondary [c]
Ozone (O_3)	8-hour	--	--	0.070 ppm	Same as primary
	1-hour	0.12 ppm	0.12 ppm	–	–
Carbon monoxide (CO)	8-hour	9 ppm	9 ppm	9 ppm	–
	1-hour	35 ppm	35 ppm	35 ppm	–
Nitrogen dioxide (NO_2)	Annual	0.05 ppm	0.05 ppm	0.053 ppm	Same as primary
	1-hour	--	--	0.10 ppm	–
Sulfur dioxide (SO_2)	Annual	0.03 ppm	--	--	--
	24-hour	0.14 ppm	--	–	–
	3-hour	--	0.5 ppm	–	0.5 ppm
	1-hour	--	--	75 ppb	–
Total Suspended Particulates (TSP)	24-hour	--	150 μg/m³	--	--
Respirable particulate matter (PM_{10})	Annual	50 μg/m³	50 μg/m³	–	–
	24-hour	150 μg/m³	150 μg/m³	150 μg/m³	Same as primary
Fine particulate matter ($PM_{2.5}$)	Annual	--	--	12 μg/m³	15 μg/m³
	24-hour	--	--	35 μg/m³	Same as primary
Lead	Rolling 3-month average	--	--	0.15 μg/m³	Same as primary
	Quarterly Average	1.5 μg/m³	1.5 μg/m³	–	–

$PM_{2.5}$ = particulate matter less than 2.5 microns in diameter; PM_{10} = particulate matter less than 10 microns in diameter; ppm = parts per million; ppb = parts per billion; μg/m³ = micrograms per cubic meter.

[a] Tennessee Standards: The table only presents the TSP standard, as sources evaluated in the project air quality analysis would not emit hydrogen chloride or fluoride.

[b] Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to protect public health.

[c] Secondary Standards: The levels of air quality necessary to protect the public from any known or anticipated adverse effects of a pollutant.

Source: EPA 2016; TDEC 2006.

EPA also regulates HAPs that are known or are suspected to cause serious health effects or adverse environmental effects. The CAA identifies 187 substances as HAPs (e.g., benzene, formaldehyde, mercury, and toluene). HAPs are emitted from a range of industrial facilities and vehicles. EPA sets Federal regulations to reduce HAP emissions from stationary sources in the NESHAP. A "major" source of HAPs is defined as any stationary facility or source that directly emits or has the potential to emit 10 tons per year or more of any HAP or 25 tons per year or more of combined HAPs. In Tennessee, TDEC regulates HAPs and seven pollutants designated as hazardous air contaminants (HACs). Both programs set ambient levels of concern for HAPs and HACs.

As stated in Section 3.1.4.2.1 of this EIS, the PSD Regulation and CAA provide special protection for air quality and air quality-related values (including visibility and pollutant deposition) in select National Parks, National Wilderness Areas, and National Monuments in the United States. The Joyce Kilmer-Slickrock Wilderness Area is the closest PSD Class I area to ORNL; its nearest border is about 38 miles south-southeast of ORNL. Due to the proximity of this pristine area to ORNL, this EIS provides qualitative analyses of the potential for emissions generated by the project alternatives to affect visibility within this area.

The TDEC Division of Air Pollution Control (APC) is responsible for enforcing air pollution regulations in Tennessee. The APC enforces the NAAQS by monitoring air quality, developing rules to regulate and to permit stationary sources of air emissions (nonradiological and radiological), and managing the air quality attainment planning processes in Tennessee. TDEC air quality regulations, "Tennessee Air Pollution Control Regulations," are found in the Rules and Regulations of the State of Tennessee Regulation 1200, Division 3 (Tennessee Secretary of State 2019). Some sources at ORNL that emit criteria pollutants and HAPs are regulated under permits to construct and operate, as required by Chapter 1200-03-09 of the Tennessee APC Regulations (ORO 2019:5-17). For example, ORNL is not a major source of HAPs in accordance with the requirements found in Title V Permit No. 571359.

3.2.4.3.1 Greenhouse Gases and Climate Change

Section 3.1.4.2.2 of this EIS defines GHGs and the concept of CO_2e and discusses the link between the worldwide proliferation of GHG emissions by humankind and global warming. Climate change associated with global warming is predicted to produce negative environmental, economic, and social consequences across the globe.

In Tennessee, the U.S. Global Change Research Program predicts that annual average temperatures will increase between 3 and 7 degrees Fahrenheit by 2100, based on both low and high global GHG emission scenarios (USGCRP 2018:42). In addition, average precipitation for each season will increase over the long-term, with the highest increase of 10 to 20 percent occurring in winter (USGCRP 2017:217). Predictions of the impacts of these changes to Tennessee include: (1) an increase in extreme rainfall events, which will increase flood risks in low-lying regions; (2) an increase in heat, flooding, and vector-borne disease in urban areas; and (3) more frequent extreme heat episodes and changing seasonal climates will increase exposure-linked health impacts and economic vulnerabilities in the agricultural, timber, and manufacturing sectors (USGCRP 2018:744-808).

As stated in Section 3.1.4.2.2 of this EIS, Federal agencies address emissions of GHGs by reporting and meeting reductions mandated in Federal laws, Executive Orders, and agency policies. Annual emissions of GHGs from ORNL do not exceed 25,000 metric tons of CO_2e and therefore their operations are not subject to the EPA mandatory reporting requirements. However, annual emissions of GHGs from Y-12 have exceeded 25,000 metric tons of CO_2e due to the operation of natural gas-fired boilers at the onsite steam plant and, therefore, the Y-12 facility does report its annual GHG emissions to EPA (ORO 2019:4-42).

The potential effects of GHG emissions from the project alternatives are by nature global and cumulative. Given the global nature of climate change and the current state of the science, it is not useful at this time to attempt to link the emissions quantified for local actions to any specific climatological change or resulting environmental impact. Nonetheless, GHG emissions from the project alternatives are quantified in this EIS for use as indicators of their potential cumulative contributions to climate change effects and for making reasoned choices among alternatives.

3.2.4.3.2 Radiological Air Emission Standards

Facilities at ORNL emit radioactive materials and therefore are subject to NESHAP, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities." Tennessee APC Regulation 1200-3-11-.08, NESHAP; Standards for Emissions of Radionuclides other than Radon from DOE Facilities, also incorporates the requirements of Subpart H. This regulation limits the radionuclide dose to a member of the public from all sources on ORR to 10 millirem per year. Subpart H also establishes requirements for monitoring emissions from facility operations and analyzing and reporting radiological doses. Airborne radiological effluents at ORNL are continuously sampled or monitored from major and minor source locations (some minor sources are sampled periodically) or are estimated based on building inventories to demonstrate compliance in accordance with the requirements of Subpart H and DOE Order 458.1, "Radiation Protection of the Public and the Environment."

3.2.4.4 Nonradiological Air Emissions

Sources of nonradiological air emissions at ORNL include natural gas and/or No. 2 fuel oil-fired boilers (steam plant), emergency diesel generators, small gasoline, diesel, and propane combustion sources such as comfort heaters, an on-road vehicle fueling station, chemical and solvent usages, and on-road and non-road vehicle sources. Facilities use emergency diesel generators for emergency electrical power and operate these sources during periodic testing activities.

3.2.4.5 Radiological Air Emissions

Sources of radionuclide emissions from ORNL mainly occur from the ventilation of (1) isotope production/handling areas, (2) reactor research, (3) accelerator operations and associated research, (4) analytical facilities, (5) out-of-service and decommissioned facilities, and (6) the storage of legacy materials (ORO 2017a:6). Minor amounts of radionuclide emissions also occur from fugitive and diffuse sources. These radionuclide emissions typically take the form of particulates, adsorbable gases, nonadsorbable gases (i.e., noble gases), and tritium. Major sources of radionuclide emissions are equipped with CEM systems and are controlled with HEPA filters, per the requirements of Subpart H. Many minor sources of radionuclide emissions also are controlled with HEPA filters.

During 2018, an estimated 147,000 curies of radioactivity were released to the atmosphere from all ORNL sources (ORO 2019:5-49). For calendar year 2018, the effective dose equivalent from all airborne radionuclide emissions on ORR to the MEI member of the public was 0.2 millirem per year, which is 2 percent of the 10 millirem per year Subpart H standard (ORO 2019:5-32). Radionuclide emissions from ORNL contributed to 19 percent of this impact. Subpart H defines the MEI as any member of the public at any offsite location where there is a residence, school, business, or office.

3.2.5 Ecological Resources

Ecological resources include the plant and animal species, habitats, and ecological relationships of the land and water areas within the ROI, which is defined as the area directly or indirectly affected by the proposed action. Particular consideration is given to sensitive species, which are those species protected under Federal or State law, including threatened and endangered species, migratory birds, and bald and golden eagles.

For the purposes of this EIS, sensitive and protected ecological resources include plant and animal species that are federally (USFWS) or State-listed (TDEC) for protection.

Ecological resources at ORNL are managed through various agencies, including DOE Reservation Management, USDA, USFWS, and TWRA. Accordingly, project managers must conform to environmental regulations, agreements, and policy at the Federal, State, and institutional level. Per 40 CFR 1508.14, potential effects on research and science education also represent probable impacts of Federal actions on the NERP. In addition, impacts to ecological resources on the Oak Ridge Wildlife Management Area must be considered when other aspects of the human environment are affected (ORNL 2020d). Further information about ecological resources is available on the ORNL website (ORNL 2020b).

3.2.5.1 Vegetation

ORR covers 32,867 acres with vegetation that consists of mostly contiguous stretches of native eastern deciduous trees and shrubs in large blocks of mature forest and interior forests (at least 656 feet from outer edge of a forest). Riparian vegetation and managed native grasslands together provide considerable habitat diversity (ORNL 2020e). Forests are mostly mixed pine-hardwoods and oak-hickory (*Quercus-Carya*), with small areas of northern hardwoods and natural stands of hemlock (*Tsuga canadensis*), white pine (*Pinus strobus*), and floodplain forests (ORNL 2017). Open water and wetland vegetation are also present in various areas throughout the ORR. Rare plant communities include northern white cedar woodland, ridge and valley calcareous mixed mesophytic forest, cedar barrens, and river bluffs (ORNL 2015, 2020c). As of 2002, over 1,100 vascular plant species were recorded on ORR (ORNL 2018a).

The majority of the 150-acre proposed project area is undeveloped and consists of about 96 percent of eastern deciduous hardwood-forest, 27 percent of which is interior forest areas, and 4 percent developed or disturbed areas (**Table 3–22**) (**Figure 3–18**). The area is comprised primarily of forested wetlands with intervening steep slopes and dry-mesic ridgetops (ORNL 2020d). Tree composition generally includes northern red oak (*Quercus rubra*), southern red oak (*Q. falcate*), black oak (*Q. velutina*), white oak (*Q. alba*), scarlet oak (*Q. coccinea*), mockernut hickory (*Carya tomentosa*), tulip poplar (*Liriodendron tulipifera*), eastern red cedar (*Juniperus virginiana*), red maple (*Acer rubrum*), green ash (*Fraxinus pennsylvanica*), sweetgum (*Liquidambar styraciflua*), Virginia pine (*Pinus virginiana*), sourwood (*Oxydendrum arboreum*), and a few small natural stands of hemlock or white pine. During 1993 to 1994 and 1999 to 2000, the southern pine beetle (*Dendroctonus frontalis*), an invasive insect, diminished most of the mature pine stands within the proposed project area. These areas are now regenerating or have been replanted. The hardwood-forested areas are mostly new growth, with the exception of a few older stands within the eastern portion of the proposed project area. A small portion of the proposed project area includes previously disturbed areas that have been cleared for development of facilities, access roads and corridors, and other supporting infrastructure (ORNL 2020d).

Table 3–22. Communities within the Oak Ridge National Laboratory Proposed Project Area

Vegetation Community	***Acres within the Proposed Project Area***
Forested Areas (Interior Forest)	143.8 acres (40.4 acres)
Previously Disturbed/Facilities	6.5 acres
	Total: ~150 acres

Source: ORNL 2020d.

Note: Due to rounding, sums and products may not equal those calculated from table entries.

3.2.5.2 Invasive Plant Species

Invasive plants are those species whose introduction does or is likely to cause economic or environmental harm or harm to human health. The Federal Noxious Weed Act of 1974 (7 U.S.C. 28142) requires each Federal land-managing agency to establish integrated management systems to control or contain undesirable plant species targeted under cooperative agreements with State agencies. Invasive species at ORNL are managed through the *Invasive Plant Management Plan for the Oak Ridge Reservation* (ORNL 2017). About 168 plant species known to occur on ORNL are non-native, and 54 have been identified as aggressively invasive (ORNL 2018a). Additionally, outbreaks of invasive insect pests, such as the hemlock woolly adelgid, southern pine beetle, and emerald ash borer, are causing the death of hemlock, pine, and ash trees.

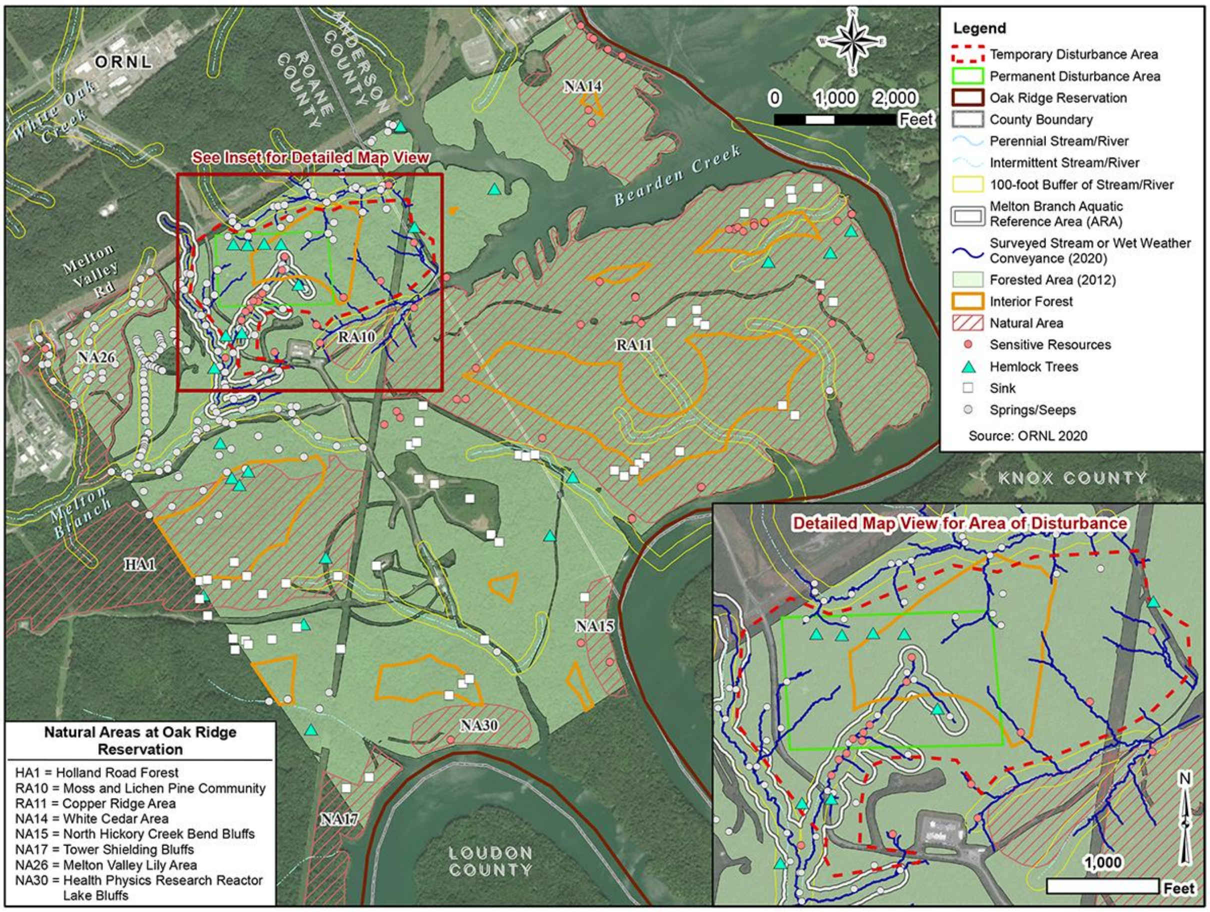

Figure 3–18. Oak Ridge National Laboratory Ecological Resources

3.2.5.3 Wildlife

The large tracts of eastern deciduous hardwood forest provide habitat for a high diversity of wildlife. The area hosts more than 63 species of fish; about 69 species of reptiles and amphibians; up to 213 species of migratory, transient, and resident birds; and 49 species of mammals, as well as numerous invertebrate species (ORNL 2020e). Game species, such as white-tailed deer (*Odocoileus virginianus*), wild turkey (*Meleagris gallopavo*), and Canada geese (*Branta canadensis*) on ORNL, are controlled through managed hunts at several times throughout the year (ORNL 2020e).

Species monitoring and management for the area is implemented through the *Wildlife Management Plan for the Oak Ridge Reservation* (ORNL 2020e). This plan includes management and protection strategies for game species, non-game species, sensitive species inventories, and nuisance species. Management includes wildlife population control through hunting, trapping, removal, and habitat manipulation; wildlife damage control; restoration of wildlife species; preservation, management, and enhancement of wildlife habitats; coordination of wildlife studies and characterization of areas; and law enforcement (ORNL 2020e).

A recent survey of the proposed project area identified 151 vertebrate species and at least one notable invertebrate species, the cave isopod (*Caecidotea incurve*/*recurvata*) (ORNL 2020d).

3.2.5.4 Special Status Species

Special status species include federally threatened, endangered (per USFWS), and State-designated sensitive (per TDEC) species and their habitats. Applicable laws include the ESA, the MBTA, the Bald and Golden Eagle Protection Act (BGEPA), Tennessee Rare Plant Protection and Conservation Act of 1985, and Tennessee Nongame and Endangered or Threatened Wildlife Species Conservation Act of 1974.

The USFWS's IPaC online system was accessed to identify current USFWS trust resources with potential to occur in the ROI. On January 23, 2020, the Tennessee Ecological Services Field Office provided an automated *Official Species List* via Section 7 letter that identified 20 threatened and endangered species as known to occur or have potential to occur within or near the proposed project area. These species are presented in **Table 3–23**. No designated critical habitat was identified at ORNL (USFWS 2020b).

Table 3–23. Federally Listed Species with Potential to Occur Near the Oak Ridge National Laboratory Proposed Project Area

Common Name	*Scientific Name*	*Protection Status*	*Historically Observed at ORNL?*	*Suitable Habitat Present Within the Proposed Project Area?*
Amphibians				
Berry Cave Salamander	*Gyrinophilus gulolineatus*	FC	no	Unknown. Underlying karst and aquatic subterranean habitat exists, but a lack of human-accessible caves might prevent detection.
Mammals				
Gray Bat	*Myotis grisescens*	FE	yes	Yes. Species detected in NA14, NA15, NA26, and RA11. Suitable foraging habitat and suitable hibernacula are present within the proposed project area. Additionally, known maternity habitat occurs within 0.5 miles of the proposed project area.
Indiana Bat	*Myotis sodalis*	FE	yes	Yes. Detected at an extremely low frequency within the proposed project area. Species detected in NA15 and RA11. Foraging, suitable hibernacula, and maternity habitat within regulatory distance of the proposed project area.
Northern Long-eared Bat	*Myotis septentrionalis*	FT	yes	Yes. Detected at an extremely low frequency within the proposed project area. Species detected in NA26 and RA11. Suitable foraging habitat and suitable hibernacula are present within the proposed project area. Additionally, known maternity habitat occurs within 0.5 miles of the proposed project area.
Tricolored Bat	*Perimyotis subflavus*	UR	yes	Yes, foraging habitat occurs within the proposed project area.
Little Brown Bat	*Myotis lucifugus*	UR	yes	Yes, foraging habitat occurs within the proposed project area.
Clams				
Alabama Lampmussel	*Lampsilis virescens*	FE	no	no
Cracking Pearlymussel	*Hemistena lata*	FE	no	no

Common Name	Scientific Name	Protection Status	Historically Observed at ORNL?	Suitable Habitat Present Within the Proposed Project Area?
Dromedary Pearlymussel	*Dromus dromas*	FE	yes	no
Fanshell	*Cyprogenia stegaria*	FE	yes	no
Finerayed Pigtoe	*Fusconaia cuneolus*	FE	yes	no
Orangefoot Pimpleback (pearlymussel)	*Plethobasus cooperianus*	FE	yes	no
Pink Mucket (pearlymussel)	*Lampsilis abrupta*	FE	yes	no
Ring Pink (mussel)	*Obovaria retusa*	FE	no	no
Rough Pigtoe	*Pleurobema plenum*	FE	no	no
Rough Rabbitsfoot	*Quadrula cylindrica strigillata*	FE	yes	no
Sheepnose Mussel	*Plethobasus cyphyus*	FE	yes	no
Shiny Pigtoe	*Fusconaia cor*	FE	yes	no
Spectaclecase (mussel)	*Cumberlandia monodonta*	FE	yes	no
White Wartyback (pearlymussel)	*Plethobasus cicatricosus*	FE	no	no
Snails				
Anthony's Riversnail	*Athearnia anthonyi*	FE	no	no
Spiny Riversnail	*Io fluvialis*	UR	yes	no
Flowering Plants				
Virginia Spiraea	*Spiraea virginiana*	FT	no	Yes, potential suitable habitat occurs within the proposed project area.
White Fringeless Orchid	*Platanthera integrilabia*	FT	no	Yes, potential suitable habitat occurs within the proposed project area.

FC = federally listed candidate species; FE = federally listed endangered species; FT= federally listed threatened species; UR = status under federal review.
NA = Natural Area; RA = Reference Area; HA = Habitat Area
Note: Species occurrence is within an ORR designated NA, RA, or HA (refer to Section 3.2.5.5 for additional details).
Source: ORNL 2020c, 2020d; USFWS 2020b.

Recent biological surveys were completed at ORNL during the spring of 2020 to support the planning and development of the VTR project. Further details of the sensitive resources identified during the survey efforts will be provided once available (ORNL 2020d).

Of the 21 federally listed species presented in Table 3–23, only three have been documented on the ORNL site. These species are the gray bat (*Myotis grisescens*), Indiana bat (*M. sodalis*), and northern long-eared bat (*M. septentrionalis*). The proposed project area includes suitable bat foraging and roosting habitat. Acoustic surveys conducted in proposed project area in the spring of 2020 confirmed the presence of 15 native bat species and 5 special status bat species (ORNL 2020d): three federally listed bat species - gray, Indiana, and northern long-eared bats; and two species under Federal review for ESA listing - little brown (*Myotis lucifugus*) and tricolored bat (*Perimyotis subflavus*) (ORNL 2020d). All five of these bat species are also State-listed in Tennessee. Furthermore, suitable hibernacula and maternity habitat for gray, Indiana, and northern-long eared bats occurs within 0.5 mile of the proposed project area (ORNL 2020c). No federally listed flowering plants have been positively identified but potential habitat occurs for the white-fringeless orchid (*Platanthera integrilabia*) and Virginia spiraea (*Spiraea virginiana*) (ORNL 2020d). Ridge and Valley Calcareous mixed mesophytic forest, a rare plant community and designated as ORR historical as well as other plant communities of management or research importance are also present within the project area (ORNL 2020d).

Additionally, 37 special status species (Tennessee State-listed species and species of special concern) were identified as known to occur, or having the potential to occur in the proposed project area following spring 2020 surveys (ORNL 2020c, 2020d). These species are presented below in **Table 3–24** (ORNL 2020c; ORNL 2020d).

Table 3–24. State-listed and Species of Special Concern Known to Occur Near the Oak Ridge National Laboratory Proposed Project Area

Common Name	*Scientific Name*	*Status in Tennessee*	*Other Protection Status*	*Historically Observed at ORNL?*	*Suitable Habitat Present Within the Proposed Project Area?*
Amphibians					
Green Salamander	*Aneides aeneus*	Rare	S3, S4	yes	Unlikely. Minimal availability of suitable habitat. Suitable habitat includes damp crevices in shaded rock outcrops and ledges; beneath loose bark and cracks of trees and sometimes in/or under logs.
Hellbender	*Cryptobranchus alleganiensis*	Endangered	S3	yes	no
Berry Cave Salamander	*Gyrinophilus gulolineatus*	Threatened	S1	no	Unlikely, but aquatic subterranean habitat present.
Four-toed Salamander	*Hemidactylium scutatum*	In Need of Management	S3 populations on ORR are the subject of ongoing research	yes	Yes, adults and nests with eggs observed throughout the proposed action area. Moist forest and sphagnum in and along all wetlands and slow-moving waterways within project area.
Mud Salamander	*Pseudotriton montanus*	Rare	populations on ORR are the subject of ongoing research	yes	Yes, detected within the proposed project area. Suitable habitat includes headwater streams, seepages, and mucky wetlands throughout project area.
Arachnids					
A cave spider	*Nesticus paynei/ tennesseensis*	Rare	S2, S3, S4	yes	Unlikely, terrestrial cave obligate.
Insects					
Cave beetle (multiple species, including one yet to be described)	*Pseudanophthalmus* spp.	Rare	S1–S3	yes	Yes. Troglobitic, typically along subterranean streams.
Mammals					
Allegheny Woodrat	*Neotoma magister*	In Need of Management	S3	yes	Yes, suitable habitat present including outcrops, cliffs, talus slopes, crevices, sinkholes, caves & karst. Observations exist in caves just outside proposed project area.
Little Brown Bat	*Myotis lucifugus*	Threatened	S3, Federal status currently under review	yes	Yes, detected at relatively high frequency within the proposed project area. Suitable habitat present within caves, hollow trees often associated with forested areas.

Common Name	Scientific Name	Status in Tennessee	Other Protection Status	Historically Observed at ORNL?	Suitable Habitat Present Within the Proposed Project Area?
Rafinesque's Big-Eared Bat	*Corynorhinus rafinesquii*	In Need of Management	S3, S4	yes	Yes, detected near the proposed project area.
Small-footed Bat	*Myotis leibii*	In Need of Management	S2	yes	Yes, detected at a relatively low frequency near the proposed project area.
Southern Bog Lemming	*Synaptomys cooperi*	In Need of Management	S4	yes	Yes, detected near the proposed project area along Bearden Creek Road.
Tri-colored Bat	*Perimyotis subflavus*	Threatened	S2, S4, Federal status currently under review	Species is associated with the VTR Study area (historical – pre-1995)	Yes, detected at relatively high frequency within the proposed project area. Suitable habitat present within marshy meadows, wet balds, and rich upland forests.
Birds					
Bald Eagle	*Haliaeetus leucocephalus*	In Need of Management	BCC, BGEPA, FS, BMC, MBTA	Yes, breeding habitat present at ORNL.	Yes, breeding pairs have been noted in recent years within the proposed project area.
Wood Thrush	*Hylocichla mustelina*	In Need of Management	BCC, PIF, BMC, FS, MBTA	Species associated with the VTR Study area.	Yes, breeding pairs have been noted within the proposed project area.
Yellow-bellied Sapsucker	*Sphyrapicus varius*	Rare	BCC, BMC, MBTA	Species associated with the VTR Study area.	Yes. Species observed in RA11.
Worm-eating Warbler	*Helmitheros vermivorum*	SNR	BCC, BMC, PIF, MBTA	Species associated with the VTR Study area.	yes
Eastern Whip-poor-will	*Caprimulgus vociferus*	SNR	BCC, PIF, MTBA	Species associated with the VTR Study area.	yes
Red-headed Woodpecker	*Melanerpes erythrocephalus*	SNR	BCC, PIF	Species associated with the VTR Study area.	yes
Chuck-Will's Widow	*Antrostomus carolinensis*	SNR	PIF, MBTA	Species associated with the VTR Study area.	yes
Yellow-billed Cuckoo	*Coccyzus americanus*	SNR	PIF, MBTA	Species associated with the VTR Study area.	yes
Kentucky Warbler	*Geothlypis formosa*	SNR	BCC, PIF, MBTA	Species associated with the VTR Study area.	yes
Plants					
Spreading False-foxglove	*Aureolaria patula*	Special Concern	S3	yes	Yes, species observed in NA14, NA17, NA30. Suitable habitat present including oak woods and edges.
Pink Lady's-slipper	*Cypripedium acaule*	Special Concern-Commercially Exploited	S4	yes	Yes, species observed in NA14.
Appalachian Bugbane	*Cimicifuga rubifolia*	Rare	S3	yes	Yes, suitable habitat present including rich woods (especially northeastern portion of project area and west of HPRR Access Rd).
Canada Lily	*Lilium canadense*	Rare	S3; monitored as rare for the ORR	yes	Yes, species observed in NA26. Suitable habitat present including rich woods and seeps.

Common Name	Scientific Name	Status in Tennessee	Other Protection Status	Historically Observed at ORNL?	Suitable Habitat Present Within the Proposed Project Area?
		(recently delisted from Threatened status)			
Goldenseal	*Hydrastis canadensis*	Special Concern-Commercially Exploited	S4	yes	Yes, species observed in RA11. Suitable habitat present including moist woods with rich soils (especially in shaded valleys in the southern and eastern portions of project area, and west of HPRR Access Rd).
Ginseng	*Panax quinquefolius*	State listed Special Concern – Commercially Exploited, Special Concern-Commercially Exploited	S3, S4	Species associated with the VTR Study area.	Yes, suitable habitat present - especially in northeastern portion of project area and west of HPRR Access Rd.
Tubercled Rein Orchid	*Platanthera flava* var. *herbiola*	Threatened	S2	Yes, possible sprout observed within project area in March 2020.	Yes, suitable habitat present including mucky seeps, swamps, and floodplain throughout project area.
October Ladies'-Tresses	*Spiranthes ovalis*	Sensitive	SNR	yes	Yes, suitable habitat present including wet to mesic forests.
Northern Bush-honeysuckle	*Diervilla lonicera*	Threatened	S2	yes	Yes, species observed in NA14. Suitable habitat present including rocky woodlands and bluffs.
Northern White Cedar	*Thuja occidentalis*	Special Concern, Rare	S3	yes	Yes, species observed in NA14. Suitable habitat present including calcareous rocky seeps, cliffs (eastern portion of project area).
Butternut	*Juglans cinerea*	Threatened	S3	yes	Yes, suitable habitat present including rich woods and hollows.
Reptiles					
Northern Pine Snake	*Pituophis melanoleucus*	Threatened	S3	yes	Yes, suitable habitat present including well-drained sandy soils in pine/pine-oak woods.
Eastern Slender Glass Lizard	*Ophisaurus attentuatus longicaudus*	In Need of Management	S3	yes	Yes, suitable habitat present including dry upland areas including brushy, cut-over woodlands and grassy fields; fossorial (eastern and central portion of the proposed project area).
Snails					
Cave Thorn Snail	*Carychium stygium*	Rare	S2	no	Possible suitable habitat available within stygobitic areas such as Highland Rim and Cumberland Plateau; no known human accessible caves in the proposed project area.
A Cave Obligate Snail	*Helicodiscus notius specus*	Rare	S1	no	Possible suitable habitat available within troglobitic areas like Ridge & Valley and Eastern Highland Rim; no known human accessible caves in the proposed project area.

Common Name	Scientific Name	Status in Tennessee	Other Protection Status	Historically Observed at ORNL?	Suitable Habitat Present Within the Proposed Project Area?

BCC = designated bird of conservation concern in the region; BGEPA = Bald and Golden Eagle Protection Act; MBTA = Migratory Bird Treaty Act; PIF = Partners In Flight; NatureServe National and Subnational Conservation Status: S2 = imperiled; S3 = vulnerable; S4 = apparently secure; SNR = unranked.
NA = Natural Area; RA = Reference Area; HA = Habitat Area
Note: Species occurrence is within an ORR designated NA, RA, or HA [refer to Section 3.2.5.5 for additional details).
The State of Tennessee adopts all federally listed (USFWS) species. Therefore, species listed in Table 3–23 (Federally Listed Species with Potential to Occur Near the ORNL Proposed Project Area) are also considered for evaluation by the State.
Source: NatureServe 2020; ORNL 2020c, 2020d; TWRA 2016.

The ORNL Natural Resources Program employs breeding bird surveys through the international Partners In Flight (PIF) program. PIF surveys are conducted yearly on the ORR by ORNL and TWRA personnel and volunteers. A total of 11 PIF routes are present on the ORR and cover a mixture of forest, edge, old field, and grassland habitats. About six to eight surveys are conducted in May and June during the breeding season for most bird species (ORNL 2020e). Several species identified as BCC under the MBTA are known to occur (observed nesting or soaring) at the ORNL site. The proposed project area is located within BCR 28 (Appalachian Mountains) and there are 25 BCC species listed (USFWS 2008). Forty-six bird species protected under the MBTA were detected during recent surveys conducted in the spring of 2020 (March – July) (ORNL 2020d). This included one species listed by the TWRA as In Need of Management (TCA §§ 70-1-206, 70-8-104, 70-8-106, and 70-8-107, TWRA 2016), three species considered by USFWS to be BCCs, five species considered by USFWS to be Birds of Management Concern, and one ORNL Focal Species. Additionally, nine species are considered by PIF to be species of Regional Concern and in Need of Management Action, one Common Bird in Steep Decline, and one species on the Yellow WatchList (ORNL 2020d).

Bald eagles (*Haliaeetus leucocephalus*), protected under the BGEPA, have been observed in the winter throughout the ORNL site. TWRA conducts yearly midwinter bald eagle counts along the Clinch River, which borders the ORR, in accordance with the continuing statewide monitoring program. It is part of a count conducted statewide by the agency to monitor population trends for this species, which is increasing in numbers in eastern Tennessee. The ORR supports one or two nests per year, and these are continually monitored (ORNL 2020e). There is one active bald eagle nest located about 2 miles northeast of the proposed project area.

3.2.5.5 Natural Areas

The ORNL is located within the ORR, much of which is categorized as a NERP and a state Wildlife Management Area. The ORR is comprised of various special and sensitive natural resource areas recognized in the Research Park. These areas are characterized as Natural Areas (NA), Aquatic Natural Areas (ANA), Reference Areas (RA), Aquatic Reference Areas (ARA), Cooperative Management Areas (CMA), Habitat Areas (HA), and Potential Habitat Areas (PHA). The *Natural Areas Analysis and Evaluation* report (ORNL 2009) serves as a systematic analysis of each area; developed in partnership between DOE Reservation Management, USDA, TDEC, and TWRA.

There are eight natural areas within the proposed project area; characterized as NAs, RAs, and one HA (Figure 3–18) (ORNL 2020c). Definitions for these natural area designations and general descriptions are as follows:

Natural Area (NA) – These are areas that contain and protect sensitive species and that have been traditionally defined as containing State-listed and Federally listed species, species under consideration for such listing, or species considered globally imperiled or rare by NatureServe, an international network of natural heritage programs. NAs are primarily terrestrial but may include aquatic aspects.

- NA14 White Cedar Area: Ridges dissected by deep ravines, with steep slopes and shaley cliffs dropping into Melton Hill Lake. Old second-growth mixed mesic hardwood forest in spots, especially in deep ravines and steep slopes; uplands are generally younger second-growth hardwood; dry to mesic oak–hickory forest with some mature beech forest, particularly in ravines. Northern white cedar and northern bush-honeysuckle are typically found at more northern latitudes. Spreading false-foxglove is present at the base of the cliff. Area includes a significant amount of forested lakeshore, some small quality wetlands, and some remnant bottomland forest.
- NA15 North Hickory Creek Bend Bluffs/Hickory Creek Bend Bluffs: Steep, forested southeast-facing slope overlooking Melton Hill Lake. The overstory is mixed hardwood and pine.
- NA 17 Tower Shielding Bluffs: Steep east-facing slope overlooking Melton Hill Lake. The overstory consists primarily of oaks and hickories with some mesic species such as sugar maple.
- NA26 Melton Valley Lily Area: The NA includes a substantial stream system with forested headwater stream bottomlands of Melton Branch, steep ridges, and older forest, including large bottomland oaks and huge white pines (*Pinus strobus*). Some regionally uncommon tree species are also present. At certain times of the year, ephemeral shallow water-filled depressions in one headwater stream bottom form that may serve as important amphibian breeding sites. Two small nonflowering Canada lily plants occur in a forested wetland.
- NA30 Health Physics Research Reactor Lake Bluffs: This area of steep rocky limestone bluffs runs along the shoreline of Melton Hill Lake south of the Health Physics Research Reactor. Spreading false-foxglove occurs here.

Reference Area (RA) – These are areas that recognize special habitats (e.g., cedar barrens, wetlands) or features (e.g., caves); these areas may also serve as references or controls for biological monitoring, environmental remediation and characterization, and other ecological research activities.

- RA10 Moss and Lichen Pine Community: This area provides a good illustration of plant community succession following serious soil erosion damage. Mosses and lichens are abundant under pines, which is typical of early successional stages in this region. The dominant ground cover is the lichen reindeer moss (*Cladonia subtenuis*).
- RA11 Copper Ridge Area: This large and relatively undisturbed area includes communities in various stages of succession. Some of the major community types include oak–hickory, pine, and cedar forests. The ridge section is extremely rocky, and there are numerous limestone rocky sinks and several caves.

Habitat Area (HA) – These are areas known to harbor commercially exploited State-listed species. The plants involved, though not rare, are listed by the State for special management because of their commercial exploitation.

- HA1 West Copper Ridge/ Holland Road Forest: Largely consists of interior forest.

3.2.5.6 Aquatic Resources

Aquatic resources at the ORNL site range from small, free-flowing streams in undisturbed watersheds to larger streams with altered flow patterns due to dam construction (DOE 2011c). These aquatic habitats include tailwaters, impoundments, reservoir embayments, and large and small seasonal and intermittent perennial streams (DOE 2011c).

Wetlands – Wetlands are recognized as a special aquatic site under CWA Section 404(b)(1) guidelines, and a "no net loss" policy continues to guide Federal regulatory actions affecting wetlands. Jurisdictional wetlands are a subset of jurisdictional waters of the United States, which include streams, rivers, ponds, and lakes. The proposed project area is located within the Bearden Creek Watershed and includes the Melton Branch stream system and its tributaries, which feed into White Oak Creek, White Oak Lake, and ultimately the Clinch River (ORNL 2006).

Numerous wetland areas occur across the ORR at low-elevation positions, primarily in the riparian zones of headwater streams and their receiving streams, as well as in Clinch River embayments (ORNL 2006). Wetland types include open water, riverine, and freshwater forested/shrub wetlands (USFWS 2019c). These wetlands are ephemeral, depressional ponds in forested, headwater streams, and stream bottom areas. Most of the wetlands on the ORR are classified as palustrine forested, scrub-shrub, and emergent (Cowardin et al. 1979).

About 9.7 acres of previously mapped wetland occur within the proposed project area. Recent field surveys documented an additional 0.8 acre of previously unmapped wetland for a total of more than 10.5 acres within the proposed project area (ORNL 2020d). Wetlands were associated with tributaries, drainages, and topographic depressions (Figure 3–18). All wetlands in the footprint are classified as palustrine forested broad-leaved deciduous wetlands (Cowardin et al. 1979).

Exceptional Tennessee Waters are aquatic resources with features that merit special attention or consideration and are significant at the national, state, or regional level. An Exceptional Tennessee Water designation is expected for aquatic features within the proposed project area. The Exceptional Tennessee Water designation is determined via the Tennessee Rapid Assessment Method, a tool designed by TDEC for mitigation planning (TDEC 2015). The requirements for a wetland to be considered Exceptional Tennessee Waters are outlined in Rule 0400-40-03-.06(4)a of the TDEC General Water Quality Criteria (TDEC Chapter 0400-40-03, 2015).

Streams – About 7,428 feet of mapped stream occur within the proposed project area. This does not include 8,209 feet of currently unclassified channels and wet weather conveyances that will require hydrological jurisdictional determinations approved by the U.S. Army Corps of Engineers. The proposed project area is drained by Melton Branch and Bearden Creek. The first- and second-order reaches of Melton Branch in the proposed project area eventually become a major tributary of the main stem of White Oak Creek, an aquatic system contained within the ORR that drains into the Clinch River. Sections of Melton Branch and White Oak Creek are part of the Biological Monitoring and Abatement program that was established 35 years ago, and portions of Melton Branch and its riparian buffer zone and wetlands comprise the Melton Branch ARA (Figure 3–18). ARAs were established on the ORR to protect special habitats and serve as reference or control areas for various ecological monitoring, research, and remediation activities (ORNL 2020d).

Seeps, Springs, and Wet Weather Conveyances – There are an estimated 3,442 seeps, active springs, sinks, and caves within ORNL (ORNL 2020d). The proposed project area contains more than 30 seeps/active springs and extensive wet weather conveyances (ORNL 2020d).

3.2.6 Cultural and Paleontological Resources

3.2.6.1 Area of Potential Effect

The project area and APE for direct physical effects is located in a currently undeveloped area about 1 mile east of ORNL's main campus (see Figure 2–8). It comprises 150 acres, including laydown areas, defensible security buffers, and egress during construction. Due to the local vegetation and terrain, the APE associated with the historic viewshed is defined as a 0.25-mile radial buffer surrounding the 150-acre APE proposed for development.

3.2.6.2 Ethnographic Resources

Resources that may be sensitive to American Indian groups include remains of prehistoric and historic villages, ceremonial lodges, cemeteries, burials, and traditional plant gathering areas. Apart from prehistoric archaeological sites, to date no American Indian resources have been identified at ORR. No American Indian sacred sites or cultural items have been found within or immediately adjacent to the 150-acre proposed VTR project area.

3.2.6.3 Cultural Resources

Archaeological Resources

Prehistoric resources are physical properties that remain from human activities that predate written record. More than 20 cultural resources surveys have been conducted at ORR. About 90 percent of ORR has received at least some preliminary walkover or archival-level study, but less than 5 percent has been intensively surveyed. Most cultural resource studies have occurred along the Clinch River and adjacent tributaries. Prehistoric sites recorded at ORR include villages, potential burial mounds, camps, quarries, a chipping station, limited activity locations, and shell scatters. Forty-four archeological sites have been recorded at ORR to date. At least 13 prehistoric sites are considered potentially eligible for the NRHP, but most of these sites have not yet been evaluated. Additional prehistoric sites may be anticipated in the unsurveyed portions of ORR. In 1994, a Programmatic Agreement concerning the management of historic and cultural properties at ORR was executed among the DOE Oak Ridge Operations Office, the Tennessee State Historic Preservation Officer (SHPO), and the Advisory Council on Historic Preservation. This agreement was executed to satisfy DOE’s responsibilities regarding Sections 106 and 110 of the National Historic Preservation Act (NHPA) and resulted in DOE preparing a Cultural Resources Management Plan for ORR (DOE-OR 2001). No prehistoric properties are known to exist within or immediately adjacent to 150-acre APE.

Historic Resources

Several historic resources surveys have been conducted at ORR. Historic resources identified at ORR consist of both archaeological remains and standing structures. Documented log, wood frame, or fieldstone structures include cabins, barns, churches, grave houses, springhouses, storage sheds, smokehouses, log cribs, privies, henhouses, and garages. Archaeological remains consist primarily of historic building foundations, roads, and trash scatters. A total of 32 cemeteries are located within the present boundaries of ORR. More than 250 historic resources have been recorded at ORR, and 41 of those sites are considered potentially eligible for listing on the NRHP. The NRHP-eligible structures that pre-date the establishment of the Manhattan Project include the Freel’s Bend Cabin and two church structures: George Jones Memorial Baptist Church (also known as the “Wheat Church”) and the New Bethel Baptist Church. Sites associated with the Manhattan Project include the X-10 Graphite Reactor at ORNL, listed on the NRHP as a National Historic Landmark, and three traffic checkpoints: Bear Creek Road, Bethel Valley Road, and Oak Ridge Turnpike Checking Stations. Many other buildings and facilities at ORR are associated with the Manhattan Project and are eligible for the NRHP (DOE-OR 2001).

Historic building surveys were conducted in 1993, 2003, and 2017 to identify properties at ORNL that are included or are eligible for inclusion in the NRHP (ORNL 2020c). Eligible properties include the ORNL Historic District in ORNL’s East Support Area, the Molten-Salt Reactor Experiment Facility, (previously known as the Aircraft Reactor Experiment Building), the Tower Shielding Facility, and White Oak Lake and Dam.

There are no known historic architectural resources within the 150-acre proposed VTR project area. Of all the known NRHP-eligible and -listed buildings, the NRHP-listed New Bethel Baptist Church is the closest to the 150-acre proposed VTR project area. It is located about 0.5 mile to the northwest. In addition, there are seven historic archaeological sites and one cemetery within 0.25 mile of the proposed VTR project area. The cemetery is identified as the Friendship Baptist Church Cemetery. The historic archaeological sites consist of the remains of a church, dwellings, barns, and various outbuildings related to homesteads. None of these sites have any standing structures, and none have been recommended eligible for listing on the NRHP (ORNL 2020c).

3.2.6.4 Paleontological Resources

Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age. Paleontological remains consist of fossils and their associated geological information. The majority of geological units with surface exposures at ORR contain paleontological materials. Paleontological materials consist primarily of invertebrate remains, and these have relatively low research potential. Paleontological resources at ORNL would not be expected to differ from those found elsewhere on ORR.

3.2.7 Infrastructure

Site infrastructure includes those basic resources and services required to support planned construction and operations activities and the continued operations of existing facilities. For the purposes of this EIS, infrastructure is defined as electricity, fuel, water, and sewage. The ROI for infrastructure includes those items at ORNL. Waste management and transportation infrastructure are addressed separately in Sections 3.2.9 and 3.2.12, respectively. Capacities and usage of ORNL's utility infrastructure are summarized in **Table 3–25**.

Table 3–25. Oak Ridge National Laboratory Infrastructure Characteristics

Resource	*Site Usage*	*Site Capacity*
Electricity		
Energy Consumption (megawatt-hours per year)	583,000 [a]	1,227,000 [b, c]
Peak Load (megawatts)	68.5 [b]	140 [b]
Fuel		
Natural Gas (million cubic feet per year)	600 [b]	3,214
Fuel Oil - for heating (gallons per year)	122,000 [a]	Not limited [d]
Diesel fuel	NA	Not limited [d]
Gasoline	NA	Not limited [d]
Propane	NA	Not limited [d]
Water (million gallons per year)	730 [b]	1,460 [b]
Sanitary Wastewater Treatment (gallons per day)	186,100 [b]	300,000 [e]

NA = not available.
[a] ORNL 2018b:10.
[b] ORNL 2020c.
[c] Capacity available if peak power were maintained 24 hours a day for every day in the year; since this assumes continual demand of peak power, annual site usage is typically well below site capacity.
[d] Capacity is limited only by the ability to ship fuel to the ORNL.
[e] DOE 1999b:4-65, 4-66.

3.2.7.1 Electricity

ORNL purchases its electricity from the Tennessee Valley Authority. Power is supplied to ORNL via three 161-kV transmission lines (DOE 2008b:3-12). At a substation, power is stepped down to 13.8 kV before distribution to ORNL via overhead and underground lines (DOE 1999b:4-64, 4-65).

Electrical energy available to ORNL is about 1,227,000 MWh per year, with 2018 electrical energy consumption of about 583,000 MWh per year. The recorded peak load for ORNL was about 140 MW (ORNL 2020c).

There are two 13.8 kV feeders that parallel Melton Valley Drive and Ramsey Drive north of the Melton Valley site (CROET 2007:11-4; ORNL 2020c). The maximum capacity of each feeder is about 12 MW. The peak load on feeder 294 is about 4 MW and the peak load on feeder 216 is about 7 MW (ORNL 2020c).

3.2.7.2 Fuel

Fuel consumed at ORNL includes natural gas, fuel oil (for heating), diesel fuel, gasoline, and propane. Natural gas is supplied to ORR via a 22-inch main that enters ORR from Morgan County to the west and Knox County to the east, crosses the Clinch River, and proceeds to a valve station located along Bethel Valley Road. Smaller pipelines (up to 6 inches) supply gas to various facilities around ORNL. Mainline pressures range from 450 to 600 pounds per square inch, but are reduced to 100 pound per square inch for distribution to ORNL. The annual natural gas demand for ORNL is about 600 million cubic feet per year; annual natural gas capacity for ORNL is about 3,214 million cubic feet per year (ORNL 2020c).

Currently, there are no natural gas lines on the Melton Valley site. There is a 6-inch, 100-pound-per-square-inch natural gas pipeline that supplies natural gas to the Main Campus Steam Plant and facilities on the main campus. A 4-inch branch line of the 6-inch line supplies natural gas to the Melton Valley Steam Plant. Currently, the line goes to the Melton Valley Steam Plant at the intersection of Melton Valley Drive and the HFIR Access Road (ORNL 2020c).

ORNL used about 122,000 gallons of fuel oil in 2018 (ORNL 2018b:10). Fuel oil, diesel fuel, gasoline, and propane are delivered to facilities at ORNL as needed. Therefore, capacities are not limited, and these fuel types are not discussed further.

3.2.7.3 Water

Water is withdrawn from the Clinch River at a point south of the eastern end of Y-12. The water is filtered and treated at the City of Oak Ridge water treatment plant, located north of Y-12, and distributed to the City of Oak Ridge, Y-12, and ORNL. This treatment facility provides potable water through two storage reservoirs with a combined capacity of 7 million gallons (DOE 1999b:4-65, 4-66). Water to ORNL is provided via a single, 24-inch gravity line from the water plant. The water line feeds the ORNL reservoir system, which consists of one 3-million-gallon concrete reservoir, a 1.5-million-gallon steel reservoir on Chestnut Ridge, and two 1.5-million-gallon steel reservoirs on Haw Ridge. From these reservoirs, water flows by gravity through the plant's water distribution system (DOE 2008b:3-13).

Total ORNL water use ranges from about 2.5 million gallons per day (912.5 million gallons annually) during the winter to about 4 million gallons per day (1.46 billion gallons annually) during the summer, but usage can approach 5 million gallons per day (1.83 billion gallons annually) (ORNL 2002). ORNL water system's capacity is about 7 million gallons per day, with an average yearly usage of about 730 million gallons (ORNL 2020c).

An existing 16-inch, potable water pipeline supplies water to HFIR/REDC. This line is backed up by a 12-inch water line that follows Melton Valley Drive (DOE 2008b:3-13). In addition, existing pipelines supply potable water to the Hazardous Waste Treatment and Storage Facility on the southern boundary of the proposed project area (ORNL 2020c).

3.2.7.4 Sanitary Wastewater Treatment

ORNL operates and maintains an individual sanitary wastewater treatment plant (SWTP). The SWTP is located at the western end of ORNL. The SWTP's current capacity is 300,000 gallons per day, while the average daily flow to the SWTP is less than 186,100 gallons per day (DOE 1999b:4-66; ORNL 2020c). There are existing sanitary sewer pipelines that connect HFIR and REDC to the SWTP (CROET 2007:11-4).

3.2.8 Noise

The ROI for noise extends 0.5 mile from the edge of the construction area, which is the area that could be susceptible to noise impacts.

This EIS considers the following data sources for characterizing the noise environment and vibration:

- Aerial photography is used to identify potential noise-sensitive receptors near the project area, including the Google Earth™ mapping service imagery for counties within the project area.
- The 2018 DOT Federal Transit Administration published the *Transit Noise and Vibration Impact Assessment Manual* with methodology to estimate ambient, construction, and operational noise levels, and to evaluate general noise and vibration concepts (DOT 2018).
- EPA methodology characterizes noise concepts and sets limits (EPA 1978).

Section 3.1.8.1, Noise and Vibration Overview, discusses background information relevant to understanding the evaluation of this resource area. Refer to that section for information about the characterization and measurement of sound, sound levels of different activities, the definition of noise, and sound attenuation.

3.2.8.1 Noise Regulations

The Noise Control Act of 1972 (42 U.S.C. 4901) directs Federal agencies to comply with applicable Federal, State, interstate roadways, and local noise control regulations. The primary responsibility of addressing noise pollution has shifted to State and local governments. In 1974, EPA Office of Noise Abatement and Control published its document entitled *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin on Safety*, which evaluated the effects of environmental noise with respect to health and safety (EPA 1974). The document provides information for State and local agencies to use in developing their ambient noise standards. As set forth in the publication, EPA provided information suggesting that an equivalent sound level of 70 dBA is the level above which environmental noise could cause hearing loss if heard consistently over several years. A day-night average sound level of 55 dBA outdoors and 45 dBA indoors is the threshold above which noise could cause interference or annoyance (EPA 1974:9).

The State of Tennessee has not established noise regulations that specify noise limits. ORNL is located in Anderson and Roane Counties and adjacent to Knox County. Anderson and Knox counties have established residential noise level standards of 65 dBA during the daytime. Anderson County has quantitative noise limit regulations per zoning district under Section 045-107 of the Zoning Resolution (refer to **Table 3–26**). Similarly, Knox County established noise limits for three specific land use types under Section 1203 of the Code of Ordinances (refer to Table 3–26). Both Anderson and Knox counties have exemptions for noise limits due to construction activities, but Section 1205 of Knox County Code of Ordinances specifies exemptions to include construction activities from 7 a.m. to 6 p.m. Roane County has not established noise regulations. For areas without standardized criteria, the Federal Transit Administration recommends the following standards for construction noise in residential areas: construction noise levels at the sensitive receptor should not exceed an 8-hour equivalent sound level of 80 dBA during daytime (7 a.m. to 10 p.m.), an 8-hour equivalent sound level of 70 dBA during nighttime (10 p.m. to 7 a.m.), and a 30-day average day-night average sound level of 75 dBA (DOT 2018:193).

Table 3–26. Allowable Noise Levels by Zoning District in Anderson and Knox Counties, Tennessee

Zoning	*Allowable Noise Levels (day-night average sound level)*	
District	*7 a.m. to 10 p.m.*	*10 p.m. to 7 a.m.*
Anderson County, Tennessee		
Suburban-residential	60	55
Rural-residential	65	60
Agricultural-forest	65	60
General Commercial	70	65
Light Industrial	70	70
Heavy Industrial	80	80
Floodway	80	80
Knox County, Tennessee		
Residential	65	60
Commercial	80	75
Industrial	80	80

dBA = A-weighted sound level in decibels.
Source: Anderson County 2015; Knox County 2019.

3.2.8.2 Existing Noise Environment

The major noise sources within ORNL include industrial facilities, equipment, and machines (e.g., cooling systems, transformers, engines, pumps, boilers, steam vents, intercom paging systems, construction and materials-handling equipment, and vehicles). These noise sources primarily occur within developed or active areas at ORNL. Noise emissions outside of these active areas consist primarily of vehicles. Most industrial facilities are a sufficient distance from the site boundary that noise levels from these sources at the boundary are not measurable or are barely distinguishable from background noise levels (DOE 2005b).

There are no existing noise-generating equipment and facilities at the proposed project area and other potential sources of noise are located over 2,000 feet away (ORNL 2020c). The only existing noise sources in the vicinity of the proposed project area would be vehicular traffic along Melton Valley Drive. The land surrounding the proposed project area includes existing ORNL-owned property in all directions. The closest offsite receptors include residential homes located to the east across the Clinch River in Knox County and more than 1.25 miles away. Because the site does not have major noise sources, the ambient noise levels were estimated based on the population density of the affected county using the methodology described in DOT's *Transit Noise and Vibration Impact Assessment* (DOT 2018).

The proposed project area is located on property within both Anderson and Roane Counties Tennessee. According to the U.S. Census Bureau, the population density of the Anderson County and Roane County is about 222.8 and 150.2 people per square mile, respectively (Census 2010b, 2010c:1). As a result, the existing day-night average sound level in the vicinity of the project area is estimated to be 40 dBA, and the existing ambient equivalent continuous sound levels (in equivalent sound level) during daytime and nighttime are estimated to be about 40 and 30 dBA, respectively (DOT 2018:66). Ambient (background) noise levels could occur from roadway traffic, farm machinery, pets, and various other household noises.

The closest Federal and State parks to the proposed project area are the Manhattan Project National Historical Park (buildings are on ORR), Frozen Head State Park (17 miles northwest), Obed National Wild and Scenic River National Park (20 miles northwest), Norris Dam State Park (22 miles north), Fort Loudoun State Historic Park (22 miles south), and Great Smoky Mountains National Park (26 miles southeast).

3.2.9 Waste and Spent Nuclear Fuel Management

This section describes the current average annual "baseline" generation rates and management practices for the waste categories that will be generated if the VTR alternative is implemented at ORNL

(ORNL 2020c). The ROI for waste management activities includes everything within the ORR boundaries. Offsite locations, including other DOE and commercial facilities, are not included in the waste management ROI. The potential impacts at these non-ORR disposition facilities were considered as part of the licensing/permitting/approval process for these sites and are not detailed in this document. There would be no additional impacts, including exposure to the offsite public or onsite workers. All waste disposition actions would comply with the licenses, permits, and/or approvals applicable to the facilities described in this document. Those waste categories are LLW, MLLW, and TRU waste; RCRA hazardous and TSCA wastes; and nonhazardous solid waste and recyclable materials. HLW is also managed at ORNL; however, no HLW will be generated under the VTR alternative. Therefore, HLW will not be discussed further in the section. Additionally, while not a waste, spent nuclear fuel will also be generated and is discussed in this section. **Table 3–27** presents the latest available 5-year annual generation by waste category.

Table 3–27. 5-Year Annual "Baseline" Generation by Waste Category in Cubic Meters

Waste Type	*2015*		*2016*		*2017*		*2018*		*2019*		*Average*	
	ORR	*ORNL*	*ORR*	*ORNL*	*ORR*	*ORNL*	*ORR*	*ORNL*	*ORR*	*ORNL*	*ORR*	*ORNL*
LLW	100,000	400	78,000	360	62,000	1,000	61,000	390	104,000	480	81,000	530
MLLW	500	36	520	65	590	61	870	50	1,000	73	700	57
TRU Waste	13	13	20	20	43	17	380	6.0	260	7.8	140	13
Hazardous and TSCA	170	130	190	150	210	100	1,200	130	1,300	110	610	120
C&D	43,000	51	33,000	110	46,000	250	34,000	80	74,000	86	46,000	120

C&D = Construction and demolition and industrial waste; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; ORR = Oak Ridge Reservation; ORNL = Oak Ridge National Laboratory; TRU = transuranic waste.
Note: All numbers are rounded to two significant figures. Due to rounding, sums and products may not equal those calculated from table entries. ORR quantities include ORNL quantities.
Source: ORNL 2020c.

3.2.9.1 Low-Level Waste, Mixed Low-Level Waste, and Transuranic Waste

LLW and MLLW are processed, treated, packaged/repackaged, characterized at the Transuranic Waste Processing Center and transported off site for disposal at NNSS or treatment, disposal, or both at other approved offsite Federal and commercial facilities. TRU waste is also processed, treated, packaged/repackaged, characterized at the Transuranic Waste Processing Center and transported off site for disposal at the WIPP facility.

3.2.9.2 Resource Conservation and Recovery Act and Hazardous and Toxic Substance Control Act Wastes

Resource Conservation and Recovery Act Wastes

The Hazardous Waste Program under RCRA establishes a system for regulating hazardous wastes from the initial point of generation through final disposal. In Tennessee, TDEC has been delegated authority by EPA to implement the Hazardous Waste Program; EPA retains an oversight role. DOE and its contractors at ORNL are jointly regulated as a "large-quantity generator of hazardous waste" under EPA ID TN1890090003 because, collectively, they generate more than 1,000 kilograms of hazardous/mixed wastes in at least one calendar month of a year. Hazardous wastes are accumulated in satellite accumulation areas or in less-than-90-day accumulation areas and are stored and/or treated in RCRA-permitted units. In addition, hazardous wastes are shipped off site for treatment and disposal. Reporting is required for hazardous waste activities on 20 active waste streams at ORNL. In April 2018, TDEC Division of Solid Waste Management conducted a Hazardous Waste Compliance Evaluation inspection of ORNL generator areas; universal waste collection areas; RCRA-permitted treatment, storage, and disposal facilities; hazardous waste training records; site-specific contingency plans; and RCRA records. TDEC also reviewed the Hazardous Waste Transporter Permit; DOT inspection records for tractors, trailers, and tankers; driver qualification files; hazardous waste manifests; and DOT training records. All records and areas were found to be in compliance with RCRA regulations and the RCRA permits.

Toxic Substance Control Act Wastes

PCB uses and waste at ORNL are regulated under TSCA. There are nine PCB waste storage areas at ORNL. When longer-term storage is necessary, PCB/radioactive wastes are stored in RCRA-permitted storage buildings at ORNL. The continued use of authorized PCBs in electrical systems or equipment (e.g., transformers, capacitors, rectifiers) is regulated at ORNL. Most of the equipment at ORNL that required regulation under TSCA has been dispositioned.

Because of the age of many of the ORNL facilities and the continued presence of PCBs in gaskets, grease, building construction, and equipment, DOE self-disclosed unauthorized use of PCBs to EPA in the late 1980s. DOE continues to notify EPA when additional unauthorized uses of PCBs, such as PCBs in paint, adhesives, electrical wiring, or floor tile, are identified at ORNL.

3.2.9.3 Nonhazardous Solid Waste and Recyclable Materials

ORNL/ORR operates several landfills that are permitted by the Tennessee Solid Waste Division. Each landfill has established criteria for determining the waste acceptable for disposal. There are three landfills that are permitted to receive construction/demolition debris, two that are permitted to receive sanitary industrial waste, and one that is permitted to receive classified waste. **Table 3–28** summarizes the permitted waste and remaining capacity of those landfills.

Table 3–28. Landfill Criteria and Capacities

Waste Disposal Facility	*Permitted Waste*	*Approximate Remaining Capacity (cubic meters)*
Construction/Demolition Landfill VII	Construction/demolition debris	990,000
Industrial Landfill IV	Classified, sanitary industrial waste (including office waste, equipment, construction/demolition debris)	42,000
Industrial Landfill V	Sanitary industrial waste (including office waste, equipment, construction/demolition debris)	940,000

Source: ORNL 2020c.

3.2.9.4 Spent Nuclear Fuel

ORNL has a long history of managing spent nuclear fuel. This spent fuel history includes post irradiation examination and onsite storage. Spent nuclear fuel from the Bulk Shielding, Health Physics Research, and Tower Shielding No. II reactors have been historically been generated, examined and analyzed, and stored at ORNL. Spent fuel from ongoing operations at HFIR are only stored onsite for a short period of time before they are transported to the DOE Savannah River Site in South Carolina where they are processed.

3.2.10 Human Health – Normal Operation

The impact on human health during normal facility operations addresses the potential impacts from exposure to ionizing radiation and chemicals. Potential human health impacts from exposure to radiation from normal operational conditions is considered for both an individual and the population as a whole for both the public and site workers; this constitutes the ROI. For the existing environment, the public population is considered to be all people living within 50 miles of ORR. The maximally exposed individual is considered to be a hypothetical person who could receive the maximum possible dose from ORR site releases. In addition, for workers the potential human health impacts associated with exposure to workplace chemicals are considered.

3.2.10.1 Radiation Exposure and Risk

DOE monitors radiation in the environment and exposure of workers and calculates the radiation exposures of members of the offsite general public[4] and onsite workers from operation of ORR. **Table 3–29** presents data on radiation doses to the public for the years 2013 to 2018. The maximum radiation dose to an offsite member of the public during this period as a result of onsite facility operations was estimated to be 3.5 millirem per year (ORO 2018:Table 7.8). The risk of developing an LCF from this dose is extremely small, about 1 in 500,000). The calculation of this total dose considers the maximum dose to an individual from air emissions, from the use of water (drinking water), and from the consumption of wildlife harvested in the vicinity of ORR. Although the annual site environmental reports include a dose contribution from irrigation, they also state that there are no known sources of irrigation using water from sources near ORR. Therefore, this contribution to the individual and population dose was not included. Direct radiation measurements have confirmed that direct radiation does not contribute to a dose to any member of the public (ORO 2015). The average annual dose to an individual from ORR operations is less than one percent of the average dose of 300 millirem per year from exposure to natural background radiation (e.g., cosmic gamma, internal, and terrestrial radiation) for someone living in the United States (ORO 2019:7-5).

There are two dose limits relevant to the exposure of an individual member of the public near a DOE site. As shown in Table 3–29, all of the doses to the maximally exposed individual from the operation of ORR are well below the DOE dose limit for a member the general public, which is 100 millirem per year from all pathways, as prescribed in DOE Order 458.1 (DOE 2011b). The table also shows that the dose from the air pathway is well below the NESHAPs dose limit for emissions from DOE facilities of 10 millirem per year (40 CFR Part 61, Subpart H).

Table 3–29. Annual Radiation Doses to the Public from Oak Ridge Reservation Operations 2014–2018

Source of Dose	*Maximally Exposed Individual*					*Population*		
	Dose (millirem per year)				*LCF Risk*			
	Airborne radionuclides [a]	*Water Use* [b]	*Consumption of Wildlife* [c]	*Total*	*Total* [d]	*Estimated Population Dose (person-rem)*	*LCFs* [d]	*Estimated Dose from Background (person-rem)*
2018	0.2	0.04	2.2	2.4	(e)	12	0.007	363,000
2017	0.3	0.02	3.2	3.5	(e)	13	0.008	363,000
2016	0.2	0.10	2.3	2.6	(e)	13	0.008	363,000
2015	0.4	0.03	1.9	2.3	(e)	13	0.008	363,000
2014	0.6	0.03	2.1	2.8	(e)	53	0.03	363,000
Average	**0.3**	**0.04**	**2.3**	**2.7**	**(e)**	**21**	**0.01**	**363,000**

LCF = latent cancer fatality.

[a] DOE (DOE 2011b) and the EPA (40 CFR Part 61 subpart H) limit the dose to a member of the public from airborne radionuclides to 10 millirem per year.

[b] Water use includes drinking water and recreational activities.

[c] Wildlife consumption includes fish, deer, geese, and turkey.

[d] Calculated using a dose conversion factor of 6×10^{-4} LCF per rem.

[e] The probability of this individual contracting a fatal cancer range from about 1 in 500,000 to 1 in 700,000.

Note: Due to rounding, sums and products may not equal those calculated from table entries.

Sources: ORO 2015:Table 7.7, 2016:Table 7.7, 2017b:Table 7.7, 2018:Table 7.8, 2019:Table 7.7.

[4] Public impacts at ORR derive from operations at Y-12, ORNL, and the ETTP. Estimates of the dose from air emissions for these individual facilities can be found in the Annual Site Environmental Reports (ORO 2015, 2016, 2017b, 2018, 2019). Only the totals for all three sites are presented here.

The population dose is the sum of average individual doses to the entire population within 50 miles of ORR. Table 3–29 shows that over the years 2014 through 2018, the population dose from operations at ORR ranged from 12 to 53 person-rem. No LCFs would be expected from these doses. The higher population dose in 2014 is coincidental with increased demolition activities at ORR (ORO 2015). Population doses from background sources of radiation are also presented in Table 3–29. The doses from ORR operations are a small fraction of the background doses to the affected population of 1,172,530 living within 50 miles of any ORR facility (ORO 2019).

Worker doses at ORNL primarily result from:

- Work related to the Spallation Neutron Source and HFIR,
- Nuclear reactor research and radioisotope production, and
- Facility maintenance.

Of the workers at ORR (about 4,800 workers in 2017 [Crocker 2017]) nearly 13 percent received a measurable dose (a detectable dose) during the period of 2014 through 2018. The average collective worker dose during this time was 73.0 person-rem per year with no LCFs expected (calculated value of 0.04). Considering only the workers who received a measurable dose (on average 622 workers per year and ranging from 598 to 661), the average annual dose to a worker was 117 millirem. No single worker received a dose greater than 2,000 millirem (DOE 2015g, 2016j, 2017g, 2018b, 2019g). To protect workers from impacts from radiological exposure, 10 CFR Part 835 imposes an individual dose limit of 5,000 millirem in a year. In addition, worker doses must be monitored and controlled below the regulatory limit to ensure that individual doses are less than an administrative limit of 2,000 millirem per year (DOE 2017f), and maintained as low as reasonably achievable. **Table 3–30** presents ORNL worker dose information for the years 2014 to 2018.

Table 3–30. Annual Radiation Doses to Oak Ridge National Laboratory Workers from Operations 2014–2018

Year	*Collective Dose (person-rem)*	*Workers With a Measurable Dose*	*Average Dose Among Workers With a Dose (rem)*	*Exposed Worker Population LCF Risk* [a]
2018	76.8	615	0.125	0 (0.05)
2017	87.6	661	0.133	0 (0.05)
2016	69.4	617	0.112	0 (0.04)
2015	60.0	598	0.100	0 (0.04)
2014	71.3	618	0.115	0 (0.04)
Average	**73.0**	**622**	**0.117**	**0 (0.04)**

[a] Calculated using a dose conversion factor of 6×10^{-4} LCF per rem. A value of less than 0.5 is considered to result in no LCFs. Values in parentheses are calculated values.

Note: Due to rounding, sums and products may not equal those calculated from table entries.

Sources: DOE 2017g:Exhibit B-1, 2018b:Exhibits B-1–B-3, 2019g:Exhibit B-3.

3.2.10.2 Nonradiological Health and Safety

Nonradiological exposures at ORNL are controlled through programs intended to protect workers from normal industrial hazards. These programs are controlled by the safety and health regulations for DOE contractor workers governed by 10 CFR Part 851, which establishes requirements for worker safety and health programs to ensure that workers have a safe work environment. Included are provisions to protect against occupational injuries and illnesses, accidents, and hazardous chemicals.

DOE monitors worker safety through CAIRS. CAIRS is a computerized database used to collect and analyze DOE reports of injuries, illnesses, and accidents that occur during facility operations. Two metrics generated for the tracking of injury, illness, and accident rates are the DART rate and the TRC rate. The

DART rate is an indication of the instances of injuries, illnesses, and accidents that result in, at worst, lost work days or days lost due to transfer or worker job restrictions. The TRC rate is an indication of the total number of work-related injuries or illnesses that resulted in death, days away from work, job transfer or restriction, or recordable case as identified in the Occupational Safety and Health Administration's Form 300. For the years 2015 through 2019 the ORNL DART and TRC rates (incidents per 200,000 work hours or the equivalent of 100 full-time workers) average 0.19 and 0.65, respectively. For the years 2015 through 2019, the DART and TRC rates for all DOE facilities combined average 0.39 and 0.86, respectively (DOE 2019a).

3.2.10.3 Regional Cancer Rates

The National Cancer Institute publishes national, State, and county incidence rates of various types of cancer (NCI 2018). However, the published information does not provide an association of these rates with their causes, e.g., specific facility operations and human lifestyles. **Table 3–31** presents incidence rates for the United States, Tennessee, Anderson County, Roane County, and the 18 counties within about 50 miles of ORR. (ORNL is located in Anderson and Roane Counties.) Additional information about cancer profiles in the vicinity of ORNL is available in State Cancer Profiles and in Incidence Rates Tables (NCI 2018). Not all types of cancer are presented in this table; totals for individual cancers will not sum to the All Cancer values.

Table 3–31. Cancer Incidence Rates for the United States, Tennessee, and Counties Adjacent to Oak Ridge National Laboratory, 2012–2016

	Cancer Incidence Rates [a]						
Region	*All Cancers*	*Thyroid*	*Breast (female)*	*Lung and Bronchus*	*Leukemia*	*Prostate*	*Colon and Rectum*
United States	448.0	14.5	125.2	59.2	14.1	104.1	38.7
Tennessee	462.6	12.9	122.6	75.1	13.7	110.4	40.5
Anderson County [(b)]	469	15	135.7	71	10.7	112.1	39.8
Bledsoe County	412.5	(c)	84.3	84.1	(c)	68.5	32.7
Blount County	483	13.6	122.7	78.6	19	99	37.5
Campbell County	510.8	16.2	113.8	115	15.8	96.6	47.4
Claiborne County	530.6	15.4	133.6	116.1	14.1	99.7	46.2
Cumberland County	448.5	14.6	116	73.5	10.1	108.5	40
Fentress County	491.8	(c)	116.3	99.2	(c)	95.6	48.7
Grainger County	501.2	17.6	103.6	91.7	13.5	105	43.7
Jefferson County	468.7	16.9	125.3	73.3	17.6	85.8	39.6
Knox County	465.4	15.1	129.3	68.7	12.9	115.7	36.2
Loudon County	494.9	19.2	136	72.3	12.5	102.2	28.8
McMinn County	441.5	10.6	106.5	78	13.9	75.3	42.1
Meigs County	505.8	(c)	95.6	90.9	(c)	89.8	48
Monroe County	462	7.6	96	95.8	13.3	87.1	33.5
Morgan County	471.5	(c)	143.5	99.1	(c)	107.2	36.8
Rhea County	498	11.7	123	102	13.4	88.1	45.1
Roane County [(b)]	459.2	16.3	135.2	79.3	15.8	89.5	37.6
Scott County	511.3	19.3	125.7	104	(c)	118	41.9
Sevier County	490	15.2	133	79.5	13.8	106.3	40.7
Union County	502	23.4	99	114.8	12	94.8	35

[a] Age-adjusted incidence rates; cases per 100,000 persons per year.
[b] ORNL is located in Anderson and Roane Counties.
[c] Data have been suppressed by the National Cancer Institute to ensure the confidentiality and stability of rate estimates when the annual average count is three or fewer cases.
Source: NCI 2018.

3.2.11 Emergency Preparedness

Every site in the DOE complex has an established emergency management program that is activated in the event of an accident. These programs have been developed and maintained to ensure adequate response to most accident conditions and to provide response efforts for accidents not specifically considered. Emergency management programs address emergency planning, training, preparedness, and response for both onsite and offsite personnel.

DOE Order 151.1D, *Comprehensive Emergency Management System* (DOE 2016i), describes detailed requirements for emergency management that all DOE sites must implement. Each DOE site, facility, and activity, including ORNL, establishes and maintains a documented emergency management program that implements the requirements of applicable Federal, State, and local laws, regulations, and ordinances for fundamental worker safety programs (e.g., fire, safety, and security). This is the Emergency Management Core Program. In addition, each DOE site, facility, and activity containing hazardous materials (i.e., radioactive materials or certain chemicals that do not fall under the purview of fundamental worker safety programs) establishes and maintains an Emergency Management Hazardous Materials Program. Finally, each site that receives or initiates shipments managed by the Office of Secure Transportation must be prepared to manage an emergency involving such a shipment, should that emergency occur on site.

These programs involve providing specialized training and equipment for local fire departments and hospitals, State public safety organizations, and other government entities that may participate in response actions, as well as specialized assistance teams. These programs also provide for notification of local governments whose constituencies could be threatened in the event of an accident. Broad ranges of drills and exercises are run to ensure the systems are working properly, from facility-specific exercises to regional responses. In addition, there are internal and external audits. Lessons learned from exercises and audits are used to continuously strengthen ORNL's emergency management program.

In summary, the emergency management system at ORNL includes emergency response facilities and equipment, trained staff, and effective interface and integration with offsite emergency response authorities and organizations. ORNL personnel maintain the necessary apparatus, equipment, and a state-of-the-art Emergency Operations Center.

3.2.12 Traffic

3.2.12.1 Transportation Infrastructure

The ROI for the transportation infrastructure includes two U.S. Interstate Highways, three U.S. Highways, four Tennessee State Highways, and the ORNL onsite road systems. Major transportation routes to ORNL are via two Interstate Highways (I) I-40 and I-75, as well as U.S. Highways (US), US 11, US 25W, and US 70. DOE has transferred some roads at ETTP to the City of Oak Ridge to provide access to property that has already been transferred.

3.2.12.2 Regional

The primary regional roadway network consists of the following main roads:

- Interstate I-40, an east-west route located south of ORR;
- State Route (SR) 95 (Oak Ridge Turnpike) from the City of Oak Ridge to the SR 95/58 interchange on ORR;
- SR 95 (White Wing Road) from Interstate I-40 to the SR 95/58 interchange;
- SR 327 (Blair Road) from SR 61 to the north to SR 58;
- SR 58 from Gallaher Road to the west to the SR 95/58 interchange;

- SR 62 (S. Illinois Avenue) and Scarboro Road from Oak Ridge southeast to roads leading onto ORR; and
- SR 162 (Pellissippi Parkway) from Interstate I-40/Interstate I-75 to SR-62.

3.2.12.3 Oak Ridge Reservation Onsite Road Systems

Within the ORR there are about 197 miles of roadways (Census 2019b). Employees leaving ORNL can choose from several routes that pass through the ORR. Within ORR, several routes are used to transfer traffic from the State routes to the main plant areas, including ORNL (ORNL 2002). Bear Creek Road, north of Y-12, runs in an east-west direction and connects Scarboro Road on the east end with SR 95 and SR 58. Bear Creek Road has restricted access around Y-12 and is not a public thoroughfare. The main ORNL access road, Bethel Valley Road, is closed to the public, but open to ORNL staff and authorized visitors. This east-west road extends from the east end of ORR at Scarboro Road to the west end at SR 95 and provides access to the site and leads to all the parking lots.

Blair Road (SR 327) is a collector roadway with a section of the roadway located on DOE property. Under a bilateral agreement with the State, a permanent easement for this section is maintained by the Tennessee DOT. The roadway provides a connection from SR 61 to SR 58. The intersection of Blair Road and SR 58 is signalized.

Once on site, access to the VTR complex will be directly provided by Melton Valley Access Road from a north-south direction and Melton Valley Drive/Ramsey Drive from an east-west direction.

Heavy equipment accessing ORNL is processed in accordance with access protocols that include all vehicles being subject to search. Preplanning and notification are necessary for oversized or unusual shipments. Loads must be configured so security personnel can do a visual inspection of both the vehicle and load. Searches are conducted randomly. Bills of lading and government forms of identification are verified prior to allowing the vehicle onto the site.

Two main branches provide rail service for ORR. The CSX Transportation line at Elza Gate (just east of Oak Ridge) serves the Y-12 Complex and the Office of Science and Technological Information in east Oak Ridge. The Norfolk Southern main line from Blair Road provides easy access to ETTP (DOE 2005b). No rail spurs run to the ORNL site.

3.2.12.4 Existing Traffic Conditions

In 2018, the annual average daily traffic for regional roadways near the study site ranged from 2,485 (SR 327) to 12,641 (SR 58) vehicles a day, which is considered light compared to other roadways in the City of Oak Ridge (TDOT 2019). There are two primary entrances/exits to ORNL: Bethel Valley Road eastbound towards SR-62 and Bethel Valley Road westbound towards SR-95. SR 95 from the intersection with SR 62 (S. Illinois Avenue) to the SR 95/58 interchange has been recently widened to a four-lane divided highway. SR-162 is the main thoroughfare for commuters to ORNL coming west on I-40 from Knoxville to ORNL's east gate at Bethel Valley Road.

Table 3–32 provides average daily traffic data for selected segments of routes in the vicinity of ORNL. The daily average of each route is the annual average daily traffic on the route.

ORNL employs about 5,000 employees (ORNL 2019). The majority of ORNL's commuting traffic comes from Oak Ridge via Bethel Valley Road, while smaller amounts come from Blair Road and south SR 95 (DOE 1997c). During 2019, an average of about 4,750 vehicles came onto the site each day. Peak travel times are considered 6:30 a.m. to 9:30 a.m. for the morning commute and 3:30 p.m. to 5:30 p.m. for the evening commute, with most congestion occurring at the east and west portals during morning and evening commute times. Traffic studies have been conducted for select intersections on site. A study for the entire site has not been completed.

Table 3–32. Average Daily Traffic Volume

Route	*Average Daily Traffic Volume (2018)*
SR 95 from the SR 95/58 Exchange to Wisconsin Avenue	11,486
SR 95 from the SR 95/58 Exchange to Bear Creek Road	5,830
SR 327 from SR 61 to SR 58	2,485
SR 58 from Gallaher Road to the SR 95/58 interchange	12,641
SR 162 from I-40/I-75 to the SR 162/62 interchange	64,715

Source: TDOT 2019.

3.2.13 Socioeconomics

This section describes current socioeconomic conditions and local community services within the four-county ROI (or region) associated with ORNL: Anderson, Knox, Loudon, and Roane Counties in eastern Tennessee. ORNL is located in Roane and Anderson Counties, about 25 miles northwest of the City of Knoxville. About 87.6 percent of people employed at ORR, including about 4,400 employees at ORNL, reside in these four counties (DOE 2005b; OREM 2019). Therefore, these four counties are identified as the ROI in this socioeconomics analysis. Figure 2–7 shows the four counties in the ROI as well as towns and major transportation routes.

3.2.13.1 Population and Housing

Knox County is the largest county in the ROI. It had a 2018 population of 465,289, including the population of Knoxville, the largest city in the ROI with a population of 187,500 in 2018 (Census 2020c). Loudon County is the smallest county in the ROI with a total population of 53,054 in 2018. The City of Oak Ridge and ORNL are located in both Roane and Anderson Counties which had 2018 populations of 53,140 and 76,482, respectively (Census 2020c); Oak Ridge, the closest city to ORNL, had a population of 29,109 in 2018 (Census 2020c).

In 2018, the population in the ROI was estimated to be 546,358. From 2010 to 2018, the total population in the ROI increased at an average annual rate of about 0.8 percent, which was slightly lower than the growth rate in Tennessee. Over the same time period, the total population of Tennessee increased at an average annual rate of about 0.84 percent, to 6,770,010 people. The populations of the ROI and Tennessee are shown in **Table 3–33**.

Table 3–33. Population of the Oak Ridge National Laboratory Region of Influence 2000–2018

County	*Year*				*Population Projection 2050*
	2000	*2010*	*2018*	*Population Change 2010-2018 (percent)*	
Anderson	71,330	75,129	76,482	1.8	82,280
Knox	382,032	432,226	465,289	7.6	587,800
Loudon	39,086	48,556	53,054	9.3	69,712
Roane	51,910	54,181	53,140	-1.9	50,723
ROI	**544,358**	**610,092**	**647,965**	**6.2**	**790,515**
Tennessee	5,689,283	6,346,105	6,770,010	6.7	8,306,294

ROI = region of influence.
Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: Census 2020a, 2020b, 2020c; Tennessee State Data Center 2020.

Housing

As of 2017, the ROI had 283,708 housing units of which 89.7 percent were occupied and 10.3 percent were vacant. In Tennessee, an estimated 12.3 percent of the stock is vacant. Vacant rental stock makes up 7 percent of the stock in Tennessee. The distribution of housing units in the ORNL ROI and Tennessee is presented in **Table 3–34**.

Table 3–34. Region of Influence Housing Characteristics (2017)

County	2017 Housing Units	Occupied Housing Units	Vacant Housing Units	Owner-Occupied Units	Renter-Occupied Units	Vacant Homeowner-Housing Units (percent)	Vacant Rental Housing Units (percent)
Anderson	34,864	30,518	4,346	20,584	9,934	872 (2.5)	2,162 (6.2)
Knox	200,608	182,315	18,293	116,893	65,422	3,810 (1.9)	11,033 (5.5)
Loudon	22,571	20,090	2,481	15,282	4,808	315 (1.4)	1,015 (4.5)
Roane	25,665	21,619	4,046	16,274	5,345	667 (2.6	2,617 (10.2)
ROI	**283,708**	**254,542**	**29,166**	**169,033**	**85,509**	**5,664 (2.0)**	**16,827 (5.9)**
Tennessee	2,903,199	2,547,194	356,005	1,688,565	858,629	52,257 (1.8)	203,224 (7.0)

ROI = region of influence.

Notes:

Homeowner and rental vacancy units do not add to total vacant housing units because the vacancy rates only include vacant housing units (i.e., proportion of total inventory) that are on the market for rent or for sale only.

Due to rounding, sums and products may not equal those calculated from table entries.

Source: Census 2017c.

3.2.13.2 Employment and Income

From 2010 to 2018, the ROI experienced an average annual growth rate in the civilian labor force of just under 0.4 percent (from 311,401 to 320,327), while the State of Tennessee's labor force grew at an average annual rate of about 0.6 percent. Employment in the ROI grew at an average annual rate of 1.0 percent, compared to the State of Tennessee's rate of about 1.5 percent. At the same time, the number of unemployed people decreased by 5.2 percent – reflecting the economic recovery from the recession of 2008 – 2010. The ROI experienced a slightly lower unemployment rate (3.2 percent) in 2018 than the State of Tennessee (3.5 percent). Within the ROI, the unemployment rate ranged from 2.9 percent in Knox County to 4.1 percent in Roane County. **Table 3–35** presents employment statistics in the ROI and Tennessee for 2010 and 2018. In 2018, there were 310,260 people employed in the ORNL ROI.

Table 3–35. Employment Statistics in the Oak Ridge National Laboratory Region of Influence and Tennessee in 2010 and 2018

Area	Civilian Labor Force		Employment		Unemployment		Unemployment Rate	
	2010	2018	2010	2018	2010	2018	2010	2018
Anderson	34,926	34,283	31,675	32,995	3,251	1,288	9.3	3.8
Knox	229,800	240,034	212,757	232,986	17,043	7,048	7.4	2.9
Loudon	22,352	22,857	20,280	22,078	2,072	779	9.3	3.4
Roane	24,323	23,153	22,089	22,201	2,234	952	9.2	4.1
ROI	**311,401**	**320,327**	**286,801**	**310,260**	**24,600**	**10,067**	**7.9**	**3.1**
Tennessee	3,090,795	3,244,921	2,792,063	3,131,660	298,732	**113,261**	9.7	3.5

ROI = region of influence.

Note: Due to rounding, sums and products may not equal those calculated from table entries.

Source: BLS 2020a, 2020b, 2020c.

ORNL/ORR Employment

ORNL is managed by UT-Battelle, LLC. ORR also includes Y-12 and the ETTP (formerly K-25 Site or Oak Ridge Gaseous Diffusion Plant), managed by UCOR. UCOR is the prime contractor for most environmental management activities at ORR, including on the ORNL campus. The Oak Ridge Institute for Science and Education is a DOE entity that is operated by Oak Ridge Associated Universities.

Table 3–36 provides residence information for the four-county ROI. As shown in this table, about 87.6 percent of ORR, employees, including those working at ORNL, reside in this ROI. Total onsite employees in 2019 was 14,300, including 1,900 at ETTP (including 200 private workers), 8,000 at Y-12, and 4,400 at ORNL (OREM 2019).

Table 3–36. Distribution of Employees by Place of Residence in the Oak Ridge National Laboratory Region of Influence

County	*Number of Employees*	*Percent of Total Site Employment*
Anderson	3,930	27.5
Knox	5,380	37.6
Loudon	760	5.3
Roane	2,460	17.2
ROI [a]	**12,530**	**87.6**

ROI = Region of Influence.
[a] Total employees and county of residence based on 2003 data (DOE 2005b).
Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: DOE 2005b; OREM 2019.

A comparison of 2018 data for direct onsite employment levels and ROI employment levels show that direct ORNL onsite residence employment accounted for about 3.6 percent of employment in the ROI.

Local Income

ORR is a major economic contributor to the Tennessee economy. In FY 2017, nearly $2.2 billion in total personal income was generated DOE-related activities in Tennessee, including a direct income benefit of over $1.1 billion, the majority of which was generated in Knox, Anderson, and Roane counties (DOE 2018g). The annual average salary for a DOE-related employee is $81,000. This is significantly higher than the average per capita income in the ROI of $45,265 in 2018 (BEA 2019a). Per capita income in 2018 in the ROI ranged from a low of $40,980 in Roane County to a high of $49,738 in Knox County. The per capita income in Tennessee was $46,900 in 2018 (BEA 2019a). Per capita annual income statistics for 2010 to 2018 are shown in **Table 3–37**.

Table 3–37. Per Capita Annual Personal Income

County	*Per Capita Income ($)*	
	2010	*2018*
Anderson	34,585	41,853
Knox	37,542	49,738
Loudon	36,759	48,491
Roane	32,984	40,980
ROI (Average)	**35,468**	**45,265**
Tennessee	35,835	46,900

Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: BEA 2019a, 2019b.

3.2.13.3 Community Services

Key community services in the ROI include education, law enforcement, fire protection, and medical services. Seven school districts with 149 schools provide public education services and facilities in the ORNL ROI. Educational services are provided for about 86,715 students by an estimated 5,428 teachers for the 2018-2019 school year (NCES 2020). The student-to-teacher ratio in these school districts ranges from a high of 16.4:1 in the Knox County School District to a low of 13.9:1 in the Oak Ridge School District. The average student-to-teacher ratio in the ROI was 16:1 (NCES 2020).

The counties within the ROI include 83 fire departments and fire stations that employ about 1,112 firefighters (601 full-time, 180 part-time, and 331 volunteer). This includes 4 fire stations in the City of Oak Ridge that employ 70 full-time firefighters and 4 part-time firefighters; and 1 fire station at ORNL that employs 40 full-time firefighters (Fire Department 2020).

The counties within the ROI include 1,070 law enforcement officers: 583 employed by the counties' sheriff departments; 487 employed by the city police departments of Knoxville (in Knox County), Clinton, and Oak Ridge; and 55 employed in Anderson County and Lenoir City in Loudon County (FBI 2020a, 2020b).

There are 15 hospitals that serve residents of the ROI with the majority located in Knox County (12). These hospitals have a total bed capacity of 2,195 persons (Tennessee Hospital Association 2020).

3.2.13.4 Public Finance

A 2018 study examined DOE's economic impact on the State of Tennessee based on data and analysis from FY 2017 (DOE 2018g). It looked at the direct effects of DOE investment, including payroll disbursements, pensions, taxes paid, charitable giving, and the indirect ripple effects of this spending within East Tennessee and the ORNL ROI. The study indicates that ORR is critical to the State's economic success.

For each job created and dollar paid by DOE, multiple jobs and additional tax revenue are generated in the State. In total, DOE's economic impact in Tennessee is $5.6 billion and supports more than 34,000 jobs, with a workforce spanning 50 of Tennessee's 95 counties. Key economic impact findings at the State level include:

- DOE and its major contractors directly created 12,618 full-time jobs, with annual wages and salaries totaling more than $1 million. For every one job created by DOE and its contractors, an additional 1.7 jobs were created across the State (12,618 direct employment; 21,878 created by multiplier effect of DOE investment).
- Tennessee's gross domestic product increased by over $3.3 billion as a result of direct and indirect effects of DOE expenditures as follows: $1.5 billion in payroll spending (46 percent), including just over $1 billion in direct payroll spending; over $200 million in pension disbursement (6 percent), including just over $137 million in direct pension disbursement; and $1.6 billion in non-payroll spending (49 percent), all indirect spending.
- DOE spending supports private-sector businesses. Of the more than $1.1 billion in non-payroll (direct procurement) spending from DOE and its contractors, more than $943 million went to Tennessee businesses for the procurement of raw materials, services, and supplies. The majority of DOE spending occurred in three counties within the ROI: Anderson (51 percent), Knox (29 percent), and Roane (7 percent).
- DOE-related spending generated over $32 million in State and local tax revenue. A portion of these tax dollars enable the City of Oak Ridge to provide critical infrastructure to support DOE missions and fund schools and education programs.
- DOE's spending in Oak Ridge creates high quality jobs throughout East Tennessee. The annual salary for a DOE employee of $81,000 is significantly above the Statewide average ($51,344 in 2016).

Local Fiscal Characteristics (City of Oak Ridge)

The City of Oak Ridge's general fund revenues and expenditures for FY 2017 and anticipated revenues and expenditures for FY 2019 are presented in **Table 3–38**. The general fund supports the ongoing operations of local governments as well as community services, such as police protection and parks and recreation. The largest revenue sources have traditionally been local taxes (which include taxes on property, real estate, hotel/motel receipts, and sales) and intergovernmental transfers from the Federal or State government. Roughly 92 percent of the 2017 general fund revenue came from these combined sources (City of Oak Ridge 2019). For FY 2019, the property tax rate is $2.54 per $100 of assessed value. The assessment rate is 40 percent for industrial and commercial property and 25 percent for residential property (City of Oak Ridge 2019). The city receives a payment-in-lieu-of-tax for ORR acreage that falls within the city limits. The payment is based on its value as farmland and assessed at the farmland rate of 25 percent. In 2019, the city expects DOE PILOT funds and grants of about $2,022,543 (City of Oak Ridge 2019). The Roane County tax rate was $2.35 per $100 of assessed value in 2017 (City of Oak Ridge 2019).

Table 3–38. City of Oak Ridge Revenues and Expenditures (in 2017 and 2019)

	2017 Actual (in dollars)	*2019 Budgeted (in dollars)*
Revenues		
Taxes	$33,987,182	$34,934,413
Licenses and Permits	306,359	307,500
Intergovernmental Revenues	4,027,393	3,943,490
Charges for Services	1,232,188	1,175,532
Fines and Forfeitures	364,740	344,500
Other	$625,133	654,762
Grants	953,970	1,918,065
Total Revenues	41,497,965	43,278,262
Expenditures and Other Financing		
Expenditures	21,658,072	24,177,407
Other Financing Uses [a]	19,259,617	19,466,238
Total Expenditures and Other Financing	**$40,917,689**	**$43,643,645**

[a] Includes items such as capital projects fund, solid waste fund, economic diversification fund, debt service, and schools.
Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: City of Oak Ridge 2019.

3.2.14 Environmental Justice

The ROI for environmental justice is the area within a 50-mile radius of the proposed project area. The 50-mile radius was selected because it is consistent with the ROI for evaluating human health impacts from radiological emissions. The potentially affected area includes parts of 31 counties throughout Tennessee, Kentucky, and North Carolina within the 50-mile radius of the site.

Discussion of the regulatory environment; definitions of minority, low-income, and minority and low-income populations; and a description of meaningfully greater populations for environmental justice concerns is provided in Section 3.1.14 for INL. In accordance with those earlier definitions, minority and low-income populations for ORNL are present when either (a) the total number of minority or low-income individuals of the affected area exceeds 50 percent of the overall population in the same area, or (b) the total number of minority or low-income individuals within the affected area is meaningfully greater (e.g., 120 percent greater) than the minority or low-income population percentage in an appropriate comparison unit of geographic analysis.

Minority and Low-Income Populations

Selection of units of analysis focus on geographic units (i.e., block groups) that represent, as closely as possible, the potentially affected areas. Refer to Section 3.1.14 for further discussion.

In order to evaluate the potential impacts on populations in closer proximity to the proposed project area at ORNL, radial distances of 5, 10, and 20 miles are analyzed. **Table 3–39** shows the composition of the ROI surrounding the proposed project area at each of these distances.

Table 3–39. Total Minority and Low-Income Population within 50 miles of Oak Ridge National Laboratory

Population Group	Within 5 Miles		Within 10 Miles		Within 20 Miles		Within 50 Miles	
	Population	Percent of Total	Population	Percent of Total	Population	Percent of Total	Population	Percent of Total
Total Population	9,648	100.0	129,979	100.0	480,103	100.0	1,229,361	100.0
Nonminority	8,602	89.2	113,139	87.0	415,389	86.5	1,089,401	88.6
Total Minority	1,046	10.8	16,840	13.0	64,714	13.5	139,960	11.4
White - Hispanic/Latino	174	1.8	4,986	3.8	15,038	3.1	33,085	2.7
Black/African American [a]	335	3.5	4,069	3.1	23,214	4.8	54,847	4.5
American Indian or Alaska Native [b]	1	0.0	203	0.2	1,260	0.3	4,692	0.4
Other Minority [a, b]	536	5.6	7,582	5.8	25,202	5.2	47,336	3.9
Low Income	1,008	10.4	13,688	10.5	64,165	13.4	195,925	15.9

[a] Includes persons who also indicated Hispanic or Latino origin.

[b] Other Minority includes all combined individuals of Asian, Native Hawaiian and Other Pacific Islander, Some Other Race, or Two or More Races. None of these other groups individually exceed 3 percent of the total population at any distance.

Source: Census 2017a, 2017b.

Minority populations were evaluated using the absolute 50 percent and the relative 120 percent or greater criteria for potentially affected block groups within 50 miles of ORNL. If a block group's percentage of minority individuals met the 50 percent criterion or was more than 120 percent of the total minority population of the percentage within the 31-county comparison population, then the area was identified as having a minority population. The total population residing in the 31-county comparison population is about 1,611,861, of which 11.1 percent would be considered members of a minority population; therefore, the meaningfully greater criterion for minority populations is 13.4 percent. Of the 766 block groups within the ROI, 22 block groups have individual racial group minority populations or aggregate minority populations that meet the 50 percent criterion, and 204 block groups meet the meaningfully greater criterion for one or more racial groups.

The overall composition of the projected populations within every radial distance is predominantly nonminority. The concentration of minority populations is greatest within the 20-mile radius. The Black or African American and Hispanic or Latino populations are the largest minority group within every radial distance, constituting 4.3 and 3.6 percent of the total population within 50 miles, respectively. **Figure 3–19** displays the block groups identified as meeting the criteria for environmental justice minority populations surrounding ORNL, as well as population density of minority populations within each block group.

As with minority populations, low-income populations were evaluated using the absolute 50 percent and the relative 120 percent or greater criteria for potentially affected block groups within 50 miles of ORNL. If a block group's percentage of low-income individuals met the 50 percent criterion or was more than 120 percent of the percentage of the total low-income population within the 31-county comparison population, then the area was identified as having a low-income population. Of the total population residing in the 31-county ORNL comparison population, about 18 percent are identified as living below the poverty line; therefore, the meaningfully greater criterion for low-income populations is 21.6 percent. Of the 766 block groups within the ROI, 26 block groups have a low-income population that exceeds the 50 percent criterion, and a total of 224 block groups meet the 120 percent criterion for low-income populations. **Figure 3–20** displays the block groups identified as meeting the criteria for environmental justice low-income populations surrounding ORNL, as well as population density of low-income populations within each block group.

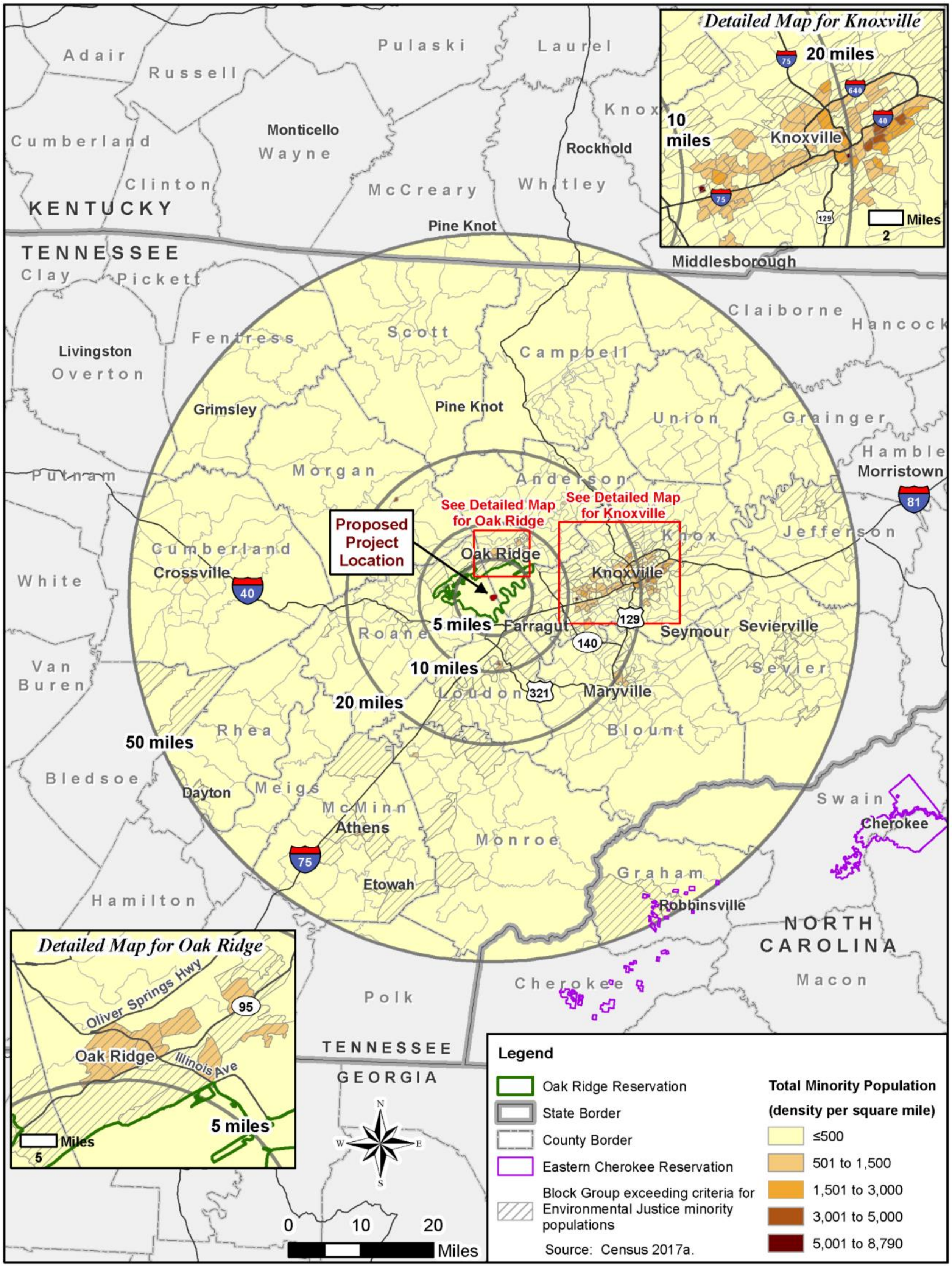

Figure 3–19. Locations of Block Groups Meeting the Criteria for Environmental Justice Minority Populations

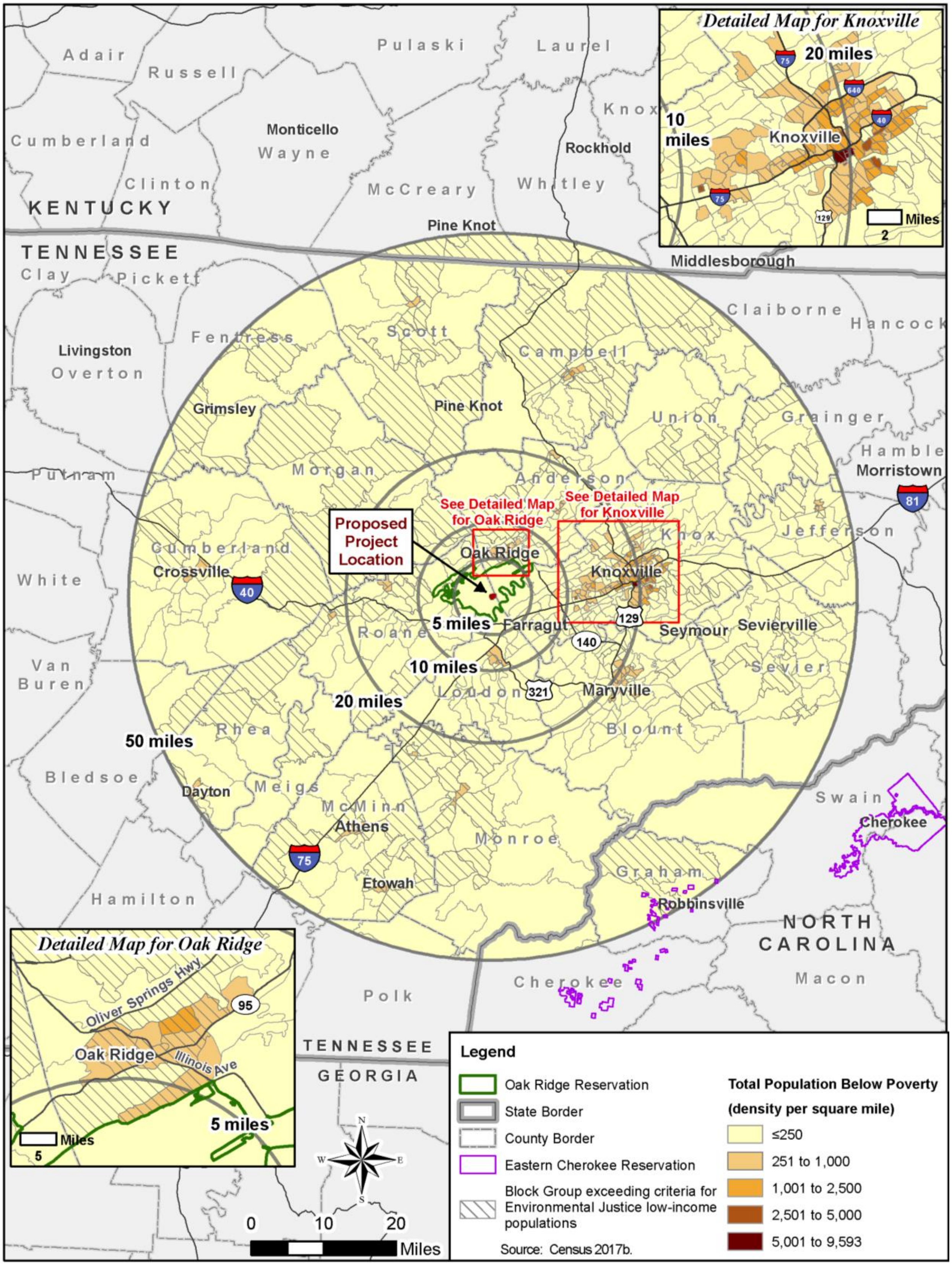

Figure 3–20. Locations of Block Groups Tracts Meeting the Criteria for Environmental Justice Low-Income Populations

3.3 Savannah River Site

3.3.1 Land Use and Aesthetics

The ROI for land use consists of SRS and land immediately adjacent, including portions of the three-county region where the site is located. Other regional land uses are described because they can be included in the ROI for other aspects of this affected environment.

3.3.1.1 Land Use at Savannah River Site

SRS is located on a 310-square mile (198,344-acre) parcel of land in southwestern South Carolina in a generally rural area about 25 miles southeast of Augusta, Georgia, and 12 miles south of Aiken, South Carolina, the nearest population centers. SRS is bordered by the Savannah River to the southwest and includes portions of three South Carolina counties: Aiken, Allendale, and Barnwell. SRS is a controlled area, with public access limited to through traffic on State Highway 125 (SRS Road A), U.S. Highway 278 (SRS Road 1), and a CSX railway line (DOE 1999b:3-163; SRNS 2019a:1-5).

DOE either owns or controls all SRS land. Specific uses of SRS land are determined by the missions established for DOE and other missions or uses established by Congress. DOE requires that any land no longer required for SRS missions be made available for public use (SRNS 2014:5). About 86 percent of the total land on SRS is a buffer zone or natural and managed forest land, and the remaining 14 percent is either industrial area (7 percent) or areas reserved for the DOE Research Set-Aside Program (7 percent). SRS consists of four major forest types: 1) mixed pine-hardwood, 2) sandhills pine savanna, 3) bottomland hardwood, and 4) swamp floodplain forest. These forests are accessible to the public when visiting the Crackerneck Wildlife Management Area and Ecological Reserve near Jackson, South Carolina (SRNS 2019a:1-7).

The USFS conducts a comprehensive natural resource management program for SRS under an interagency agreement. Under this agreement, the USFS manages timber production on about 149,000 acres on SRS. Other management activities covered under this agreement include wildland fire suppression, threatened and endangered species restoration, invasive species control, habitat management, watershed management, boundary maintenance, management of secondary roads, and related research (SRNS 2014:10).

Public hunts for white-tailed deer (*Odocoileus virginianus*), feral hogs (*Sus scrofa*), wild turkeys (*Meleagris gallopavo*), and coyote (*Canis latrans*) are allowed on site. In 2018, public hunts harvested 275 deer, 66 hogs, 14 coyotes, and 27 turkeys (SRNS 2019a:5-30).

Soil map units that meet the requirements for prime farmland soils exist on SRS. However, the USDA NRCS does not identify these as prime farmlands because the land is not available for agricultural production (DOE 1999b:3-163–165).

Decisions on future land uses at SRS are made by DOE through site development, land use, and future planning processes. SRS has established a Land Use Technical Committee that is composed of representatives from DOE, the management and operating contractor, and other SRS organizations (DOE 1999b:3-165). DOE has prepared a number of documents addressing the future of SRS, including the *Savannah River Site End State Vision* (SRS 2005), *Savannah River Site Comprehensive Plan/Ten Year Site Plan, Fiscal Year 2011-2020* (SRNS 2010), *Savannah River Site Ten Year Site Plan, Fiscal Year 2016 – 2025* (SRNS 2015a), and *SRS Environmental Management Program Management Plan* (DOE 2016c). As noted in these documents, the Environmental Management Cleanup Project and mission will be complete by 2065 and ongoing National Nuclear Security Administration (NNSA) nuclear industrial missions will continue. SRS is a site with an enduring mission and is not a closure site; thus, SRS land will be federally owned, controlled, and maintained in perpetuity (SRNS 2015a:1-4; SRS 2005:4).

As depicted in **Table 3–40** and **Figure 3–21**, SRS is divided into six land use management areas, based on existing biological and physical conditions, operational capability, and suitability for mission objectives. The 38,300-acre Industrial Core Management Area contains the major SRS facilities. The primary objective of this area is to support facilities and site missions. Other important objectives are to promote conservation and restoration, provide research and educational opportunities, and generate revenue from the sale of forest products. Protection of the red-cockaded woodpecker (*Picoides borealis*) dominates natural resource decisions in the 87,200-acre Red-cockaded Woodpecker Management Area and the 47,100-acre Supplemental Red-cockaded Woodpecker Management Area (DOE 2019f:3-6). The Crackerneck Wildlife Management Area and Ecological Reserve is 11,000 acres and is managed by the South Carolina Department of Natural Resources (SCDNR) (SCDNR 2016). The primary objective of this management area is to enhance wildlife habitat through forestry and wildlife management practices. The management objective of the 9,900-acre Savannah River Swamp and 4,300-acre Lower Three Runs Corridor Management Area is to improve the physical and biological quality of the wetland environment (DOE 2019f:7).

Table 3–40. Savannah River Site Management Area Descriptions

Management Area	Name	Size (acres)	Primary Functions	Facility Areas
1	Industrial Core Management Area	38,300	SRS facility operations	B, C, D, E, F, H, N, S, T
2	Red-Cockaded Woodpecker Management Area	87,200	Protection of the red-cockaded woodpecker	None
3	Supplemental Red-Cockaded Woodpecker Management Area	47,100	Protection of the red-cockaded woodpecker; reintroduction of native savanna species	A, L, K, P, R, RR, Z
4	Crackerneck Wildlife Management Area and Ecological Reserve	11,000	Enhance wildlife habitat	None
5	Savannah River Swamp Management Area	9,900	Wetland improvement; limited natural resource management	None
6	Lower Three Runs Corridor Management Area	4,300	Wetland improvement; limited natural resource management	None

Source: DOE 2019f.

In 1972, SRS was designated as a National Environmental Research Park. The purpose of the National Environmental Research Park is to provide research and education activities that assess and document environmental effects associated with energy and weapons material production. Park staff explores methods for eliminating or minimizing adverse effects of energy development and nuclear materials on the environment and train others in ecological and environmental sciences (Rhodes 2018). DOE has also established a set-aside program to provide reference areas for understanding human impacts on the environment. The SRS set-aside program currently contains 30 research reserves totaling 14,006 acres and represents 7 percent of total SRS land. These reserves were chosen as representatives of the eight major vegetation communities on the site (SREL 2019).

No areas on SRS are subject to American Indian treaty rights. However, six American Indian groups, the Yuchi Tribal Organization, the National Council of Muskogee Creek, the Indian Peoples Muskogee Tribal Town Confederacy, the Pee Dee Indian Association, the Ma Chis Lower Alabama Creek Indian Tribe, and the United Keetoowah Band of Cherokee Indians have expressed concern over sites and items of religious significance on SRS. DOE routinely notifies these organizations about major planned actions at SRS and asks them to comment on SRS documents prepared in accordance with NEPA (DOE 1999b:5-15).

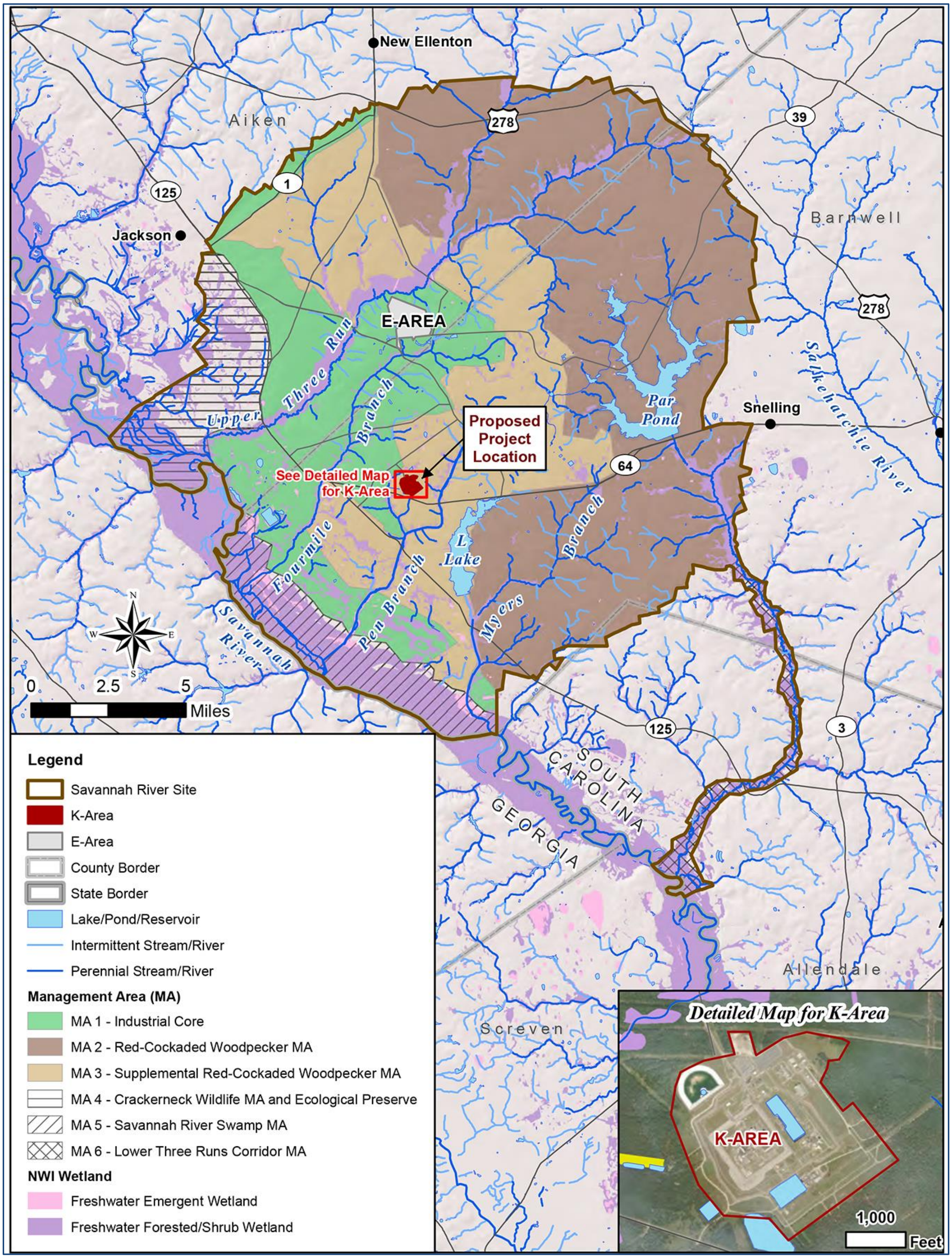

Figure 3–21. Savannah River Site Management Areas

Land Use at Proposed Facility Location (K Area)

The location of the facility at SRS that would support the VTR project is known as K Area. K Area is a 3,558-acre area situated near the center of SRS and located just outside of the Industrial Core Management Area within the Supplemental Red-Cockaded Woodpecker Management Area. The area is 5.5 miles from the site boundary. K Area was one of five SRS reactor areas with the original mission of producing material for the U.S. nuclear weapons program for four decades during the Cold War. However, the K Area production reactor is shutdown with no restart capability. The K Area Material Storage Area is located in the K Area Complex, which is used by the NNSA to safely store non-pit plutonium awaiting disposition. NNSA also uses the K Area Complex to perform inspections to confirm the safe storage of plutonium and to dilute plutonium in order to prepare it for disposal as transuranic waste at the WIPP facility near Carlsbad, New Mexico (SRNS 2010:3-85; SRNS 2019a).

Regional Land Use

Predominant regional land uses in the vicinity of SRS include urban, residential, industrial, agricultural, and recreational. SRS is bordered largely by forest and agricultural land, with limited urban and residential development. The nearest residential areas are located to the west, north, and northeast, some within 200 feet of the SRS boundary (NRC 2005a:3-36). Farming and livestock production is diversified throughout Aiken, Allendale, and Barnwell Counties and includes such crops as corn, hay, peanuts, cotton, and winter wheat. Agricultural production in these three counties represents 7 percent of South Carolina's total production (USDA 2019b). Industrial areas are also present within 25 miles of the site; industrial facilities include textile mills, polystyrene foam and paper plants, chemical processing plants, the Barnwell LLW facility, and the Vogtle Electric Generating Plant (a commercial nuclear power plant). Open water and nonforested wetlands occur along the Savannah River Valley. Recreational areas within 50 miles of SRS include Sumter National Forest, Santee National Wildlife Refuge, and J. Strom Thurmond Reservoir (also known as Clarks Hill Lake). State, county, and local parks include Redcliffe Plantation State Historic Site, Battle of Rivers Bridge State Historic Site, Barnwell State Park, and Aiken State Park in South Carolina, and Mistletoe State Park in Georgia. The Crackerneck Wildlife Management Area and Ecological Reserve occupies a portion of SRS along the Savannah River and is open for hunting and fishing only during designated dates and times when public access is tightly controlled (SCDNR 2016).

The State of South Carolina Councils of Governments were formed in 1967, when the State was divided into 10 planning districts, with the goal of coordinating cooperative development among local governments. Six counties are included in the Lower Savannah River Planning District, including Aiken, Allendale, and Barnwell Counties, the three counties within which SRS is located (SCARC 2019). Private lands bordering SRS are subject to the planning regulations of these three counties (DOE 1999b:3-163).

3.3.1.2 Aesthetics at Savannah River Site

Aesthetics consider natural and manmade features that provide a particular landscape its character and visual quality. Landscape character is determined by the visual elements of form, line, color, and texture. All four elements are present in every landscape and, they exert varying degrees of influence. Landscapes are aesthetically pleasing when they offer a harmonious balance of multiple inviting elements in a natural composition (DOE 1999b:3-166). The ROI for aesthetics would include SRS and areas that are located within the view of industrial areas at SRS. Assessment of the aesthetics in this EIS follows the BLM Visual Resource Management guidelines (BLM 1986). The guidelines are discussed in Section 3.1.1, Land Use and Aesthetics for the INL Site.

General Site Description

The dominant viewshed at and in the vicinity of SRS consists mainly of agricultural land and forest, with some limited residential and industrial areas. The SRS landscape is characterized by wetlands and upland hills. Vegetation includes bottomland hardwood forests, scrub oak and pine forests, and forested wetlands. Facilities are scattered throughout SRS and are brightly lit at night. These facilities are generally not visible off site, as views are limited by rolling terrain, normally hazy atmospheric conditions, and heavy vegetation. The only areas visually impacted by the DOE facilities are those within the view corridors of State Highway 125 and U.S. Highway 278 (DOE 1999b:3-166).

Developed areas and utility corridors (e.g., transmission lines and aboveground pipelines) of SRS are consistent with a VRM Class IV designation. The remainder of SRS is consistent with a VRM Class II or Class III designation. Management activities within Class II and Class III areas may be seen but do not dominate the view; management activities in Class IV areas dominate the view and are the focus of viewer attention (BLM 1986:6, 7).

Aesthetics at K Area

Industrial facilities within K Area consists of large concrete structures, smaller administrative and support buildings, trailers, and parking lots. The structures range in height from 10 to 100 feet, with a few stacks and towers that reach up to 200 feet. The facilities in these areas are brightly lit at night and visible when approached via SRS access roads (DOE 1999b:3-164). Visual resource conditions in the proposed facility location is consistent with a VRM Class IV designation. K Area is about 1.2 miles from State Highway 125 and 10 miles from U.S. Highway 278. Heavily wooded areas and the nature of the terrain bordering segments of State Highway 125 and U.S. Highway 278 restrict public views of facilities within K Area. Moreover, facilities are not visible from the Savannah River, which is about 5.5 miles from any of industrialized area at SRS (DOE 1999b:3-166).

3.3.2 Geology and Soils

The ROI for geology and soils includes SRS and K Area. SRS is located in the Atlantic Coastal Plain physiographic province (DOE 2015a:3-7). Elevations at SRS range from 420 feet above mean sea level in the northwest part of the site to about 80 feet above mean sea level along the Savannah River to the south (DOE 2016a:10-11).

3.3.2.1 Geology

The Atlantic Coastal Plain sediments at SRS are about 600 to 1,400 feet thick (DOE 2002b:3-1). The sedimentary sequence consist of sand, silt, clay, limestone, and conglomerate ranging in age from Late Cretaceous to Holocene (DOE 2016a:10-12). The youngest deposits on SRS are fine to coarse sands associated with Savannah River stream terraces and tributary stream alluvium. The loosely consolidated Atlantic Coastal Plain sediments are located above bedrock that consists of Paleozoic-age metamorphic and igneous rock (e.g., schist and granite), and Triassic-age sedimentary rock (e.g., siltstone and sandstone) of the Dunbarton Basin (DOE 2015a:3-7). The geology of the region and SRS are described in more detail in Section 3.1.2.1 of the *Surplus Plutonium Disposition Supplemental EIS* (DOE 2015a) and by Denham (1999).

Geologic conditions in K Area are consistent with those found throughout SRS, including the occurrence of "soft zones" (i.e., areas of sand containing calcium carbonate subject to dissolution by water, encountered in boreholes throughout SRS). Soft zones at SRS are limited in areal extent, less than about 15 feet thick, and are poorly interconnected. The most well-developed soft zone in K Area is about 50 feet wide by 200 feet long (DOE 2015a:3-9).

3.3.2.2 Soils

The Natural Resources Conservation Service identified 28 soil series occurring on SRS, grouped into seven broad soil associations. Generally, sandy soils that are well drained occupy the uplands and ridges, and loamy-clayey soils that are poorly to moderately well drained occupy the stream terraces and floodplains

(Rogers 1990:62-82, 127). The soils at SRS are considered acceptable for standard construction techniques (DOE 1999b:3-151).

Most soils within the fence lines of K Area have been disturbed to accommodate buildings, parking lots, and roadways. Disturbed soils within these areas are considered to be urban land where covered by structures or udorthents (NRCS 2018). Udorthents are well-drained, heterogeneous soil materials that are the spoil or refuse from excavations and major construction activities, and they are often heavily compacted (Rogers 1990:79). Undisturbed soils near K Area are classified as the Fuquay–Blanton–Dothan Association. These soils are nearly level to sloping and are well drained. Soils along the Pen Branch floodplain are classified as the Vaucluse-Ailey Association. These soils are sloping and strongly sloping soils of low permeability (DOE 2015a:3-10). Four soil map units near K Area could be classified as prime farmland (NRCS 2018; Rogers 1990:43-44, 62-82, 127). However, USDA's NRCS does not identify these lands as prime farmland because they are not available for agricultural use (NRC 2005a:3-5).

3.3.2.3 Geologic and Soil Resources

The mixed sands, gravels, and clays commonly found beneath SRS are widespread and, therefore, are of limited commercial value. A possible exception might be well-sorted quartz sand, which is valuable as a filtration medium, an abrasive, or an engineering backfill. No sizable, economically valuable deposits of quartz sand are evident at the surface or in the shallow subsurface in K Area (DOE 2015a:3-9, 3-10).

3.3.2.4 Geologic Hazards

Seismic Hazards

Geophysical studies have identified seven subsurface faults beneath SRS. The actual faults do not reach the surface, stopping at least several hundred feet below grade (DOE 2015a:3-8). None of the fault systems at SRS is considered "capable" (as defined in 10 CFR Part 100) because there has been no movement along these faults that can be traced to the ground surface in the past 35,000 years (DOE 2016a:10-15). The only known faults within a 200-mile radius of SRS capable of producing a significant earthquake are within the Charleston, South Carolina, seismic zone (located about 70 miles southeast of SRS) (NRC 2005a:3-4).

The Charleston earthquake of 1886 (estimated Richter scale magnitude of 6.8) is the most damaging earthquake known to have occurred in the southeastern United States and one of the largest historic shocks in eastern North America. At SRS, this earthquake had an estimated Richter scale magnitude ranging from 6.5 to 7.5. The SRS area experienced an estimated peak ground acceleration (PGA) of 0.10 g (one-tenth the acceleration of gravity) during this event (DOE 2015a:3-8). Paleoliquefaction features indicate that the Charleston-type earthquake has reoccurred at least 7 times in the last 6,000 years. The paleoliquefaction features were produced by earthquakes with magnitudes between 5.3 and 7.8 (NRC 2005b:1-16).

The U.S. Geological Survey reported 88 earthquakes greater than magnitude 2.5 occurred within 100 miles of the SRS K Area between January 1973 and October 2019. Only 1 of the 88 earthquakes had a magnitude greater than 4.5. A magnitude 4.7 event occurred 90 miles east-southeast of K Area on November 22, 1974 (USGS 2019a). Earthquakes capable of producing structural damage are not likely to originate in the vicinity of SRS (DOE 1999b:3-149).

Earthquake-produced ground motion is expressed in units of percent g (acceleration relative to that of the Earth's gravity). PGA data from the U.S. Geological Survey are used to indicate seismic hazard. At K Area, the calculated PGA is based on an earthquake with a 2 percent probability of exceedance in 50 years (an annual occurrence probability of 1 in 2,500) and is about 0.16 g (USGS 2014a, 2014b).

Volcanic Hazards

There are no volcanic hazards at SRS. The area has not experienced volcanic activity within the last 230 million years. Future volcanism is not expected because SRS is located along the passive continental margin of North America (DOE 1999b:3-151).

Slope Stability, Subsidence, and Liquefaction

Soils at SRS are subject to erosion, although slope instability has not been a significant regional issue (NRC 2005a:3-5). Because the land at K Area is relatively flat, slope instability is not expected.

Dissolution of the carbonate materials in the soft zones is so slow (if it is occurring at all) that it is not expected to affect any present or future SRS facility. Because of the depth of the soft zones, there are no static stability issues, but a conservative analysis was performed, assuming that the arches supporting the soft zones would lose strength during a seismic event and result in surface subsidence. Estimates of the total potential ground surface settlements from design-basis earthquake loading of the soft zones were between 1.4 and 1.75 inches at K Area (DOE 2015a:3-8, 3-9).

No evidence of seismically induced liquefaction has been discovered at SRS (NRC 2005b:1-24, 1-25). Previous studies at other SRS sites (e.g., F-Area) found the liquefaction susceptibility of soils to be low because of their low clay content and liquid limit and because earthquakes at SRS historically do not have the shear wave velocities required to cause liquefaction of soils (DOE 2016a:10-17).

3.3.3 Water Resources

The ROI for water resources at SRS includes the Savannah River and the groundwater present beneath and downstream of the site. This section describes SRS surface and groundwater resources in general and provides specific information regarding water availability and quality. Wastewater, stormwater, and flooding potential are discussed.

South Carolina's State Safe Drinking Water Act (Title 44 Chapter 55 of South Carolina Code of Laws) and South Carolina Department of Health and Environmental Control (SCDHEC) Regulation 61-58 outline state drinking water standards and constituent standards for groundwater.

3.3.3.1 Surface Water

3.3.3.1.1 Natural Water Features

The Savannah River is the principal surface water feature in the region, forming the southwestern border of SRS for about 35 miles (WSRC 2006a). The Savannah River reach along the SRS boundary has a wide channel, numerous tributaries, and extensive floodplain swamps (WSRC 2006b). Five major watershed tributaries of the Savannah River Basin within SRS discharge into the Savannah River: Upper Three Runs, Beaver Dam Creek, Fourmile Branch, Steel Creek, and Lower Three Runs. Pen Branch is also a major stream at SRS, but it does not flow directly into the Savannah River (DOE 2002d). No streams or tributaries at SRS are federally designated Wild and Scenic Rivers or State-designated Scenic Rivers (NPS 2019).

Additionally, there are about 300 natural Carolina bays at SRS. Carolina bays, a type of wetland unique to the southeastern United States, are natural shallow depressions that occur in interstream areas where they collect surface and groundwater. No direct effluent discharges from SRS are released into the Carolina bays. However, they do receive stormwater runoff (NRC 2005a).

Surface water samples are collected monthly and quarterly from 11 onsite streams and 5 locations along the Savannah River. About 85 percent of the samples collected in 2018 met South Carolina Freshwater Quality Standards (SRNS 2019a).

3.3.3.1.2 Fabricated Water Features

There are two fabricated lakes at SRS: L-Lake (which discharges to Steel Creek) and Par Pond (which discharges to Lower Three Runs). Additionally, there are about 50 other small, fabricated ponds at SRS.

3.3.3.1.3 Surface Water Quality

The Savannah River, except for sections of the river near the coast, and all streams located within SRS are classified as "freshwater" (Class FW) that are suitable for primary- and secondary-contact recreation, drinking water supply (after appropriate treatment), fishing, industrial purposes, and agricultural uses (SRNS 2019a). The nearest downstream water intake is the Beaufort-Jasper Water and Sewer Authority's (BJWSA) Purrysburg Water Treatment Plant, which is about 90 river miles and 78.5 hours of river travel time from the easternmost extent of the SRS boundary. The BJWSA is permitted to withdraw 100 million gallons of water per day. The treatment plant produces about 15 million gallons of water per day for Beaufort and Jasper Counties, South Carolina (City of Hardeeville 2009). This production rate is well within the plant's capacity of up to 39 million gallons of water per day (BJWSA 2019).

3.3.3.1.4 Wastewater and Storm Water

In accordance with NPDES permits, industrial wastewater and stormwater samples are collected from outfalls located across SRS for nonradiological monitoring. A total of 28 industrial wastewater outfalls and 39 industrial stormwater outfalls were monitored in 2018. All samples collected from industrial wastewater outfalls met NPDES permit requirements, and only one outfall, located in N-Area, exceeded benchmark limits for industrial stormwater (SRNS 2019a). A summary of K Area outfalls is presented in **Table 3–41**.

Table 3–41. Summary of K Area Outfalls Sampled in 2018

Outfall	*Receiving Stream*	*Drainage (acres)*	*Type*
K-02	Pen Branch	2.55	Industrial stormwater
K-06	Indian Grave Branch	0.02	Industrial wastewater
K-12		None	
K-18		5.1	

Source: DOE 2007; SCDHEC 2003; SRNS 2012b, 2019a.

The SCDHEC is the regulatory authority for the physical properties and concentrations of chemicals and metals in SRS effluents under the NPDES program. In 2018, SRS held 11 Clean Water Act permits (see Section 7.2.3). SRS stormwater runoff permits require the implementation and maintenance of approved best management practices to assure that SRS stormwater discharges do not impair the water quality of receiving water resources (DOE 2007).

Industrial wastewater monitoring results are reported to SCDHEC through monthly discharge monitoring reports. SRS industrial wastewater outfalls were 100 percent compliant with NPDES permit requirements in 2018 (SRNS 2019a).

3.3.3.1.5 Floodplains and Wetlands

SRS wetlands, most of which are associated with floodplains, streams, and impoundments, include bottomland hardwood, cypress-tupelo, scrub-shrub, emergent vegetation, Carolina bays, and open water. Bottomland hardwood forest is the most extensive wetlands vegetation type along the Savannah River (DOE 1999b).

DOE Order 420.1B outlines the requirements for natural phenomena hazard (including flood events) mitigation for new and existing DOE facilities. In 2000, SRS was required to determine flood elevations as a function of return period for up to 100,000 years and to determine the flood recurrence intervals for

SRS facilities. The facility-specific probabilistic flood hazard curve defines the annual probability of occurrence (or the return period in years) as a function of water elevation. The calculated results in 2000 of the probabilistic flood hazard curve illustrated that the probabilities of flooding in K Area are significantly less than 0.00001 per year (WSRC 2000).

The majority of land within the K Area has been developed for industrial use. As a result, no wetlands currently exist within this location, although fabricated impoundments occur throughout the developed portions of this area, including a large impoundment adjacent to the main processing building at the K Area Complex.

3.3.3.2 Groundwater

3.3.3.2.1 Local Hydrology

Topography and lithology are major factors controlling the direction and relative rate of groundwater flow. Groundwater can flow in aquifers both horizontally and vertically to points of discharge such as streams, swamps, underlying aquifers, and sometimes to overlying aquifers. SRS is underlain by sediment of the Atlantic Coastal Plain, which consists of a southeast-dipping wedge of unconsolidated sediment that extends from its contact with the Piedmont Province at the fall line to the edge of the continental shelf. The sediment, existing as layers of sand, muddy sand, and clay with subordinate calcareous sediments, rests on crystalline and sedimentary basement rock. Water flows easily through the sand layers, but is slowed by less-permeable clay beds, creating a complex system of aquifers (WSRC 2007).

Groundwater recharge is a result of infiltration of precipitation at the land surface. The precipitation moves downward through the unsaturated zone to the water table. The depth to the water table varies throughout SRS. Upon entering the saturated zone at the water table, water moves predominantly in a horizontal direction toward local discharge zones along the headwaters and midsections of streams, while some water moves into successively deeper aquifers. Groundwater velocities at SRS range from several inches to several feet per year in aquitards and from tens to hundreds of feet per year in aquifers (WSRC 2007).

Although many different systems have been used to describe groundwater systems at SRS, for this EIS, the uppermost aquifer is referred to as the "water table aquifer." It is supported by the leaky "Green Clay" Aquitard, which confines (overlies) the Congaree Aquifer. Below the Congaree Aquifer is the leaky Ellenton Aquitard, which confines the Cretaceous Aquifer, also known as the Tuscaloosa Aquifer. In general, groundwater in the water table aquifer flows downward to the Congaree Aquifer or discharges to nearby streams. Flow in the Congaree Aquifer is downward to the Cretaceous Aquifer or horizontal to stream discharge or the Savannah River, depending on the location within SRS (DOE 1999b).

3.3.3.2.2 Subsurface Water Quality

To meet State and Federal laws and regulations, extensive groundwater monitoring is conducted around SRS waste sites and operating facilities, using about 3,000 monitoring wells. Major contaminants include volatile organic compounds, metals, and radionuclides. Groundwater quality varies across the site, but groundwater contamination has not been detected beyond SRS boundaries (DOE 1999b). All drinking water samples collected and analyzed by SRS and SCDHEC in 2018 meet the SCDHEC and EPA bacteriological and chemical drinking water quality standards (SRNS 2019a).

The water table at K Area is encountered at about 70 feet and flows in the southwest direction toward Indian Grave Branch at about 75 feet per year (WSRC 2008). Due to the historical treatment, storage, and disposal of chemical and radioactive waste byproducts of SRS nuclear material production, about 5 to 10 percent of SRS groundwater resources have been contaminated with radionuclides, industrial solvents, metals, and other chemicals. Groundwater contamination sites are primarily located in proximity to the reactor facilities (including K Area), the General Separations Area, and the waste management areas. For the reactor facilities, tritium and trichloroethylene are the primary contaminants identified in groundwater plumes; however, concentrations of other radionuclides, organics, and metals are also present. Groundwater from the K Area Seepage Basin, closed in 2002, migrates toward Pen Branch (SRNS 2019a). A 2007 evaluation by the U.S. Department of Health and Human Services Agency for Toxic Substances and Disease Registry (ATSDR) determined that, based on existing conditions and operations, SRS posed no apparent public health hazard to surrounding communities from groundwater or surface water exposure (ATSDR 2007).

3.3.3.3 Drinking Water

SRS hydrology is complex due to heterogeneities in the vadose zone (i.e., the unsaturated area between the ground surface and the water table) and in the multilayer aquifer system (SRNS 2009). SRS's groundwater flow system is characterized by four major aquifers separated by confining units. All aquifers are defined as potential sources of drinking water by the South Carolina Pollution Control Act (WSRC 2008). None of these aquifers, however, is designated as a sole-source aquifer. A sole-source aquifer is defined as an aquifer that supplies at least 50 percent of the drinking water to the area above the aquifer (EPA 2011).

Groundwater withdrawn in and around SRS is used extensively for domestic, industrial, and municipal purposes. Groundwater is regularly withdrawn from the Cretaceous and water table aquifers (DOE 1999b).

Domestic and process water for SRS is supplied by water supply systems that use groundwater sources. SRS's domestic and process water systems are supplied from a network of about 40 production wells in widely scattered locations across the site, eight of which supply the primary drinking water system. No domestic water systems are located in K Area, but this area does contain process water systems.

3.3.3.4 Water Use and Rights

The South Carolina Groundwater Use and Reporting Act of 2000 and Surface Water Withdrawal, Permitting Use, and Report Act of 2010 mandate that any person withdrawing groundwater or surface water for any purpose in excess of 3 million gallons during any 1 month from a single or multiple wells or intakes under common ownership and within 1 mile of an existing or proposed well or intake must register with, annually report to, and be permitted by SCDHEC (SCDHEC 2005). SRS consumed about 2.49 million gallons of water per day in 2018 (SRNS 2019a). As such, SRS reports water use to SCDHEC, which compiles data from all registered and permitted users into an annual report. According to the 2018 annual report, 1,088 water withdrawers used more than 2.2×10^{13} gallons of surface and groundwater; the vast majority (over 91 percent) of these withdrawals were for hydroelectric purposes (SCDHEC 2019).

While SRS continues to consume large volumes of water, onsite water withdrawals have declined in recent years. Groundwater withdrawals were reduced by more than two-thirds, from 10.8 million gallons per day from 1983 to 1986 to 3.4 million gallons per day in 2010. Total annual water use was reduced by about 22 percent between 2008 and 2010 (from 2.3 billion gallons to 1.8 billion gallons) (SRNS 2011). Potable water consumption was reduced by about 17 percent through FY 2018 as compared to the base year of 2007 (SRNS 2019a). Facility shutdowns, site population reductions, and water supply system upgrades and consolidation have contributed to this observed reduction in water use demand.

SRS occupies portions of Aiken, Allendale, and Barnwell Counties within the Savannah River Basin. Primary tri-county water use categories for 2010 included irrigation, golf course, industrial, water supply, mining, and thermoelectric (SCDHEC 2011). For the tri-county area, surface water uses accounted for about 89 percent of total water withdrawals. Industrial (fabrication, processing, washing, in-plant conveyance and cooling) and thermoelectric (electricity generation from fossil fuel, biomass, solid waste, geothermal, or nuclear energy) sources accounted for about 23 and 73 percent of total surface water withdrawal, respectively. Water supply accounted for about 53 percent of total groundwater withdrawals. SRS primary water use categories related to the 2010 tri-county data would include industrial and water supply. For comparison, SRS total water withdrawals accounted for about 2 percent of the total reported water withdrawals for the tri-county area.

3.3.4 Air Quality

This section describes the existing air quality and climatic conditions of SRS. Aiken and Barnwell Counties encompass the portions of SRS affected by the proposed fuel fabrication action and, therefore, comprise the ROI for the project air quality analysis.

3.3.4.1 Meteorology and Climatology

Due to its southern latitude and location on the eastern side of North America, SRS experiences a humid subtropical climate. This climate is characterized by humid and hot summers, mild winters, and abundant precipitation during all months of the year.

During the warmer months of the year, SRS experiences frequent intense rain showers and thunderstorms. The remnants of tropical storms can produce substantial amounts of precipitation during late summer and early fall. During the colder months of the year, polar storms produce precipitation events that are of longer duration compared to summertime thunderstorms.

Climate and meteorological data collected at Barnwell (NCEI 2019a) and the Aiken area (National Weather Service 2019a), about 16 miles east and 20 miles north of the SRS K Area, respectively, are used to describe the climatic conditions of SRS. The average high and low temperatures at SRS in July are about 93 and 68 degrees Fahrenheit, respectively. The average high and low temperatures for January are about 58 and 32 degrees Fahrenheit, respectively. Annual precipitation averages about 47 inches per year. July and November are the wettest and driest months of the year, respectively. An average of 1 inch of snow falls annually at SRS.

Thunderstorms cause several occurrences of high winds each year in the region. Hailstorms can occur with these storms and large hail (greater than 0.75 inch in diameter) has been observed annually since 1993 in the Aiken/Barnwell Counties region (NCEI 2019b). Tornadoes do occur in the region, as 57 were observed in Aiken and Barnwell Counties from 1950 through 2018 (National Weather Service 2019b). From 1950 to 2017, 10 hurricanes hit South Carolina (National Hurricane Center 2019). On one occasion, during Hurricane Gracie in 1959, hurricane-force winds of 75 miles per hour (mph) were observed at SRS (DOE 2015a:3-20).

3.3.4.2 Air Quality Standards and Regulations

The CAA and its subsequent amendments establish the NAAQS and air quality regulations and delegate their enforcement to the States. In South Carolina, SCDHEC has the authority to regulate air quality. The CAA establishes air quality planning processes and requires States to develop an SIP that details how they will maintain the NAAQS or attain a standard in nonattainment within mandated timeframes. The requirements and compliance dates for attainment are based on the severity of the nonattainment classification of the area. The following section summarizes the air quality rules and regulations that apply to the proposed action at SRS.

3.3.4.2.1 Nonradiological Air Emission Standards

Section 3.1.4.2.1 of this EIS defines air quality concepts related to (1) criteria pollutants, (2) HAPs, and (3) ozone formation. The SCDHEC implements the NAAQS and State ambient standards for benzene and gaseous fluoride for purposes of regulating air quality in South Carolina. The NAAQS are shown in

Table 3–2, Section 3.1.4.2.1 of this EIS. The SCDHEC also regulates HAPs and 257 TAPs. Both programs set ambient levels of concern for HAPs and TAPs.

If the air quality in an area of the United States meets or is cleaner than the national standard, EPA designates it as an attainment area; if worse than the national standard, it is a nonattainment area. Former nonattainment areas that have attained the NAAQS are designated as maintenance areas. Presently, EPA categorizes Aiken and Barnwell Counties that encompass SRS as in attainment of all NAAQS.

The SCDHEC is responsible for enforcing air pollution regulations in South Carolina. The SCDHEC enforces the NAAQS by monitoring air quality, developing rules to regulate and permit stationary sources of air emissions (nonradiological and radiological), and managing the air quality attainment planning processes in South Carolina. The SCDHEC air quality regulations, "Air Pollution Control Regulations and Standards," are found in the South Carolina Code of State Regulations Chapter 61-62 (South Carolina Legislature 2019). Some sources at SRS that emit criteria pollutants and HAPs are regulated under construction and operational permits, as required in Chapter 61-62.1, Section II of the Air Pollution Control Regulations and Standards (SRNS 2018a:3-11). The following permits regulate air emissions activities at SRS:

- Part 70 Air Quality Permit (TV-0080-0041)
- 784-7A Biomass Boiler Construction Permit (TV-0080-0041a-CG-R1)
- 784-7A Oil Boiler Construction Permit (TV-0080-0041a-CF-R1)
- Mixed Oxide Fuel Fabrication Facility (TV-0080-0139-CA-R1)
- Building 235-F D&D Construction Permit (TV-0080-0041-C1)
- Ameresco Federal Solutions, Inc., Biomass Facilities Permit (TV-0080-0144)

3.3.4.2.2 Greenhouse Gases and Climate Change

Section 3.1.4.2.2 of this EIS defines GHGs and the concept of CO_2e and discusses the link between the worldwide proliferation of GHG emissions by humankind and global warming. Global climate change has already had observable negative effects on the environment. The potential future effects of global climate change include more worldwide environmental, economic, and social consequences.

In South Carolina, the U.S. Global Change Research Program predicts that annual average temperatures will increase between 3 and 6 degrees Fahrenheit by 2100, based on both low and high global GHG emission scenarios (USGCRP 2018:42). In addition, average precipitation for each season will increase over the long-term, with the highest increase of 10 to 20 percent occurring in winter (USGCRP 2017:217). Predictions of climate change impacts to South Carolina include: (1) an increase in extreme rainfall events, which will increase flood risks in low-lying regions; (2) an increase in urban heat and vector-borne disease; and (3) more frequent extreme heat episodes and changing seasonal climates, which will increase exposure-linked health impacts and economic vulnerabilities in the agricultural, timber, and manufacturing sectors (USGCRP 2018:744-808).

As stated in Section 3.1.4.2.2 of this EIS, Federal agencies address emissions of GHGs by reporting and meeting reductions mandated in Federal laws, Executive orders, and agency policies. SRS uses its Site Sustainability Plan to implement its environmental and sustainability goals of conserving energy and water and reducing solid waste generation. The Savannah River Site Biomass Cogeneration Facility became operational in 2012, and SRS no longer uses coal to generate energy. Operation of the Biomass Cogeneration Facility and three biomass facilities play a significant role in supporting the renewable and alternative energy goals of SRS. As a result, annual emissions of GHGs from SRS operations no longer exceed 25,000 metric tons of CO_2e and, therefore, their operations are not subject to the EPA mandatory GHG reporting requirements (EPA 2019d).

The potential effects of GHG emissions from the project alternatives are by nature global and cumulative. Given the global nature of climate change and the current state of the science, it is not useful at this time to attempt to link the emissions quantified for local actions to any specific climatological change or resulting environmental impact. Nonetheless, GHG emissions from the project alternatives are quantified in this EIS for use as indicators of their potential cumulative contributions to climate change effects and for making reasoned choices among alternatives.

3.3.4.2.3 Radiological Air Emission Standards

Facilities at SRS emit radioactive materials and, therefore, are subject to NESHAP, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities." South Carolina's Air Pollution Control Regulations and Standards Subchapter 61-62.61 incorporates Subpart H by reference. This regulation limits the radiological dose to a member of the public from all sources on SRS to 10 millirem per year. Subpart H also establishes requirements for monitoring emissions from facility operations and analyzing and reporting of radiological doses. Airborne radiological effluents are monitored at individual SRS facilities to demonstrate compliance with the requirements of Subpart H and DOE Order 458.1, "Radiation Protection of the Public and the Environment."

3.3.4.3 Nonradiological Air Emissions

Sources of nonradiological air emissions at SRS include a biomass (wood) cogeneration facility that produces steam and electricity, wood- and fuel oil-fired boilers, diesel engines, emergency diesel generators, small gasoline and propane combustion sources, chemical and solvent usages, and on-road and non-road vehicle sources. K Area facilities use emergency diesel generators for emergency electrical power; emissions from these sources occur from periodic testing. **Table 3–42** presents a summary of the nonradiological air emissions that occurred in 2017 from stationary sources at SRS (SRNS 2018b).

Table 3–42. Savannah River Site Facility-Wide Emissions – Calendar Year 2017

Source	*Air Pollutant (tons per year)*							
	VOC	*CO*	*NO_x*	*SO_2*	*PM_{10}*	*$PM_{2.5}$*	*Single HAP/TAP*	*Total HAPs/TAPs*
SRS Facility-Wide	35.6	45.9	62.1	4.2	6.8	5.0	1.26	32.2

CO = carbon monoxide; HAP = hazardous air pollutant; NOx = nitrogen oxides; $PM_{2.5}$ = particulate matter less than 2.5 microns in diameter; PM_x = particulate matter less than x microns in diameter; Single HAP/TAP = nitric acid; SO_2 = sulfur dioxide; TAP = toxic air pollutant; VOC = volatile organic compounds.
Source: SRNS 2018b.

3.3.4.4 Radiological Air Emissions

Sources of radionuclide emissions from SRS mainly occur from the ventilation of: (1) lab hoods, (2) evaporators, (3) waste tanks, (4) tritium separation areas, and (5) non-operating reactors and spent nuclear fuel facilities (SRNS 2019b:5-6). Minor amounts of radionuclide emissions also occur from fugitive and diffuse sources. These radionuclide emissions mainly take the form of tritium and krypton-85. Major sources of radionuclide emissions are equipped with CEM systems and are controlled with HEPA filters, per the requirements of Subpart H. Many minor sources of radionuclide emissions within SRS also are controlled with HEPA filters.

During 2018, an estimated 49,593 curies of radioactivity were released to the atmosphere from all SRS sources (SRNS 2019b:A1). The effective dose equivalent from all airborne radionuclide emissions on SRS to the MEI member of the public was 0.09 millirem, which is about 1 percent of the 10 millirem per year Subpart H standard (SRNS 2019b:8). Subpart H defines the MEI as any member of the public at any offsite location where there is a residence, school, business, or office.

3.3.5 Ecological Resources

Ecological resources at SRS are managed through the Natural Resources unit of the USDA/USFS Savannah River office under an existing interagency agreement with DOE/SRS. This agreement includes managing timber; maintaining and improving habitat for special status species; maintaining secondary roads and SRS boundaries; performing prescribed burns and protecting SRS from wildland fires; and evaluating the effects of its management practices on the environment (SRNS 2018a). The USDA/USFS prepared a *Natural Resources Management Plan* for DOE to implement in 2005 and an updated plan in 2019. The plan details all-natural resource operations, including management, education, and research programs (DOE 2019f). Further information for Ecological Resources on SRS are available on the USDA Forest Service's Savannah River website (USDA 2019c).

3.3.5.1 Vegetation

SRS covers about 198,000 acres and consists almost entirely (90 percent) of forested lands managed by the USFS. The remaining area (10 percent) is developed or disturbed and includes industrial areas, roads, buildings, and landscaped vegetation (SRNS 2018a). Forest habitats include mixed pine-hardwood, sandhills pine savanna, bottomland hardwood, and swamp floodplain. Land management by the USFS has focused largely on timber management and watershed protection, thus changing the site's land predominantly to forested areas. SRS and surrounding lands are comprised of six Management Areas as presented on Figure 3–21.

Project activities would occur in the K Area Complex located in K Area. All of K Area has been previously developed or disturbed (classified as "industrial"). The remaining vegetation in K Area consists of managed grassy meadows subject to periodic mowing (DOE 2019f).

3.3.5.2 Invasive Plant Species

Invasive species at SRS are managed by the USFS and controlled locally where they present a threat to natural resource management goals and objectives (DOE 2019f).

Due to the disturbed and developed nature of K Area, invasive species are relatively sparse and limited to areas such as fence lines and roadways.

3.3.5.3 Wildlife

The forested ecosystems provide habitat for a variety of terrestrial wildlife species at SRS. According to the *Environmental Information Document* (WSRC 2006b), 44 species of amphibians, 60 species of reptiles, 255 species of birds, and 55 species of mammals are known to occur within SRS. These populations include urban wildlife, such as frogs, toads, snakes, squirrels, skunks, foxes, and cottontails. Also included are game species [white-tailed deer (*Odocoileous virginianus*) and wild pig (*Sus scrofa*)] and avifauna (raptors, waterfowl, game bird species, and various passerines). Federally listed wildlife species have potential to occur near the proposed project area.

Thirty-six wildlife species are documented as occurring in K Area, most of which live in the open, nonforested habitats (WSRC 2006b). See the *Environmental Information Document* for a full taxonomic listing of these species (WSRC 2006b).

3.3.5.4 Special Status Species

According to the USFWS IPaC report, 10 federally listed species were identified as "known to occur" or "with potential to occur" within or near the SRS proposed project area (see **Table 3–43**). There is no federally designated critical habitat at SRS (USFWS 2020b).

Table 3–43. Federally Listed Species with Potential to Occur Near K Area

Common Name	Scientific Name	Protection Status	Historically Observed at SRS?
Birds			
Red-cockaded Woodpecker	*Picoides borealis*	FE	yes
Wood Stork	*Mycteria americana*	FT	yes
Reptiles			
Gopher Tortoise	*Gopherus polyphemus*	FC	yes
Amphibians			
Frosted Flatwoods Salamander	*Ambystoma cingulatum*	FT	no
Flowering Plants			
Smooth Coneflower	*Echinacea laevigata*	FE	yes
Pondberry	*Lindera melissifolia*	FE	yes
Canby's Dropwort	*Oxypolis canbyi*	FE	no
Harperella	*Ptilimnium nodosum*	FE	no
American Chaffseed	*Schwalbea americana*	FE	no
Relict Trillium	*Trillium reliquum*	FE	no

FE = federally listed endangered species; FT= federally listed threatened species; FC = federally listed candidate species.
Source: USFWS 2020b.

Of the 10 federally listed species presented in Table 3–43, 5 species have been documented at SRS. These species include two plants (smooth coneflower and pondberry), one reptile (gopher tortoise), and two birds (red-cockaded woodpecker and wood stork). None of these species, except the red-cockaded woodpecker, occurs near the K Area (SREL 2018a, 2018b; SRNS 2018a; Tuberville et al. 2007). The K Area is located within a red-cockaded woodpecker habitat management area (DOE 2019f) (Figure 3–21); however, the nearest colony is located about 4 miles to the east.

SRS provides habitat for at least 40 plant species that are of State or regional concern (SRNS 2018a). Based on a field review conducted in 2005, no federally or State-listed species were found to be present within the then-proposed 210-acre K Area boundary expansion (DOE 2019f).

Several species identified as BCC under the MBTA are known to occur (observed nesting or soaring) at SRS. The proposed project area is located within BCR 27 (Southeastern Coastal Plain) (USFWS 2008). There are 53 species listed in BCR 27. Additionally, the USFWS IPaC system identified 22 migratory bird species with potential to occur in the proposed project area (USFWS 2020b).

Bald (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos canadensis*), protected under the BGEPA, have been observed throughout SRS. Golden eagles have been seen foraging in SRS within open habitats (DOE 2019f). According to the SCDNR bald eagle monitoring program, there are four known bald eagle nests within SRS (SCDNR 2019); however, none of these nests occur within the K Area. The closest known bald eagle nest occurs about 10 miles away. Due to development and ongoing disturbance, there is no suitable foraging habitat available within the K Area.

3.3.5.5 Aquatic Resources

The Savannah River bounds SRS on the southwest for 35 river miles and includes an extensive network of tributaries, fabricated ponds, Carolina bays, reservoirs, and floodplain swamps. SRS also encompasses various ponds and lakes. There are more than 50 fabricated impoundments throughout the site that support populations of bass and sunfish. Carolina bays can range from lakes to shallow marshes, herbaceous bogs, shrub bogs, or bottomland hardwood forests. Among the 300 Carolina bays found throughout SRS, fewer than 20 have permanent fish populations. Wetlands compose about 49,000 acres on SRS, or roughly 25 percent of the total area (SRNS 2018a). More than 400 isolated wetlands occur on SRS, many of which are Carolina bays, fed largely by rain and shallow groundwater (SREL 2018c;

SRNS 2018a). While wetlands are prevalent on SRS and surround most of K Area, there are no wetlands within K Area (DOE 2019f).

3.3.5.6 Wildfire

Fire management at SRS is enforced through the USDA Forest Service Savannah River Fire unit. Annual management activities include fire suppression and prescribed burns within the 310 square miles of DOE's SRS. Prescribed burns reduce hazardous forest fuels and restore ecological processes, including land clearing for timber to restore longleaf pine populations and to create habitat for the red-cockaded woodpecker. Fire is commonly used as a management tool under the current silvicultural practices employed on much of the SRS forested areas (WSRC 2006b).

3.3.6 Cultural and Paleontological Resources

Cultural resources are human imprints on the landscape; this section will discuss cultural resources on SRS (DOE 2015a). The section also contains SRS's paleontological resources, as defined in the Paleontological Resources Preservation Act (16 U.S.C. § 470aaa).

The proposed fuel preparation equipment would be installed in Building 105-K that is part of the K Area Complex, which is designated as site industrial. Internal modifications to Building 105-K would require minimal ground disturbances outside the existing facility. The ROI includes Building 105-K and previously disturbed area within K Area that could be used for a construction laydown area. The construction of the K Area during the 1950s likely destroyed any archaeological resources, so there is little likelihood that prehistoric resources with research potential would be found (DOE 2005c).

3.3.6.1 Cultural Resources

SRS is federally owned land managed and operated by a private contractor, and as such, is required to comply with Federal cultural resources compliance requirements in addition to those required by NHPA Section 106 (54 U.S.C. § 306101) and NEPA (42 U.S.C. § 4321 et seq.).

Archaeological resources at SRS are managed through a Programmatic Memorandum of Agreement between the DOE Savannah River Operations Office, South Carolina Historic Preservation Office (SHPO), and the Advisory Council on Historic Preservation (SRARP 2016). DOE uses this agreement to identify archaeological resources, assess their eligibility for listing on the NRHP, and consult with the South Carolina SHPO to develop mitigation plans for resources affected by SRS undertakings (SRARP 2016). Guidance on the management of archaeological resources at SRS is included in the Archeological Resource Management Plan of the Savannah River Archeological Research Program (SRARP 2016).

DOE developed a Programmatic Agreement in consultation with the South Carolina SHPO, the Advisory Council on Historic Preservation, the SRS Citizen Advisory Board, Citizens for Nuclear Technology Awareness, and the cities of Aiken, Augusta, and New Ellenton for the preservation, management, and treatment of NRHP-eligible structures constructed during SRS's operational history that are contributing to the SRS Cold War Historic District (DOE, SC SHPO, and ACHP 2020). As a result, the SRS Cultural Resources Management Plan, which was developed to preserve the site's historic contributions in the 1950 to 1989 period, outlines the decision-making process for managing NRHP-eligible Cold War historic properties (DOE, SC SHPO, and ACHP 2020).

As of 2018, 36.4 percent of surveyable land has been studied (70,458 acres of 193,276 acres) for archaeological resources and for identification of historic-era built resources that date prior to 1950. In addition, 100 percent of Cold War-era resources constructed between 1950 and 1989 were inventoried by 2004 (SRARP 2017:16).

Archaeological Resources and Historic-Era Buildings and Structures

A total of 2,043 archaeological sites have been identified at SRS; of which 1,303 are prehistoric-era sites and 740 are historic-era sites.

At SRS, seven historic buildings/structures constructed prior to 1950 have been identified, and all have been determined to be NRHP-eligible (SRNS 2020). There are 232 Cold War-era buildings and structures determined to be individually eligible for listing on the NRHP and/or as contributing elements to the NHRP-eligible Cold War Historic District (DOE, SC SHPO, and ACHP 2020). The District includes a landscape, sites, buildings, and structures constructed between 1950 and 1989.

Within K Area, 20 Cold War buildings and structures are eligible for listing on the NRHP (DOE, SC SHPO, and ACHP 2020).

3.3.6.1.1 Traditional Cultural Properties

Although no documented traditional cultural properties are identified on SRS, Native American resources in the region include remains of villages or townsites, ceremonial lodges, burials, cemeteries, and natural areas, containing traditional plants used in religious ceremonies and for medicinal purposes (DOE 1999b).

3.3.6.2 Paleontological Resources

Paleontological materials in the SRS area date largely from the Eocene Age (54 to 39 million years ago) and include fossilized plants and invertebrate fossils, including giant oysters (*Crassostrea gigantissima*), other mollusks, and bryozoa. With the exception of the giant oysters, all other fossils are fairly widespread and common; therefore, the assemblages have low research potential or scientific value (DOE 2015a:3-36). Paleontological resources are unlikely to be found within K Area due to the highly disturbed nature of these areas (DOE 2015a:3-36).

3.3.7 Infrastructure

Site infrastructure includes those basic resources and services required to support planned construction and operations activities and the continued operations of existing facilities. For the purposes of this EIS, infrastructure is defined as electricity, fuel, water, and sewage. **Table 3–44** describes the SRS infrastructure. Waste management and transportation infrastructure are addressed separately in Sections 3.3.9 and 3.3.12, respectively. Capacities and characteristics of SRS's utility infrastructure are described in Table 3–44.

3.3.7.1 Electricity

The majority of the electrical power consumed by SRS is generated by offsite, coal-fired and nuclear power plants, and is supplied by Dominion Energy (formerly South Carolina Electric and Gas Company). About 310,000 megawatt-hours per year of electricity is used at SRS, with an available capacity of 4,400,000 megawatt-hours per year (SRNS 2012a). The peak load use is estimated to be 60 megawatts, with a peak load capacity of 500 megawatts.

3.3.7.2 Fuel

Biomass is used primarily at SRS to produce steam in boiler plants. Fuel oil is used to back up biomass when needed and is also used to power emergency generators. The steam plant in A-Area, which burned coal, is no longer used and was replaced with a biomass plant with fuel oil backup. Natural gas is not used at SRS (DOE 2015a:3-42). An estimated 410,000 gallons of fuel oil per year are consumed at SRS (SRNS 2012a). Onsite fuel oil supplies can be replenished by truck or rail deliveries as needed. In addition, temporary storage tanks can be installed to supplement fuel consumption needs during construction or other activities. Due to these factors, the capacity for fuel is generally not considered to be limited for SRS.

Table 3–44. Savannah River Site-wide Infrastructure

Resource	*Estimated Site Use*	*Site Capacity*	*Available Site Capacity*
Electricity			
Power Consumption (megawatt-hours per year) [a]	310,000	4,400,000	4,100,000
Peak Load (megawatts) [a]	60	500	440
Fuel [b]			
Oil (gallons per year)	410,000	NA [c]	NA
Biomass (tons per year)	300,000	20,000,000	19,700,000
Domestic Water (gallons per year) [a]	320,000,000	2,950,000,000	2,630,000,000
Sewage (gallons per year)	250,000,000	383,000,000 [d]	133,000,000

NA = not applicable or not available.
[a] DOE 2015a.
[b] Oil use is for A-Area and K Area.
[c] Capacity is generally not limited, as delivery frequency can be increased to meet demand.
[d] Capacity includes the Central Sanitary Wastewater Treatment Facility and smaller treatment units in K- and L-Areas.
Note: Totals are rounded to two significant figures from information included in SRS Infrastructure Power Quantity Cost Distribution Report D7257000, FY 2010 (SRNS 2012a).

3.3.7.3 Water

SRS has 13 domestic water systems, including 1 large system that supplies 98 percent of the site's domestic water requirements. The large system consists of a primary plant in A-Area and a backup plant in B-Area. This water system, including elevated storage tanks and distribution mains, was constructed between 1993 and 1997. The water system currently consists of 1 large system, the A-Area and B-Area treatment plants, and 12 small systems. The large system consists of A- and B-Area plants for chemical treatment and system monitoring, 4 deep wells, 4 elevated storage tanks and about 27 miles of 10-inch pipe for the site loop. Average domestic water production at SRS is about 820,000 gallons per day (SRNS 2019c). Raw water is drawn from subsurface aquifers through 20-inch- (51-centimeter-) diameter production wells using vertical turbine pumps. Once treated, the potable water is stored in the four elevated storage tanks and distributed to the various facilities through a network of piping (DOE 2015a:3-42).

About 320 million gallons of domestic water are used at SRS annually, with a capacity to supply up to 2,950 million gallons per year (SRNS 2012). Process water for individual areas is supplied through separate deep groundwater wells or river intake systems (DOE 2015a:3-43).

Sewage

The Central Sanitary Wastewater Treatment Facility (CSWTF), installed on Burma Road in 1995, collects and treats 98 percent of sanitary wastewater generated at SRS. Also constructed in 1995, 18 miles of pressurized sewer line and 12 lift stations are used to transport sanitary waste to the CSWTF. The CSWTF has a treatment capacity of 1.05 million gallons per day. The balance of the sanitary waste is treated at two smaller, older independent facilities installed in the 1970s located in K Area and L-Area. The K Area plant has an operating capacity of 24,000 gallons per day. The original treatment facilities, lift stations, and about 45 miles of gravity pipe were installed in the 1950s. Collectively, the sanitary systems at SRS include 56 lift stations, and 18 miles of force main (pressure), and 48 miles of gravity drain piping throughout the site (SRNS 2019c:408-411). The CSWTF and the smaller treatment units in K Area and L-Area are estimated to collect and treat about 250 million gallons of sewage per year with a capacity to treat up to 383 million gallons per year of sewage (SRNS 2012a).

3.3.7.4 Proposed Facility Location (K Area)

Proposed activities analyzed in this EIS would be located in K Area. **Table 3–45** provides estimated current consumption of resources in K Area.

Table 3–45. Current Use of Resources at K Area

Resource	*K Area*
Electricity	
Power Consumption (megawatt-hours per year)	9,200
Peak Load (megawatts)	5.8
Diesel/Fuel Oil (gallons per year)	170,000
Domestic Water (gallons per year)	3,600,000

Note: Totals are rounded to two significant figures from information included in SRS Infrastructure Power Quantity Cost Distribution Report D7257000, FY 2010 (SRNS 2012a).

3.3.7.4.1 Electricity

Step-down transformers are used to reduce the electrical power from the 115-kV transmission loop to medium voltage levels, typically 4.16 or 13.8 kV, in individual areas. There are two 30-megavolt-amp transformers for K Area.

The current estimated yearly power consumption for K Area that would be affected by the proposed activities totals about 9,200 MWh, which accounts for about 2 percent of current site-wide electrical usage and represents about 0.1 percent of the site-wide available capacity. The current theoretical maximum peak load that could be experienced by K Area's given current estimated peak is 5.8 MW, compared to a site-wide peak load of 60 MW. SRS has the capacity to deliver a peak load of up to 500 MW.

3.3.7.4.2 Fuel

Package boilers in K Area have been deactivated and replaced with a single boiler unit that can run on biomass fuel or fuel oil. This biomass facility only operates in the winter. The estimated 170,000 gallons of fuel oil used annually in K Area represents about 41 percent of the current site-wide consumption of fuel oil.

3.3.7.4.3 Water

The estimated current annual consumption of domestic water for K Area is about 3.6 million gallons, which represents 3 percent of the site-wide use and about 0.1 percent of site-wide capacity.

3.3.8 Noise

Region of Influence

The ROI for noise extends 0.5 mile from the edge of the SRS construction area, which is the area that could be susceptible to noise impacts.

State of South Carolina Regulations

The State of South Carolina and Barnwell County have not established noise regulations that specify noise limits. Aiken County Zoning and Development Standards Ordinance provides limits to noise levels per frequency band (Aiken County Planning Commission 2013:145). For areas without standardized criteria, the Federal Transit Administration recommends the following standards for construction noise in residential areas: construction noise levels at the sensitive receptor should not exceed an 8-hour equivalent sound level of 80 dBA during daytime (7 a.m. to 10 p.m.); an 8-hour L_{eq} of 70 dBA during nighttime (10 p.m. to 7 a.m.); and a 30-day average day-night average sound level of 75 dBA (DOT 2018:193).

3.3.8.1 Environmental Noise and Vibration

3.3.8.1.1 Major Noise Sources

The major noise sources within SRS include industrial facilities, equipment, and machines (e.g., cooling systems, transformers, engines, pumps, boilers, steam vents, intercom paging systems, construction and materials-handling equipment, and vehicles). These noise sources primarily occur within developed or active areas at SRS. Noise emissions outside of these active areas consist primarily of vehicles and rail operations. Existing noise sources of importance to the public and sensitive receptors at SRS are related to transportation of people and materials to and from the site, including trucks, private vehicles, helicopters, and trains (DOE 2015a). In addition, noise emissions from traffic to and from SRS occur along access highways through the nearby towns of New Ellenton, Jackson, and Aiken, South Carolina.

3.3.8.1.2 Noise Measurements

Noise measurements recorded during 1989 and 1990 along State Route 125 in the town of Jackson at a point about 50 feet from the roadway estimated day-night average sound levels of 66 dBA for summer and 69 dBA for winter. Similarly, noise measurements along State Route 19 in the town of New Ellenton at a point about 50 feet from the roadway estimated average day-night average sound levels of 68 dBA for summer and 67 dBA for winter (DOE 1999b:324). Although SRS does not publish reports on ambient noise, typical noise levels are estimated to be about 50 to 60 dBA, with some equipment, such as heating, ventilation, and air conditioning (HVAC) systems, causing noise levels to be about 70 dBA.

The proposed K Area Complex is about 5.5 miles from the SRS boundary and the closest offsite receptors. The proposed project area and most industrial facilities at SRS are far enough from the site boundary that noise levels at the boundary from these sources would not be measurable or would be barely distinguishable from background levels.

The existing noise levels in a particular area are generally based on its proximity to nearby major roadways or railroads or on population density (DOT 2018:64). The land surrounding the K Area Complex and the closest offsite receptors are primarily rural with agricultural areas. The Alvin W. Vogtle Electric Generating Plant is located off site to the southwest of the proposed site in Burke County. State Route 125 (Augusta Highway) accounts for the majority of noise but since it is more than 1.5 miles away, it is not considered a major source of noise for the closest sensitive receptor. Therefore, ambient noise levels were estimated based on the population density of the affected county using the methodology described in USDOT's Transit Noise and Vibration Impact Assessment (DOT 2018).

According to the Census Bureau, the population densities of Aiken and Barnwell Counties are about 149.5 and 41.2 people per square mile, respectively (Census 2010b, 2010d). As a result, the existing day-night average sound level in the vicinity of the proposed project area and the closest offsite receptors is estimated to be 40 dBA, and the existing ambient equivalent continuous sound levels (in equivalent sound level) during daytime and nighttime are estimated to be about 40 dBA and 30 dBA, respectively (DOT 2018:66). Burke County, Georgia has a population density of 28.2 people per square mile (Census 2010c). As a result, the existing day-night average sound level for the offsite receptors to the south/southwest of the proposed project area is estimated to be 35 dBA (DOT 2018:66). Ambient (background) noise levels could occur from roadway traffic, farm machinery, pets, and various other household noises.

3.3.8.1.3 Public Parks

The closest Federal and State parks to the K Area Complex are the Redcliffe Plantation State Historic Site, Barnwell State Park, and Congaree National Park, which are about 18 miles northwest, 22 miles northeast, and 62 miles northeast of the proposed project location, respectively.

3.3.9 Waste Management

This section describes the current average annual "baseline" generation rates and management practices for the waste categories that will be generated if fuel preparation activities are implemented at SRS (SRNS 2020). The ROI for waste management activities includes everything within the SRS boundaries. Offsite locations including other DOE and commercial facilities are not included in the waste management ROI. The potential impacts at these non-SRS disposition facilities were considered as part of the licensing/permitting/approval process for these sites and are not detailed in this document. There would be no additional impacts, including exposure to the offsite public or onsite workers. All waste disposition actions would comply with the licenses, permits, and/or approvals applicable to the facilities described in this document. Those waste categories are LLW, MLLW, and TRU waste; RCRA hazardous and TSCA wastes; and nonhazardous solid waste and recyclable materials. HLW is also managed at SRS; however, no HLW would be generated by fuel preparation activities and, therefore, is not discussed further in the section. **Table 3–46** presents the latest available 5-year annual generation by waste category.

Table 3–46. 5-Year Annual "Baseline" Generation by Waste Category in Cubic Meters

	2015		*2016*		*2017*		*2018*		*2019*		*Average*	
Waste Type	***SRS***	***K Area***	***SRS***	***K Area***	***SRS***	***K Area***	***SRS***	***K Area***	***SRS***	***K Area***	***SRS***	***K Area***
LLW	4,400	0	6,800	48	4,800	14	5,900	10	4,400	15	5,300	17
MLLW [a]	180	0	3.7	5.7	84	1.3	3.4	0	3.7	0	55	1.4
TRU waste	10	0	7.2	0.21	8.6	0	13	0	17	0.63	11	0.17
Hazardous and TSCA [a]	77	0.095	230	0.004	100	0	150	0.001	5,700	0.033	1,300	0.027
C&D	41,000	260	25,000	170	23,000	340	43,000	510	45,000	1,200	35,000	500

C&D = construction and demolition and industrial waste; LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; SRS = Savannah River Site; TRU = transuranic waste.

[a] Quantities are in 1,000s of pounds [will be converted to cubic meters when the specific waste category conversion factors are available].

Note: All numbers are rounded to two significant figures. Due to rounding, sums and products may not equal those calculated from table entries.

Source: SRNS 2020c.

3.3.9.1 Radioactive Waste

Low-Level Waste

Liquid and solid LLW are treated and disposed of at SRS. Most aqueous LLW streams are sent to the F- and H-Area Effluent Treatment Project and treated by pH adjustment, submicron filtration, organic removal, reverse osmosis, and ion exchange to remove chemical and radioactive contaminants other than tritium. This facility is designed to process 100,000 to 250,000 gallons of low-level radioactive wastewater daily. After treatment, the effluent is discharged to Upper Three Runs through an NPDES-permitted outfall. The treatment residuals are concentrated by evaporation and stored in the H-Area tank farm for eventual treatment in the onsite Z-Area Saltstone Facility, where wastes are immobilized with grout for disposal.

Solid LLW is primarily disposed of in engineered trenches and slit trenches. About 14,000 cubic meters of disposal space remains in the engineered trenches and about 23,000 cubic meters of disposal space remains in two active slit trenches. Together, the remaining solid LLW disposal capacity at SRS is estimated to be 37,000 cubic meters. While most solid LLW is disposed of on site at SRS, some is shipped off site for disposal at Federal and commercial disposal facilities.

Mixed Low-Level Waste

MLLW is radioactive waste that contains material that is regulated as hazardous waste. Storage facilities for MLLW are located in several different SRS areas. These facilities are regulated under RCRA or as Clean

Water Act-permitted tank systems. MLLW is sent off site to NNSS or RCRA-regulated treatment, storage, and disposal facilities. A section of the TRU waste storage pads has been permitted to store MLLW and hazardous waste and has a storage capacity of 296 cubic meters.

Transuranic Waste/Mixed Transuranic Waste

Transuranic waste, including mixed transuranic waste, is transported to E-Area via closed-body trucks from the generating site and stored on covered storage pads. The TRU waste storage pads in E-Area can store up to about 13,200 cubic meters of transuranic waste. Transuranic waste is characterized, packaged, and certified to meet the criteria for transportation and disposal. The certified waste containers are subsequently loaded into Type B shipping casks and transported to the WIPP facility near Carlsbad, New Mexico, for disposal.

3.3.9.2 Resource Conservation and Recovery Act Hazardous and Toxic Substances Control Act

Hazardous waste is nonradioactive waste that is regulated by the State of South Carolina under RCRA. Hazardous waste is accumulated at the generating location as permitted by regulation or stored in DOT-approved containers. A section of the TRU waste storage pads in E-Area has been permitted to store hazardous waste and has a storage capacity of 296 cubic meters. Most of the waste is shipped off site to commercial RCRA-permitted treatment and disposal facilities using DOT-certified transporters. DOE plans to continue to recycle, reuse, or recover certain hazardous wastes, including metals, excess chemicals, solvents, and chlorofluorocarbons.

PCBs are present at SRS in various forms. The majority of the PCBs are in special purpose coatings and paints. PCBs are also known to be present in fluorescent light ballasts and old capacitors, and may be present in caulking materials and cable insulation. Wastes containing PCBs are managed in accordance with TSCA regulations (40 CFR Part 761) and applicable EPA approval documents issued to SRS. PCB wastes are not eligible for disposal at SRS and must be disposed of at an offsite TSCA-authorized facility.

3.3.9.3 Nonhazardous Solid Waste

Nonhazardous solid sanitary waste is sent to the Three Rivers Regional Landfill, which is located within the SRS boundary and serves as a regional municipal landfill for Aiken, Allendale, Bamberg, Calhoun, Edgefield, McCormick, Orangeburg, and Saluda Counties. The Three Rivers Landfill has a total permitted capacity of 30 million metric tons and can receive up to 500,000 metric tons per year. About 2.4 million metric tons of solid waste had been disposed of in the landfill. Construction and demolition debris is disposed of in a landfill near N-Area.

3.3.10 Human Health – Normal Operation

The impact on human health during normal facility operations addresses the potential impacts from exposure to ionizing radiation and chemicals. Potential human health impacts from exposure to radiation from normal operational conditions is considered for both an individual and the population as a whole for both the public and site workers; this constitutes the ROI. For the existing environment, the public population is considered to be all people living within 50 miles of SRS. The maximally exposed individual is considered to be a hypothetical person who could receive the maximum possible dose from SRS site releases. In addition, for workers the potential human health impacts associated with exposure to workplace chemicals are also considered.

3.3.10.1 Radiation Exposure and Risk

DOE monitors radiation in the environment and exposure of workers and calculates the radiation doses of members of the offsite general public and onsite workers from operation of SRS. **Table 3–47** presents data on radiation doses to the public for the years 2014 through 2018. The average radiation dose to a representative offsite member[5] of the public as a result of onsite facility operations was estimated to be 0.21 millirem per year. The risk of developing an LCF from this dose is extremely small, much less than 1 in a million. The calculation of this maximum dose considers the maximum dose to an individual from air emissions and from the use of water (drinking water).[6] The maximum dose to an offsite individual does not include a contribution from direct radiation. This dose is less than one-tenth of a percent of the average dose of 311 millirem per year from exposure to natural background radiation (e.g., cosmic gamma, internal, and terrestrial radiation) for someone living in the United States (SRNS 2019a).

Table 3–47. Annual Radiation Doses to the Public from Savannah River Site Operations 2014–2018

Source of Dose	Representative Individual					Population		
	Dose (millirem per year)				LCF Risk			
	Airborne Radionuclides [a]	Water Use [b]	Sportsman Dose [c]	Total	Total [d]	Estimated Population Dose (person-rem)	LCFs [d]	Estimated Dose from Background (person-rem)
2018	0.082	0.19	11.1	0.27	e	6.0	0 (0.004)	243,000
2017	0.027	0.22	12.2	0.25	e	4.4	0 (0.003)	243,000
2016	0.038	0.15	13.5	0.19	e	4.9	0 (0.003)	243,000
2015	0.032	0.15	12.9	0.18	e	3.7	0 (0.002)	243,000
2014	0.044	0.12	18.3	0.16	e	3.7	0 (0.002)	243,000
Average	**0.045**	**0.17**	**13.6**	**0.21**	**e**	**4.5**	**0 (0.002)**	**243,000**

LCF = latent cancer fatality

[a] DOE (DOE 2011b) and EPA (40 CFR Part 61 Subpart H) limit the dose to a member of the public from airborne radionuclides to 10 millirem per year.

[b] Water use includes drinking water, irrigation, and recreational activities.

[c] Sportsman dose is the dose from hunting and consuming wildlife including fish, deer, and wild hog. The value given is the largest estimate from the doses to an onsite hunter, fisherman, or an offsite hunter.

[d] Calculated using a dose conversion factor of 6×10^{-4} LCF per rem. Values in parentheses are the calculated number of LCFs in the population. A value less than 0.5 is considered to result in no LCFs.

[e] The probability of this individual contracting a fatal cancer range from about 1 in 6,000,000 to 1 in 10,000,000.

Note: Due to rounding, sums and products may not equal those calculated from table entries.

Sources: SRNS 2015b, 2016, 2017, 2018a, 2019a.

There are two dose limits relevant to the exposure of an individual member of the public near a DOE site. As shown in Table 3–47, all of the doses to the representative individual from the operation of SRS are well below the DOE dose limit for a member the general public, which is 100 millirem per year from all pathways, as prescribed in DOE Order 458.1 (DOE 2011b). The table also shows that the dose from the air pathway is well below the NESHAPs dose limit for emissions from DOE facilities of 10 millirem per year (40 CFR Part 61, Subpart H).

The population dose is the sum of average individual doses to the entire population within 50 miles of SRS. Table 3–47 shows that over the years 2014 through 2018, the population dose from operations at SRS ranged from 3.7 to 6.0 person-rem. No LCFs would be expected from these doses. Population doses

[5] SRS calculates individual doses to a representative member of the public for air and liquid releases. SRS also calculates an MEI dose for air releases using parameters defined by EPA, which differ from those used by SRS, to comply with NESHAP regulations. For the NESHAP calculation, SRS assumes all site releases are from the H-Area versus the multiple release points in several areas for the DOE calculation. For 2018, the NESHAP reported MEI dose was 0.088 millirem.

[6] SRS does not include the wildlife consumption dose in the estimated total representative individual dose. The largest estimated sportsman dose to an onsite hunter, 18.3 millirem in 2014, would increase the risk of an LCF by about a 1 in 90,000 and is about 6 percent of the average annual dose from natural background radiation.

from background sources of radiation are also presented in Table 3–47. The doses from SRS operations are a small fraction of the background doses.

Worker doses at SRS primarily result from:

- Liquid waste evaporator repair;
- Defense Waste Processing Facility equipment removal and replacement;
- Glovebox maintenance;
- Target residual material processing; and
- Gallery inspections in high radiation areas.

Of the estimated 5,500 workers at SRS during 2017, nearly 70 percent received a measureable (detectable) dose (DOE 2017b). The total worker dose averaged 113 person-rem for the 5-year period of 2014 through 2018 with no LCFs expected. Considering only the workers who received a measurable dose (on average 2,767 workers and ranging between 1,584 and 4,101), the average annual dose to a worker was 44 millirem. No single worker received a dose greater than 500 millirem during this period (DOE 2015g, 2016j, 2017g, 2018b, 2019g). To protect workers from impacts from radiological exposure, 10 CFR Part 835 imposes an individual dose limit of 5,000 millirem in a year. In addition, worker doses must be monitored and controlled below the regulatory limit to ensure that individual doses are less than an administrative limit of 2,000 millirem per year (DOE 2017f), and maintained as-low-as-reasonably-achievable. **Table 3–48** presents SRS worker dose information for the years 2014 to 2018.

Table 3–48. Annual Radiation Doses to Savannah River Site Workers from Operations 2014–2018

Year	*Collective Dose (person-rem)*	*Workers with a Measurable Dose*	*Average Dose Among Workers with a Dose (rem)*	*Exposed Worker Population LCFs* [a]
2018	126.9	4,101	0.031	0 (0.08)
2017	152.4	3,830	0.039	0 (0.09)
2016	99.0	2,437	0.041	0 (0.06)
2015	95.1	1,884	0.050	0 (0.06)
2014	93.0	1,584	0.059	0 (0.06)
Average	**113.3**	**2,767**	**0.044**	**0 (0.07)**

LCF = latent cancer fatality; rem = roentgen equivalent man.

[a] Calculated using a dose conversion factor of 6×10^{-4} LCF per rem. Values in parentheses are the calculated number of LCFs within the worker population. A value less than 0.5 is considered to result in no LCFs.

Note: Due to rounding, sums and products may not equal those calculated from table entries.

Sources: DOE 2017b:Exhibit B-1; DOE 2018b:Exhibits B-1, B-2, B-3; DOE 2019g:Exhibit B-3.

3.3.10.2 Nonradiological Health and Safety

Nonradiological exposures at SRS are controlled through programs intended to protect workers from normal industrial hazards. These programs are controlled by the safety and health regulations for DOE contractor workers governed by 10 CFR Part 851, which establishes requirements for worker safety and health programs to ensure that workers have a safe work environment. Included are provisions to protect against occupational injuries and illnesses, accidents, and hazardous chemicals.

DOE monitors worker safety through CAIRS. CAIRS is a computerized database used to collect and analyze DOE reports of injuries, illnesses, and accidents that occur during facility operations. Two metrics generated for the tracking of injury, illness, and accident rate are the DART rate and the TRC rate. The DART rate is an indication of the instances of injuries, illnesses, and accidents that result in, at worst, lost work days or days lost due to transfer or worker job restrictions. The TRC rate is an indication of the total number of work-related injuries or illnesses that resulted in death, days away from work, job transfer or restriction, or recordable case as identified in the Occupational Safety and Health Administration

Form 300. For the years 2015 through 2019 the SRS DART and TRC rates (incidents per 200,000 work hours or the equivalent of 100 full-time workers) averaged 0.26 and 0.48, respectively. For the years 2015 through 2019, the DART and TRC rates for all DOE facilities combined averaged 0.39 and 0.86, respectively (DOE 2019a).

3.3.10.3 Regional Cancer Rates

The National Cancer Institute publishes national, State, and county incidence rates of various types of cancer (NCI 2018). However, the published information does not provide an association of these rates with their causes, e.g., specific facility operations and human lifestyles. **Table 3–49** presents cancer incidence rates for the United States and the 12 South Carolina and Georgia counties within about 50 miles of SRS. Additional information about cancer profiles near SRS is available in State Cancer Profiles, Incidence Rates Tables (NCI 2018). Not all types of cancer are presented in this table; totals for individual cancers will not sum to the All Cancers values.

Table 3–49. Cancer Incidence Rates for the United States, South Carolina, Georgia, and Counties Adjacent to Savannah River Site, 2012–2016

Region	*Cancer Incidence Rates* [a]						
	All Cancers	*Thyroid*	*Breast (female)*	*Lung and Bronchus*	*Leukemia*	*Prostate*	*Colon and Rectum*
United States	448.0	14.5	125.2	59.2	14.1	104.1	38.7
South Carolina	457.3	11.6	129.2	65.5	13.5	115.4	38.6
Aiken County [b]	411	13.5	123.6	55.9	15	92.3	36.9
Allendale County [b]	388.2	(c)	83.7	61.4	(c)	122.6	28
Bamberg County	432.3	20	128.9	54.5	(c)	127.8	37.6
Barnwell County [b]	412.8	14.1	123.4	54.7	(c)	93.2	31.8
Edgefield County	399.5	13.3	109.4	52.4	17.1	101.9	41.5
Georgia	466.4	12.1	125.8	64.1	14.5	122.3	41.8
Burke County	473.6	(c)	130.8	77.4	14.7	102.7	57.6
Columbia County	401.1	10.6	131.7	56.5	10.2	98.3	25.3
Emanuel County	424.3	(c)	94.4	85.5	13.6	92.6	54.3
Jefferson County	447.9	(c)	97.6	56.2	(c)	135	54.1
Jenkins County	434.4	(c)	127.8	71	(c)	111.8	29.7
Richmond County	468.6	11.3	134	70.2	10.8	130.4	38.3
Screven County	478.2	(c)	139.2	79.5	19.6	117.4	45.4

[a] Age-adjusted incidence rates; cases per 100,000 persons per year.
[b] SRS is located in Aiken, Barnwell, and Allendale Counties, South Carolina.
[c] Data have been suppressed by the National Cancer Institute to ensure the confidentiality and stability of rate estimates when the annual average count is three or fewer cases.
Source: NCI 2018.

3.3.11 Emergency Preparedness

Savannah River Nuclear Solutions, LLC (SRNS) is responsible for overall site management and operations, including the site-level emergency management program. Savannah River Remediation, LLC, and Ameresco, Inc., operate hazardous material facilities at SRS and are responsible for implementing the facility-level exercise program at their respective facilities. The DOE Office of Environmental Management is responsible for overall site operation, including oversight of the site-level emergency management program, and provides Federal oversight through the Savannah River Operations Office. The NNSA Savannah River Field Office provides Federal oversight for tritium facilities and operations.

Much of detailed information below is abstracted from a recent audit of the SRS Emergency Plan. The audit was carried out by DOE's Office of Emergency Management Assessments within the independent Office of Enterprise Assessments (DOE 2018i).

DOE Order 151.1D, *Comprehensive Emergency Management System* (DOE 2016i),[7] describes requirements for emergency management that all DOE sites must implement. These requirements include:

- Develop a formal exercise program that includes: (1) a matrix that identifies planned exercises and the elements tested over the next 5 years; (2) rotation among scenarios identified in the Technical Planning Basis; (3) exercise scenarios involving radiological hazardous materials (HAZMAT), if applicable; (4) a method for determining the appropriate number of exercises and rotation of exercise scenarios among HAZMAT facilities over a 5-year period to ensure demonstration of responder proficiency; (5) invitations every 3 years to offsite responding agencies and national assets (e.g., Centers for Disease Control, Department of Agriculture); (6) severe event scenarios every 5 years; (7) test of design control and/or mitigation features in multiple facilities; (8) demonstration of Emergency Response Organization capability; and (9) integration with local, State, and Federal agencies.
- Develop challenging exercises based on scenarios identified in the technical planning basis that involve high-consequence scenarios, include multiple response elements, and result in offsite effects.
- In order to test and demonstrate the site/facility/activity integrated emergency response capability, conduct the annual site-level exercise as a full-scale exercise that involves site-level Emergency Response Organization elements and resources. Invite some offsite response organizations to participate in a full-scale or full-participation exercise every 3 years. This exercise must use a scenario from the spectrum of potential operational emergencies, as identified in DOE's *Emergency Planning Hazard Assessments* (EPHAs) guidance (rotated among facilities and type of incident and/or initiator) and include demonstration of protective actions. An EPHA is required be conducted for each DOE site or activity where identified hazardous materials are present in quantities exceeding the quantity that can be "easily and safely manipulated by one person" and whose potential release would cause the impacts and require response activities characteristic of an Operational Emergency (DOE Order 151.1D, Attachment 4, paragraph 15).

The SRS plan for complying with the above requirements is documented in SCD–7, *Savannah River Site Emergency Plan*, which includes drills and exercises.

A full-scale exercise scenario was carried out in May 2018 and, as noted above, was audited by the Office of Enterprise Assessments. The scenario involved an earthquake with limited damage to SRS H-Area facilities. The hypothesized damage included a partial loss of power to the H-Canyon and HB-line, loss of containment of nitric acid in the Outside Facilities H-Area, a ceiling collapse, and combustion in a Savannah River Tritium Enterprise (SRTE) building. The hypothesized scenario's damage in SRTE "resulted" in a radiological stack release of tritium in the form of tritium oxide gas (referred to as tritium in this report) and loss of power to the H-Area Tank Farm. Multiple injuries "occurred," some of which included chemical or radiological contamination. All H-Canyon, HB-line, Outside Facilities H-Area, SRTE, H-Area Tank Farm, and Effluent Treatment Facility personnel participated in the response, although by exercise design, only H-Canyon/Outside Facilities H-Area and SRTE Emergency Response Organizations were activated. In

[7] SRNS emergency management program is currently making the transition from DOE Order 151.1C (DOE O 151.1C, Comprehensive Emergency Management System, 11/2/05) to DOE Order 151.1D requirements, which is scheduled to be completed during calendar year 2020.

addition, personnel in the nearby site training center participated by taking appropriate protective actions for co-located workers. This was a complicated and challenging exercise.

After observation of the 2018 full-scale exercise and other documentation, the Office of Enterprise Assessments concluded that "overall, the site, area, and facility emergency response organizations followed procedures and adequately performed many response functions, including issuing appropriate protective actions to co-located workers and notifications to executives and workers. Nevertheless, integrated emergency response organization actions to communicate, assess, and respond to the potential exposure to fire department and facility responders from the postulated tritium release were not fully adequate." The Office of Enterprise Assessments' observations resulted in a number of recommendations that will result in improvements to the SRS Emergency Plan.

3.3.12 Traffic

This section describes the traffic and transportation conditions in the SRS environment.

The ROI for the transportation infrastructure includes two U.S. Interstate Highways (Interstates I-20 and I-520), two U.S. Highways (U.S. Highways 278 and 301), four South Carolina State Highways (State Highways 19, 64, 125, 781), and the SRS onsite road network.

3.3.12.1 Transportation Infrastructure

3.3.12.1.1 Transportation Planning Agencies

In addition to State transportation departments, three major planning agencies collect and maintain data on the efficiency of the transportation system in the region: the Augusta Planning Commission in Georgia, the North Augusta Planning Commission, and the Lower Savannah Council of Governments Planning Department in South Carolina.

Regional Infrastructure

Vehicular access to SRS is provided from South Carolina State Highways 19, 64, 125, 781, and U.S. Highway 278. State Highway 19 runs north from the site through New Ellenton toward Aiken; State Highway 64 runs in an easterly direction from the site toward Barnwell; State Highway 125 runs through the site itself in a southeasterly direction between North Augusta and Allendale, passing through Beech Island and Jackson. U.S. Highway 278 also runs through the site, in a southeasterly direction between North Augusta and Barnwell. State Highway 781 connects U.S. Highway 278 with Williston to the northeast of the site. The northern perimeter of the site is about 10 miles from downtown Aiken. Commuter traffic between SRS and Georgia crosses the Savannah River primarily on I–20 and I–520 and primary arteries, State Routes 28 and 1, and Business Route 25 to the north of SRS. Another primary artery, U.S. Highway 301, crosses the Savannah River to the south of SRS.

A major expansion of the I-20 bridge over the Savannah River and Augusta Canal between Augusta and North Augusta began in December 2019 and is expected to be completed in early 2022 (GDOT 2020). The bridges are currently parallel two-lane structures that will be expanded to a single large six-lane structure (three lanes in each direction).

Rail service in the region is provided by the Norfolk Southern Corporation and CSX Transportation; rail access to SRS is provided by the Robbins Station on the CSX Transportation line (DOE 1999b:3-144). Barge transportation is available using the Savannah River. Currently, the Savannah River is used primarily for recreation.

SRS Onsite Infrastructure

SRS is managed as a controlled area with limited public access. Within SRS, there are about 130 miles of primary and 1,230 miles of secondary roads (DOE 2005a, 2005e:3.1.4-3, 2015a). The primary SRS roadways are in good condition, and are typically wide, firm shoulder border roads that are either straight or have wide gradual turns. Intersections are well marked for both traffic and safety identification.

In addition, 32 miles of railroad tracks are present within SRS, dedicated primarily for transporting large volumes or oversized loads of materials or supplies (DOE 2005e:3.1.4-3, 2015a). The railroad tracks are well maintained, and the rails and cross lines are in good condition. The Savanah River rail classification yard is east of P-Area. This facility sorts and redirects railroad cars. The railroads support delivery of foreign and domestic research reactor spent nuclear fuel shipments, delivery of construction materials for new projects, and movement of nuclear materials and equipment on site (DOE 2005a).

Travel between facilities in K Area and facilities in E-, F-, H-, and S-Areas can be accomplished by both surface roads and railroads.

SRS has no commercial docking facilities but has a boat ramp in the former T-Area that has accepted large transport barge shipments (DOE 1999b:3-144).

DOE operates a heliport on SRS in B-Area, about 3 miles from the facility formerly known as the Mixed Oxide Fuel Fabrication Facility, where two lightweight, multipurpose helicopters are based to provide support to the security services at SRS. USFS conducts regular helicopter operations across SRS for purposes of wildfire detection/response, prescribed fire operations, and wildlife/forest health surveillance. USFS operations originate from the heliport adjacent to the USFS facility on SRS. In addition, Dominion Energy (formerly known as South Carolina Electric and Gas) conducts limited helicopter operations across SRS for purposes of right-of-way inspection and clearance. Operations originate off site, with site access only accomplished via electrical line pathways (NNSA 2020).

3.3.12.2 Existing Traffic Conditions

Refer to Section 3.1.12.1 for an overview of road performance measurements using LOS ratings. In the Lower Savannah Council of Governments planning area, the roads with the highest levels of traffic operate at LOS A (LSCOG 2006). This area includes the counties immediately surrounding SRS. In the North Augusta Planning Area, roads operate at LOS C or better (NA 2005). This area includes the northwest part of Aiken County and Edgefield County. In the Augusta-Richmond County Planning Area, several streets and highway system segments operate below LOS C. These roads include segments of Interstate 520 (I–520) (Bobby Jones Expressway) and I–20 (Carl Sanders Highway), and segments of principal arterial roads, including Deans Bridge Road, Doug Barnard Parkway, Mike Padgett Highway, Peach Orchard Road, Washington Road, and Wrightsboro Road.

Most of the congested segments are located in the urbanized part of the county (ARC 2008). Roads in Columbia County operating below LOS C also include segments of I–520, I–20, Belair Road, Lewiston Road, Horizon South Parkway, Old Evans Road, and Washington Road (TEI 2004). Most SRS employees live in the Augusta area and the city of Aiken and would use roads in these planning areas to commute to SRS (DOC 2008).

Table 3–50 lists the annual average daily traffic statistics for several routes used to access the site. Traffic levels have shifted over time, depending on the route. State routes accessing the site from the south and from the northeast have increased traffic by more than 20 percent since 2009. Although LOS determinations have not been reported for these access routes, in terms of the impacts on LOS of higher baseline traffic, the increases are not likely sufficient to cause a decline in the LOS of those routes, because sufficient capacity likely still exists (LSCOG 2017).

Table 3–50. 2009–2018 Annual Average Daily Traffic for Principal Savannah River Site Access Routes

Access Route	Annual Average Daily Traffic 2009	2012	2018	2009–2018 Change
SR-125: Barnwell County Line to SRS Gate	2,700	2,700	2,300	-14.8%
SR-125: Barnwell to Allendale County Line	1,800	1,900	2,200	22.2%
SR-125: Jackson, SC, to SRS Gate	10,900	12,800	11,700	7.3%
Woodland Drive: Old Whiskey Road to SR-278	1,950	1,900	2,300	17.9%
SR-278: Whiskey Road to Barnwell County Line	3,700	4,100	4,600	24.3%
SR-64: Snelling, SC to SRS Gate	1,150	1,550	1,000	-13.0%

SC = South Carolina; SR = State Route; SRS = Savannah River Site
Source: PNNL 2018; SCDOT 2019.

3.3.13 Socioeconomics

This section describes current socioeconomic conditions and local community services within the four-county ROI (or region) associated with SRS where the activities described in Chapter 2 would most likely occur. These counties include Columbia and Richmond Counties, Georgia, and Aiken and Barnwell Counties, South Carolina. Figures 2–11 and 3–21 show the counties in the ROI as well as towns and major transportation routes. SRS borders the Savannah River and encompasses about 310 square miles in the South Carolina counties of Aiken and Barnwell. SRS is about 12 miles south of Aiken, South Carolina, and 15 miles southeast of Augusta, Georgia (Figure 2–11). The Savannah River flows along the site's southwestern border.

3.3.13.1 Population and Housing

3.3.13.1.1 Population

In 2018, the population in the ROI was estimated to be 546,358 (Census 2018). From 2010 to 2018, the total population in the ROI increased at an average annual rate of about 1 percent, which was slightly lower than the growth rate in both Georgia and South Carolina. Over the same time period, the total population of Georgia increased at an average annual rate of about 1.1 percent, to 10,519,475 people. South Carolina experienced an increase of about 1.2 percent annually to 5,084,127 people in 2018. The populations of the ROI, Georgia, and South Carolina are shown in **Table 3–51**. Population projections are also provided out to 2050, based on an extrapolation of the state projected growth rates between 2018 and 2025.

Table 3–51. Population of the Savannah River Site Region of Influence: 2000–2018

County	Year 2000	2010	2018	Population Change 2010-2018 (percent)	Population Projection 2050
Aiken, South Carolina	142,552	160,099	169,401	5.8	193,188
Barnwell, South Carolina	22,478	22,621	21,112	-6.7	13,972
Columbia, Georgia	89,288	124,053	154,291	24.4	188,389
Richmond, Georgia	199,775	200,549	201,554	0.5	198,965
ROI	**454,093**	**507,322**	**546,358**	**7.7**	**594,514**
South Carolina	4,012,012	4,625,364	5,084,127	9.9	7,697,956
Georgia	9,186,453	9,687,653	10,519,475	8.6	14,186,991

ROI = region of influence.
Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: Census 2020a, 2020b, 2020c; Georgia Governor's Office 2020; South Carolina Revenue and Fiscal Affairs Office 2020.

3.3.13.1.2 Housing

The most recent housing stock statistics from the Census Bureau report (Census 2017c) estimated the 2017 housing occupancy by type (owned or rented). Of interest for impact analysis is the capacity of the ROI to absorb any new housing demand projected by the project. As of 2017, the ROI had 228,447 housing units of which 84.2 percent were occupied and 15.8 percent were vacant. In Georgia, an estimated 12.9 percent of the stock is vacant, while 16.1 percent of the stock in South Carolina is vacant. Vacant rental stock makes up almost 3 percent of the stock in both states. The distribution of housing units in the SRS ROI, Georgia, and South Carolina in 2017 is presented in **Table 3–52**.

Table 3–52. Region of Influence Housing Characteristics (2017 data)

County	*2017 Housing Units*	*Occupied Housing Units*	*Vacant Housing Units*	*Owner-Occupied Units*	*Renter-Occupied Units*	*Vacant Homeowner Housing Units (percent)*	*Vacant Rental Housing Units (percent)*
Aiken	75,249	65,703	9,546	47,484	18,219	1,430 (1.9)	3,537 (4.7)
Barnwell	10,525	8,426	2,099	5,826	2,600	200 (1.9)	905 (8.6)
Columbia	57,472	43,990	13,482	34,706	9,284	3,620 (6.4)	9,770 (17.0)
Richmond	88,641	71,411	17,230	37,704	33,707	2,660 (3.0)	11,965 (13.5)
ROI	**231,887**	**189,530**	**42,357**	**125,720**	**63,810**	**7,910 (3.4)**	**26,177 (11.3)**
Georgia	4,282,254	3,745,074	537,180	2,354,992	1,390,152	81,363 (1.9)	286,911 (6.7)
South Carolina	2,284,820	1,905,100	379,720	1,309,670	595,430	41,127 (1.8)	205,634 (9.0)

Notes:
Homeowner and rental vacancy units do not add to total vacant housing units because the vacancy rates only include vacant housing units (i.e., proportion of total inventory) that are on the market for rent or for sale only.
Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: Census 2017c.

3.3.13.2 Employment and Income

From 2010 to 2018, the ROI experienced an average annual growth rate in the civilian labor force of just over 0.7 percent (from 231,266 to 243,863), while the State of Georgia's and South Carolina's labor force grew at average annual rates of about 1.1 percent and 1 percent, respectively. Employment in the ROI grew at an average annual rate of 1.4 percent, compared to the State of Georgia and South Carolina, each of which had an average annual growth rate of 2.1 percent. The ROI experienced a higher unemployment rate (4.1 percent) in 2018, compared to the unemployment rates in Georgia (3.9 percent) and South Carolina (3.5 percent); within the ROI, the unemployment rate ranged from 3.3 percent in Aiken County (South Carolina) to 5.1 percent in Richmond County (Georgia). **Table 3–53** presents employment statistics in the ROI and the states of Georgia and South Carolina for 2010 and 2018. In 2018, there were 232,921 people employed in the SRS ROI.

Table 3–53. Employment Statistics in the Savannah River Site Region of Influence, Georgia, and South Carolina in 2010 and 2018

Area	*Civilian Labor Force*		*Employment*		*Unemployment*		*Unemployment Rate*	
	2010	*2018*	*2010*	*2018*	*2010*	*2018*	*2010*	*2018*
Aiken	72,368	73,944	65,639	71,470	6,729	2,474	9.3	3.3
Barnwell	9,489	8,343	7,913	7,944	1,576	399	16.6	4.8
Columbia	61,522	74,950	57,027	71,341	4,495	2,609	7.3	3.5
Richmond	87,887	86,626	78,209	82,166	9,678	4,460	11.0	5.1
ROI	**231,266**	**243,863**	**208,788**	**232,921**	**22,478**	**9,942**	9.7	4.1
Georgia	4,696,676	5,080,472	4,202,052	4,880,038	494,624	200,434	10.5	3.9

Area	Civilian Labor Force		Employment		Unemployment		Unemployment Rate	
	2010	2018	2010	2018	2010	2018	2010	2018
South Carolina	2,155,668	2,339,939	1,915,045	2,259,057	240,623	80,882	11.2	3.5

ROI = region of influence
Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: BLS 2020a, 2020b, 2020c.

SRS Employment

The DOE Environmental Management program and the NNSA offices direct operations at SRS. They are supported in a variety of ways by the USDA, USFS, two state universities (University of Georgia and University of South Carolina), and several contractors (e.g., SRNS, Savannah River Remediation, LLC, and Parsons Government Services, Inc.) (SRNS 2019a). Nearly 11,100 people were employed at SRS as of September 30, 2019, including employees of SRNS, SRR, DOE, NNSA, Centerra-SRS, MOX, SREL, USFS, subcontractors, limited service employees, and others. Of this total, 6,305 persons were directly employed at SRS; 4,438 resided in South Carolina and 1,831 resided in Georgia (36 in other locations). Much of the services and material consumed by SRS activities are provided by local businesses. A comparison of 2018 data for direct onsite employment levels and ROI employment levels show that direct SRS onsite residence employment accounted for about 4 percent of employment in the ROI. **Table 3–54** provides residence information for the four-county ROI. As shown in this table, about 87.4 percent of SRS employees reside in this ROI.

Table 3–54. Distribution of Employees by Place of Residence in the Savannah River Site Region of Influence in 2019

County	Number of Employees	% of Total Site Employment
Aiken	3393	53.8
Barnwell	402	6.4
Columbia	977	15.5
Richmond	738	11.7
ROI	**5,510**	**87.4**

Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: SRNS 2020.

Employment in the K Area Complex

Activities in K Area include packaging, storage, and monitoring of special nuclear materials and a low level of activities to process surplus plutonium for disposal as waste. Staffing at the K Area Complex is currently about 300 people.

Local Income

SRS employs highly skilled technical personnel with an annual average salary of $85,000 in 2010 (Noah et al. 2011). This is significantly higher than the average per capita income in the ROI of $40,886 in 2018 (BEA 2019a). From 2010 to 2018, the average real per capita income of the ROI increased by about 24.9 percent, to $40,886. Georgia and South Carolina experienced a higher increase than in the ROI, with Georgia increasing about 33.6 percent to $46,482 and South Carolina increasing 34.6 percent to $43,702. **Table 3–55** presents the per capita incomes of the ROI, Georgia, and South Carolina.

Table 3–55. Per Capita Personal Income

County	Per Capita Income	
	2010	2018
Aiken	33,489	42,511
Barnwell	26,811	33,363
Columbia	40,094	49,473
Richmond	30,515	38,196
ROI (Average)	**32,727**	**40,886**
Georgia	34,524	46,482
South Carolina	32,454	43,702

ROI -= region of influence.
Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: BEA 2019a, 2019b.

3.3.13.3 Community Services

Key community services in the ROI include education, law enforcement, fire protection, and medical services. Seven school districts provide public education services and facilities in the SRS ROI.

Aiken County Public Schools in Aiken, South Carolina has 24,135 students in 43 public schools, including 21 elementary schools, 11 middle schools, 8 high schools, and 2 charter schools. Barnwell County, South Carolina has 3 school districts that operate a total of 10 school facilities located in Barnwell, Blackville, and Williston. These include four elementary schools, three middle schools (one is combined with an elementary school), three high schools and a career center. There are 3,640 students in the public school system and over 250 students attending 4 private schools (NCES 2020).

The Columbia County School System in Georgia includes 17 elementary schools, 8 middle schools, and 6 high schools. Total enrollment in the 2018-2019 school year was 24, 649 students, about a 15 percent increase over the past 10 years based on comparative data from the Georgia Department of Education (NCES 2020).

Richmond County Public School System operates 60 schools. Of these, 33 are elementary, 11 are middle (including 2 charter schools), 8 are high schools, 4 are magnet schools, and 3 are alternative or specialty schools. There are 14 private grade schools in Augusta, serving 3,038 students. Combined, these schools serve more than 32,000 students; it is the tenth largest school district in Georgia. With over 4,000 employees, Richmond County public schools are the third largest employer in Augusta-Richmond County (NCES 2020).

The numbers of full-time law enforcement employees and firefighters by county are shown in **Table 3–56**.

There are 20 police and sheriff departments within the ROI, employing about 654 law enforcement personnel (406 officers and 248 civilians) (FBI 2020a, 2020b). There are 74 fire stations within 31 cities/communities within the ROI, including 683 career (paid) firefighters and a total of 1,493 career and volunteer firefighters (Fire Department 2020).

There are 10 hospitals in the ROI, all of which provide short-term acute medical care and emergency services. Nine are in Richmond County, Georgia (all in the Augusta area) and one hospital is in Aiken County, South Carolina. Aiken Regional Medical Center is a 266-bed acute care facility offering a comprehensive range of specialties and services. University Hospital in Augusta, Georgia is a 574-bed private hospital and the largest hospital in the ROI (AHD 2020). There are no hospitals in Barnwell County, South Carolina (Barnwell County Hospital, a 53-bed facility closed in 2016) or Columbia County, Georgia. Residents of Columbia County rely on the closest hospitals in Augusta, Georgia.

Table 3–56. Police and Firefighter Full-Time Employees within Region of Influence

County	*Law Enforcement*	*Sworn Officers*	*Civilians*	*City/Community Fire Departments*	*Firefighters*
Aiken, SC	246 (county/sheriff's department) 114 (city of Aiken)	136 86 (city of Aiken)	110 28 (city of Aiken)	17/25 stations	145 (FTEs in Aiken and North Augusta); most of others are volunteer with some part-time too
Barnwell, SC	64	28	36	5/8 stations	0 (all staffed by volunteers)
Columbia, GA	344	242	102	5/19 stations	176
Richmond, GA	No data available specific to county or largest city of Augusta, GA. Only data indicate that the Richmond County Sheriff's Department employs more than 250 professionals (presumably full-time and part-time employees).			4/22 stations	362
ROI	**654 (excluding Richmond County)**	**406 (excluding Richmond County)**	**248 (excluding Richmond County)**	**31/74 stations**	**683**

FTE = full-time equivalent.
Source: FBI 2020a, 2020b; Richmond County Sheriff's Department 2020; Fire Department 2020.

3.3.13.4 Public Finance

SRS is a major employer and economic contributor in the ROI. The operations at SRS create jobs, generate income, and contribute to the tax revenues across both South Carolina and Georgia.

A study was conducted to determine the economic impact the SRS has on a multi-county region in South Carolina and Georgia based on FY 2010 (Noah et al. 2011). The study examined five counties surrounding SRS – the four-county ROI and Allendale County, South Carolina – but the results are applicable in that they support the significant contribution SRS makes to the local and regional economy. Report highlights are provided below:

- During FY 2010, SRS spent $1.191 billion within the region (through payroll and procurement), thus greatly and positively stimulating local economies. These expenditures generated an additional $1.195 billion in output. As a result of this spending, the local labor force market was enriched by a total of 23,262 preserved or newly created jobs. These jobs represent 12.09 percent of the local labor force, which in essence means that for every one job created by SRS an additional 2.5 jobs are created in the local economy.
- Industry diversification is commonly viewed as a goal of economic development. While SRS may seem homogenous from an outside view, from an economic perspective it is actually diverse, with its major economic impact falling in the manufacturing, waste, and construction categories.
- The average salary of local workers at SRS is about $85,031 as compared to the average salary of $35,427 in the five-county area.
- Overall, for the five-county area, the total SRS economic effect on household incomes is $853 million. In FY 2010, DOE, their contractors, and other SRS organizations spent a total of $2.4 billion on wages, fringes, and other direct expenditures. Thirty-nine percent of this total was spent on wages, 10 percent on fringes, and the reminder (51 percent) on other direct expenditures
- Locally, DOE and SRS Site contractors spent $1.2 billion (or 50.6 percent of the total expenditures of the site) in the five-county area on wages, fringes, and other direct expenditures.
- The increase in sales and income results in increases from sales tax, personal tax, property tax, tax contributions (and other types of tax revenue), and social insurance. **Table 3–57** illustrates the tax impacts of SRS operations on different State and local taxes.

Table 3–57. State and Local Tax Impacts of Savannah River Site Operations (2010)

Taxes	*Amount*	*Percentage*
Sales Tax	$42,427,076	33
Property Tax	$34,880,671	28
Personal Income Tax	$18,796,622	15
Corporate Profits and Dividends	$12,371,308	10
Indirect Business Tax	$9,062,212	7
Other Personal Tax	$8,563,168	7
Total State and Local Tax Impact	$126,101,057	–

Source: Noah et al. 2011.

SRS also contributes to the local economy by a mechanism known as "Payment in Lieu of Taxes". Payments in Lieu of Taxes is Federal compensation to local governments that help offset losses in property taxes due to non-taxable Federal lands within their boundaries. In SRS's case this is land that used to be owned by Aiken, Barnwell, and Allendale Counties but has been taken off their tax rolls because it is now owned by the Federal government. Each year the Federal government provides $6.2 million for the counties to use as they see fit (Aiken County designates 60 percent of its share to public education). In 2009, the Federal government allocated $6.2 million to three of the five area counties: Barnwell – $4,506,166, Aiken – $1,620,000, Allendale – $89,508.

3.3.14 Environmental Justice

The ROI for environmental justice is the area within a 50-mile radius of the proposed location of the VTR fuel production facilities within the K-Area at SRS. The 50-mile radius was selected because it is consistent with the ROI for evaluating human health impacts from radiological emissions. The potentially affected area includes parts of 26 counties throughout Georgia and South Carolina.

Discussion of the regulatory environment; definitions of minority, low-income, and minority and low-income populations; and a description of meaningfully greater populations for environmental justice is provided in Section 3.1.14 of this EIS. In accordance with those earlier definitions, low-income populations for SRS are present when either (a) the total number of low-income individuals of the affected area exceeds 50 percent of the overall population in the same area, or (b) the total number of low-income individuals within the affected area is meaningfully greater (e.g., 120 percent greater) than the low-income population percentage in an appropriate comparison unit of geographic analysis. The definition of minority populations is distinguished for SRS due to the high presence of minority populations in the region. The average minority population percentage of South Carolina and Georgia is about 43 percent and the average minority population percentage of the 26 counties within 50 miles of the K-Area at SRS is about 42 percent. Comparatively, a meaningfully greater minority population percentage relative to the general population of the State and the surrounding counties would exceed the 50 percent threshold defined by the Council on Environmental Quality. Therefore, the lower threshold of 50 percent is used to identify areas with meaningfully greater minority populations surrounding SRS.

Minority and Low-Income Populations

Selection of units of analysis focus on geographic units (i.e., block groups) that represent, as closely as possible, the potentially affected areas. Refer to Section 3.1.14 for further discussion.

In order to evaluate the potential impacts on populations in closer proximity to the proposed project area at SRS, radial distances of 5, 10, and 20 miles are analyzed. **Table 3–58** shows the composition of the ROI surrounding the proposed SRS facilities at each of these distances. No populations reside within the 5-mile radius of the proposed project location.

Table 3–58. Total Minority and Low-Income Population within 50 Miles of K Area

Population Group	Within 10 Miles		Within 20 Miles		Within 50 Miles	
	Population	Percent of Total	Population	Percent of Total	Population	Percent of Total
Total Population	1,235	100.0	56,883	100.0	756,593	100.0
Nonminority	558	45.2	36,132	63.5	412,201	54.5
Total Minority	677	54.8	20,751	36.5	344,392	45.5
White - Hispanic/Latino	13	1.1	1,504	2.6	23,684	3.1
Black/African American [a]	645	52.2	17,048	30.0	280,151	37.0
American Indian or Alaska Native [b]	5	0.4	240	0.4	2,240	0.3
Other Minority [a, b]	14	1.1	1,959	3.4	38,317	5.1
Low Income	383	31.0	10,545	18.5	140,240	18.5

Source: Census 2017a, 2017b.

[a] Includes persons who also indicated Hispanic or Latino origin.

[b] Other Minority includes all combined individuals of Asian, Native Hawaiian and Other Pacific Islander, Some Other Race, or Two or More Races.

Minority populations were evaluated using the absolute 50 percent criterion for potentially affected block groups within 50 miles of the K-Area at SRS. If a block group's percentage of minority individuals met the 50 percent criterion, then the area was identified as having a minority population. Of the 550 block groups within the ROI, 230 block groups have individual racial group minority populations or aggregate minority populations that meet the environmental justice criterion.

The overall composition of the projected populations is predominantly Black or African American within the 10-mile radial distance and predominantly non-minority within the 50-mile radial distance. The concentration of minority populations is greater within the 10-mile radial distance. The Black or African American population is the largest minority group within every radial distance, constituting about 37 percent of the total population within 50 miles. **Figure 3–22** displays the block groups identified as meeting the criteria for environmental justice minority populations surrounding SRS, as well as population density of minority populations within each block group.

Low-income populations were evaluated using the absolute 50 percent and the relative 120 percent or greater criteria for potentially affected block groups within the ROI. If a block group's percentage of low-income individuals met the 50 percent criterion or was more than 120 percent of the total low-income population within the 26 counties encompassing the 50-mile radius of the K-Area at SRS, then the area was identified as having a low-income population. Of the total population residing in the 26-county SRS comparison population, about 18.0 percent are identified as living below the poverty line; therefore, the meaningfully greater criterion for low-income populations is 21.6 percent. Of the 550 block groups within the ROI, 30 block groups have a low-income population that exceeds the 50 percent criterion, and a total of 230 block groups meet the 120 percent criterion for low-income populations. **Figure 3–23** displays the block groups identified as meeting the criteria for environmental justice low-income populations surrounding SRS, as well as population density of low-income populations within each block group.

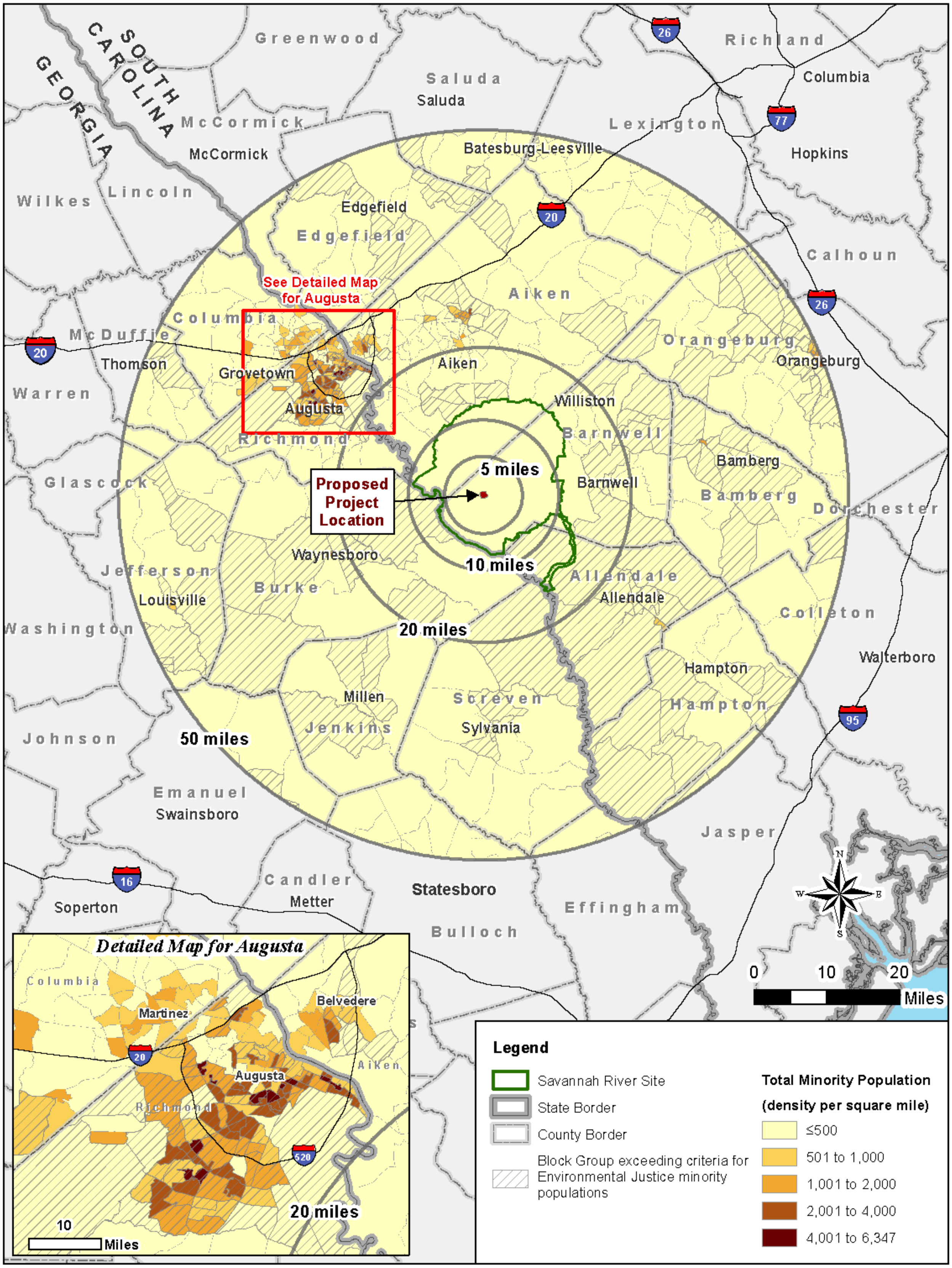

Figure 3–22. Locations of Block Groups Meeting the Criteria for Environmental Justice Minority Populations

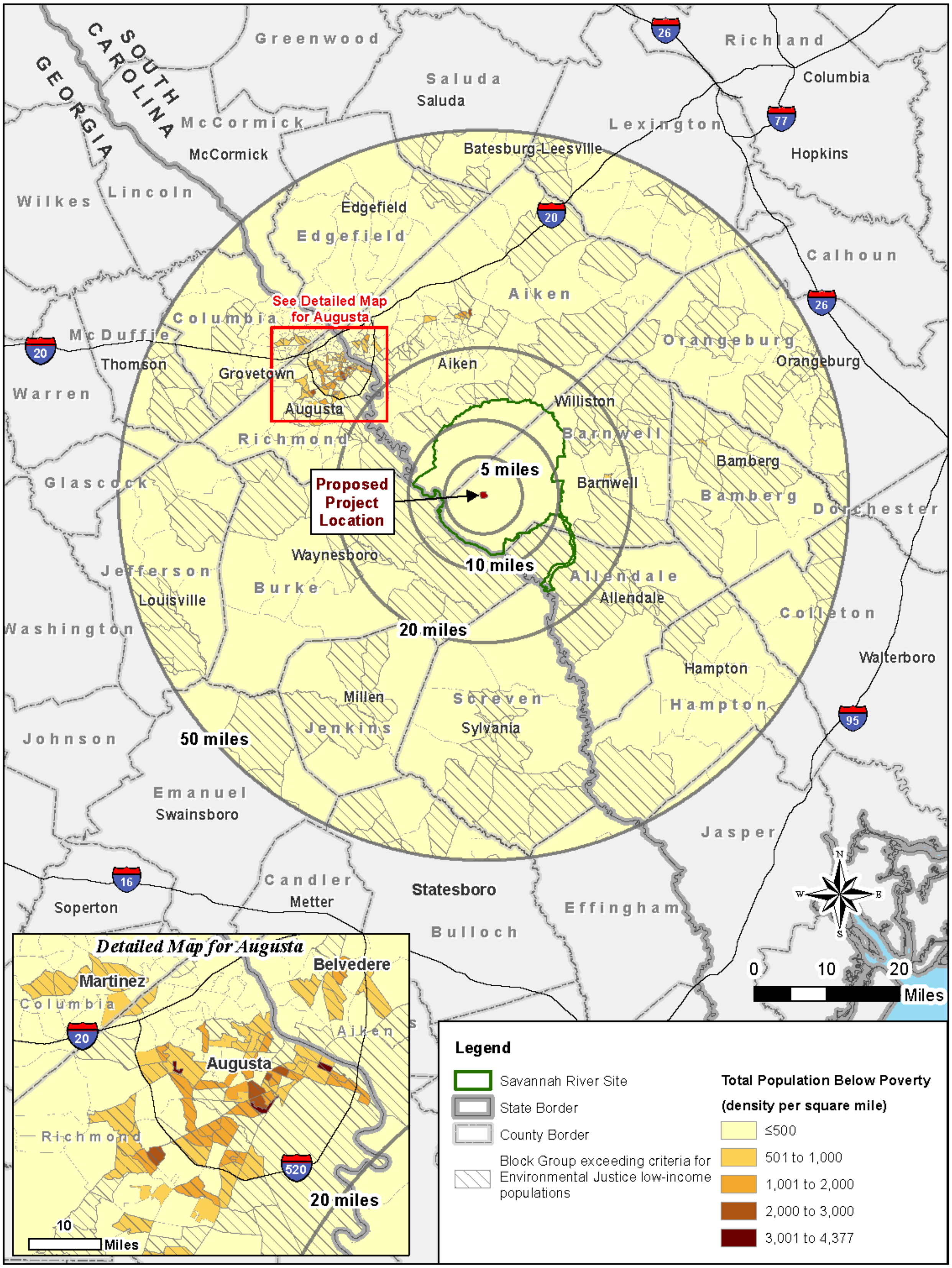

Figure 3–23. Locations of Block Groups Tracts Meeting the Criteria for Environmental Justice Low-Income Populations

Chapter 4
Environmental Consequences

4.0 ENVIRONMENTAL CONSEQUENCES

The potential environmental consequences for each of 15 resource areas are discussed in this chapter in Sections 4.1 through 4.15. The resource areas evaluated are land use and aesthetics, geology and soils, water resources (surface water and groundwater), air quality, ecological resources, cultural and paleontological resources, infrastructure, noise, waste management, human health (normal operations), human health (facility accidents), human health (transportation impacts), traffic, socioeconomics, and environmental justice. Each of the 15 resource area sections is organized to evaluate the environmental consequences of construction and facility modifications and operations of the Idaho National Laboratory (INL) and Oak Ridge National Laboratory (ORNL) Versatile Test Reactor (VTR) Alternatives. The INL and ORNL VTR Alternatives include the VTR, post-irradiation examination facilities, other support facilities, and spent nuclear fuel (SNF) management facilities. The INL and ORNL VTR Alternatives are described in more detail in Chapter 2, Sections 2.4 and 2.5, respectively. In addition, the environmental consequences for construction or facility modifications and operations of reactor fuel production options at the INL Site and the Savannah River Site (SRS) are evaluated. If the SRS Fuel Fabrication option were selected, there would be a fuel fabrication development/demonstration capability established in the Fuel Manufacturing Facility (FMF) at INL. The impacts of a 3-to-4-year INL fuel development effort would approximate those of a single year of fuel fabrication under the INL Fuel Fabrication option.

Reactor fuel production options include feedstock preparation and fuel fabrication. Reactor fuel production fabrication components could be located at the INL Site, SRS, or both. INL and SRS reactor fuel fabrication are described in more detail in Chapter 2, Sections 2.6.2 and 2.6.3, respectively. The environmental consequences of the Combined INL VTR Alternative and INL Reactor Fuel Production Options are also described. Additionally, each of the resource sections includes a summary table of the potential environmental consequences that gives an “at-a-glance” compilation of the information discussed in the sections. The information in these summary tables are the basis for the potential environmental consequences information compiled for all of the resource areas that are presented in Chapter 2. A No Action Alternative; deactivation, decommissioning, and demolition; and mitigation measures are evaluated in separate sections at the end of the chapter in Sections 4.16, 4.17, and 4.18, respectively.

4.1 Land Use and Aesthetics

Land Use

The INL Site and ORNL regions of influence (ROIs) for land use evaluation includes the land contained within both developed and undeveloped areas inside the boundaries of each location and lands immediately adjacent to their boundaries. For SRS, the ROI would be the K Area Complex (location of the K-Reactor Building) and the areas surrounding it. Facility construction, modifications, and land disturbance would occur within and adjacent to developed areas of the INL Site and largely undeveloped areas of the ORNL; only facility modifications would occur at SRS. Potential impacts of the VTR alternatives and reactor fuel production options to land use would occur if the land uses resulting from the Proposed Action were incompatible with surrounding land uses, if the Proposed Action results in a change to current land-use designation, or if a significant percentage of facility lands were disturbed for development.

Aesthetics

This section discusses the potential impacts on aesthetics (visual and scenic) of the VTR alternatives and reactor fuel production options. Aesthetics considers natural and manmade features that give a particular landscape its character and aesthetic quality. The Proposed Action would cause visual and scenic impacts if actions introduced deterioration(s) to the visual landscape(s).

The INL Site ROI is any area with a line of sight to the INL Site facilities, including the Eastern Snake River Plain, the Bitterroot, Lemhi, and Lost River mountain ranges, the Big Southern Butte, East Butte, Middle Butte, Circular Butte, Antelope Butte, Hell's Half Acre National Natural Landmark, and Hell's Half Acre Wilderness Study Area. Other areas potentially within the ROI for aesthetics would include Class I areas evaluated for visibility impacts from air emissions (i.e., Craters of the Moon National Monument).

The ORNL ROI is any area with a line of sight to the ORNL facilities, including, the East Fork Valley, Bear Creek Valley, Bethel Valley, Melton Valley, the Clinch River/Melton Hill Lake, and the bluffs on the opposite side of the Clinch River. Because of the topography of the Oak Ridge Reservation (ORR) where ORNL is located and, specifically, of the land surrounding the potential VTR site, the areas potentially affected by the ORNL VTR Alternative are limited. Other areas potentially within the ROI for aesthetics would include Class I areas evaluated for visibility impacts from air emissions (i.e., Joyce Kilmer-Slickrock Wilderness).

The SRS ROI includes the SRS (primarily the K Area Complex), and areas of the three-county area that would have line of sight visibility to the K Area Complex.

Table 4–1 presents a summary of the potential environmental consequences on land use and aesthetics for the INL and ORNL VTR Alternatives and the INL and SRS Reactor Fuel Production Options.

Table 4–1. Summary of Environmental Consequences on Land Use and Aesthetics

	VTR Alternatives	
Resource Area	***INL VTR***	***ORNL VTR***
Land Use	*Construction*: There would be minor impacts on land use from the disturbance of about 100 acres during construction activities. The VTR complex would occupy 25 acres after construction. *Operations*: There would be no impact on land use since no land would be disturbed.	*Construction*: There would be minor impacts on land use from the disturbance of about 150 acres during construction activities. The VTR complex would occupy 50 acres after construction. *Operations*: There would be no impact on land use because no land would be disturbed.
Aesthetics	*Construction*: There would be small, temporary visual impacts during construction. *Operations*: There would be minimal impacts on aesthetics as newly constructed facilities would not dominate the local landscape and would be similar in design to existing facilities in a developed area with an industrial appearance, with no change to VRM classification. Impacts on Craters of the Moon National Monument (a designated International Dark Sky Park) would not be expected by additional exterior lighting required for the VTR.	*Construction*: There would be small, temporary visual impacts during construction. *Operations*: There would be minimal impacts on aesthetics as newly constructed facilities would not dominate the local landscape and would be similar in design to existing facilities.
	Reactor Fuel Production Options	
	INL Reactor Fuel Production	***SRS Reactor Fuel Production***
Land Use	**Feedstock Preparation**	
	Construction: No impacts on land use as modifications/construction would occur in existing facilities (FCF) and not require construction of new facilities or the alteration of existing land uses at the MFC.	*Construction*: No impacts on land use as modifications/construction would occur in existing facilities (in the K Area Complex) and not require construction of new facilities or the alteration of existing land uses in K Area. Up to 3 acres of previously disturbed land would be used.

	Operations: No impacts on land use as feedstock preparation activities would occur in existing facilities and not require the alteration of existing land uses at the MFC.	*Operations*: No impacts on land use as feedstock preparation activities would occur in existing facilities and not require the alteration of existing land uses in K Area.
	Fuel Fabrication	
	Construction: No impacts on land use as modifications/construction would occur in existing facilities (FMF and ZPPR) and not require construction of new facilities or the alteration of existing land uses at the MFC. *Operations*: No impacts on land use as fuel fabrication activities would occur in existing facilities and not require the alteration of existing land uses at the MFC.	*Construction*: No impacts on land use as modifications/construction would occur in existing facilities (in the K Area Complex) and not require construction of new facilities or the alteration of existing land uses in K Area. Up to 3 acres of land disturbance, a small amount of excavation, and small quantities of geological and soil materials may be associated with constructing ancillary facilities. *Operations*: No impacts on land use as fuel fabrication activities would occur in existing facilities and not require the alteration of existing land uses in K Area.
Aesthetics	**Feedstock Preparation**	
	Construction: No impacts on aesthetics as modifications/ construction would occur in existing facilities (i.e., FCF). *Operations*: No impact on aesthetics as operations would occur in existing facilities.	*Construction*: No impacts on aesthetics as modifications/construction would occur in existing facilities (i.e., the K Area Complex). *Operations*: No impact on aesthetics as operations would occur in existing facilities.
	Fuel Fabrication	
	Construction: No impacts on aesthetics as modifications/ construction would occur in existing facilities (i.e., FMF and ZPPR). *Operations*: No impact on aesthetics as operations would occur in existing facilities.	*Construction*: No impacts on aesthetics as modifications/ construction would occur in existing facilities (i.e., the K Area Complex). *Operations*: No impact on aesthetics as operations would occur in existing facilities.
	Combined INL VTR Alternative and INL Reactor Fuel Production Options	
Land Use	*Construction*: Impacts on land use would be the same as described for VTR construction, as reactor fuel options would occur in already established facilities and not require any changes to existing land use designations. *Operations*: Impacts on land use would be the same as described for VTR operations, as reactor fuel options would occur in already established facilities and not require any changes to existing land use designations.	
Aesthetics	*Construction*: Impacts on aesthetics would be the same as described for VTR construction, as reactor fuel options would occur in already established facilities and not require any changes to existing land use designations. *Operations*: Impacts on aesthetics would be the same as described for VTR operations, as reactor fuel options would occur in already established facilities and not require any changes to existing land use designations.	

FCF = Fuel Conditioning Facility; FMF = Fuel Manufacturing Facility; MFC = Materials and Fuels Complex; VRM = Visual Resource Management; VTR = Versatile Test Reactor; ZPPR = Zero Power Physics Reactor.

4.1.1 INL VTR Alternative

4.1.1.1 Construction/Facility Modification

Land Use. Construction would occur in an approximate 100-acre area adjacent to the southeastern portion of the existing Materials and Fuels Complex (MFC) area. Construction would result in land disturbance and development for permanent buildings, temporary structures, utilities, extension of the existing security perimeter fence, temporary roadways, temporary electrical lines, new electrical lines and other infrastructure needs, and other construction-related activities (e.g., gravel pit, batch plant, and additional staging areas). Areas of potential disturbance would be located within or adjacent to previously developed and active areas of the MFC. Areas within the footprint and construction staging areas would be cleared of any existing vegetation, including, but not limited to, building footprint areas, walkways, paving, and any landscaping areas.

Disturbed areas not used for building footprints or impervious surfaces (e.g., roads, walkways) would be revegetated per DOE/ID-12114, *Guidelines for Revegetation of Disturbed Sites at the Idaho National Engineering Laboratory* (DOE-ID 2019a). An area of 25 acres within the area disturbed during construction would remain permanently developed for use as facilities and infrastructure (including expanded and new sections of security perimeter fence). This represents an increase of about 0.09 percent to the amount of the total area at the INL Site presently used for facilities and supporting infrastructure.

Aesthetics. Proposed facilities would be similar to the type and visual character of structures already present on the MFC. The buildings would be of a block concrete construction and would not be taller than existing structures at the MFC. Additionally, the facilities would not substantially increase the number of structures or the footprint of the MFC. Therefore, the visual character of the MFC would not be altered. Localized and temporary visual impacts could result from construction equipment (e.g., cranes), but only in areas outside the INL Site boundary, but within line of sight of the MFC. As discussed in Section 3.1.1.2, lands within the INL Site have been designated as Class III and Class IV, indicating that management activities may attract attention but should not dominate the view of the casual observer and management activities may dominate the view and be the major focus of viewer attention, respectively. As the proposed facilities are of specifications and type similar to the existing facilities at the MFC, impacts on aesthetics related to the proposed VTR would be expected to be minimal. Impacts on visibility from air emissions during the construction of the VTR could be localized and temporary, but only in areas of the INL Site within line of sight of the MFC. Also see Section 4.4.1.1.

While exterior lighting sources at the VTR would be consistent with existing developed areas at the MFC, it would be expected that exterior lighting (e.g., buildings, parking lots, walkways) would employ technologies designed for increased energy savings, reduced maintenance costs, improved visual environment, enhanced safety measures, and reduced light pollution (DOE 2010b). This would include the prevention of projection of light above the horizon, by using light fixtures with specifically designed optics. Impacts on aesthetics in the region, including to the International Dark-Sky Association (IDA)-designated International Dark Sky Park, Craters of the Moon National Monument, would be minimal from additional exterior lighting required for the VTR.

4.1.1.2 Operations

Land Use. The operation of VTR facilities at the INL Site would occur in an area adjacent to the existing MFC. These operations would be consistent with existing land use and activities currently occurring at the MFC. The operation of the new VTR facilities would not require additional land disturbance or development. The establishment and operation of VTR facilities would not impact the opportunities available at the INL Site in its capacity as a National Environmental Research Park (NERP). As grazing is not permitted within 0.5 miles of any primary facility boundary or within 2.0 miles of any nuclear facility, the VTR would not impact livestock grazing (including on the Sagebrush-Steppe Ecosystem Reserve). Since Idaho Department of Fish and Game controlled hunts for elk and antelope occur in the northern half of the INL Site, the VTR would have no impact on these activities. Therefore, there would be no impact from land disturbance or any changes to existing land use designations during operations of the VTR.

Aesthetics. There would be minimal impact on aesthetics as newly constructed facilities would not dominate the local landscape and would be similar in design to existing facilities in a developed area with an industrial appearance, with no changes to existing Visual Resource Management (VRM) classification of Class III and Class IV. Air emissions after operations begin at the VTR would increase over the baseline demonstrated in Chapter 3, Section 3.1.4 but are much less than established threshold values and would not be considered significant enough to affect regional air quality or any Class I visual resource area. Also see Section 4.4.1.2 for more information on air quality impacts from operation of the INL VTR Alternative.

4.1.2 ORNL VTR Alternative

4.1.2.1 Construction/Facility Modification

Land Use. Construction would occur on ORR on about 150-acres about 1 mile east of the ORNL main campus, on a site previously considered for other projects (Melton Valley Site) not subject to any land use controls addressed by the Melton Valley Watershed Record of Decision (ROD) (CROET 2007; DOE 2000a). Construction would result in land disturbance and development for permanent buildings, temporary structures, utilities, extension of the existing security perimeter fence, temporary roadways, temporary electrical lines, new electrical lines and other infrastructure needs, and other construction-related activities (e.g., gravel pit, batch plant, and additional staging areas). Areas within the footprint and construction staging areas of the proposed VTR area would be cleared of any existing vegetation, including, but not limited to, building footprint areas, walkways, paving, and any landscaping areas.

After construction of VTR associated facilities, about 50 acres of the disturbed area would remain permanently developed for use as facilities and infrastructure (including expanded and new sections of security perimeter fence). This represents an increase of about 0.5 percent to the amount of the total area at the ORNL presently used for facilities and supporting infrastructure. The proposed VTR development area is located in a portion of ORNL zoned for Federal Industry and Research and designated as institutional/research and mixed research/future initiatives and would not result in a reassignment of zoning or land use designation.

Aesthetics. Proposed facilities would be similar to the type and visual character of structures already present on ORNL. The buildings would be of a block concrete construction and would not be taller than existing structures at located at ORNL. Additionally, the facilities would not substantially increase the number of structures or the footprint of the ORNL. Therefore, the visual character of the ORNL would not be altered. Localized and temporary visual impacts could result from construction equipment (e.g., cranes), but only in areas of ORNL within line of sight of the proposed VTR site. Impacts on visibility from air emissions during the construction of the VTR could be localized and temporary, but only in areas within line of sight of ORNL. Also see Section 4.4.2.1 for more information on air quality impacts from construction of the ORNL VTR Alternative.

4.1.2.2 Operations

Land Use. The operation of VTR facilities would occur about 1 mile east of the ORNL main campus, on a site previously considered for other projects. These operations would be consistent with existing land use and activities currently occurring at the ORR. The operation of the new VTR facilities would not require additional land disturbance or development. In addition, the proposed VTR development area is located in a portion of ORR zoned for Federal Industry and Research and designated as institutional/research and mixed research/future initiatives (CROET 2007). Due to these land use designations and the relatively small percentage of ORNL's overall available land that the VTR footprint would clear, the establishment and operation of VTR facilities would not impact the opportunities available at ORNL in its capacity as a NERP. The proposed area for VTR operations is partially located in an area of the Oak Ridge Wildlife Management Area designated open to all permit holders, but represents a small percentage of the overall area available to hunters. Therefore, there would be no impact from land disturbance or any changes to existing land use designations during operation of the VTR.

Aesthetics. There would be minimal impact on aesthetics as newly constructed facilities should not dominate the local landscape and would be similar in design to existing facilities in a developed area with an industrial appearance, with no changes to existing VRM classification of Class III and Class IV. Air emissions after operations begin at the VTR would increase over the baseline demonstrated in Chapter 3, Section 3.2.4 but are much less than established threshold values and would not be considered significant enough to affect regional air quality or any Class I visual resource areas. Also see Section 4.4.2.2 for more information on air quality impacts from operation of the ORNL VTR Alternative.

As discussed in Section 3.2.1, viewpoints affected by DOE facilities at ORNL are primarily associated with the public access roadways, the Clinch River/Melton Hill Lake, and the bluffs on the opposite side of the Clinch River. Hilly terrain, heavy vegetation, and hazy atmospheric conditions limits the views of the proposed VTR site from public vantage points.

4.1.3 Reactor Fuel Production Options

4.1.3.1 INL Reactor Fuel Production Options

4.1.3.1.1 INL Feedstock Preparation Option

Construction/Facility Modification

Land Use and Aesthetics. Feedstock preparation would be located in the existing Fuel Conditioning Facility (FCF) within the MFC. Construction or facility modifications would be confined to buildings within the MFC in areas already designated for such uses and would not be directly associated with new facility construction for the VTR. Localized and temporary land use and visual impacts could result from construction or facility modifications. However, visual impacts would only be in areas of the INL Site within line of sight of the MFC.

Operations

Land Use and Aesthetics. Feedstock preparation would be located in the existing FCF within the MFC in an area currently designated for industrial purposes. Activities would be contained within existing structures, with little to no visibility from areas outside the MFC. Therefore, there would be no impacts on land use or aesthetics related to operations.

4.1.3.1.2 INL Fuel Fabrication Option

Construction/Facility Modification

Land Use and Aesthetics. Fuel fabrication would be located in the existing FMF and Zero Power Physics Reactor (ZPPR) facilities within the MFC. Construction or facility modification would be confined to buildings within the MFC in areas already designated for such uses and would not be directly associated with new facility construction for the VTR. Localized and temporary land use and visual impacts could result from construction or facility modifications. However, visual impacts would only be in areas of the INL Site within line of sight of the MFC.

Operations

Land Use and Aesthetics. Fuel fabrication would be located in the existing FMF and ZPPR facilities within the MFC in an area currently designated for industrial purposes. Activities would be contained within existing structures, with little to no visibility from areas outside the MFC. Therefore, there would be no impacts on land use or aesthetics related to operations.

4.1.3.2 SRS Reactor Fuel Production Options

4.1.3.2.1 SRS Feedstock Preparation Option

Construction/Facility Modification

Land Use and Aesthetics. Modifications would be made 20 to 40 feet below ground in an existing facility (K-Reactor Building) within the K Area Complex in an area currently designated for industrial purposes. Activities would be contained within existing structures, with little to no visibility from areas outside the K Area Complex. Localized and temporary land use and visual impacts could result from construction or facility modifications. However, visual impacts would only be in areas of SRS within line of sight of the K Area Complex. Up to 3 acres of previously disturbed land would be used.

Operations

Land Use and Aesthetics. Operations would be located 20 to 40 feet below ground in an existing facility within the K Area Complex in an area currently designated for industrial purposes. Activities would be contained within existing structures, with little to no visibility from areas outside the K Area Complex. Therefore, there would be no impacts on land use or aesthetics related to operations. Up to 3 acres of land disturbance, a small amount of excavation, and small quantities of geological and soil materials maybe associated with constructing ancillary facilities.

4.1.3.2.2 SRS Fuel Fabrication Option

Construction/Facility Modification

Land Use and Aesthetics. Modifications would be made 20 to 40 feet below ground in an existing facility within the K Area Complex in an area currently designated for industrial purposes. Activities would be contained within existing structures, with little to no visibility from areas outside the K Area Complex. Localized and temporary land use and visual impacts could result from construction or facility modifications. However, visual impacts would only be in areas of SRS within line of sight of the K Area Complex. Up to 3 acres of previously disturbed land would be used.

Operations

Land Use and Aesthetics. Operations would be located 20 to 40 feet below ground in an existing facility within the K Area Complex in an area currently designated for industrial purposes. Activities would be contained within existing structures, with little to no visibility from areas outside the K Area Complex. Therefore, there would be no impacts on land use or aesthetics related to operations. Up to 3 acres of land disturbance, a small amount of excavation, and small quantities of geological and soil materials maybe associated with constructing ancillary facilities.

4.1.4 Combined INL VTR Alternative and INL Reactor Fuel Production Options Impacts

Because operational activities for feedstock preparation and reactor fuel fabrication would occur in existing MFC facilities, no changes or modification of existing land use designations at the INL Site would result. Thus, the combined impacts on land use would be the same as those described in Section 4.1.1. Similarly, impacts on aesthetics primarily would be the result of the construction and operation of VTR facilities.

4.2 Geology and Soils

This section discusses the potential environmental consequences on geology and soils that could occur during land-clearing, excavation, and grading and filling activities. This section also describes the use of geologic and soils materials (such as crushed stone, sand and gravel, and fill) during facility construction and operations. Geologic hazards can impact facility construction and operation.

As described in Chapter 3, Sections 3.1.2.2, 3.2.2.2, and 3.3.2.2, no prime or unique farmlands have been designated at the INL Site, ORNL, or SRS, respectively. As a result, the Proposed Action would have no effects on prime or unique farmland soils, and this topic is not discussed further in this section. Additionally, there are no anticipated impacts to soils from radiological releases which are very small. There were no identified mechanisms for concentration in soils. Section 4.10 discusses the potential estimated human health impacts of these releases which included evaluation of potential soils pathways. The total impacts are very small and the soils pathways are a small fraction of the total. Therefore, this topic is not discussed further in this section.

There would be no impacts on rare or valuable geologic and soil resources, including fossil fuels (e.g., oil, gas, and coal) and minerals, because as described in Chapter 3, Sections 3.1.2.3, 3.2.2.3, and 3.3.2.3, none are present at the INL Site, ORNL, or SRS, respectively. Therefore, this topic is also not discussed further in this section.

Geologic hazards (such as earthquakes, volcanoes, and slope stability) with the potential to affect facilities at the INL Site, ORNL, and SRS are described in Chapter 3, Sections 3.1.2.4, 3.2.2.4, and 3.3.2.4, respectively. All facilities would be designed, constructed, and operated in compliance with all applicable DOE orders, other Federal, State, and local requirements and standards established to protect public and worker health and safety and the environment. DOE Order 420.1B requires that nuclear and nonnuclear facilities be designed, constructed, and operated so that the public, workers, and environment are protected from adverse impacts of natural phenomena hazards, including earthquakes. The potential for geologic hazards such as earthquakes to cause accidents, and the impacts on public and worker health and safety, are discussed under accident analyses in Section 4.11.

Table 4–2 presents a summary of the potential environmental consequences on geology and soils for the INL and ORNL VTR Alternatives and the INL and SRS Reactor Fuel Production Options.

Table 4–2. Summary of Environmental Consequences on Geology and Soils

	VTR Alternatives	
	INL VTR	***ORNL VTR***
Construction	**Area disturbed:** about 100 acres **Percent of the INL Site:** 0.02 percent of 569,600 acres **Rock and soil excavated:** 135,000 cubic yards; some ripping or blasting likely **Rock/gravel needed:** 45,000 cubic yards **Backfill/soil needed:** 202,000 cubic yards	**Area disturbed:** about 150 acres **Percent of ORR:** 0.5 percent of 32,867 acres **Rock and soil excavated:** 886,000 cubic yards; some ripping or blasting likely **Rock/gravel needed:** 74,000 cubic yards **Backfill/soil needed:** 989,000 cubic yards
Operations	**Area occupied:** 25 acres No additional land disturbance, no additional excavation, and little or no use of geologic and soil materials	**Area occupied:** 50 acres No additional land disturbance, no additional excavation, and little or no use of geologic and soil materials
Discussion	BMPs would be used to limit soil erosion; total quantities of geologic and soils materials needed are unlikely to adversely impact regionally plentiful geologic and soils resources; minimal impacts are expected	

	Reactor Fuel Production Options	
	INL Feedstock Preparation and Fuel Fabrication	***SRS Feedstock Preparation and Fuel Fabrication***
Construction and Operations	No additional land disturbance, no additional excavation, and little or no use of geologic and soil materials	
Discussion	Minimal impacts on geology and soils	
	Combined INL VTR Alternative and INL Reactor Fuel Production Options	
Discussion	Same as for INL VTR Alternative because little or no impacts from reactor fuel production	

BMP = best management practices; INL = Idaho National Laboratory; ORNL = Oak Ridge National Laboratory; ORR = Oak Ridge Reservation; SRS = Savannah River Site; VTR = Versatile Test Reactor.
Note: Affected environment information is from Chapter 3 of this VTR EIS.
Source: Appendix B.

4.2.1 INL VTR Alternative

As described in Chapter 3, Section 3.1.2, the ROI for geology and soils under the INL VTR Alternative, includes the INL Site and MFC.

4.2.1.1 Construction/Facility Modification

Rock and soil disturbance would be associated with site clearing, excavation, and grading conducted as part of constructing building foundations, roadways, parking areas, and laydown areas. Rock and soil disturbance would also occur during trenching and excavation work to install piping, utilities, and other conveyances between buildings and other facilities.

Site clearing required for construction would remove the vegetative cover and destroy the structure of the native soils. About 100 acres would be disturbed. There would be no additional land disturbance during modification of the post-irradiation examination and SNF conditioning facilities at the INL Site; any activities outside the buildings (e.g., construction laydown and parking) would occur on previously disturbed areas in the MFC. At the end of construction, the 75-acre temporarily disturbed area outside the VTR complex would be graded, covered with soil stockpiled from site clearing and excavation, planted with native vegetation, and returned to natural conditions.

Construction activities are estimated to result in the excavation of 135,000 cubic yards of rock and soil over the 51-month site preparation and facility construction period. As described in Chapter 3, Section 3.1.2.2, the site is relatively flat with little elevation change and the thickness of surficial soils near MFC range from 0.5 to 26.0 feet, with two locations in the MFC that have deposits of 31.5 and 46.0 feet. Some ripping or blasting of bedrock would likely be required to install building foundations and utility trenches. Levelling the site and construction of the facilities would require a total excavation volume of about 135,000 cubic yards and a fill volume of about 202,000 cubic yards. The deficit fill volume of about 67,000 cubic yards is anticipated to be obtained from onsite borrow sources, such as Rye Grass Flats.

The U.S. Environmental Protection Agency (EPA) and Idaho Department of Environmental Quality require a Stormwater Pollution Prevention Plan (SWPPP) under the National Pollutant Discharge Elimination System (NPDES) General Permit for stormwater discharges from construction activities. Although soils disturbed during construction would be temporarily subject to wind and water erosion, adherence to standard best management practices (BMPs) for soil erosion and sediment control (e.g., use of silt fencing, staked hay bales, mulching and geotextile fabrics, and revegetation) during facility construction would serve to minimize soil erosion and loss. Because the 100 acres of disturbed land would be less than 0.02 percent of the 569,600 acres of the INL Site, a limited area of soil would be actively disturbed at any one time, and BMPs would be used to limit soil erosion, minimal impacts on soils at the INL Site are expected.

Other uses for geologic and soil materials include components of concrete and asphalt, as a base under parking lots, roadways, concrete slabs, fill, grading, and revegetation of the site. Sources of construction materials would include rock and soil stockpiled during site excavation; soil from INL Site borrow sources; and crushed stone, sand, gravel, and soil supplied by offsite commercial operations. As discussed in Chapter 3, Section 3.1.2.3, a number of active borrow pits at the INL Site have been identified for borrow materials for ongoing and future activities at INL. The nearest borrow source, Rye Grass Flats, is about 11 miles southwest of MFC. The total quantities of geologic and soil materials needed during construction would represent small percentages of regionally plentiful resources and are unlikely to adversely impact geology and soil resources.

4.2.1.2 Operations

4.2.1.3 The VTR and Associated Facilities Operations

The VTR and associated facilities would occupy about 25 acres during operations. The 25 acres of land within the footprint of the completed VTR complex would be occupied by facilities, covered by parking areas, walkways and roads, or revegetated. BMPs for collection and management of stormwater during operations would ensure that soil erosion within the 25-acre VTR complex would be minimized. Operation of the VTR and associated facilities would involve no ground disturbance, minimal soil erosion, and little or no use of local geologic and soil materials and, therefore, would have little additional impact on geology and soils.

4.2.2 ORNL VTR Alternative

As described in Chapter 3, Section 3.2.2, the ROI for geology and soils under the ORNL VTR Alternative, includes ORR, ORNL, and the Melton Valley Site.

4.2.2.1 Construction/Facility Modification

Rock and soil disturbance would be associated with site clearing, excavation, and grading conducted as part of constructing building foundations, roadways, parking areas, and laydown areas. Rock and soil disturbance would also occur during trenching and excavation work to install piping, utilities, and other conveyances between buildings and other facilities.

Site clearing required for construction of the VTR complex would remove the vegetative cover and destroy the structure of the native soils and would disturb about 150 acres over a 5-month period (Leidos 2020). At the end of construction, the 100-acre temporarily disturbed area outside the VTR complex would be graded, covered with soil stockpiled from site clearing and excavation, planted with native vegetation, and returned to natural conditions.

Construction activities are estimated to result in the excavation of 886,000 cubic yards of rock and soil over the 51-month site preparation and facility construction period. As described in Chapter 3, Section 3.2.2, elevations at the Melton Valley Site range from about 820 to 940 feet above mean sea level with the thickness of soils and saprolite above the bedrock, likely to average about 20 feet. Some ripping and/or blasting of bedrock would likely be required to level the site, and install building foundations and utility trenches. Because of the variation in elevation across the Melton Valley Site, the excavated rock and soil would be used to fill and level other portions of the site. Levelling the site and construction of the facilities would require a total excavation volume of about 886,000 cubic yards and a fill volume of about 989,000 cubic yards. The deficit fill volume of about 103,000 cubic yards would be obtained from onsite borrow sources such as the Copper Ridge borrow area.

EPA and Tennessee Department of Environment and Conservation (TDEC) require a SWPPP under the NPDES General Permit for stormwater discharges from construction activities. Although soils disturbed during construction would be temporarily subject to wind and water erosion, adherence to standard BMPs for soil erosion and sediment control (e.g., use of silt fencing, staked hay bales, mulching and geotextile fabrics, and revegetation) during facility construction would serve to minimize soil erosion and loss. Because the 150 acres of disturbed soils would be less than 0.5 percent of the 32,867 acres of ORR, a limited area of soils would be actively disturbed at any one time, and BMPs would be used to limit soil erosion, minimal impacts on soils at ORR are expected.

Uses of geologic and soil materials include components of concrete and asphalt, as a base course under parking lots, roadways and concrete slabs, and for fill, grading, and revegetation of the site. Sources of construction materials would include: rock and soil stockpiled during site excavation; soil from ORR borrow pits; and crushed stone, sand, gravel, and soils supplied by offsite commercial operations. As discussed in Chapter 3, Section 3.2.2.3, a number of active borrow pits at ORR have been identified for use in supplying borrow materials for ongoing and future activities at ORR. The Copper Ridge Borrow Area is about 0.5 mile southeast of the Melton Valley Site. The total quantities of geologic and soil materials needed during construction would represent small percentages of regionally plentiful resources and are unlikely to adversely impact geology and soil resources.

4.2.2.2 Operations

The VTR and associated facilities would occupy about 50 acres during operations. The 50 acres within the footprint of the completed VTR complex would be occupied by facilities, covered by parking areas, walkways and roads, or revegetated. BMPs for collection and management of stormwater during operations would ensure that soil erosion within the 50-acre VTR complex would be minimized. Operation of the VTR and associated facilities would involve no ground disturbance, minimal soil erosion, and little or no use of local geologic and soil materials and, therefore, would have little additional impact on geology and soils.

4.2.3 Reactor Fuel Production Options

4.2.3.1 INL Reactor Fuel Production Options

As described in Chapter 2, Section 2.6.2, modification and operation of MFC facilities for reactor fuel production would occur within existing buildings with no additional land disturbance and little or no use of geologic and soil materials. Therefore, impacts on geology and soils from these activities would be minimal and are not discussed further in this section.

4.2.3.2 SRS Reactor Fuel Production Options

As described in Chapter 2, Section 2.6.3, modification and operation of K Area facilities for reactor fuel production would occur within existing buildings with no additional land disturbance and little or no use of geologic and soil materials. Therefore, impacts on geology and soils from these activities would be minimal and are not discussed further in this section.

4.2.4 Combined INL VTR Alternative and INL Reactor Fuel Production Options Impacts

Because there would be little or no geology and soils impacts from construction and operation of reactor fuel production, the impacts of the combined activities would be essentially the same as the impacts of the INL VTR Alternative alone as described in Section 4.2.1.

4.3 Water Resources

This section discusses the potential environmental consequences to water resources of the VTR alternatives and reactor fuel production options. The ROIs for impacts on water resources, which include surface water and groundwater within and downstream of the proposed project sites within the INL Site, ORNL, and SRS are described in Chapter 3, Sections 3.1.3, 3.2.3, and 3.3.3, respectively. There are no anticipated impacts to water resources from radiological releases which are very small. There were no identified mechanisms for concentration in water resources. Section 4.10 discusses the potential estimated human health impacts of these releases which included evaluation of potential water resources pathways. The total impacts are very small and the water resources pathways are a small fraction of the total. Therefore, this topic is not discussed further in this section. Water resources would be affected if actions associated with the alternatives increased any of the following parameters:

- Constituents in industrial wastewater or stormwater (regulated by wastewater reuse permits and NPDES permits)
- Industrial wastewater or stormwater discharge volumes (regulated by wastewater reuse permits)
- Constituents in groundwater (regulated by Federal maximum contaminant levels and State primary/secondary constituent standards)
- Groundwater use (regulated by Federal reserved water rights)

Unless wastewater reuse permit limits, NPDES permit limits, water right limits, or water system infrastructure capabilities are exceeded, impacts would be expected to be small. Impacts on water resources are assessed for two general categories: water quality and water use. Water quality is evaluated through constituents in and volume of process and sanitary wastewater discharges, constituents in and volume of stormwater discharges, and potential for discharges to eventually impact groundwater. Water use is evaluated through workforce, process, and other needs for potable and non-potable water.

Table 4–3 presents a summary of the potential environmental consequences on water resources for the INL and ORNL VTR Alternatives and the INL and SRS Reactor Fuel Production Options.

Table 4–3. Summary of Environmental Consequences on Water Resources

	VTR Alternatives	
Resource Area	***INL VTR***	***ORNL VTR***
Surface Water	*Construction*: Normal activities conducted during the construction phase for the INL VTR Alternative would discharge to surface water during stormwater discharge, batch plant operations, piping and equipment flushing, and hydrotesting. Water used during the construction phase of the INL VTR Alternative would be drawn from groundwater and discharged as surface water.	*Construction*: During the construction period of the ORNL VTR Alternative, potable water for construction workforce consumption would be drawn from the Clinch River and pumped to the water treatment plant located northeast of Y-12. The water treatment plant is owned and operated by the City of Oak Ridge. During times of peak demand, construction personnel may require a maximum of about 20 million gallons of potable water per year, or a total of about 46 million gallons over the course of the construction phase. Additional water would be required for construction activities, such as dust control and backfill. An estimated annual peak of about 52 million gallons per year would be needed or 121 million gallons over the entire construction period. The total water demand during construction of the ORNL VTR Alternative is expected to be about 172 million gallons. Normal activities conducted during the construction phase for the ORNL VTR Alternative would discharge to surface water during excavation dewatering, stormwater discharge, batch plant operations, piping and equipment flushing, and hydrotesting. Water would be discharged to surface water located adjacent to or within the proposed construction footprint.

	Operations: Process wastewater used during operations of the INL VTR Alternative would be drawn from groundwater but discharged as surface water to either the Industrial Waste Pond or active sewage lagoons. Annual wastewater totals during operations would include about 1.7 million gallons of firewater and up to 0.25 million gallons of demineralized water following treatment in the VTR liquid radioactive waste system. Altogether, this annual total of about 2 million gallons represents about 12 percent of the permitted limit of 17 million gallons per year. The estimated 2.4 million gallons of potable water to be used during operations annually would be discharged as sanitary wastewater; however, sanitary wastewater would not be discharged to the Industrial Waste Pond, and this volume would not contribute toward the permitted limit of 17 million gallons per year.	*Operations*: Process wastewater used during operations of the ORNL VTR Alternative would be drawn from the Clinch River and discharged to Bearden Creek or Melton Branch. During the operation phase of the ORNL VTR Alternative, normal operations would require and discharge an estimated 1.6 million gallons per year of potable water and 2.2 million gallons per year of firewater. Following treatment at in the VTR liquid radioactive waste system, up to 0.3 million gallons of demineralized water would also be discharged. The total annual water demand during operation of the ORNL VTR Alternative is expected to be about 4.4 million gallons.
Groundwater	*Construction:* During the construction period of the INL VTR Alternative, potable water for construction workforce consumption would be drawn from existing drinking water wells that access the Snake River Plain Aquifer and the water would be treated through the existing MFC potable water system. Up to 1,300 full-time employees may be onsite during peak times; under these conditions, construction personnel may require a maximum of about 16 million gallons of potable water per year, or a total of about 34 million gallons over the course of the construction phase. Additional water would be required for construction activities, such as dust control and backfill. An estimated annual peak of about 40 million gallons per year would be needed or 94 million gallons over the entire construction period. During times of peak need, the annual volume required during the construction phase of the INL VTR Alternative would be greater than the total of 31,055,987 gallons cited in the 2019 Water Use Report. The total water demand during construction of the INL VTR Alternative is expected to be about 128 million gallons.	*Construction*: Water used during the construction phase of the ORNL VTR Alternative would be drawn from surface water and discharged as surface water.
	Operations: The estimated 4.4 million gallons per year of water used during the operation phase of the INL VTR Alternative would be drawn from groundwater but discharged as surface water to the Industrial Waste Pond or active sewage lagoons.	*Operations*: Water used during the operation phase of the ORNL VTR Alternative would be drawn from surface water and discharged as surface water.
	Reactor Fuel Production Options	
	INL Reactor Fuel Production	***SRS Reactor Fuel Production***
Surface Water	**Feedstock Preparation**	
	Construction: The 5,000 gallons of water required for cleaning and the estimated 230,000 gallons of potable water required by construction workers would be drawn from groundwater but discharged as surface water.	*Construction*: The 6 million gallons of water needed during the construction phase would be drawn from groundwater but discharged as surface water.
	Operations: About 1.4 million gallons of water would be drawn annually from groundwater. Sanitary waste would be discharged as surface	*Operations*: About 1.4 million gallons of water would be drawn annually from groundwater but discharged as surface water.

	water. Process waters would be transported off site for treatment and disposal.	
	Fuel Fabrication	
	Construction: The 5,000 gallons of water required for cleaning and the estimated 230,000 gallons of potable water required by construction workers would be drawn from groundwater but discharged as surface water.	*Construction*: The 6 million gallons of water needed during the construction phase would be drawn from groundwater but discharged as surface water.
	Operations: About 880,000 gallons of water would be drawn annually from groundwater and discharged as surface water.	*Operations*: About 1.4 million gallons of water would be drawn annually from groundwater but discharged as surface water.
Groundwater	**Feedstock Preparation**	
	Construction: An estimated maximum of 5,000 gallons would be required during the construction phase, primarily for cleaning construction areas and equipment. A total of about 230,000 gallons of potable water would be required to serve the 18 construction workers anticipated over the entire construction phase.	*Construction*: An estimated 120 full-time employees would increase potable water use by about 20 gallons per minute or require a total about 3 million gallons over the course of the construction phase. The additional volume of non-potable water required during construction is expected to total about 6 million gallons.
	Operations: Operations and the addition of 300 new full-time employees would require about 1.4 million gallons of water per year.	*Operations*: Operations and the addition of 300 new full-time employees would require about 1.4 million gallons of water per year.
	Fuel Fabrication	
	Construction: An estimated maximum of 5,000 gallons would be required during the construction phase, primarily for cleaning construction areas and equipment. A total of about 230,000 gallons of potable water would be required to serve the 18 construction workers anticipated over the entire construction phase.	*Construction*: An estimated 120 full-time employees would increase potable water use by about 20 gallons per minute or require a total about 3 million gallons over the course of the construction phase. The additional volume of non-potable water required during construction is expected to total about 6 million gallons.
	Operations: The addition of 70 new full-time employees would increase potable water use by about 880,000 gallons per year. In addition, about 20 gallons of water would be required per week (1,000 gallons per year) for mopping and cleaning.	*Operations*: Operations and the addition of 300 new full-time employees would require about 1.4 million gallons of water per year.
	Combined INL VTR Alternative and INL Reactor Fuel Production Options	
Surface Water	*Construction*: Water used during construction of the reactor fuel production options would be discharged to the same surface waters as discussed above for in the INL VTR Alternative but much lower in volume. As such, impacts on surface water would be generally as discussed for the INL VTR Alternative.	
	Operations: Feedstock preparation and fuel fabrication operations would require an additional 2.4 million gallons of water over VTR operations for a combined total of about 6.8 million gallons discharged as surface water.	
Groundwater	*Construction*: The anticipated water usage under the reactor fuel production options would represent a small percentage of the anticipated water required by the INL VTR Alternative. As such, construction impacts on groundwater would be generally as discussed above for the INL VTR Alternative.	
	Operations: Feedstock preparation and fuel fabrication operations would require an additional 2.4 million gallons of water over VTR operations for a combined total of about 6.8 million gallons drawn from groundwater sources.	

INL = Idaho National Laboratory; MFC = Materials and Fuels Complex; ORNL = Oak Ridge National Laboratory; SRS = Savannah River Site; VTR = Versatile Test Reactor.

4.3.1 Surface Water

4.3.1.1 INL VTR Alternative

Construction/Facility Modification

It is anticipated that construction activities would require about 51 months following the completion of the project's design phase. The impacts on water resources from construction activities are presented below in terms of increases over the baseline described in Section 3.1.3. Impacts on surface water resources are expected to vary over the construction period depending on the activity.

Normal activities conducted during the construction phase for the INL VTR Alternative would discharge to surface water during stormwater discharge, batch plant operations, piping and equipment flushing, and hydrotesting. Specific stormwater drainage plans for construction would be finalized in later stages of design. Low-impact techniques would be used to prevent groundwater pollution and keep stormwater runoff on the construction site. For example, the construction area would be graded, and local infiltration at the construction site would be used for stormwater management prior to establishment of paved areas or roofs. Silt and debris in stormwater runoff from construction areas could be captured by silt fencing. Water could be collected in infiltration basins down gradient of the exposed areas to minimize erosion and sedimentation on the surrounding environment once paved or roof areas are established. Stormwater in infiltration basins would evaporate or infiltrate the ground surface. Established BMPs would continue to be used to minimize sediment and chemical constituents in stormwater runoff. No activities are expected to add to or change the constituents in the stormwater discharge during construction. Therefore, the construction period would have no impact on stormwater quality.

Equipment washing would generate routine wastewater throughout the construction phase. Construction equipment could either be taken to the Central Facilities Area to be washed in an established maintenance area or washed in a temporary wash area that would prevent greases, oils, or material residues from contacting the ground surface and migrating to the subsurface.

Wastewater and stormwater discharges to unlined infiltration basins or the ground, or uncontrolled spills of chemicals or petroleum products, are potential pathways of groundwater contamination. Spills prevention and cleanup programs, the wastewater discharge management plan, and waste management programs control contaminants in these pathways. These plans and programs conform to applicable Federal and State requirements and some are subject to Federal and State compliance inspections. Examples of BMPs used to protect groundwater include reducing soil erosion and stormwater runoff by using silt fencing, hay bales, or rills that catch sediment or confining runoff to designated areas (e.g., infiltration basins). Using the minimum, effective quantity of chemicals and considering the use of "greener" alternatives when available, and applying practicable and careful management of hazardous materials and wastes are also BMPs.

Sanitary wastewater from the construction workforce would be handled by portable systems and hauled off site for disposal in accordance with regulations. Sanitary wastewater discharges during the construction period would not introduce novel constituents not already present on site under baseline conditions. Constituents and constituent concentrations in active sewage lagoons are not regulated by permit; however, all design, testing, and operations requirements in Idaho Administrative Procedure Act code (IDAPA) 58.01.16 are met and approved by the State. The active sewage lagoons are lined to contain constituents. Therefore, the construction period would not impact constituent concentrations in effluent. As portable sanitary systems would be used, sanitary discharge volumes to the active sewage lagoons would not increase.

Because construction workers would use portable sanitary systems and other construction-related water would be drawn from groundwater, no changes to surface water use would be expected during implementation of the INL VTR Alternative.

Operations

Process wastewater used during operations of the INL VTR Alternative would be drawn from groundwater but discharged as surface water to either the Industrial Waste Pond or active sewage lagoons. During the operation phase of the INL VTR Alternative, normal operations would discharge about 1.7 million gallons per year of fire water and up to 0.25 million gallons per year of demineralized water following treatment in the VTR liquid radioactive waste system (following such treatment, the discharged demineralized water would only exhibit negligible levels of radioactivity and would not represent an increased risk over existing operations). Altogether, this total of about 2 million gallons represents about 12 percent of the permitted limit of 17 million gallons per year stipulated in the State of Idaho Industrial Wastewater Reuse Permit for the INL Site's MFC Industrial Waste Pond. In addition, an estimated 2.4 million gallons per year of potable water would be required during operations and discharged as sanitary wastewater. However, sanitary wastewater would not be discharged to the Industrial Waste Pond and would not contribute toward the permitted limit of 17 million gallons per year.

4.3.1.2 ORNL VTR Alternative

Construction/Facility Modification

It is anticipated that construction activities would require about 51 months following the completion of the project's design phase. The impacts on water resources from construction activities are presented below in terms of increases to the baseline described in Section 3.2.3. Impacts on surface water resources are expected to vary over the construction period depending on the activity.

Normal activities conducted during the construction phase for the ORNL VTR Alternative would discharge to surface water during excavation dewatering, stormwater discharge, batch plant operations, piping and equipment flushing, and hydrotesting. Water would be discharged to surface water located adjacent to or within the proposed construction footprint (e.g., tributaries to Bearden Creek to the north and southeast or Melton Branch to the west and southwest).

Excavation activities associated with the construction phase of the ORNL VTR Alternative are expected to encounter groundwater. The groundwater table exists about 50 to 175 feet below grade across the ORNL, and the proposed project would require VTR components to be installed at depths of up to 93 feet below grade. As such, dewatering efforts would discharge water through outfalls to a creek. It is possible that outfalls needed for such efforts would require new or modified permits. The TDEC requires a NPDES Stormwater Construction permit for "…construction sites involving clearing, grading or excavation that result in an area of disturbance of one or more acres".

Specific stormwater drainage plans for construction would be finalized in later stages of design. Low-impact development techniques would be used to prevent groundwater pollution and keep stormwater runoff on the construction site. For example, the construction area would be graded, and local infiltration at the construction site would be used for stormwater management prior to establishment of paved areas or roofs. Silt and debris in stormwater runoff from construction areas could be captured by silt fencing. Water could be collected in infiltration basins down gradient of the exposed areas to minimize erosion and sedimentation on the surrounding environment once paved or roof areas are established. Stormwater in infiltration basins would evaporate or infiltrate the ground surface. Established BMPs would continue to be used to minimize sediment and chemical constituents in stormwater runoff. The TDEC's Erosion and Prevention Control Handbook provides guidance regarding erosion prevention and sediment control BMPs and for the development and implementation of SWPPPs, as required for

Tennessee General NPDES Permits for Discharges Associated with Construction Activities and individual NPDES permits. No activities are expected to add to or change the constituents in the stormwater discharge during construction. Therefore, the construction period would have no impact on stormwater quality.

Equipment washing would generate routine wastewater throughout the construction phase. Construction equipment could either be taken to an established maintenance area or washed in a temporary wash area that would prevent greases, oils, or material residues from contacting the ground surface and migrating to the subsurface. Due to BMPs, sedimentation and erosion in existing surface water drainage ways are not expected to increase during the construction period.

Wastewater and stormwater discharges to sediment basins or the ground, or uncontrolled spills of chemicals or petroleum products, are potential pathways of groundwater contamination. Spill prevention and clean-up programs, the wastewater discharge management plan, and waste management programs control contaminants in these pathways. These plans and programs conform to applicable Federal and State requirements, and some are subject to Federal and State compliance inspections. Examples of BMPs used to protect groundwater include reducing soil erosion and stormwater runoff by using silt fencing, hay bales, or rills that catch sediment, or confine runoff to designated areas (e.g., infiltration basins); minimizing use of chemicals; and careful management of hazardous materials and wastes.

Sanitary wastewater from the construction workforce would be handled by portable systems and hauled off site for disposal in accordance with regulations. Sanitary wastewater discharges during the construction period would not introduce novel constituents not already present on site under baseline conditions.

Construction workers would use portable sanitary systems, but industrial and other construction-related water would be drawn from surface water. During the construction period of the ORNL VTR Alternative, potable water for construction workforce consumption would be drawn from the Clinch River and pumped to the water treatment plant located northeast of Y-12. The water treatment plant is owned and operated by the City of Oak Ridge. This water would be used for both sanitation purposes and construction activities. Up to 1,300 full-time employees may be onsite during peak times and may utilize up to 20 million gallons per year; a total of about 46 million gallons of potable water are expected to be required during the construction phase of the ORNL VTR Alternative. Additional water would be required for construction activities, such as dust control and backfill. An estimated total of about 121 million gallons would be needed over the entire construction period, with annual volumes ranging from an average of about 29 million gallons to a peak of about 52 million gallons. The total water needs for construction of the ORNL VTR Alternative are expected to be about 172 million gallons. The existing ORNL water treatment system can accommodate an annual rate of 2.55 billion gallons per year, so the existing treatment and supply system has the capacity to serve the ORNL VTR Alternative.

Intermittent tributaries to Bearden Creek form the north and southeast boundaries of the construction footprint for the ORNL VTR Alternative; intermittent tributaries to Melton Branch form the west and southwest boundaries. In addition, intermittent waterways extend into the proposed permanent footprint of the VTR complex at ORNL. Wetlands associated with these surface waters occupy about 4.7 acres of the temporary construction area. The TDEC requires an Aquatic Resource Alteration Permit or a Section 401 Water Quality Certification for projects that result in “physical alterations to properties of waters of the state”. Construction activities associated with the ORNL VTR Alternative could release discharged water or sediment to these resources. However, any impacts on wetlands would occur in compliance with all Federal, State, and permit requirements to reduce or avoid impacts on onsite wetlands.

Operations

Process wastewater used during operations of the ORNL VTR Alternative would be drawn from the Clinch River and discharged to Bearden Creek or Melton Branch. During the operation phase of the ORNL VTR Alternative, normal operations would discharge about 1.6 million gallons of sanitary wastewater and about 2.2 million gallons of fire water. Following treatment in the VTR liquid radioactive waste system, up to 0.3 million gallons of demineralized water would also be discharged. Following such treatment, the discharged demineralized water would only exhibit negligible levels of radioactivity and would not represent an increased risk over existing operations. These wastewater discharges would flow through new outfalls to Bearden Creek or Melton Branch; these outlets may require a new or modified permit prior to use.

About 1.8 acres of palustrine, forested wetlands exist within the operational footprint of the ORNL VTR Alternative. These wetlands, associated with the tributaries to Bearden Creek and Melton Branch would be permanently affected by the proposed project, but activities would be conducted in compliance with the terms of an Aquatic Resource Alteration Permit or a Section 401 Water Quality Certification obtained from the TDEC, if required. As such, potential impacts on wetland structure or quality would be reduced and maintained at less-than-significant levels or avoided altogether.

4.3.1.3 INL and SRS Reactor Fuel Production Options

Because groundwater serves as the primary water sources at both the INL Site and SRS, no changes to surface water use would be expected during implementation of the reactor fuel production options. The water required by construction of the INL Fuel Fabrication Reactor Fuel Production Options would be discharged to the same sources as described in Section 4.3.1.1, but in much smaller volumes. As such, anticipated impacts on surface water quality would be similar to, but less intense than, the impacts discussed in Section 4.3.1.1. Operation of the INL Fuel Fabrication Reactor Fuel Production Options would require about 2.4 million gallons of water, almost all of which would be potable. This water would be discharged as sanitary wastewater and, therefore, would not affect the site's permitted limit of 17 million gallons per year for the Industrial Waste Pond. Operation of the feedstock preparation option at INL would require about 50,000 gallons for steam, aqueous processing, and waste treatment. The 50,000 gallons of treated wastewater would be discharged to the MFC's Industrial Waste Pond or as surface water depending on the characteristics following evaporative and chemical treatment or sent off site for treatment and disposal. This volume would represent a 0.3 percent contribution toward the permitted limit of 17 million gallons.

Sanitary wastewater from construction and operation of the SRS Fuel Fabrication Reactor Fuel Production Options would be discharged to the sanitary treatment plant, located within K Area, and then discharged through K-12 Outfall. This outfall comingles with the river at the water discharge of K-18 Outfall. Depending on the characteristics following evaporation and chemical treatment, about 50,000 gallons of treated wastewater generated by aqueous processing and waste treatment during operation of the feedstock preparation option may be suitable for onsite discharge to surface water or sent off site for treatment and disposal. The additional wastewater anticipated through construction and operation of the SRS Fuel Fabrication Reactor Fuel Production Options are not expected to affect permit thresholds.

4.3.1.4 Combined INL VTR Alternative and INL Reactor Fuel Production Options Impacts

This section presents the total impacts that would occur if the VTR and the fuel fabrication capability were both established at the INL Site. Water used during construction of the reactor fuel production options would be discharged to the same surface waters as discussed above for in the INL VTR Alternative but much lower in volume. As such, the combined construction impacts would be as described in Section 4.3.1.1 for the INL VTR Alternative and the INL Options. Operation of the INL VTR Alternative, feedstock preparation, and fuel fabrication all at the INL Site would require a combined total of about 6.8 million gallons of water per year. This volume would be drawn from groundwater but discharged as surface water to the Industrial Waste Pond and active sewage lagoons, as discussed in Section 4.3.1.1. However, all but about 51,000 gallons of the estimated 2.4 million gallons required for operation of the reactor fuel options would be discharged as sanitary wastewater and therefore, not counted toward the Industrial Waste Pond's permitted limit of 17 million gallons. As such, the combined impacts from all three of these components would still be generally as described in Section 4.3.1.1.

4.3.2 Groundwater

4.3.2.1 INL VTR Alternative

Construction/Facility Modification

During the construction period of the INL VTR Alternative, potable water for construction workforce consumption would be drawn from existing drinking water wells that access the Snake River Plain Aquifer (SRPA) and the water would be treated through the existing MFC potable water system. Up to 1,300 full-time employees may be onsite during peak times; during such times, about 16 million gallons of potable water could be required per year. Anticipated potable water needs during the entire construction phase total about 34 million gallons. Additional water would be required for construction activities, such as dust control and backfill. An estimated total of about 94 million gallons would be needed over the entire construction period, with annual volumes ranging from an average of about 22 million gallons to a peak of about 40 million gallons. Altogether, the total water demand during the construction phase is anticipated to be about 128 million gallons. During times of peak need, the annual volume required during the construction phase of the INL VTR Alternative would be greater than the total of 31,055,987 gallons cited in the 2019 Water Use Report.

Construction of the VTR would involve excavation activities at depths of up to 93 feet below grade. However, the water table exists about 649 to 662 feet below grade at the MFC, located adjacent to the proposed project site. Therefore, construction activities are not expected to encounter groundwater during excavation.

Constituent concentrations in onsite groundwater are expected to remain similar to existing baseline conditions during the construction period. Therefore, activities during the construction period for this alternative would not impact groundwater quality compared to baseline conditions described in Section 3.3. The drinking water monitoring program has shown that constituents in drinking water wells are below regulatory limits. Activities during the construction period of the INL VTR Alternative would not impact the wellhead protection areas compared to baseline conditions described in Section 3.3.

Operations

Water used during the operation phase of the INL VTR Alternative would be drawn from groundwater but discharged as surface water to the Industrial Waste Pond or active sewage lagoons. The total volume of water required during operations is discussed in Section 4.3.1.1.

4.3.2.2 ORNL VTR Alternative

Construction/Facility Modification

Water used during the construction phase of the ORNL VTR Alternative would be drawn from surface water and discharged as surface water. The total volume of water required during operations are discussed in Section 4.3.1.2. Groundwater is expected to be encountered during excavation activities, as discussed in Section 4.3.1.2, but groundwater withdrawn during dewatering activities would be discharged as surface water.

Operations

Water used during the operation phase of the ORNL VTR Alternative would be drawn from surface water and discharged as surface water. The total volume of water required during operations is discussed in Section 4.3.1.2.

4.3.2.3 Reactor Fuel Production Options

4.3.2.3.1 INL Option – Feedstock Preparation

Construction/Facility Modification

Under this scenario, the only construction activities would be to modify existing space in the FCF's operating floor/high bay, mockup area, and workshop and convert it for use in feedstock preparation. An estimated maximum of 5,000 gallons of water would be required during the 3-year construction phase, primarily for cleaning construction areas and equipment. A total of about 230,000 gallons of potable water would be required to serve the 18 construction workers anticipated over the entire construction phase.

Operations

Under this scenario, feedstock preparation capabilities would occur within the modified FCF. A series of glovebox lines would be installed for feedstock polishing and conversion. Water usage would be well within the existing capacities of the individual facilities and the MFC. Operations would require about 50,000 gallons of water for steam, aqueous processing, and waste treatment. Together with the addition of 300 full-time employees, operation of the feedstock preparation option would increase potable water use by about 1.4 million gallons per year. This volume would be drawn from groundwater but discharged as surface water.

4.3.2.3.2 INL Option – Fuel Fabrication

Construction/Facility Modification

Under this scenario, the VTR fuel fabrication process at the INL Site would be located in existing facilities at MFC (FCF, FMF, and ZPPR). The only construction activities, occurring over a 2-year period, would be the build out of the equipment locations in the FMF, ZPPR, and FCF. An estimated maximum of 5,000 gallons would be required during the construction phase, primarily for cleaning construction areas and equipment. A total of about 230,000 gallons of potable water would be required to serve the 18 construction workers anticipated over the entire construction phase.

Operations

Under this scenario, the VTR fuel fabrication process at the INL Site would be located in existing facilities at MFC (FCF, FMF, and ZPPR). Volumes of water used during operations would be well within the existing capacities of the individual facilities and the MFC. The addition of 70 new full-time employees would increase potable water use by about 880,000 gallons per year. In addition, about 20 gallons of water would be required per week (1,000 gallons per year) for mopping and cleaning.

4.3.2.3.3 SRS Option – Feedstock Preparation

Construction/Facility Modification

Under this scenario, no new facilities would be constructed at SRS. The capability would be located adjacent to the location for the fuel fabrication capability, in the K Area Complex, primarily at the minus-20-foot level (20 feet below grade). An estimated 120 full-time employees would increase potable water use by about 20 gallons per minute or require a total about 3 million gallons over the course of the construction phase. The additional volume of non-potable water required during construction is expected to total about 6 million gallons.

Operations

The feedstock processing capability at SRS would be located adjacent to the location for the fuel fabrication capability, which is in the K Area Complex, and the process equipment would be located at the minus-20-foot level at the minus-40-foot level (20 and 40 feet below grade). Operations and the addition of 300 new full-time employees would require about 1.4 million gallons of water per year.

4.3.2.3.4 SRS Option – Fuel Fabrication

Construction/Facility Modification

Under this scenario, no new facilities would be constructed at SRS. The only construction activities would be the build-out of the equipment locations within an existing facility in the K Area Complex and the removal of existing equipment. Construction is assumed to require 3 years. The fuel fabrication facility would be located on the minus-20- and minus-40-foot levels (20 and 40 feet below grade) of the Building 105-K. An estimated 120 full-time employees would increase potable water use by about 20 gallons per minute or require a total about 3 million gallons over the course of the construction phase. The additional volume of non-potable water required during construction is expected to total about 6 million gallons.

Operations

The fuel fabrication facility would be located on the minus-20-and minus-40-foot levels (20 and 40 feet below grade) of the Building 105-K. Although the VTR modifications have not been designed, based on similar K Area upgrade projects, the space needed for support facilities for the needed HVAC, fire suppression, etc., are expected to be substantial. At least one and possibly two of the adjacent 108-K Buildings could be needed for these support operations. Operations and the addition of 300 new full-time employees would require about 1.4 million gallons of water per year for potable use and cleaning.

4.3.2.4 INL VTR, Feedstock Preparation, and Fuel Fabrication Combined Impacts

This section presents the total potential groundwater impacts that would occur if the VTR and the reactor fuel production capability were both established at the INL Site. The anticipated water usage under construction of the reactor fuel options would represent a small percentage of the anticipated water required by construction of the INL VTR Alternative. Operations would require about 4.4 million gallons for the VTR alternative, 1.4 million gallons for feedstock preparation, and 880,000 gallons for fuel fabrication per year for a total of about 6.8 million gallons. Of the volume required for operation of the Reactor Fuel Production Options, almost all would be potable water and therefore discharged as sanitary wastewater. Sanitary wastewater would not be discharged to the Industrial Waste Pond and would not contribute against the permitted limit of 17 million gallons. About 50,000 gallons required for aqueous processing and waste treatment would be discharged to the Industrial Waste Pond or as surface water depending on the characteristics following evaporation and chemical treatment or sent off site for treatment and disposal. This volume would represent about 0.3 percent of the permitted limit of 17 million gallons. Because of this, and since all water used during construction and operation would be drawn from groundwater sources and discharged to surface water, impacts would be generally as discussed in Section 4.3.1.1.

4.4 Air Quality

Construction and operations activities under the proposed project alternatives would result in air emissions of criteria pollutants, hazardous air pollutants (HAPs), and greenhouse gases (GHGs). The following analysis evaluates projected emissions relative to air quality conditions within several project regions and their applicable Federal, State, and local air pollution standards and regulations. For criteria pollutants that would occur within a region that attains a National Ambient Air Quality Standard (NAAQS), the analysis compares estimates of annual emissions from a project alternative to the EPA prevention of significant deterioration- (PSD) permitting threshold of 250 tons per year. The comparison would then be used to make an initial determination of the significance of potential impacts on air quality. The PSD-permitting threshold represents the level of potential new emissions below which a new stationary source can emit without triggering the requirement to obtain a PSD permit. For criteria pollutants that would occur within a region that does not attain a NAAQS, the analysis compares the increase in annual emissions to the applicable pollutant conformity de minimis threshold. If the intensity of annual emissions increases for a project alternative are below a PSD or applicable conformity threshold, the indication is that air quality impacts would be insignificant for that pollutant.

If emissions from a project alternative would exceed one of the indicator thresholds mentioned above, further analysis was conducted to predict whether impacts would be significant. In such cases, if emissions would (1) not contribute to an exceedance of an ambient air quality standard or (2) conform to the approved State Implementation Plan, then impacts would not be significant.

Air quality impacts of nonradiological HAPs from construction and operation activities at each site are evaluated in terms of whether they would produce adverse impacts on the public. Additionally, the analysis predicts GHG and radiological air emissions for each project alternative for purposes of making reasoned choices among the alternatives. Sections 4.10 through 4.12 (Human Health) present estimates of the health effects from potential radiological air emissions.

Table 4–4 presents a summary of the potential environmental consequences on air quality for the INL and ORNL VTR Alternatives and the INL and SRS Reactor Fuel Production Options.

Table 4–4. Summary of Environmental Consequences on Air Quality

	VTR Alternatives	
	INL VTR	***ORNL VTR***
Construction	Annual nonradiological emissions from construction of the VTR facilities would be well below the annual indicator thresholds. HAPs emissions generated by construction activities would not result in adverse air quality impacts on the public. Construction activities would not generate radiological air emissions.	Annual nonradiological emissions from construction of the VTR facilities would be below the annual indicator thresholds. HAPs emissions generated by construction activities would not result in adverse air quality impacts on the public. Construction activities would not generate radiological air emissions.
Operations	Annual nonradiological emissions from operation of the VTR facilities would be well below the annual indicator thresholds. Operations activities would generate radiological air emissions.	Annual nonradiological emissions from operation of the VTR facilities would be well below the annual indicator thresholds. Operations activities would generate radiological air emissions. Each source of radiological air emissions would operate under a Construction Permit and existing Title V operating permit. An Air Permitting and Applicability Determination (APAD) would be performed to ensure compliance with NESHAP, Subpart H.
Discussion	DOE would implement protective measures to minimize the generation of fugitive dust during construction. Construction and operation of the VTR Alternative at either location would not result in adverse impacts from nonradiological air emissions. Impacts of radiological air emissions are evaluated in EIS Sections 4.10 through 4.12 (Human Health).	

	Reactor Fuel Production Options	
	INL Reactor Fuel Production	*SRS Reactor Fuel Production*
Construction and Operations	Construction and operations of the Reactor Fuel Production Options at either location would result in minor amounts of nonradiological emissions that would be well below the annual indicator thresholds. These actions at both locations also would produce minimal amounts of HAPs. Construction activities at INL/SRS would not generate radiological air emissions. Operations activities at both sites would generate radiological air emissions.	
Discussion	Construction and operation of the Reactor Fuel Production Options at either location would not result in adverse impacts from nonradiological air emissions. Impacts of radiological air emissions are evaluated in EIS Sections 4.10 through 4.12 (Human Health).	
	Combined INL VTR Alternative and INL Reactor Fuel Production Options	
Discussion	Same as for INL VTR Alternative because of minimal impacts from fuel fabrication.	

Note: Affected environment information is from Chapter 3 of this VTR EIS.
Sources: INL 2020f; ORNL 2020c.

4.4.1 INL VTR Alternative

The air quality analysis estimates air emissions that would result from the construction and operation of the INL VTR Alternative. The counties that encompass the INL Site currently attain all of the NAAQS. Therefore, the analysis used the PSD-permitting threshold of 250 tons per year for criteria pollutants as indicators of the significance of projected air quality impacts within the INL Site project region.

4.4.1.1 Construction/Facility Modification

The INL VTR Alternative would require construction of new facilities and modifications to existing facilities at the INL Site. Air quality impacts from projected construction activities would result from (1) combustive emissions due to the use of fossil-fuel-powered equipment, trucks, and worker commuter vehicles and (2) fugitive dust emissions (PM_{10}/$PM_{2.5}$) due to the operation of equipment on exposed soil. Construction activity data developed by INL staff were used to estimate projected construction equipment usages and associated combustive and fugitive dust emissions (INL 2020f). Construction activities for the alternative would take about 4 years to complete (INL 2020f).

Factors needed to derive construction source emission rates were obtained from EPA's Motor Vehicle Emission Simulator (MOVES) MOVES2014b model for non-road construction equipment and on-road vehicles (EPA 2018a) and Western Regional Air Partnership's Fugitive Dust Handbook (Countess Environmental 2006). The analysis assumes that DOE would implement protective measures to minimize the generation of fugitive dust during construction and to comply with Sections 650 and 651 (Rules for Control of Fugitive Dust) of the IDAPA Rules for the Control of Air Pollution in Idaho. Implementation of these measures would reduce fugitive dust emissions from active disturbed areas by up to 74 percent compared to uncontrolled levels (Countess Environmental 2006). Chapter 6, Section 6.1, of this EIS includes details of the air quality protective measures assessed in this EIS.

Table 4–5 presents estimates of calendar year emissions that would occur from construction of new facilities and modifications to existing facilities under the INL VTR Alternative. The data in Table 4–5 show that the combined annual emissions from construction of the VTR facilities would be well below the annual indicator thresholds. Therefore, annual emissions from construction of the combined facilities under the alternative would not result in adverse air quality impacts.

Combustion of fossil fuels in construction equipment, trucks, and worker commuter vehicles also would emit nonradiological HAPs. Combined HAPs from diesel-powered internal combustion engines compose about 15 and 3 percent, respectively, of total volatile organic compounds and PM_{10} emissions (California Air Resources Board 2018). The analysis estimates that onsite HAPs emissions from construction of the INL VTR Alternative would peak in year 2023 at 0.14 tons per year. The mobile and intermittent operation of construction emission sources would result in dispersed concentrations of these HAPs adjacent to construction activities. The substantial transport distance of construction emissions from MFC to the nearest locations of the INL Site boundary (about 3 miles) would produce further dispersion and inconsequential concentrations of HAPs beyond the INL Site boundary. In addition, the intermittent operation of construction trucks and worker commuter vehicles on public roads would result in low concentrations of HAPs at these offsite locations. As a result, HAPs concentrations generated by construction activities would not result in adverse air quality impacts on the public.

Table 4–5. Calendar Year Nonradiological Construction Emissions – INL VTR Alternative

Calendar Year/Source Type	Air Pollutant Emissions (tons per year)						
	VOC	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$	CO_2e (metric tons)
Year 2022							
Onsite On-road Sources	0.05	1.00	0.48	0.002	0.06	0.02	261
Onsite Non-road Sources	0.35	2.47	4.66	0.01	0.27	0.27	1,614
Fugitive Dust					56.78	5.68	
Offsite On-road Sources	0.08	5.12	1.00	0.006	0.20	0.05	761
Total Annual Emissions	**0.48**	**8.59**	**6.13**	**0.02**	**57.31**	**6.01**	**2,637**
Year 2023							
Onsite On-road Sources	0.08	1.46	0.78	0.004	0.09	0.04	445
Onsite Non-road Sources	0.73	4.61	8.59	0.02	0.47	0.45	2,755
Fugitive Dust					102.21	10.22	
Offsite On-road Sources	0.36	24.37	4.28	0.03	0.95	0.22	3,666
Total Annual Emissions	**1.16**	**30.44**	**13.64**	**0.05**	**103.72**	**10.93**	**6,866**
Year 2024							
Onsite On-road Sources	0.06	1.27	0.61	0.003	0.08	0.03	393
Onsite Non-road Sources	0.68	4.16	8.50	0.02	0.43	0.41	2,773
Fugitive Dust					68.14	6.81	
Offsite On-road Sources	0.32	24.32	3.91	0.03	0.98	0.22	3,763
Total Annual Emissions	**1.06**	**29.75**	**13.03**	**0.05**	**69.62**	**7.47**	**6,929**
Year 2025							
Onsite On-road Sources	0.02	0.73	0.22	0.002	0.04	0.01	182
Onsite Non-road Sources	0.21	1.50	2.50	0.01	0.13	0.13	1,051
Fugitive Dust					34.07	3.41	
Offsite On-road Sources	0.03	1.09	0.50	0.00	0.10	0.02	336
Total Annual Emissions	**0.26**	**3.32**	**3.21**	**0.01**	**34.33**	**3.57**	**1,569**
Annual Indicator Thresholds	**250**	**250**	**250**	**250**	**250**	**250**	**NA**
Exceed Threshold?	**No**	**No**	**No**	**No**	**No**	**No**	**NA**

CO = carbon monoxide; CO_2e = carbon dioxide equivalent; NA = not applicable; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter less than 2.5 microns in diameter; PM_{10} = particulate matter less than 10 microns in diameter; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Note: Due to rounding, sums and products may not equal those calculated from table entries.

Construction activities from the INL VTR Alternative would not generate radiological air emissions. Construction of new facilities that occur in nonradiological areas and facility modifications within radiological areas would not be expected to increase existing radiological air emissions.

Air emissions from construction of the INL VTR Alternative would have the potential to affect the Craters of the Moon National Monument PSD Class I area, whose nearest border is about 45 miles southwest of the MFC. As stated above for potential HAPs impacts from proposed construction, the mobile and intermittent operation of construction emission sources would result in dispersed concentrations of air pollutants at locations outside of the INL Site. The substantial transport distance of these emissions to the nearest boundary of the Craters of the Moon National Monument (about 45 miles) would produce substantial dispersion and would result in negligible concentrations of air pollutants within this pristine Class I area. Therefore, construction of the INL VTR Alternative would negligibly affect air quality values within the Craters of the Moon National Monument pristine Class I area.

4.4.1.2 Operations

Air quality impacts from the operation of the INL VTR Alternative would occur from (1) intermittent use of two diesel-powered backup electrical generators rated at one megawatt each, (2) intermittent use of propane-fired heaters for the VTR sodium heat exchanger system during maintenance activities, (3) diesel-powered trucks that deliver material and haul off wastes, and (4) worker commuter vehicles. Vehicle trips and associated trip lengths used in the analysis are consistent with metrics developed for proposed VTR activities at the INL Site (INL 2020f).

Factors needed to derive on-road vehicle emission rates were obtained from the EPA MOVES2014b model. To estimate emissions from the proposed backup generators, the analysis assumes that these units would operate at EPA non-road Tier 4 standard levels (EPA 2018b). The backup generators would operate for about four days per year (INL 2020a). At this level of annual operation (less than 500 hours per year) with use of diesel fuel, these units would not require a permit to construct, as outlined in Section 58.01.01.222.01.d of the IDAPA Rules for the Control of Air Pollution in Idaho. Factors needed to estimate emissions for the propane-fired heaters were obtained from the EPA AP-42 document (EPA 2008).

Table 4–6 presents estimates of annual nonradiological emissions that would occur due to operation of the INL VTR Alternative. The data in Table 4–6 show that annual emissions from operations of the INL VTR Alternative would be well below the annual indicator thresholds.

Table 4–6. Annual Nonradiological Operations Emissions – INL VTR Alternative

	Air Pollutant Emissions (tons per year)						
Source-Facility	***VOC***	***CO***	***NO_x***	***SO_2***	***PM_{10}***	***$PM_{2.5}$***	***CO_2e (metric tons)***
Back-up Generators – VTR	0.03	0.50	0.10	0.001	0.004	0.004	93
Sodium Heaters – Normal Operations	0.000	0.002	0.003	0.000	0.000	0.000	3
Haul Trucks	0.03	0.15	0.55	0.003	0.08	0.02	277
Worker Commuter Vehicles	0.02	2.85	0.18	0.003	0.08	0.02	347
Total – Normal Operations	**0.09**	**3.50**	**0.84**	**0.01**	**0.17**	**0.04**	**720**
Sodium Heaters – Large Component Replacement [a]	0.02	0.16	0.27	0.00	0.01	0.01	**239**
Annual Emissions during LCR Cycle [b]	**0.11**	**3.66**	**1.11**	**0.01**	**0.18**	**0.06**	**956**
Annual Indicator Thresholds	**250**	**250**	**250**	**250**	**250**	**250**	**NA**
Exceed Threshold?	**No**	**No**	**No**	**No**	**No**	**No**	**NA**

CO = carbon monoxide; CO_2e = carbon dioxide equivalent; LCR = large component replacement; NA = not applicable; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter less than 2.5 microns in diameter; PM_{10} = particulate matter less than 10 microns in diameter; SO_2 = sulfur dioxide; VOC = volatile organic compound.

[a] LCR would occur every 15 years.

[b] Equal to normal operations plus sodium heaters – LCR.

Note: Due to rounding, sums and products may not equal those calculated from table entries.

Combustion of fossil fuels in operations equipment, trucks, and worker commuter vehicles also would emit nonradiological HAPs. Operation of the diesel-powered backup generators at the VTR Facility would produce about 0.005 tons per year of combined HAPs emissions (equal to 15 and 3 percent, respectively, of combustive VOC and PM_{10} emissions from diesel equipment). The substantial transport distance of these HAPs emissions from the MFC to the nearest locations of the INL Site boundary (about 3 miles) would produce HAPs impacts that would not exceed an ambient concentration of concern beyond the INL Site boundary. In addition, the intermittent operation of delivery and haul trucks and worker commuter vehicles on public roads would result in low concentrations of HAPs at these offsite locations. As a result, HAPs concentrations generated by operations activities would not result in adverse air quality impacts on the public.

Operation of the INL VTR Alternative would generate radiological air emissions from processes in the VTR, Test Assembly Examination, and Spent Fuel Storage and Treatment Facilities. INL would develop an Air Permitting and Applicability Determination (APAD) for each applicable source of radiological air emissions to ensure compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP), Subpart H. All radionuclide sources within these facilities would vent to stacks that would operate with continuous emission monitoring (CEM) systems and high-efficiency particulate air (HEPA) filters or a series of HEPA filters that have a control efficiency of at least 99.9 percent. Section 4.10.1 of this EIS presents estimates of annual radiological emissions that would occur from the operation of the INL VTR Alternative.

Air emissions from operation of the INL VTR Alternative would have the potential to affect the Craters of the Moon National Monument PSD Class I area. The substantial transport distance of minor amounts of operations emissions to the nearest boundary of the Craters of the Moon National Monument (about 45 miles) would produce substantial dispersion and would result in negligible concentrations of air pollutants within this pristine PSD Class I area. Therefore, operation of the INL VTR Alternative would negligibly affect air quality values within the Craters of the Moon National Monument pristine PSD Class I area.

4.4.2 ORNL VTR Alternative

The air quality analysis estimates air emissions that would result from the construction and operation of the ORNL VTR Alternative. Roane and Anderson Counties that encompass ORNL currently attain all of the NAAQS. Therefore, the analysis used the PSD-permitting threshold of 250 tons per year for criteria pollutants as indicators of the significance of projected air quality impacts within the ORNL project region.

4.4.2.1 Construction/Facility Modification

The ORNL VTR Alternative would require construction of new facilities for the VTR, Test Assembly Examination, and Spent Fuel Treatment and Storage facilities. Air quality impacts from projected construction activities would result from (1) combustive emissions due to the use of fossil-fuel-powered equipment, trucks, and worker's commuter vehicles and (2) fugitive dust emissions due to the operation of equipment on exposed soil.

Activity data needed for the estimation of construction emissions were based on the effort needed to construct the VTR complex at INL, plus site-specific activity data developed for site clearing, site excavation, and construction of the hot cell and spent fuel storage facilities at ORNL (Leidos 2020). Factors needed to derive construction source emission rates were obtained from the EPA MOVES2014b model for non-road construction equipment and on-road vehicles (EPA 2018a), the Western Regional Air Partnership's Fugitive Dust Handbook (Countess Environmental 2006) for fugitive dust, and the First Order Fire Effects Model (FOFEM) for slash burning (USFS 2020). The analysis assumes that DOE would implement protective measures to minimize the generation of fugitive dust during construction and to comply with Chapter 1200-3-8 (Fugitive Dust) of the Tennessee Air Pollution Control Regulations.

Implementation of these measures would reduce fugitive dust emissions from active disturbed areas by up to 74 percent compared to uncontrolled levels. DOE also would comply with Chapter 1200-3-4 (Open Burning) of the Tennessee Air Pollution Control Regulations to minimize emissions from proposed site clearing activities. Chapter 6, Section 6.1, of this EIS includes details of the air quality protective measures assessed in this EIS.

Table 4–7 presents estimates of calendar year emissions that would occur from construction of the VTR alternative at ORNL. The data in Table 4–7 show that construction of the VTR facilities would result in emissions that would be below the annual indicator thresholds. Therefore, annual emissions from construction of the combined facilities under the Alternative would not result in adverse air quality impacts.

Table 4–7. Calendar Year Nonradiological Construction Emissions – ORNL VTR Alternative

Calendar Year/Source Type	*Air Pollutant Emissions (tons per year)*						
	VOC	*CO*	*NO_x*	*SO_2*	*PM_{10}*	*$PM_{2.5}$*	*CO_2e (metric tons)*
Year 2022							
Onsite On-road Sources	0.01	0.14	0.15	0.00	0.02	0.01	72
Onsite Non-road Sources	0.33	1.80	0.99	0.00	0.08	0.08	272
Fugitive Dust					6.95	0.69	
Offsite On-road Sources	0.03	0.32	0.54	0.00	0.07	0.02	236
Slash Burning	28.88	136.80	3.06	1.91	26.64	22.64	2,787
Total Annual Emissions	**29.26**	**139.06**	**4.75**	**1.91**	**33.76**	**23.45**	**3,367**
Year 2023							
Onsite On-road Sources	0.08	2.99	0.62	0.00	0.10	0.03	552
Onsite Non-road Sources	0.68	4.27	8.45	0.02	0.42	0.41	2,571
Fugitive Dust					43.21	4.32	
Offsite On-road Sources	0.11	6.93	1.20	0.01	0.27	0.06	1,055
Total Annual Emissions	**0.87**	**14.19**	**10.27**	**0.03**	**44.02**	**4.82**	**4,178**
Year 2024							
Onsite On-road Sources	0.18	7.90	1.41	0.01	0.27	0.07	1,437
Onsite Non-road Sources	1.05	6.18	12.66	0.03	0.62	0.60	3,630
Fugitive Dust					13.00	1.30	
Offsite On-road Sources	0.28	19.58	3.23	0.02	0.82	0.18	3,117
Total Annual Emissions	**1.51**	**33.67**	**17.30**	**0.07**	**14.70**	**2.15**	**8,184**
Year 2025							
Onsite On-road Sources	0.13	5.55	1.14	0.01	0.22	0.06	1,157
Onsite Non-road Sources	1.00	5.64	12.35	0.03	0.58	0.56	3,912
Fugitive Dust					7.32	1.08	
Offsite On-road Sources	0.18	13.45	2.15	0.02	0.60	0.12	2,257
Total Annual Emissions	**1.31**	**24.64**	**15.64**	**0.06**	**8.72**	**1.83**	**7,326**
Annual Indicator Thresholds	**250**	**250**	**250**	**250**	**250**	**250**	**NA**
Exceed Threshold?	**No**	**No**	**No**	**No**	**No**	**No**	**NA**

CO = carbon monoxide; CO_2e = carbon dioxide equivalent; NA = not applicable; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter less than 2.5 microns in diameter; PM_{10} = particulate matter less than 10 microns in diameter; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Note: Due to rounding, sums and products may not equal those calculated from table entries.

Slash burning and the combustion of fossil fuels in construction equipment, trucks, and worker commuter vehicles would emit nonradiological HAPs. Onsite HAPs emissions from construction of the ORNL VTR Alternative would peak in year 2022 at 1.15 tons per year (equal to 15 and 3 percent, respectively, of combustive volatile organic compound (VOC) and PM_{10} emissions from diesel equipment plus 1 and 3 percent, respectively, of VOC and PM_{10} emissions from slash burning). The overwhelming majority of these emissions would occur from slash burning (equal to one and three percent, respectively, of VOC and PM_{10} emissions from this source). The intermittent emissivity of slash burning and the substantial transport distance of these emissions from the proposed location of the VTR facilities to the nearest locations of the ORNL facility boundary (about 2 miles) would produce substantial dispersion and inconsequential concentrations of HAPs beyond the ORNL property boundary. In addition, the intermittent operation of construction trucks and worker commuter vehicles on public roads would result in low concentrations of HAPs at these offsite locations. As a result, HAPs concentrations generated by construction activities would not result in adverse air quality impacts on the public.

Construction of the ORNL VTR Alternative would not generate radiological air emissions, as proposed construction activities would occur in nonradiological areas.

Air emissions from construction of the ORNL VTR Alternative would have the potential to affect the Joyce Kilmer-Slickrock Wilderness Area PSD Class I area, whose nearest border is about 38 miles south-southeast of the ORNL. As stated above for potential HAPs impacts from proposed construction, the intermittent operation of construction emission sources would result in dispersed concentrations of air pollutants at locations offsite ORNL. The substantial transport distance of these emissions to the nearest boundary of the Joyce Kilmer-Slickrock Wilderness Area (about 38 miles) would produce substantial dispersion and would result in negligible concentrations of air pollutants within this pristine Class I area. Therefore, construction of the ORNL VTR Alternative would negligibly affect air quality values within the Joyce Kilmer-Slickrock Wilderness Area pristine Class I area.

4.4.2.2 Operations

Air quality impacts from the operation of the ORNL VTR Alternative would occur from (1) intermittent use of diesel-powered backup electrical generators, (2) intermittent use of propane-fired heaters for the VTR sodium secondary heat transport system during maintenance activities, (3) diesel-powered trucks that deliver material and haul off wastes, and (4) worker commuter vehicles. Generator and heater operations, vehicle trips, and vehicle trip lengths used in the analysis are consistent with metrics developed for proposed VTR activities at ORNL (ORNL 2020c; Leidos 2020).

Factors needed to derive on-road vehicle emission rates were obtained from the EPA MOVES2014b model. To estimate emissions from the proposed backup generators, the analysis assumes that these units would operate at EPA non-road Tier 4 standard levels (EPA 2018a). The backup generators would operate for about four days per year (INL 2020a) within the VTR and hot cell facilities. If used exclusively for emergency replacement or standby service and at this proposed level of annual operation, these generator units would not require a construction or operating permit, as outlined in Chapter 1200-3-9-.04 (Construction and Operating Permits) of the Tennessee Air Pollution Control Regulations. In addition, the potential to emit for the generator units based on 500 hours of operation would produce insignificant emissions (less than 5 tons per year for criteria pollutants and less than 1,000 pounds per year for an individual HAP), as defined in Chapter 1200-03-09 of the Tennessee Air Pollution Control Regulations. Factors needed to estimate emissions for the propane-fired heaters were obtained from the EPA AP-42 document (EPA 2008).

Table 4–8 presents estimates of annual nonradiological emissions that would occur due to operation of the ORNL VTR Alternative. The data in Table 4–8 show that operation of the VTR facilities would result in minimal emissions that would be well below the annual indicator thresholds.

Table 4–8. Annual Nonradiological Operations Emissions – ORNL VTR Alternative

Source-Facility	Air Pollutant Emissions (tons per year)						
	VOC	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$	CO_2e (metric tons)
Back-up Generators	0.05	0.66	0.13	0.001	0.01	0.005	121
Sodium Heaters – Normal Operations	0.000	0.002	0.003	0.000	0.000	0.000	3
Haul Trucks	0.03	0.13	0.45	0.002	0.07	0.02	246
Worker Commuter Vehicles	0.06	7.21	0.39	0.006	0.19	0.03	852
Total– Normal Operations	**0.13**	**8.00**	**0.97**	**0.01**	**0.27**	**0.06**	**1,222**
Sodium Heaters - Large Component Replacement [a]	0.02	0.16	0.27	0.00	0.01	0.01	239
Annual Emissions during LCR Cycle [b]	**0.15**	**8.16**	**1.24**	**0.01**	**0.28**	**0.07**	**1,460**
Annual Indicator Thresholds	**250**	**250**	**250**	**250**	**250**	**250**	**NA**
Exceed Threshold?	**No**	**No**	**No**	**No**	**No**	**No**	**NA**

CO = carbon monoxide; CO_2e = carbon dioxide equivalent; LCR = large component replacement; NA = not applicable; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter less than 2.5 microns in diameter; PM_{10} = particulate matter less than 10 microns in diameter; SO_2 = sulfur dioxide; VOC = volatile organic compound.

[a] LCR would occur every 15 years.

[b] Equal to normal operations plus sodium heaters – LCR.

Note: Due to rounding, sums and products may not equal those calculated from table entries.

Combustion of fossil fuels in operations equipment, trucks, and worker commuter vehicles also would emit nonradiological HAPs. Operation of these sources by the VTR Facility would produce about 0.03 tons per year of combined HAPs emissions (equal to 15 and 3 percent, respectively, of combustive VOC and PM_{10} emissions from diesel equipment). The substantial transport distance of these HAPs emissions from the proposed location of the VTR facilities to the nearest locations of the ORNL facility boundary (about 2 miles) would produce HAPs impacts that would not exceed an ambient concentration of concern beyond the ORNL property boundary. In addition, the intermittent operation of delivery and haul trucks and worker commuter vehicles on public roads would result in low concentrations of HAPs at these offsite locations. As a result, HAPs concentrations generated by operations activities would not result in adverse air quality impacts on the public.

Operation of the ORNL VTR Alternative would generate radiological air emissions from processes in the VTR, Test Assembly Examination, and Spent Fuel Storage and Treatment Facilities. All radionuclide sources within these facilities would vent to stacks that would operate with CEM systems and HEPA filters or a series of HEPA filters that have a control efficiency of at least 99.9 percent. Each source of radiological air emissions would operate under a Construction Permit and existing Title V operating permit. An APAD would be performed to ensure compliance with NESHAP, Subpart H. Section 4.10.2 of this EIS presents levels of radiological emissions that would occur from operation of the VTR facilities at ORNL.

Air emissions from operation of the ORNL VTR Alternative would have the potential to affect the Joyce Kilmer-Slickrock Wilderness Area PSD Class I area. The substantial transport distance of minor amounts of operations emissions to the nearest boundary of the Joyce Kilmer-Slickrock Wilderness Area (about 38 miles) would produce substantial dispersion and would result in negligible concentrations of air pollutants within this pristine Class I area. Therefore, operation of the ORNL VTR Alternative would negligibly affect air quality values within the Joyce Kilmer-Slickrock Wilderness Area pristine Class I area.

4.4.3 Reactor Fuel Production Options

4.4.3.1 INL Reactor Fuel Production Options

4.4.3.1.1 INL Feedstock Preparation Option

Construction/Facility Modification

The feedstock preparation option would not require construction of new facilities at the INL Site. The only construction activities would be the build-out of equipment within the FMF, ZPPR, and FCF. Construction activity data developed by INL staff were used to estimate projected construction equipment usages and associated combustive emissions (INL 2020f).

Table 4–9 presents estimates of calendar year nonradiological emissions for construction of the feedstock preparation at the INL site. The analysis assumed that all modifications would occur in calendar years 2024 and 2025. The data in Table 4–9 show that construction under this option would result in minimal emissions that would be well below the annual indicator thresholds.

Combustion of fossil fuels in construction equipment, trucks, and worker commuter vehicles also would emit nonradiological HAPs. Onsite HAPs emissions from construction of the feedstock preparation option at the INL Site would be less than 0.001 tons per year (equal to 15 and 3 percent, respectively, of combustive VOC and PM_{10} emissions from diesel equipment). This minimal amount of HAPs emissions from construction would not result in adverse air quality impacts on the public.

Construction activities from the feedstock preparation at the INL site would not generate radiological air emissions.

Table 4–9. Calendar Year Nonradiological Emissions – Construction of Feedstock Preparation Facilities at INL

Calendar Year/Source Type	Air Pollutant Emissions (tons per year)						
	VOC	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$	CO_2e (metric tons)
Year 2024							
Onsite On-road Sources	0.000	0.02	0.002	0.000	0.000	0.000	53
Onsite Non-road Sources	0.000	0.001	0.002	0.000	0.000	0.000	2
Offsite On-road Sources	0.001	0.13	0.01	0.000	0.004	0.001	16
Total Annual Emissions	**0.002**	**0.15**	**0.02**	**0.000**	**0.005**	**0.001**	**20**
Year 2025							
Onsite On-road Sources	0.000	0.02	0.001	0.000	0.000	0.000	3
Offsite On-road Sources	0.001	0.12	0.01	0.000	0.004	0.001	16
Total Annual Emissions	**0.001**	**0.13**	**0.01**	**0.000**	**0.004**	**0.001**	**18**
Annual Indicator Thresholds	**250**	**250**	**250**	**250**	**250**	**250**	**NA**
Exceed Threshold?	**No**	**No**	**No**	**No**	**No**	**No**	**NA**

CO = carbon monoxide; CO_2e = carbon dioxide equivalent; NA = not applicable; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter less than 2.5 microns in diameter; PM_{10} = particulate matter less than 10 microns in diameter; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Note: Due to rounding, sums and products may not equal those calculated from table entries.

Operations

Air quality impacts from the operation of the feedstock preparation facilities at the INL Site would occur from (1) diesel-powered trucks that deliver material and haul off wastes and (2) worker's commuter vehicles. Operation of the INL Site feedstock preparation facilities would not produce any nonradiological emissions from stationary sources. Vehicle trips and associated trip lengths used in the analysis are consistent with the metrics developed for proposed activities at the INL Site.

Table 4–10 presents estimates of annual nonradiological emissions that would occur due to operation of the feedstock preparation at the INL Site. These data show that annual emissions from this scenario would be well below the annual indicator thresholds.

Table 4–10. Annual Nonradiological Operations Emissions from Feedstock Preparation Facilities at the INL Site

Facility	*Air Pollutant Emissions (tons per year)*						
	VOC	*CO*	*NO_x*	*SO_2*	*PM_{10}*	*$PM_{2.5}$*	*CO_2e (metric tons)*
Haul Trucks	0.000	0.000	0.001	0.000	0.000	0.000	1
Worker Commuter Vehicles	0.003	0.39	0.03	0.000	0.01	0.002	248
Total Annual Emissions	**0.003**	**0.39**	**0.03**	**0.000**	**0.01**	**0.002**	**49**
Annual Indicator Thresholds	**250**	**250**	**250**	**250**	**250**	**250**	**NA**
Exceed Threshold?	**No**	**No**	**No**	**No**	**No**	**No**	**NA**

CO = carbon monoxide; CO_2e = carbon dioxide equivalent; NA = not applicable; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter less than 2.5 microns in diameter; PM_{10} = particulate matter less than 10 microns in diameter; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Note: Due to rounding, sums and products may not equal those calculated from table entries.

Combustion of fossil fuels in trucks and worker commuter vehicles also would emit nonradiological HAPs. Onsite HAPs emissions from operation of the feedstock preparation facilities at the INL Site would be less than 0.001 tons per year (equal to 15 and 3 percent, respectively, of combustive VOC and PM_{10} emissions from diesel equipment). This minimal amount of HAPs emissions from operations would not result in adverse air quality impacts on the public.

Operation of the feedstock preparation facilities at the INL Site would generate radiological air emissions. INL would develop an APAD for each applicable source of radiological air emissions to ensure compliance with NESHAP, Subpart H. All radionuclide sources within these facilities would vent to stacks that would operate with CEM systems and HEPA filters or a series of HEPA filters that have a control efficiency of at least 99.9 percent. Section 4.10.3.1 of this EIS presents estimates of annual radiological emissions that would occur from the operation of the feedstock preparation at the INL Site.

4.4.3.1.2 INL Fuel Fabrication Option

Construction/Facility Modification

Construction activities for the fuel fabrication would be nearly identical to those associated with the feedstock preparation option. Therefore, emissions estimated for construction of the feedstock preparation, as presented in Table 4–9, would approximate those for construction of the fuel fabrication. As a result, construction of the fuel fabrication at the INL Site would result in minimal emissions that would be well below the annual indicator thresholds.

Combustion of fossil fuels in construction equipment, trucks, and worker commuter vehicles also would emit nonradiological HAPs. Onsite HAPs emissions from construction of the fuel fabrication option at the INL Site would be less than 0.001 tons per year (equal to 15 and 3 percent, respectively, of combustive VOC and PM_{10} emissions from diesel equipment). This minimal amount of HAPs emissions from construction would not result in adverse air quality impacts on the public.

Construction activities from the fuel fabrication option at the INL Site would not generate radiological air emissions.

Operations

Operations for the fuel fabrication option at the INL Site would be nearly identical to those associated with feedstock preparation, except that they would include a truck trip to dispose of waste. Therefore, nonradiological emissions estimated for operation of the feedstock preparation option, as presented in Table 4–10, would approximate those for operation of the fuel fabrication option. As a result, operation of the fuel fabrication option at the INL Site would result in minimal nonradiological emissions that would be well below the annual indicator thresholds.

Combustion of fossil fuels in trucks and worker commuter vehicles also would emit nonradiological HAPs. Onsite HAPs emissions from operation of the fuel fabrication at the INL Site would be less than 0.001 tons per year (equal to 15 and 3 percent, respectively, of combustive VOC and PM_{10} emissions from diesel equipment). This minimal amount of HAPs emissions from operations would not result in adverse air quality impacts on the public.

Operation of the fuel fabrication at the INL Site would generate radiological air emissions. INL would develop an APAD for each applicable source of radiological air emissions to ensure compliance with NESHAP, Subpart H. All radionuclide sources within these facilities would vent to stacks that would operate with CEM systems and HEPA filters or a series of HEPA filters that have a control efficiency of at least 99.9 percent. Section 4.10.3.1 of this EIS presents estimates of annual radiological emissions that would occur from the operation of the fuel fabrication option at the INL Site.

4.4.3.2 SRS Reactor Fuel Production Options

The air quality analysis estimates air emissions that would result from the construction and operation of the reactor fuel production options at SRS. Aiken and Barnwell Counties that encompasses SRS currently attain all of the NAAQS. Therefore, the analysis used the PSD permitting threshold of 250 tons per year for criteria pollutants as indicators of the significance of projected air quality impacts within the SRS project region.

4.4.3.2.1 SRS Feedstock Preparation Option

Construction/Facility Modification

The feedstock preparation option would not require construction of new facilities at SRS. Construction activities would include the build-out of the equipment locations within an existing facility in the K Area Complex and removal of existing equipment. Construction equipment fuel usages developed by SRS staff were used to estimate projected construction equipment combustive emissions (SRNS 2020). Vehicle trips and associated trip lengths used in the analysis are consistent with the metrics developed for proposed activities at SRS. Construction activities under this option would take about 3 years to complete.

Table 4–11 presents estimates of total emissions for construction of the feedstock preparation capability at SRS. The data in Table 4–11 show that construction of the option would result in total emissions that would be well below the annual indicator thresholds. Therefore, annual emissions from construction of the Scenario would not result in adverse air quality impacts.

Combustion of fossil fuels in construction equipment, trucks, and worker commuter vehicles also would emit nonradiological HAPs. Total onsite HAPs emissions from construction of the feedstock preparation option at SRS would be about 0.01 tons (equal to 15 and 3 percent, respectively, of combustive VOC and PM_{10} emissions from diesel equipment). The substantial transport distance of construction emissions from the K Area Complex to the nearest locations of the SRS facility boundary (about 5.5 miles) would result in inconsequential concentrations of HAPs beyond the SRS property boundary. Therefore, the minimal amount of HAPs emissions from construction would not result in adverse air quality impacts on the public.

Table 4–11. Annual Nonradiological Emissions – Construction of Feedstock Preparation Capability at SRS

Source	*Air Pollutant Emissions (tons per year)*						
	VOC	*CO*	*NO_x*	*SO_2*	*PM_{10}*	*$PM_{2.5}$*	*CO_2e (metric tons)*
Onsite On-road Sources	0.02	1.62	0.20	0.00	0.05	0.01	201
Onsite Non-road Sources	0.04	0.85	0.24	0.00	0.02	0.01	57
Offsite On-road Sources	0.05	3.24	0.44	0.00	0.10	0.02	416
Total Annual Emissions	0.11	5.71	0.88	0.01	0.17	0.05	**674**
Annual Indicator Thresholds	**250**	**250**	**250**	**250**	**250**	**250**	**NA**
Exceed Threshold?	**No**	**No**	**No**	**No**	**No**	**No**	**NA**

CO = carbon monoxide; CO_2e = carbon dioxide equivalent; NA = not applicable; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter less than 2.5 microns in diameter; PM_{10} = particulate matter less than 10 microns in diameter; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Note: Due to rounding, sums and products may not equal those calculated from table entries.

It is anticipated that asbestos would be encountered during demolition and renovation (D&R) activities. An inspection would be conducted by a licensed inspector prior to initiation of D&R activities and as needed during D&R to identify asbestos containing materials. D&R activities would comply with NESHAP Subpart M - National Emission Standard for Asbestos, as cited in South Carolina Department of Health and Environmental Control (SCDHEC) Air Pollution Control Regulations and Standards Regulation 61-62.61.

The majority of the material and equipment to be removed are expected to be radiologically clean, with the exception of heavy water tanks and their contents. Construction activities from the feedstock preparation at SRS would not generate radiological air emissions.

Operations

Air quality impacts from the operation of the feedstock preparation option at SRS would occur from (1) intermittent use of a diesel-powered backup electrical generator, (2) diesel-powered trucks that deliver and haul off materials, and (3) worker's commuter vehicles. Generator operations, vehicle trips, and vehicle trip lengths used in the analysis are consistent with metrics developed for proposed activities at SRS (SRNS 2020).

Table 4–12 presents estimates of annual nonradiological emissions that would occur due to operation of the feedstock preparation option at SRS. These data show that annual emissions from operations under this option would be well below the annual indicator thresholds.

Combustion of fossil fuels in operations equipment, trucks, and worker commuter vehicles also would emit nonradiological HAPs. Operation of the feedstock preparation and fuel fabrication option at SRS would generate onsite HAPs emissions of about 0.01 tons per year (equal to 15 and 3 percent, respectively, of combustive VOC and PM_{10} emissions from diesel equipment). The substantial transport distance of operations emissions from the K Area Complex to the nearest locations of the SRS facility boundary (about 5.5 miles) would result in inconsequential concentrations of HAPs beyond the SRS property boundary. Therefore, the minimal amount of HAPs emissions from operations would not result in adverse air quality impacts on the public.

Operation of the SRS feedstock preparation facilities would generate radiological air emissions that would approximate those estimated for the INL Site feedstock preparation facilities and are presented in Section 4.10.3.2 of this EIS. All radionuclide sources within these facilities would vent to stacks that would operate with CEM systems and HEPA filters or a series of HEPA filters that have a control efficiency of at least 99.9 percent.

Table 4–12. Annual Nonradiological Operations Emissions for Feedstock Preparation - SRS

	Air Pollutant Emissions (tons per year)						
Source - Facility	***VOC***	***CO***	***NO_x***	***SO_2***	***PM_{10}***	***$PM_{2.5}$***	***CO_2e (metric tons)***
Back-up Generators - VTR	0.02	0.23	0.03	0.0003	0.001	0.00	42
Haul Trucks	0.00	0.01	0.05	0.00	0.01	0.00	29
Worker's Commuter Vehicles	0.07	7.58	0.39	0.01	0.19	0.04	909
Total Annual Emissions	**0.08**	**7.83**	**0.47**	**0.01**	**0.20**	**0.04**	**980**
Annual Indicator Thresholds	**250**	**250**	**250**	**250**	**250**	**250**	**NA**
Exceed Threshold?	**No**	**No**	**No**	**No**	**No**	**No**	**NA**

CO = carbon monoxide; CO_2e = carbon dioxide equivalent; NA = not applicable; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter less than 2.5 microns in diameter; PM_{10} = particulate matter less than 10 microns in diameter; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Note: Due to rounding, sums and products may not equal those calculated from table entries.

4.4.3.2.2 SRS Fuel Fabrication Option

Construction/Facility Modification

Construction activities for the fuel fabrication at SRS would be nearly identical to those associated with the feedstock preparation option. Therefore, emissions estimated for construction of the feedstock preparation, as presented in Table 4–11, would approximate those for construction of the fuel fabrication. As a result, construction of the fuel fabrication at SRS would result in minimal emissions that would be well below the annual indicator thresholds.

Combustion of fossil fuels in construction equipment, trucks, and worker commuter vehicles also would emit nonradiological HAPs. Total onsite HAPs emissions from construction of the fuel fabrication at SRS would be about 0.01 tons (equal to 15 and 3 percent, respectively, of combustive VOC and PM_{10} emissions from diesel equipment). This minimal amount of HAPs emissions from construction would not result in adverse air quality impacts on the public.

It is anticipated that asbestos would be encountered during D&R activities. An inspection would be conducted by a licensed inspector prior to initiation of D&R activities and as needed during D&R to identify asbestos containing materials. D&R activities would comply with NESHAP Subpart M - National Emission Standard for Asbestos, as cited in SCDHEC Air Pollution Control Regulations and Standards Regulation 61-62.61.

The majority of the material and equipment to be removed is expected to be radiologically clean, with the exception of heavy water tanks and their contents. Construction activities from the fuel fabrication at SRS would not generate radiological air emissions.

Operations

Operations for the fuel fabrication option at SRS would be nearly identical to those associated with the feedstock preparation options Therefore, nonradiological emissions estimated for operation of the feedstock preparation, as presented in Table 4–12, would approximate those for operation of the fuel fabrication option. As a result, operation of the fuel fabrication at SRS would result in minimal nonradiological emissions that would be well below the annual indicator thresholds.

Combustion of fossil fuels in operations equipment, trucks, and worker commuter vehicles also would emit nonradiological HAPs. Operation of the fuel fabrication at SRS would generate onsite HAPs emissions of about 0.003 tons per year (equal to 15 and 3 percent, respectively, of combustive VOC and PM_{10} emissions from diesel equipment). This minimal amount of HAPs emissions from operations would not result in adverse air quality impacts on the public.

Operation of the fuel fabrication at SRS would generate radiological air emissions that would approximate those estimated for operation of the fuel fabrication at the INL Site and presented in Section 4.10.3.2 of this EIS. All radionuclide sources within these facilities would vent to stacks that would operate with CEM systems and HEPA filters or a series of HEPA filters that have a control efficiency of at least 99.9 percent.

4.4.4 Combined INL VTR Alternative and INL Reactor Fuel Production Options Impacts

4.4.4.1 Construction/Facility Modification

Tables 4–5 and 4–9 present estimates of annual nonradiological emissions that would occur from the construction of the VTR alternative and reactor fuel production options at the INL Site. Summing the data in Tables 4–5 and 4–9 would result in annual construction emissions from the combined activities that would equate to no more than 41 percent of an annual emission indicator threshold for any pollutant. As a result, nonradiological emissions generated by the combined construction activities would not result in adverse air quality impacts.

Onsite HAPs emissions generated from construction of the combined VTR alternative and reactor fuel options at the INL Site would peak in year 2023 at 0.14 tons per year (equal to 15 and 3 percent, respectively, of combustive VOC and PM_{10} emissions from diesel equipment). The mobile and intermittent operation of construction emission sources would result in dispersed concentrations of these HAPs adjacent to construction activities. The substantial transport distance of construction emissions from MFC to the nearest locations of the INL Site boundary (about 3 miles) would produce further dispersion and inconsequential concentrations of HAPs beyond the INL Site boundary. In addition, the intermittent operation of construction trucks and worker commuter vehicles on public roads would result in low concentrations of HAPs at these offsite locations. As a result, HAPs concentrations generated by the combined construction activities would not result in adverse air quality impacts on the public.

Construction activities from the INL VTR Alternative would not generate radiological air emissions, as facility modifications within radiological areas would not be expected to increase existing radiological air emissions. Construction activities from the reactor fuel production options at the INL Site would not generate radiological air emissions.

4.4.4.2 Operations

Tables 4–6 and 4–10 present estimates of annual nonradiological emissions that would occur from the operation of the VTR alternative and reactor fuel production options at the INL site. Summing the data in Tables 4–6 and 4–10 would result in annual operations emissions from the combined activities that would equate to no more than 1.6 percent of an annual emission indicator threshold for any pollutant. As a result, nonradiological emissions generated by the combined operations activities would not result in adverse air quality impacts.

Emissions from the combined onsite operations of the VTR alternative and reactor fuel production options at the INL Site would produce about 0.01 tons per year of HAPs emissions (equal to 15 and 3 percent, respectively, of combustive VOC and PM_{10} emissions from diesel equipment). The substantial transport distance of these HAPs emissions from the MFC to the nearest locations of the INL Site boundary (about 3 miles) would produce HAPs impacts that would not exceed an ambient concentration of concern beyond the INL Site boundary. In addition, the intermittent operation of delivery and haul trucks and worker's commuter vehicles on public roads would result in low concentrations of HAPs at these offsite locations. As a result, HAPs concentrations generated by combined operations activities would not result in adverse air quality impacts on the public.

Operation of the VTR alternative and reactor fuel options at the INL Site would generate radiological air emissions from facility processes. INL would develop an APAD for each applicable source of radiological air emissions to ensure compliance with NESHAP, Subpart H. All radionuclide sources within these facilities would be vented to stacks that would operate with CEM systems and HEPA filters or a series of HEPA filters that have a control efficiency of at least 99.9 percent. Section 4.10.4 of this EIS presents estimates of annual radiological emissions that would occur from the operation of the INL VTR Alternative and maximum emissions from the reactor fuel fabrication option (specifically, feedstock preparation) at the INL Site.

Air emissions from operation of the combined VTR alternative and fuel production at the INL Site would have the potential to affect the Craters of the Moon National Monument PSD Class I area. The substantial transport distance of minor amounts of operations emissions to the nearest boundary of the Craters of the Moon National Monument (about 45 miles) would produce substantial dispersion and would result in negligible concentrations of air pollutants within this pristine Class I area. Therefore, operation of the Combined VTR Alternative and INL Reactor Fuel Production Options would negligibly affect air quality values within the Craters of the Moon National Monument pristine Class I area.

4.5 Ecological Resources

Vegetation, wildlife wetlands and aquatic habitat, and rare, threatened, endangered, or sensitive species are the ecological resources at the INL Site and ORNL. Under the Proposed Action, potential impacts on ecological resources could include temporary and permanent disturbance, degradation, or loss of habitat from land clearing activities or disturbance or displacement of wildlife due to an increase in noise and human activity associated with construction. Impacts could also include fragmentation of remaining habitats resulting from project developments and increase in human-wildlife interactions (such as encounters and collisions between wildlife and motor vehicles). Multiple hazards (e.g., accidental spill or disaster) pose a risk for potential deleterious effects on vegetation and wildlife such as decline in species diversity, mortality, growth rate, vigor, and genetic mutations. For the VTR at the INL Site or ORNL, operational accidents are all managed so that no fuel melts and results in negligible releases. A fire involving VTR spent fuel subassemblies in the VTR Experiment Hall is considered extremely unlikely (see Section 4.1.1, Human Health Facility Accidents). Radiological exposure has different effects on ecological resources where some species are more sensitive than others. For the Proposed Action, radiological impacts on human health was used as a measure to determine the need to address the potential impacts on ecological resources. Radiological exposure from the Proposed Action does not differ significantly from current levels, and radiological impacts on human health was determined to be insignificant; therefore, impacts on ecological resources were considered to be minor and were not analyzed in detail. Furthermore, the project design provides additional structures, spill prevention, and management plans (e.g., wastewater discharge, waste management) that would contain and control any spills. Thus, any potential impacts on ecological resources caused from chemical spills are considered minor.

Impact significance for ecological resources is assessed based on intensity of the impact (how severely the resources is affected) and context (what proportion of the resource is affected). Context takes into account the importance of the resources, which is related to such factors as function, condition, and relative scarcity. Significant impacts are considered to occur if activities (e.g., construction) were to take place within important habitat use areas during critical seasons or if permanent habitat disturbance would exceed 1 percent of available similar habitat within the site and surrounding area. Likewise, if construction or operation of the Proposed Action were to cause population-level effects to any species from direct mortality or diminished survivorship, it would be considered significantly impactful. This analysis focuses on wildlife or vegetation types that are important to the function of the ecosystem or are protected under Federal or State law or statute.

Table 4–13 presents a summary of the potential environmental consequences on ecological resources for the INL and ORNL VTR Alternatives and the INL and SRS Reactor Fuel Production Options.

Table 4–13. Summary of Environmental Consequences on Ecological Resources

	VTR Alternatives	
	INL VTR	***ORNL VTR***
Construction	**Area disturbed:** about 100 acres	**Area disturbed:** about 150 acres
Operations	**Area occupied:** about 25 acres Operations would take place in the newly constructed facilities. No additional land disturbance, no additional excavation, therefore no impacts on ecological resources.	**Area occupied:** about 50 acres Operations would take place in the newly constructed facilities. No additional land disturbance, no additional excavation, therefore no impacts on ecological resources.
Discussion	*Vegetation*: Construction would result in a loss of sagebrush habitat. In compliance with the CCA, pre- and post-construction surveys must be completed to establish the amounts of sagebrush restoration and other native revegetation efforts needed to rehabilitate disturbed areas as determined by DOE's ESER contractor. To comply with DOE's policy, the loss of sagebrush from the Proposed Action requires monitoring sagebrush disturbance and planting amounts equal to that disturbed in areas beneficial to sage-grouse. Revegetation of temporary disturbance areas would occur in accordance with annual INL Site Revegetation Assessment program practices (INL/EXT-19-56726). Invasive species management will continue to be implemented at the INL Site. *Wildlife*: Operational and administrative controls would be evaluated and implemented, if warranted, to reduce the potential for adverse effects to wildlife species and human-wildlife interactions. These controls include (but are not limited to) seasonal timing of project activities, enforcing low speed limits, ultrasonic warning whistles to flush wildlife, hazing animals from the road, and preemptive awareness programs for construction crews. Administrative controls would include the posting of speed limit signs, and roping off sensitive areas (such as snake hibernacula and the pygmy rabbit burrow area). Wildlife habitat fragmentation could occur. Land clearing would cause disturbances in the landscape resulting in new habitat edges, potentially disrupting wildlife ecosystem processes and habitats. Infrastructure and traffic could impose dispersal barriers to most non-flying terrestrial animals. *Special status species*: In addition to the operational and administrative controls listed above, construction/land clearing activities that include vegetation removal, occurring from April 1 to October 1 would be controlled to preclude damage to active nests of all MBTA-protected species including waterfowl, corvids (ravens), owls, hawks, eagles, and passerines. Nesting bird surveys, as indicated in the MBTA permit, would occur prior to any ground disturbance or vegetation removal to confirm the absence of MBTA protected species, as well as sage-	*Vegetation:* Construction would result in a loss of forested habitat, including up to 37 hemlock trees. A forester (as administered by the ORNL Natural Resource Manager) would survey the site to assess the age and value of hemlock trees subject to permanent disturbance, as well as inspect for non-native insect pests prior to construction and/or site clearing activities. Additionally, invasive species management would continue to be implemented through the Invasive Plant Management Program at ORNL. *Wildlife*: Operational and administrative controls will be evaluated and implemented, if warranted, to reduce the potential for adverse effects to wildlife species and human-wildlife interactions. These controls include (but are not limited to) seasonal timing of project activities, reduced speed limits, ultrasonic warning whistles, hazing animals from the road, and preemptive awareness programs for construction crews. ONRL would time tree removal to occur outside of times of increased migratory bird activity. Increased activity typically occurs from late March through early August. Wildlife habitat fragmentation could occur. Land clearing would cause disturbances in the landscape resulting in new habitat edges, potentially disrupting wildlife ecosystem processes and habitats. For less mobile species, such as amphibians and insects, there is the potential for impacts on local populations. *Special status species:* If the ORNL VTR Alternative were selected, additional species-specific surveys will need to occur to adequately determine the severity of effects to federally and State-listed special status species from the Proposed Action. Mitigation for federally and State-listed species, aquatic features and sensitive habitats may also be required. Tree removal and other activities would avoid certain times of the year to minimize impacts on species, such as federally and State listed bats and migratory birds. Construction/land clearing activities, including vegetation removal, that occur from April 1 through October 1 would be controlled to preclude damage to active nests of passerines. Work during the migratory bird nesting season (April 1 through October 1) requires a migratory bird nesting survey 72 hours

	grouse, from the proposed project area. A 300-foot buffer would be established around active pygmy rabbit burrow systems to prevent direct impacts. Temporary staging of VTR components, construction equipment, and worker parking would occur outside of this area. Although habitat fragmentation could occur from the loss of sagebrush due to land clearing, sagebrush habitats would be restored elsewhere onsite under the CCA. *Aquatic Resources*: There are no aquatic resources within the proposed project area. Therefore, no impacts on aquatic resources would occur under the INL VTR Alternative.	prior to vegetation disturbance in an area. Any tree removal from April 1 to November 15 may impact roosting sites for federally and State-listed bats. DOE would be required to consult with USFWS and the TWRA and/or TDEC prior to construction and/or site clearing activities. *Aquatic Resources:* Vegetation within the proposed project area is comprised primarily of forested wetland habitats. About 10.5 acres (4.25 hectares) of wetlands, 15,637 feet (4,766 meters) of streams, conveyances and/or channels, and 30 seeps and spring could be impacted. Compliance with all Federal and State (e.g., Exceptional Tennessee Waters) and regulations will occur. A Section 404 wetland permit from USACE must be obtained prior to any construction work within jurisdictional features and compensatory mitigation would be required for any unavoidable impacts.
	Reactor Fuel Production Options	
	INL Reactor Fuel Production	***SRS Reactor Fuel Production***
Construction and Operations	No additional land disturbance, no additional excavation, therefore no impacts on ecological resources would occur.	
Discussion	Activities associated with constructing/modifying and operating facilities would occur in existing facilities or adjacent to those facilities on previously developed or disturbed areas. Therefore, no impacts on ecological resources.	
	Combined INL VTR Alternative and INL Reactor Fuel Production Options	
Discussion	Same as for INL VTR Alternative because minimal or no impacts from fuel fabrication.	

CCA = Candidate Conservation Agreement; ESER = Environmental Science, Education and Research Program; MBTA = Migratory Bird Treaty Act.

4.5.1 INL VTR Alternative

As described in Chapter 3, Section 3.1.5, the ROI for ecological resources under the INL VTR Alternative, includes the MFC facility and surrounding area within the INL Site.

4.5.1.1 Construction/Facility Modification

Vegetation

Under the INL VTR Alternative, potential temporary and permanent impacts on sagebrush steppe habitats would occur as a result of site clearing, excavation, and grading conducted as part of constructing building foundations, roadways, parking areas, and laydown areas. **Table 4–14** presents the permanent and temporary impacts on vegetation communities as a result of the INL VTR Alternative.

Table 4–14. Impacts on Vegetation Communities within the INL VTR Alternative Proposed Project Area

Proposed Project Area	*Vegetation Community*	*Impacted Acreages*
Permanent Impact Area	Cheatgrass Ruderal Grassland	0.07
	Big Sagebrush – Green Rabbitbrush (Threetip Sagebrush) Shrubland	10.37
	Previously disturbed/facilities	17.71
	Total	**28.15**
Temporary Impact Area	Cheatgrass Ruderal Grassland	1.07
	Big Sagebrush – Green Rabbitbrush (Threetip Sagebrush) Shrubland	24.63

Proposed Project Area	Vegetation Community	Impacted Acreages
	Crested Wheatgrass Ruderal Grassland	0.07
	Green Rabbitbrush/Thickspike Wheatgrass Shrub Grassland and Needle and Thread Grassland	24.88
	Previously disturbed/facilities	20.71
	Total	**71.36**
	TOTAL IMPACT AREA	**~100 acres**

Note: Due to rounding, sums and products may not equal those calculated from table entries.

Under implementation of the INL VTR Alternative, development would cause permanent impacts on about 17.7 acres of previously disturbed habitat and 10.4 acres of sagebrush shrublands. Temporary impacts would affect about 20.7 acres of previously disturbed habitat and about 50.6 acres of shrublands and grassland communities (Table 4–13). Temporary impacts on vegetation could occur from the impermanent staging of VTR components, construction equipment, and worker parking for the duration of 51 months. These impacts would be temporary and localized and would not be anticipated to result in long-term or permanent impacts on surrounding vegetation communities. Vegetation would be restored within the staging and parking areas. Initially it would be very difficult to rehabilitate native vegetation similar in species composition, structure, and ecological function to that originally present, but over time the area would be expected to recover and serve similar ecological functions. These impacts on vegetation would account for less than 1 percent (about 0.02 percent) of the 496,877 acres of sagebrush steppe habitat available within the INL Site. However, the DOE implements a 'no net loss of sagebrush habitat' policy on the INL Site under the Candidate Conservation Agreement (CCA) for the sage-grouse. Therefore, impacts would be mitigated.

In compliance with the CCA, the project must complete pre and post-construction surveys to establish the amounts of sagebrush restoration and other native revegetation efforts needed to rehabilitate disturbed areas as determined by DOE's Environmental Science, Education and Research Program (ESER) contractor. To mitigate the loss of sagebrush and comply with DOE policy, the INL VTR Alternative would require monitoring sagebrush disturbance and planting amounts equal to that disturbed in non-project areas that are beneficial to sage-grouse. Replacement of about 36 acres of sagebrush habitat (11.0 acres due to permanent impacts and 25 acres due to temporary impacts) would be required. Revegetation would occur in accordance with annual INL Site Revegetation Assessment program practices (INL/EXT-19-56726). Refer to the *Invasive Species* section below for additional information regarding revegetation of the proposed project area.

Invasive Species

Under the INL VTR Alternative, construction and land clearing activities would potentially increase soil disturbance. Soil disturbance is a primary contributor to the spread of invasive plants and increases in weedy non-native invasive species. As a result, invasive species management and weed control would be necessary to facilitate re-establishment of native communities. Prior to revegetation efforts, the need for a Weed Management Plan will be evaluated and, if warranted, would be developed to establish proactive invasive species management goals. Invasive species management will continue to be implemented under the Proposed Action. INL staff identify and implements BMPs to reduce the need for revegetation efforts during the National Environmental Policy Act (NEPA) process (e.g., minimizing off-road vehicle travel, limiting soil disturbance to previously disturbed areas, mowing vegetation instead of grubbing, etc.). There is also an environmental checklist process to determine when project activities have the potential to result in soil disturbance and to identify when vegetation restoration is required (INL/EXT-19-56726).

Wildlife

Under the INL VTR Alternative, wildlife within the proposed project area could be permanently or temporarily disturbed or displaced due to an increase in noise and human activity associated with construction and/or the loss of habitat from land clearing activities. Noise effects from construction would be short term (lasting the duration of the project construction) and would only affect wildlife in the immediate project areas. Species would likely flush from the area to similar habitat(s) available nearby. Those affected would generally be able to return to the temporarily disturbed areas after project construction completion. While some wildlife might avoid project sites long term, the affected areas would be small compared with other, similar habitats available nearby.

Construction activities could also result in potential collisions between wildlife and motor vehicles. In addition, commuter traffic from facility operation could increase by about 5 percent (Section 4.13.1) and could directly impact species (e.g., snakes) through increased risk of collision over time.

In an effort to minimize potential impacts, the need for operational and administrative controls would be evaluated and implemented, if warranted, to reduce adverse effects to wildlife species. These controls include but are not limited to, daily and seasonal timing of project activities, reduced speed limits, ultrasonic warning whistles, hazing animals from the road, and preemptive awareness programs for construction crews. Administrative controls would include the posting of speed limit signs, and roping off sensitive areas (such as snake hibernacula and the pygmy rabbit burrow area). Increased vehicle activity within the proposed project area could potentially increase the risk for wildlife strikes by vehicles. Mortality to wildlife caused by a collision could be minimized by reducing speeds to less than 15 miles per hour and increasing awareness of construction crews to the presence of any animals that may frequent the area. If an animal is observed in the road, vehicles will stop and wait until the animal leaves the road, and if necessary, encourage the animal to move on by driving forward slowly.

Timing of Project Activities. The following information details sensitive breeding, nesting or generally more active times of wildlife known to occur within or near the proposed project area. Operational controls would be evaluated and implemented, if warranted, to minimize impacts on those species.

- <u>Migratory Bird Treaty Act (MBTA)-protected species: waterfowl, corvids (ravens), owls, raptors (hawks, eagles), and passerine birds</u>: All year. Surface and vegetation disturbing activities should avoid nesting season for the various groups of birds or be preceded by surveys to confirm the absence of nesting birds. Work during the migratory bird nesting season (April 1 through October 1) for passerines requires a migratory bird nesting survey 72 hours prior to vegetation disturbance in an area. Nesting season for owls, hawks, and eagles may begin earlier than passerines, as early as October, and peak nesting season for corvids is from February 1 – July 1. There is one common raven nest located within the proposed project footprint on a met tower. Nest removal and removal of the met tower has not been proposed at this time. The second closest active nest (common raven) is located about 0.97-mile northwest of the proposed project area. Under the Proposed Action, impacts on this nest would be avoided.

- <u>Sage-grouse</u>: March 15 – May 15 from 6 p.m. to 9 a.m. Eliminate human disturbance within 0.6 mile of active leks.

- <u>Pygmy rabbits</u>: All year. To the maximum extent practical areas known to be occupied by pygmy rabbit would be avoided. There is one documented pygmy rabbit burrow system located within the temporary disturbance area. Minimize activity or completely avoid rabbit locations (where practicable) within 300 feet to prevent direct impacts.

- <u>Snakes</u>: May – September. Potential suitable habitat for snakes is present within the sagebrush communities that occur throughout the proposed project area. There is one known hibernaculum (located in the southeast corner of the proposed project area). To avoid or reduce human-snake encounters, the hibernaculum location should be avoided and construction activity should be minimized during the summer active season when snakes are known to occur in high densities (May – early June and September – early October). If construction were to occur during these times, there could be an increased risk of snake mortality and an increase in safety concerns for workers. Construction workers would be encouraged to check dark places before operating machinery, to step on rather than over rocks where a snake may be hiding, and to be extra cautious during cooler times of the day throughout the summer.

Additionally, under the INL VTR Alternative indirect impacts on wildlife from habitat fragmentation could occur. Land clearing would cause disturbances in the landscape resulting in new habitat edges, potentially disrupting wildlife ecosystem processes and habitats. The degree of the loss would depend on the behavior response of the individual species. Infrastructure and traffic could impose dispersal barriers to most non-flying terrestrial animals. To mitigate the loss of sagebrush and comply with DOE policy in accordance with annual INL Site Revegetation Assessment program practices (INL/EXT-19-56), the proposed project would create additional sagebrush habitat that would provide opportunities for wildlife movement. Furthermore, there would be unaffected habitat in the region able to support wildlife movement thus impacts on habitat fragmentation would be limited.

Special Status Species

Land clearing activities within the proposed project area at the INL Site are not anticipated to result in temporary or permanent impacts on federally threatened and endangered species. No federally listed species or designated critical habitats have been recorded within the proposed project area and no federally listed species were observed during surveys conducted in September of 2019 and May of 2020 (Veolia 2019; VNSFS 2020). Additionally, no federally listed species have been historically documented within the INL Site under the ESER Program.

Land clearing activities could result in potential temporary and permanent impacts on State-listed species (such as bats and pygmy rabbits) at the INL Site. Bat roost sites and foraging habitat could be removed during construction and land clearing associated with the MFC; however, there would be no loss of bat hibernacula (or winter habitat). The Proposed Action could result in the direct loss of vegetation and associated indirect impacts on pygmy rabbit habitat. However, impacts are not expected to cause a loss in the local population. The recently (May 2020) documented burrow system is located within the temporary disturbance area, and direct impacts caused by construction activities within 300 feet would be avoided completely to the maximum extent practical. Noise effects from construction would be short term, lasting the duration of the project. Pygmy rabbits use burrows for means of escape and are closely tied to their burrow system; therefore, pre-construction/land clearing surveys would be conducted and any impacts on their burrows would be avoided and mitigated, as necessary. Therefore, no significant impacts on State listed species are expected under implementation of the Proposed Action.

While sage-grouse are known to utilize the INL Site, there are no sage-grouse lek locations within the proposed project area. The closest known active lek is located about 2.7 miles to the east of the proposed project area (see Chapter 3, Figure 3–8). Fecal pellets were observed during the May 2020 survey, indicating recent species presence likely moving between sagebrush habitats (VNSFS 2020). Nesting bird surveys, as indicated in the MBTA permit, would occur prior to any ground disturbance or vegetation removal to confirm the definitive absence of sage-grouse from the proposed project area. Although the sage-grouse does not warrant protection under the Endangered Species Act (ESA), the DOE and U.S. Fish and Wildlife Service (USFWS) continue to collaborate on sage-grouse protection at the INL Site under the CCA (DOE-ID & USFWS 2014). While the proposed project area is not within the established sage-grouse conservation area, the loss of potential suitable habitat is subject to the DOE's "no net loss of sagebrush habitat" policy on the INL Site. In compliance with the CCA, the project must complete pre- and post-construction surveys to establish the amounts of sagebrush restoration and other native revegetation efforts needed to rehabilitate disturbed areas as determined by DOE's ESER contractor. Revegetation of the project site with native grasses would be evaluated and implemented to address soil stabilization and long-term weed control. To mitigate the loss of sagebrush and comply with the DOE's policy, the Proposed Action requires monitoring sagebrush disturbance and planting amounts equal to that disturbed in areas beneficial to sage-grouse. This would include the 11.0 acres of sagebrush habitat within the permanent impact area and the 24.63 acres of sagebrush habitat within the temporary impact area. Although habitat fragmentation could occur from the loss of sagebrush because of land clearing, sage-brush habitats would be restored elsewhere onsite under the CCA.

Under the Proposed Action, breeding bird monitoring would continue to occur. DOE-ID has a USFWS MBTA *Special Purpose Permit* for limited nest relocation and destruction and the associated take of migratory birds if deemed absolutely necessary for mission-critical activities. The permit would be applied in very limited and extreme situations where no other recourse is practicable (INL 2019c). In accordance with the USFWS Mitigation Policy, DOE would be required to evaluate ways to avoid or minimize any such impacts during construction and operation of the proposed facilities. The addition of manmade features could entice wildlife, such as nesting birds. For example, the construction of new facilities could attract swallows to newly available eaves and overhangs where swallows like to build mud nests. To prevent swallows and other birds from building nests in newly constructed facilities, INL would take the following proactive steps:

- Install a physical barrier, such as bird netting under eaves and overhangs;
- Use of sound deterrents such as swallow distress calls; and/or
- Use of visual deterrents, such as flash tape, predator eye balloon and/or reflective eye diverters.

As previously discussed above under *Wildlife*, the need for operational and administrative controls would be evaluated and implemented, if warranted, and would include employing time of year restrictions during land clearing activities. Suitable bird nesting habitat is present throughout the proposed project area. Construction/land clearing activities, including vegetation removal, that occur from April 1 to October 1 would be controlled to preclude damage to active nests of passerines. Work during the migratory bird nesting season (April 1 through October 1) for passerines requires a migratory bird nesting survey 72 hours prior to soil or vegetation disturbance in an area. Nesting season for owls, hawks, and eagles may begin earlier than passerines, as early as October, and peak nesting season for corvids is from February 1 – July 1. Nesting bird surveys, as indicated in the MBTA permit, would occur prior to any ground disturbance or vegetation removal. If surveys discover active nests, the project would implement measures, such as creating suitable buffer areas around active nests or halting work, to prevent nest failure or abandonment until young have fledged.

The annual MFC Breeding Bird Survey Route intersects with the proposed project area, including both temporary and permanent disturbance areas (Figure 3-8). As a result, future annual routes may need to be modified accordingly. Therefore, impacts on migratory birds (including Birds of Conservation Concern [BCC] species) would be minimized and implementation of the Proposed Action would not result in any significant impacts.

No bald or golden eagles are known to nest in or near the proposed project area. Therefore, impacts on bald eagles are not expected to occur.

Aquatic Resources

There are no aquatic resources located within the proposed project area. Therefore, no impacts on aquatic resources are expected to occur under implementation of the Proposed Action.

Wildfire

Under the INL VTR Alternative, land clearing activities could cause disturbance to soil, which could indirectly promote the invasion of weeds that may alter the fire regime. An increase in weedy species can lead to high fuel loads (dense, dry vegetation) and generally lead to increased fire intensity and risk for a wildfire. As previously discussed under *Invasive Species*, invasive species management will continue to be implemented under the Proposed Action. Restoration and other native revegetation efforts would be evaluated and employed, if warranted, to rehabilitate the disturbed areas (as determined by DOE's ESER contractor). Revegetation of the project site with native grasses would be recommended to address soil stabilization and long-term weed control. Additionally, wildland fire management will continue to be employed at the INL Site to reduce the risk of wildfire and prevent any additional losses of sagebrush habitats.

4.5.1.2 Operations

As presented in Table 4–13, the VTR and associated facilities would occupy about 25 acres during operations. The 25 acres of land within the footprint of the completed VTR complex would be occupied by facilities, parking areas, walkways and roads, or revegetated. Operation of the VTR and associated facilities would not involve ground disturbance and therefore would have little additional impact on ecological resources, other than those previously described for construction/facility modification.

4.5.2 ORNL VTR Alternative

As described in Chapter 3, Section 3.2.5, the ROI for ecological resources under the ORNL VTR Alternative, includes ORR and the Melton Valley Site.

4.5.2.1 Construction/Facility Modification

Vegetation

Under the ORNL VTR Alternative, potential temporary and permanent impacts on vegetation could occur because of land clearing, excavation, and grading conducted as part of constructing building foundations, roadways, parking areas, and laydown areas. An estimated 144.8 acres of forested-hardwood areas (including 0.6 acres of early successional forest and 15.3 acres of mature forest) would be impacted under the Proposed Action. Additionally, about 2.5 acres of previously disturbed areas as well as 4.0 acres of right-of-way areas would be developed. The western portion (15.3 acres) of the proposed project area is mature forest (not subject to pine salvage during 1965-1966) that was used in 1960s and 1970s as an ORNL Ecological Field Area. Furthermore, the ORNL VTR Alternative could affect various special and sensitive natural resource areas (i.e., NA, RA, and HA) recognized in the NERP; thus impacting long-term research opportunities and on-going studies that have occurred within these unique habitats.

Additionally, up to 37 hemlock trees (among the largest trees on ORNL) could be removed. In Tennessee, hemlock trees are voluntarily protected as part of the Hemlock Conservation Partnership (TWRF 2018). If the ORNL VTR Alternative were selected, a forester (as administered by the ORNL Natural Resource Manager) would survey the site to assess the age and value of trees, as well inspect for non-native insect pests prior to construction and/or site clearing activities. If warranted, additional coordination between the ORNL Natural Resource Manager and the Hemlock Conservation Partnership would occur.

These impacts on vegetation would account for less than one percent (about 0.6 percent) of the 24,000 acres of forested-hardwood habitat and less than one percent (about 0.98 percent) of the 4,100 acres of interior forest within the ORNL. These impacts on vegetation from the ORNL VTR Alternative would generally be considered minor due to the availability of forested-hardwood habitats within the ORNL and intermountain regions of Appalachia. Ongoing assessments of the ORNL's ecological resources suggest that in-kind mitigation (i.e., protection or enhancement of ecologically similar resources) could be required due to impacts on vegetation and may entail greater acreage than available elsewhere on ORNL (ORNL 2020d).

Invasive Species

Under the ORNL VTR Alternative, construction and land-clearing activities could potentially increase soil disturbance. Soil disturbance is a primary contributor to the spread of invasive plants and increases in weedy non-native species. As a result, invasive species management and weed control would be necessary to facilitate re-establishment of native communities. ORNL is proactive in the effort to prevent and control invasive species. Prior to revegetation efforts, the need for a *Weed Management Plan* would be evaluated and, if warranted, would be developed to establish invasive species management goals. This plan, as well as invasive species management, would continue to be implemented through the Invasive Plant Management Program under the Proposed Action.

Wildlife

Under the ORNL VTR Alternative, wildlife within the proposed project area could potentially be disturbed or displaced (permanently or temporarily) due to the loss of habitat from land clearing activities, an increase in noise, and human activity associated with construction and/or operations. Construction activities could also result in potential collisions between wildlife and motor vehicles. In addition, commuter traffic from facility operation could increase by about 5 percent (Section 4.13.2) and could directly impact species through increased risk of collision over time.

In an effort to minimize potential impacts, operational controls would be implemented by ORNL to reduce the possibility for adverse effects to wildlife species. These controls include (but are not limited to) seasonal timing of project activities, reduced speed limits, ultrasonic warning whistles, hazing animals from the road, and preemptive awareness programs for construction crews. Wildlife strikes by vehicles may occur when animals are present in roadways. Mortality may be minimized by reducing speeds to less than 15 miles per hour and increasing awareness of construction crews to the presence of any animal that might frequent the area. If an animal is observed in the road, vehicles will stop and wait until the animal leaves the road, and if necessary, encourage the animal to move on by driving forward slowly.

In addition to the potential for temporary wildlife disturbance during construction activities, vegetation removal could represent long-term habitat loss to wildlife as well as cause habitat fragmentation. Land clearing would cause disturbances in the landscape resulting in new habitat edges, potentially disrupting wildlife ecosystem processes and habitats. For less mobile species, such as amphibians and insects, loss of habitat could cause mortality and potentially impact local populations. Additional surveys, accounting for seasonal patterns of wildlife within the proposed project area, would be needed to determine the extent of projected loss to species. Ongoing assessments of the ORNL's ecological resources suggest that in-kind mitigation (i.e., protection or enhancement of ecologically similar resources) could be required due to impacts on wildlife habitat, specifically to sensitive species.

Infrastructure and traffic could impose dispersal barriers to most non-flying terrestrial animals. Trees and other vegetation subject to clearing could support foraging, nesting, and other behaviors for mammals, birds (including migratory birds and BCC), amphibians, and reptiles. In an effort to avoid impacts on nesting birds, ORNL would time tree removal, to the extent practicable, to occur outside of migratory bird activity. Increased activity typically occurs from late March through early May (refer to section *Special Status Species* below for a more detailed discussion of migratory birds).

While any habitat loss could potentially adversely affect individual animals, the amount of impacted habitat would be relatively small (less than 1 percent) compared to similar habitat available within the ORNL and intermountain regions of Appalachia. It is expected that noise effects would be short term and would only affect wildlife in the immediate vicinity of the project. Those affected would generally be able to return to the area(s) after completion of construction and land clearing activities. While some wildlife might avoid the project sites long-term, the affected areas would be small compared with other, similar habitat available nearby.

Overall, population-level effects to wildlife species are not expected. Under the Proposed Action, species monitoring and management for the area would continue to be implemented through the *Wildlife Management Plan for the Oak Ridge Reservation* (ORNL 2020e).

Special Status Species

Under the ORNL VTR Alternative, direct and indirect impacts on federally and State-listed species could potentially occur due to construction and tree clearing activities associated with the Proposed Action. If the ORNL VTR Alternative were selected, additional species-specific surveys would be required to account for the seasonal patterns of various species (federally and State-listed plants and wildlife) to adequately determine the severity of effects to special status species from the Proposed Action. DOE would be required to consult with the USFWS Tennessee Ecological Services Field Office under Section 7 Interagency Cooperation regarding potential impacts on federally listed species protected under the ESA. Additionally, DOE would be required to consult with the Tennessee Wildlife Resources Agency (TWRA) and/or TDEC regarding State listed species of special concern.

Land clearing activities, including tree removal and any changes to hydroperiods, may affect special status bat and salamander species and their habitats (such as caves and underlying karst and aquatic subterranean habitat). Past surveys have identified multiple federally and State-listed species and special use habitats (such as nearby caves) within the vicinity of the proposed project area. Additional surveys would be required and would need to be conducted at specific times of the year for the various sensitive plant and wildlife species (Tables 3-22 and 3-23) to determine the level of impact. Species-specific survey protocols could be required as directed through consultations with the USFWS, U.S. Army Corps of Engineers (USACE), TWRA, and/or TDEC prior to work.

Mitigation for federally and State-listed species, aquatic features and sensitive habitats may also be required. Some species, such as federally and State-listed bats (e.g., Indiana bat, northern long-eared bat, gray bat, little brown bat, tricolored bat, small-footed bat), birds (e.g., wood thrush), amphibians (e.g., four-toed salamander), migratory birds, USFWS BCC and USFWS BMC would require tree removal and other activities to be avoided during certain times of the year. DOE would be required to consult with the USFWS about the potential impacts of construction and operation of from the proposed VTR and associated facilities action on migratory birds, bats, and amphibians. In accordance with the USFWS Mitigation Policy, DOE would be required to evaluate ways to avoid or minimize any such impacts during construction and operation of the proposed VTR land clearing activities (DOE 1999b). Construction/land clearing activities, including vegetation removal that occur from April 1 to October 1 would be controlled to preclude damage to active nests of passerines. Nesting season for owls, hawks, and eagles may begin earlier than passerines, as early as October. Work during the bird nesting season requires a migratory bird nesting survey 72 hours prior to vegetation disturbance in an area. If surveys discover active nests, the project would implement measures, such as creating suitable buffer areas or halting work, to prevent nest failure or abandonment until after the bird nesting season or until young have fledged. Any tree removal from April 1 to November 15 may impact foraging habitat and roosting sites for federally and State-listed bats. Direct impacts on amphibians (e.g., four-toed salamander) and suitable habitats may also be greater at certain times of the year. Implementation of studies and ongoing monitoring under the

ORNL management plan (ORNL 2020e) as well as pre-construction/ land clearing and species-specific protocol surveys will document occurrence of federally and State-listed species and necessary measures will be incorporated to minimize and avoid impacts on these species.

No bald or golden eagles are known to nest in or near the proposed project area. The nearest recorded active bald eagle nest is about 2 miles northeast of the site. Therefore, impacts on bald eagles or sensitive nesting habitats are not likely to occur. If bald or golden eagles appear to be nesting near (within 1 mile) the proposed project area prior to the initiation of construction-related activities, DOE would be required to obtain a permit if disturbance or relocation was determined to be necessary.

Aquatic Resources

Under the ORNL VTR alternative, direct and indirect impacts on aquatic resources could potentially occur due to construction and land clearing activities associated with the Proposed Action.

Direct impacts could include permanent habitat loss and/or alternation of the land due to construction and excavation activities. Indirect impacts could include temporary changes to hydrology from land-clearing activities, disruption of the soil profile, loss of vegetation, introduction of pollutants, creation of new impervious surfaces, and an increased rate or volume of runoff after major storm events. Generally, impacts can be avoided or minimized to a level of insignificance if proper construction techniques, erosion control measures, and structural engineering designs are incorporated.

Potential indirect impacts from proposed construction could result in additional sediment loads being transported to surface waters in the project vicinity. Additional sediment loads would be managed by appropriately designed conveyance structures (e.g., channels and culverts) in accordance with site-specific engineering standards that take into consideration surface water drainage within, adjacent to, and downstream of the project. In addition, surface water runoff control measures would be incorporated into the design. These measures would help to avoid or minimize conflicts with city, county, State, or Federal regulations and would prevent adversely affecting adjacent properties and/or the project area. These measures could include the use of porous materials, directing runoff to permeable areas, and use of detention basins to release runoff over time. All necessary permits, including a NPDES permit for stormwater discharges, would be obtained prior to construction. Refer to Section 4.3 *Water Resources* for a detailed discussion on impacts on groundwater, surface water, and stormwater resources.

Under the ORNL VTR Alternative aquatic features (e.g., channels, tributaries, drainages, catchments, seeps, springs, or wetlands) would be impacted. Vegetation within the proposed project area is comprised primarily of forested wetland habitats. About 10.5 acres (4.25 hectares) of wetlands, likely considered Exceptional Tennessee Waters (ETW), 15,637 feet (4,766 meters) of streams, conveyances and/or channels, and 30 seeps and active springs could be affected by the Proposed Action. These streams and channels are associated with creeks (e.g., Melton Branch and Bearden Creek) that flow into major rivers. Many of these areas are included in various ecological monitoring research and remediation activities thus long-term biological monitoring and research at ORNL would be impacted (ORNL 2020d).

If the ORNL VTR Alternative were selected, additional assessment would be required. Minimally, this would include wetland delineations (USACE 1987), stream evaluations (TDEC 2019a), and hydrologic determinations of currently unclassified channels and wet weather conveyances (TDEC 2020a). Any potential ETW would require additional assessment using the Tennessee Rapid Assessment Method, as required by the TDEC. Evaluation of aquatic resources at proposed mitigation sites might also be required to assess adequate mitigation actions (TDEC 2015, 2019a). A Section 404 wetland permit must be obtained from USACE prior to any construction work within jurisdictional features, and compensatory mitigation would be required for any unavoidable impacts. Mitigation ratios are broadly defined as 2:1 for restoration, 4:1 for creation/enhancement, and 10:1 for preservation and for ETW, TDEC equivalent quality habitat within the same watershed be placed into permanent conservatorship (preservation) and at rates higher than non-ETW (ORNL 2020d). Additional effort would be required to assess the full scale of impacts and to determine appropriate mitigation strategies given the number, complexity, and quality of aquatic resources (i.e., wetlands, streams, and conveyances). The ORNL Natural Resources Program is equipped for such assessment should the project proceed (ORNL 2020d).

Natural Areas

Under the ORNL VTR Alternative, direct and indirect impacts on eight natural areas within the ORR could potentially occur due to construction and land-clearing activities associated with the Proposed Action (NA14, 15, 17, 26, 30; RA10, 11; and HA1). Impacts on the ecological resources (vegetation, wildlife, special status species, and aquatic resources) within these areas would be the same as those previously described in the sections above.

If the ORNL VTR Alternative were selected, additional species specific surveys will need to occur to adequately determine the severity of effects to federally and State-listed special status species. Mitigation for federally and State-listed species, aquatic features and sensitive habitats may be required.

4.5.2.2 Operations

As presented in Table 4–13, the VTR and associated facilities would occupy about 50 acres during operations. The 50 acres of land within the footprint of the completed VTR complex would be occupied by facilities, parking areas, walkways and roads, or revegetated. Operation of the VTR and associated facilities would involve no ground disturbance and therefore would have little additional impact on ecological resources, other than those previously described for construction/facility modification.

4.5.3 Reactor Fuel Production Options

4.5.3.1 The INL Site Reactor Fuel Production Options

As described in Chapter 2, Section 2.6.2, modification and operation of the INL Site's MFC facilities to fabricate reactor fuel for the VTR would occur within existing buildings with no additional land disturbance. Therefore, no impacts on ecological resources would occur from these activities and are not discussed further in this section.

4.5.3.2 SRS Reactor Fuel Production Options

4.5.3.2.1 Construction/Facility Modification

Vegetation

Under the SRS options, activities associated with constructing/modifying and operating facilities in the K Area Complex would occur in previously developed or disturbed areas. No natural vegetation communities (such as forested areas) would be disturbed. If warranted, revegetation of the grass and landscaped areas that may be temporarily disturbed would be conducted as directed by the natural resource manager to minimize the potential for invasive species. Therefore, no significant impacts on vegetation would occur under implementation of the SRS options.

Wildlife

The areas planned for development within the K Area are highly disturbed yet create minimal habitat for urban adapted wildlife species. Noise resulting from constructing/modifying and operating facilities in support of the fuel fabrication option would be localized, short-term, and only occur during daylight hours. Although a small number of wildlife species could occur in the grass areas (generally those tolerant of human presence and activity) during construction, the limited habitat decreases the ecological value of the site. Additionally, all construction would be conducted consistent with the *Natural Resources*

Management Plan for the Savannah River Site (DOE 2019f). Therefore, no significant impacts on wildlife would occur under implementation of the SRS Options.

Special Status Species

No impacts on special status species would occur under the SRS fuel production options. No federally or State-listed species occur within the proposed project area and activities associated with constructing/modifying and operating facilities in the K Area Complex would occur in previously developed or disturbed areas. Noise resulting from constructing/modifying and operating facilities in support of the fuel fabrication option would be localized, short-term, and only occur during daylight hours. Additionally, all construction would be conducted consistent with the *Natural Resources Management Plan for the Savannah River Site* (DOE 2019f).

Under the SRS fuel production options, no impacts on migratory birds (including BCC) would occur as no habitats occur within the proposed project area. Bald eagle and golden eagles have been observed throughout the SRS; however, no nests are known to occur within or in the immediate vicinity (within 1 mile) of the K Area. Therefore, no impacts on bald eagles or sensitive nesting habitats would occur under the SRS Reactor Fuel Production Options.

4.5.3.3 Operations

As described in Chapter 2, Section 2.6.3, modification and operation of K Area Complex to fabricate fuel for the VTR would occur within existing buildings with no additional land disturbance. Therefore, no impacts on ecological resources would occur from these activities and are not discussed further in this section.

4.5.4 Combined INL VTR Alternative and the INL Site Reactor Fuel Production Options Impacts

Because there would be little or no ecological impacts from construction and operation of the fuel production capability at the INL Site, the impacts of the combined activities would be essentially the same as the impacts of the INL VTR Alternative alone as previously described in Section 4.5.1.

4.6 Cultural and Paleontological Resources

This section discusses the potential impacts on cultural resources of the VTR alternatives and reactor fuel production options. The INL and ORNL ROIs for cultural resources evaluation would include the land that would be disturbed by VTR facility construction, and buffer immediately adjacent with potential effects to setting of adjacent historic properties. For SRS, the ROI would be the K-Reactor Building. Facility construction and land disturbance would occur within undeveloped areas of the INL Site and ORNL. Only facility modifications would occur at SRS. No impacts on cultural resources would occur from facility construction and land disturbance (the INL Site and ORNL) or from facility modifications (the INL Site and SRS).

Table 4–15 presents a summary of the potential environmental consequences on cultural and paleontological resources for the INL and ORNL VTR Alternatives and the INL and SRS Reactor Fuel Production options.

Table 4–15. Summary of Environmental Consequences on Cultural Resources

Resource Area	VTR Alternatives	
	INL VTR	***ORNL VTR***
Cultural and Paleontological Resources	*Construction*: No impacts on significant cultural and paleontological resources would occur from facility construction and land disturbance. *Operations*: No impacts on significant cultural and paleontological resources would occur from facility operations.	*Construction*: No impacts on significant cultural and paleontological resources would occur from facility construction and land disturbance. *Operations*: No impacts on significant cultural and paleontological resources would occur from facility operations.
	Reactor Fuel Production Options	
	INL Reactor Fuel Production	***SRS Reactor Fuel Production***
Cultural and Paleontological Resources	**Feedstock Preparation**	
	Construction: No impacts on significant cultural and paleontological resources as modifications/construction would occur in existing facilities (FCF) and not require construction of new facilities at the MFC. Changes to the internal configuration of active laboratories or other experimental or testing properties to accommodate new experiments or tests are exempt activities per the INL CRMP (INL 2016f:51). *Operations*: No impacts on significant cultural and paleontological resources as feedstock preparation activities would occur in existing facilities at the MFC. Changes to the internal configuration of active laboratories or other experimental or testing properties to accommodate new experiments or tests are exempt activities per the INL CRMP (INL 2016f:51).	*Construction*: No impacts on significant cultural and paleontological resources as modifications/construction would occur in existing facilities (in the K Area Complex) and not require construction of new facilities. *Operations*: No impacts on significant cultural and paleontological resources as feedstock preparation activities would occur in existing facilities in K Area.
	Fuel Fabrication	
	Construction: No impacts on significant cultural and paleontological resources as modifications/construction would occur in existing facilities (FMF and ZPPR) and not require construction of new facilities at the MFC. Changes to the internal configuration of active laboratories or other experimental or testing properties to accommodate new experiments or tests are exempt activities per the INL CRMP (INL 2016f:51). *Operations*: No impacts on significant cultural and paleontological resources as fuel fabrication activities would occur in existing facilities at the MFC. Changes to the internal configuration of active laboratories or other experimental or testing properties to accommodate new experiments or tests are exempt activities per the INL CRMP (INL 2016f:51).	*Construction*: No impacts on significant cultural and paleontological resources as modifications/construction would occur in existing facilities (in the K Area Complex) and not require construction of new facilities in K Area. *Operations*: No impacts on significant cultural and paleontological resources as fuel fabrication activities would occur in existing facilities in K Area.
	Combined INL VTR Alternative and INL Reactor Fuel Production Options	
Cultural and Paleontological Resources	*Construction:* No impacts on significant cultural and paleontological resources would occur from facility construction and land disturbance. Changes to the internal configuration of active laboratories or other experimental or testing properties to accommodate new experiments or tests are exempt activities per the INL CRMP (INL 2016f:51). *Operations:* No impacts on significant cultural and paleontological resources would occur from facility operations.	

4.6.1 INL VTR Alternative

4.6.1.1 Construction/Facility Modification

No impacts on significant cultural resources are anticipated to result from construction and facility modification for the proposed VTR at the INL Site. An intensive archeological survey was conducted across 167 acres that include the 138-acre area of potential effect (APE). The investigation identified five pre-contact cultural resources, but none of the resources were determined to meet the threshold of significance for listing in the National Register of Historic Places (NRHP).

Four buildings within the MFC facility have been proposed for modification to support fabrication of VTR reactor fuel: the Hot Fuels Examination Facility (HFEF), the Fuel Conditioning Facility (FCF), ZPPR, and FMF. Internal reconfiguration activities within these existing MFC facilities, in which additional equipment would be installed for proposed post-irradiation testing, spent fuel treatment, and fuel fabrication, are exempt from cultural resource review by agreement among INL, the Idaho State Historic Preservation Officer (SHPO), the Advisory Council on Historic Preservation (ACHP), and the Shoshone-Bannock Tribes (INL 2016f:51). The proposed activities would not compromise the integrity of these architectural resources. The Experimental Fuels Facility may also be used for testing VTR Fuel cladding. However, no modifications are anticipated, and similar work is currently being performed in the facility.

Visual, auditory, and atmospheric effects that may be imposed by the proposed undertaking on architectural properties within the MFC facility were considered. While noise levels may increase and there would likely be higher concentrations of dust particles in the air during construction, these impacts would be short term in duration. The new construction's visual impacts would be more permanent; however, the addition of VTR is consistent with the facility's historic function as a prime testing center for advanced technologies associated with nuclear energy power systems. MFC consists of a 90-acre developed area, which includes an undeveloped security perimeter. Structures include analytical laboratories and other facilities, which tend to be one- or two-story, block concrete buildings with towers and holding tank structures interspersed. The new construction design (Chapter 1, Figure 1) repeats the basic elements of form, line, color, and texture found within the existing building components and will not diminish the integrity of setting for any historic or potentially historic property located within the MFC complex. Construction of VTR and the proposed building modifications will have no effect on any historic properties.

There are no traditional cultural properties or sacred sites identified within the 138-acre APE for the Proposed Action. Therefore, impacts on these resources are not anticipated.

4.6.1.2 Operations

No impacts on ethnographic, cultural, and paleontological resources at the INL Site are anticipated to result from operations of the proposed VTR. Six existing facilities within the MFC at the INL Site are proposed for use in operations of the VTR, including post-irradiation testing and spent fuel treatment. Internal reconfiguration of active laboratories or other experimental or testing properties that accommodate new experiments or tests are considered exempt activities on the INL Site (INL 2016f:51). Therefore, no impacts on historic properties would result from this alternative.

In compliance with Section 106 of the National Historic Preservation Act (NHPA), DOE has initiated consultation with the Idaho State Historic Preservation Officer (SHPO); federally recognized tribes; and interested parties regarding its determination of effects for the proposed construction and operations of VTR at INL. If necessary, DOE would develop management actions and mitigation measures to resolve any adverse effects prior to implementing the Proposed Action.

4.6.2 ORNL VTR Alternative

4.6.2.1 Construction/Facility Modification

No impacts on cultural and paleontological resources at ORNL are anticipated to result from construction and facility modification for the proposed VTR. Although the 150-acre proposed area of potential disturbance has not been surveyed for cultural resources, there are no known NRHP-listed or -eligible archaeological or architectural resources within the APE for VTR facilities construction.

There is one cemetery potentially eligible for the NRHP within the 0.25-mile viewshed APE, which could be within visual range of the proposed new VTR facility. The cemetery is identified as the Friendship Baptist Church Cemetery. While the siting and massing of the proposed VTR are significant, it would not diminish the characteristics that make the cemetery potentially eligible for the NRHP. The minor change to the setting would not change the character or use of the cemetery. The minimal increase in visual elements introduced by the undertaking would not diminish the integrity of the cemetery's significant historic attributes and would not alter the characteristics that could qualify it for inclusion in the NRHP. Therefore, the proposed construction of VTR and subordinate buildings and structures would cause no adverse effect to the historic cemetery.

There are no traditional cultural properties or sacred sites identified within the 150-acre APE for direct physical effects for the Proposed Action. Therefore, impacts on these resources are not anticipated.

4.6.2.2 Operations

No impacts on ethnographic, cultural, and paleontological resources at ORNL are anticipated to result from operations of the proposed VTR. There are no known NRHP-listed or -eligible or architectural resources within the APE for VTR facilities construction.

If the ORNL VTR Alternative were selected and prior to any land disturbing activities, DOE would comply with Section 106 of the NHPA by consulting with the Tennessee Historical Commission, which acts as the SHPO; federally recognized tribes; and interested parties regarding potential effects for the proposed construction and operations of VTR at ORNL. If necessary, DOE would develop management actions and mitigation measures to resolve any adverse effects prior to implementing the Proposed Action.

4.6.3 Reactor Fuel Production Options

4.6.3.1 INL Reactor Fuel Production Options

Under the INL fuel production options, the VTR fuel fabrication process would be located in the existing FMF, FCF, and ZPPR. Installation of new equipment in existing space at FMF, FCF, and ZPPR would not impact ethnographic, cultural, and paleontological resources at the INL Site. Therefore, there would be no impacts on these resources at the INL Site under these fuel production options.

4.6.3.2 SRS Reactor Fuel Production Options

Under the SRS fuel production options, the VTR fuel fabrication process would be located in the K-Reactor Building (Building 105-K) in the K Area Complex. Building 105-K is not eligible for listing on the NRHP. Installation of new equipment in existing space would not involve ground disturbances outside the existing facility, and thus would not impact ethnographic, cultural, and paleontological resources at SRS. Therefore, there would be no impacts on these resources at SRS under these fuel production options.

4.6.4 Combined INL VTR Alternative and INL Reactor Fuel Production Options Impacts

Because there would be no impacts on ethnographic, cultural, and paleontological resources at the INL Site under the INL Reactor Fuel Production Options, combined impacts on cultural resources at the INL Site would be as described for the INL VTR Alternative.

4.7 Infrastructure

This section discusses the potential impacts associated with energy use and utility infrastructure for the ROI at each location. For the INL Site this would include overall capacities at the INL Site, MFC, and for the proposed VTR site associated with the alternatives. For ORNL, this would include ORNL, the proposed VTR Site, and portions of ORR. For SRS, the ROI would include the K Area Complex and SRS. Section 4.13, Traffic, addresses potential impacts on transportation infrastructure (i.e., roads and rails).

This section also evaluates increased demand and infrastructure modifications for the Proposed Action and compares them to the current operation of each location in the following areas:

- Consumption of electricity and fuel
- Changes to water, gas, and electrical systems
- Impacts from the consumption of electricity, fuel, and other resources would result if demand exceeds existing capacity at a given location. Impacts on utility infrastructure would occur if the existing infrastructure were insufficient to support the alternatives during either the construction or operational phase. **Table 4–16** summarizes potential environmental consequences on infrastructure.

Table 4–16. Summary of Environmental Consequences on Infrastructure

	VTR Alternatives	
Resource Area	***INL VTR***	***ORNL VTR***
Infrastructure	***Construction***: Some MFC infrastructure would be allocated during the 51-month construction period. But building requirements would not place excessive demand on existing systems at the INL Site or MFC. Construction electricity usage projected to be 1,000,000 KWh average annual value with annual peak value of 2,000,000 KWh. Diesel fuel usage would total 2,300,000 gallons. Total water usage during construction projected to be 128 million gallons. ***Operations***: VTR utility demands would be supplied by existing MFC utility systems. With the exception of electricity, no modifications to the MFC utility systems would be required to support the addition of the VTR. Operations at VTR are projected to use 150,000 MWh per year of electricity, 18,500 cubic feet of propane per year, and 4.4 million gallons of water per year. Some modifications of the existing electrical system at MFC would be required to handle the loads generated by VTR operations, including the installation of a dynamic volt amperage reactive device at the ATR and MFC (to ensure voltage stability).	***Construction***: Some ORNL infrastructure would be allocated during construction period but would not place excessive demand on existing systems at ORNL. Resources required would include not only those for the construction of facilities, but also the resources required for site preparation in a previously undisturbed, wooded area. Construction electricity usage projected to be 1,300,000 KWh average annual value with annual peak value of 2,600,000 KWh. Diesel fuel usage would total 3,300,000 gallons. Total water usage during construction projected to be 172 million gallons. ***Operations***: VTR utility demands (electricity, water, etc.) would be supplied by existing ORNL utility systems. As the proposed VTR is located in a previously undeveloped area, about 1 mile east of the HFIR, connections and modifications would need to be made to nearby ORNL infrastructure. Some new infrastructure would be required. Once connected, no modifications to the ORNL utility systems would be required to support the addition of the VTR. Operations at VTR are projected to use 180,000 MWh per year of electricity, 18,500 cubic feet of propane per year, and 4.4 million gallons of water per year.

	Reactor Fuel Production Options	
	INL Reactor Fuel Production	***SRS Reactor Fuel Production***
Infrastructure	**Feedstock Preparation**	
	Construction: Use of existing facilities (e.g., FCF) and infrastructure at MFC. Minimal allocation of electricity, water, and other resources at MFC well below existing capacities.	*Construction*: Use of existing infrastructure would be well below capacity (build out of the equipment locations within K-Reactor Building). Electric use during construction would be minimal; Total water use during construction would be about 9.0 million gallons.
	Operations: Use of existing infrastructure within the FCF would be well below existing capacities. Electric demand would be 6,700 MWh per year and water usage would average 1.4 million gallons per year.	*Operations*: Use of existing infrastructure within K-Reactor Building would be well below existing capacities. Electric demand would be 6,700 MWh per year and water usage would average 1.4 million gallons per year.
	Fuel Fabrication	
	Construction: Use of existing facilities (FMF and ZPPR) and infrastructure at MFC. Minimal allocation of electricity, water, and other resources at MFC well under existing capacities.	*Construction*: Use of existing infrastructure would be well below capacity (build out of the equipment locations within K-Reactor Building). Electric use during construction would be minimal and about 9.0 million gallons of water would be used.
	Operations: Use of existing infrastructure within FMF and ZPPR would be well below existing capacities. Electric demand would be 8,300 to 13,300 MWh per year and water usage would average 0.88 million gallons per year.	*Operations*: Use of existing infrastructure within K-Reactor Building would be well below existing capacities. Electric demand would be 8,300 to 13,300 MWh per year and water usage would average 1.4 million gallons per year.
	Combined INL VTR Alternative and INL Reactor Fuel Production Options	
Infrastructure	*Construction*: Additional impacts from fuel fabrication construction would be minimal in scale for most resources when compared to impact from VTR construction, therefore, impacts would be similar to those described for the VTR. *Operations*: Fuel fabrication operations would add an additional 8,300 to 13,300 MWh per year and 2.4 million gallons of water over VTR operations.	

4.7.1 INL VTR Alternative

4.7.1.1 Construction/Facility Modification

Construction of the VTR at the INL Site is estimated to occur over a 51-month period in a previously undeveloped area southeast of the MFC. During construction, an incremental and temporary increase in energy demand at existing MFC facilities may result due to the use of equipment and tools. Minimal utilization of existing INL Site infrastructure (e.g., electric, water) would be expected during the construction phase. It is assumed that the majority of energy expenditure will result from materials procured from offsite vendors and brought to the construction site by contractors. **Table 4–17** provides a summary of fuel and other resources that would be committed to construction of the VTR. These requirement projections assume the construction effort would ramp up until peaking in the third year.

Table 4–17. Resource Requirements During Construction of VTR at the INL Site

Resource	*Units*	*Annual Average Value*	*Annual Peak Value*	*Total* [a]
Electricity	KWh	1,000,000	2,000,000	4,300,000
Gasoline	gallons	87,000	145,000	370,000
Diesel Fuel				
Road Diesel	gallons	84,000	144,000	360,000
Non-Road Diesel	gallons	447,000	750,000	1,900,000
Total Diesel	gallons	531,000	894,000	2,300,000

Resource	***Units***	***Annual Average Value***	***Annual Peak Value***	***Total* [a]**
Water				
Potable	gallons	8,000,000	16,000,000	34,000,000
Dust control, etc.	gallons	22,000,000	40,000,000	94,000,000
Total Water	gallons	30,000,000	56,000,000	128,000,000

FTE = full-time equivalent (person); KWh = kilowatt-hour.
[a] Total amount or resource used over 51-month construction period.
Note: Due to rounding, sums and products may not equal those calculated from table entries.
Source: INL 2020f.

4.7.1.2 Operations

Under the conceptual design for the VTR, existing infrastructure, including utilities and waste management facilities, would be used to support construction and operation of the VTR. While some modifications and upgrades to the infrastructure would be necessary during the construction phase, the current infrastructure should be largely adequate to support the VTR. When operations begin at the VTR, the facility will add to the overall infrastructure demands of the MFC. Specific estimated resource requirements for operation of the VTR are given in **Table 4–18**.

Table 4–18. Annual Resource Requirements for Operation of VTR at the INL Site

Resource	***Units***	***Value***
		Annual
Electricity	MWh	150,000
Diesel Fuel [a]	gallons	9,200
Propane [b]	cubic feet	18,500
Water		
Potable	gallons	2,400,000
Fire water	gallons	1,700,000
Demineralized Water	gallons	250,000
Total Water	gallons	4,400,000

MWh = megawatt-hour.
[a] Diesel generators would operate 1 percent of the time, 88 hours per year.
[b] Propane heaters are an alternative design for preheating air in the sodium to air heat exchangers. Use of this alternative design would be a site-specific decision. These heaters would be used for short periods when the reactor is shutdown following a test cycle. 1.5 million standard cubic feet would be used in years of peak usage (associated with an extended maintenance outage, projected to be needed once every 15 years).
Source: INL 2020f.

As the proposed VTR is located in a previously undeveloped area, connections and modifications would need to be made to existing infrastructure at MFC to provide electricity, water, and other needed services to the VTR, including the following:

Electricity: The proposed VTR complex has been estimated to require an additional 16.2 MW of electrical power annually (150,000 MWh/year). The existing transmission line can accommodate that additional power need, however, to prevent fluctuations in the voltage when the VTR is brought on- or off-line, a dynamic volt amperage reactive device will be included in the design of the MFC power distribution system. To provide longer-term power need, upgrades to the existing INL Site 13.8 kV transmission loop would be required. Two near-term actions are recommended for the INL Site power grid before 2022, including renegotiation of the power provider contract and installation of additional cooling capabilities on an Antelope substation transformer. An analysis of long-term options for power is under consideration for implementation by 2021. These options could include installation of a dynamic volt amperage reactive device at the Advanced Test Reactor (ATR) and MFC (to ensure voltage stability), construction of a 138-kV line between the ATR and MFC, construction of a 138-kV line between Scoville and the Test Area North, and conversion of the existing loop to 230 kV (Wayment et al. 2019).

Fire System/Potable Water: Average annual water usage at VTR is projected to be 4.4 million gallons per year. The existing deep well and pumps currently at the MFC would adequately support new demands from the VTR complex. Two options have been explored for fire/potable water routing from MFC to the proposed VTR site: 1) a new loop around the VTR site with new 12-inch and 10-inch water mains, providing 2 supply connections, and 2) completing the existing fire water loop around the east side of the MFC plant and provide a loop around the VTR site. Because the MFC water system is a combination of fire and potable water and the fire water demands are significantly higher, the existing system would be able to meet the potable water demands for the VTR facilities (INL 2017c).

Sanitary Sewer: Existing wastewater lagoons have been assessed to not have the capacity to store and treat flows from the existing MFC, VTR, and the future projects planned for the west side of MFC. The existing lagoons, built in 2012, were based on a buildout to the year 2020. Although the lagoons do not appear to have adequate capacity for a buildout of the year 2030, they have been assessed to be able to handle the volumes generated by the proposed VTR facilities. Calculations for the VTR and support facilities indicate that anticipated average daily flow would be 3,250 gallons per day, with an average daily flow of 2.4 gallons per minute. This assumes that no industrial waste flows will be routed into the sanitary sewer system or eventually into existing lagoons (INL 2017c).

Industrial Wastewater: New 6-inch gravity industrial wastewater lines will convey industrial wastewater from the VTR complex and tie-into an existing 6-inch pipe located near MFC-789. The VTR would produce industrial wastewater that would be required to be conveyed to a proper location for treatment. While the exact flows from the facility are not available, it is assumed that the facility would produce less than 1 million gallons per year. Therefore, the addition of industrial wastewater from the VTR facilities would not exceed the allowed flows permitted by the Idaho Department of Environmental Quality (INL 2017c).

Telecommunications: A telecommunications connection would need to be routed from existing facilities at MFC. The completion of the West Campus Utility Corridor Project would allow a tie-in point with available duct structure to install fiber and copper cabling from MFC-1728 to the VTR area. Two options have been explored for this routing, each of which would add two 144-count fiber optic cables and two 200-pair copper cables from MFC-1728 at two strategic locations that would serve as distribution or connectivity points for VTR buildings (INL 2017c).

4.7.2 ORNL VTR Alternative

4.7.2.1 Construction

Under the conceptual design for the VTR, existing ORNL infrastructure would need to be extended to the proposed VTR site. The location selected for the VTR is relatively undeveloped and does not have sufficient infrastructure to support construction and operation of the VTR. Existing waste management facilities within ORNL would be used to support waste management during the construction of the VTR. The environmental resources required or affected by construction of the VTR at ORNL would include not only the construction of necessary facilities, but also the resources required for site preparation in an undisturbed, wooded area. Specific estimated additional resource requirements for site preparation and construction of the VTR at ORNL are presented in **Table 4–19.**

Table 4–19. Resource Requirements During VTR Construction at ORNL

Resource	*Units*	*Annual Average Value*	*Annual Peak Value*	*Total* [a]
Electricity	KWh	1,300,000	2,600,000	5,600,000
Gasoline	gallons	110,000	190,000	480,000
Diesel Fuel				
Road Diesel	gallons	110,000	190,000	540,000
Non-Road Diesel	gallons	580,000	980,000	2,700,000
Total Diesel	gallons	690,000	1,170,000	3,300,000
Water				
Potable	gallons	10,000,000	20,000,000	52,000,000
Dust control, etc.	gallons	29,000,000	52,000,000	120,000,000
Total Water	gallons	39,000,000	72,000,000	172,000,000

KWh = kilowatt-hour.

[a] Total amount or resource used over 51-month construction period; site preparation duration of about 10 months; includes 5 months for tree removal and 5 months for site grading.

Source: INL 2020f.

4.7.2.2 Operations

Prior to operations beginning at VTR, existing ORNL infrastructure would be extended to the VTR site. The location selected for the VTR is relatively undeveloped and does not have sufficient infrastructure to support VTR operation. Existing waste management facilities within ORNL would support waste management during operation of the VTR. VTR utility demands would be supplied by existing ORNL utility systems. Additional infrastructure systems (e.g., electricity, wastewater) would need to be extended from nearby ORNL infrastructure or built new. Once connected, no modifications to the ORNL utility systems would be required to support the addition of the VTR. When operations begin at the VTR, the facility would add to the overall infrastructure demands of the ORR. The environmental resources required for operation of the VTR at ORNL would be the same as those described for the INL Site in 4.7.1.2 and are shown in **Table 4–20.**

Table 4–20. Annual Resource Requirements for operation of VTR at ORNL

Resource	*Units*	*Value*
		Annual
Electricity	MWh	180,000
Diesel Fuel [a]	gallons	11,900
Propane [b]	cubic feet	18,500
Water		
Potable	gallons	2,400,000
Fire water	gallons	1,700,000
Demineralized water	gallons	250,000
Total	gallons	4,400,000

MWh = megawatt-hour.

[a] Diesel generators would operate 1 percent of the time, 88 hours per year.

[b] Propane heaters are an alternative design for preheating air in the sodium to air heat exchangers. Use of this alternative design would be a site-specific decision. These heaters would be used for short periods when the reactor is shutdown following a test cycle. 1.5 million standard cubic feet would be used in years of peak usage (associated with an extended maintenance outage, projected to be needed once every 15 years).

Source: INL 2020f.

As the proposed VTR site is located in a previously undeveloped area about one mile southeast of the ORNL, connections and modifications would need to be made to existing infrastructure at ORNL to deliver electricity, water, and other needed services to the VTR, including the following:

Electrical: The proposed VTR complex has been estimated to require an additional 16.2 MW of electrical power annually (180,000 MWh/year at ORNL). While there are two 13.8 kV feeders near the proposed VTR siting area, the maximum capacity of each feeder is about 12 MW and there is currently not enough capacity to support loads that would be required by the VTR. In order to support this load, a new overhead feeder would have to be constructed from a nearby substation.

Fire System/Potable Water: Average annual water usage at VTR is projected to be about 4.4 million gallons per year. System capacity at ORNL is about 1,460 million gallons per year, with usage of an average of 730 million gallons per year from 2017 to 2019. Water supply to the proposed VTR site would be attained by extending the current existing 16-inch potable water pipeline that supplies water to High Flux Isotope Reactor (HFIR) and Radiochemical Engineering Development Center and the backup 12-inch water line that follows Melton Valley Drive.

Sanitary Sewer: Calculations for the VTR and support facilities indicate that anticipated Average Daily Flow would be 3,250 gallons per day, with an average daily flow of 2.4 gallons per minute. This assumes that no industrial waste flows will be routed into the sanitary sewer system or eventually into existing lagoons (INL 2017c). These flows would be well below ORNL's sanitary wastewater treatment plant current system capacity of 300,000 gallons per day.

Industrial Wastewater: The VTR would produce industrial wastewater that will be required to be conveyed to a proper location for treatment. While the exact flows from the facility are not available, it is assumed that the facility will produce less than 1 million gallons per year (INL 2017c). The existing industrial wastewater system at ORNL is not allowing new piping system connections; therefore, the proposed VTR site would need to be put on a new industrial wastewater system.

4.7.3 Reactor Fuel Production Options

4.7.3.1 INL Reactor Fuel Production Options

4.7.3.1.1 INL Feedstock Preparation Option

Construction/Facility Modification

Under this option, the VTR feedstock preparation activities would occur in existing facilities at the FCF. The only construction activities, occurring over a 3-year period, would be associated with the feedstock preparation facility and are limited to modifications to the FCF needed to convert space from its current purpose to feedstock preparation. **Table 4–21** gives a summary of the key resources committed to these construction activities.

Table 4–21. Resource Requirements for Feedstock Preparation Facility Construction at the INL Site

Resource	*Units*	*Value*	
		Annual Average	*Total* [a]
For Modifications to Existing Facilities			
Electricity	KWh	Minimal [b]	Minimal
Diesel Fuel			
Forklift Fuel [c]	gallons	-	32
Mobile Crane Diesel [d]	gallons	-	120
Total Diesel	gallons	-	150

Resource	*Units*	*Value*	
		Annual Average	*Total* [a]
Water			
Potable	gallons	75,000	230,000
Construction Area Cleaning	gallons	1,700	5,000
Total	gallons	76,700	235,000

KWh = kilowatt-hour.

[a] Construction duration of 3 years is assumed.

[b] Electrical use is limited to hand held or cordless hand tools and occasional welding.

[c] Assuming 40 hours of operation and fuel consumption of 0.8 gallons per hour of operation.

[d] Assuming 30 hours of operation and fuel consumption of 4 gallons per hour of operation.

Source: INL 2020f.

Operations

Under this option, feedstock preparation capabilities currently located at FCF would be relocated to the existing facilities at MFC. Usage of electricity and other infrastructure would be well within the existing capacities of the individual facilities and the MFC. **Table 4–22** gives a summary of the key resources committed to the preparation of feedstock at the VTR.

Table 4–22. Resource Requirements for Feedstock Preparation Facility Operations at the INL Site

Resource	*Units*	*Value*
		Annual
Electricity	MWh	6,700
Diesel Fuel		
Diesel (Centerra) [a]	gallons	1,500
Diesel (Operations) [a]	gallons	2,000
Total Diesel	gallons	3,500
Water		
Potable [b]	gallons	1,400,000

MWh = megawatt-hour.

[a] Diesel fuel for one additional security vehicle (Centerra) and an additional diesel generator (Operations).

[b] Water use provided as gpm, converted to annual assuming 10-hour workdays, 5 days a week, and 50 weeks per year.

4.7.3.1.2 INL Fuel Fabrication Option

Construction/Facility Modification

Under this option, the VTR fuel fabrication process at the INL Site would be located in existing facilities at MFC (FCF, FMF, and ZPPR). The only construction activities, occurring over a 2-year period, would be the build out of the equipment locations in the FMF, ZPPR, and FCF. **Table–23** provides a summary of the key resources committed to the construction of a fuel fabrication facility.

Table 4–23. Resource Requirements for Fuel Fabrication Facility Construction at the INL Site

Resource	*Units*	*Value*	
		Annual Average	*Total* [a]
For Modifications to Existing Facilities			
Electricity	KWh	Minimal [b]	minimal
Diesel Fuel			
Forklift Fuel [c]	gallons	—	32
Mobile Crane Diesel [d]	gallons	—	120
Total Diesel	gallons	—	152

Resource	Units	Value	
		Annual Average	Total [a]
Water			
Potable	gallons	75,000	230,000
Construction Area Cleaning	gallons	1,700	5,000
Total	gallons	76,700	235,000

KWh = kilowatt-hour.
[a] Construction duration of 3 years is assumed.
[b] Electrical use is limited to hand held or cordless hand tools and occasional welding.
[c] Assuming 40 hours of operation and fuel consumption of 0.8 gallons per hour of operation.
[d] Assuming 30 hours of operation and fuel consumption of 4 gallons per hour of operation.
Source: INL 2020f.

Operations

Under this option, the VTR fuel fabrication process at the INL Site would be located in existing facilities at MFC (FCF, FMF, and ZPPR). Usage of electricity and other infrastructure would be well within the existing capacities of the individual facilities and the MFC. **Table 4–24** provides a summary of the key resources committed to the operation of a fuel fabrication facility.

Table 4–24. Resource Requirements for Fuel Fabrication Facility Operations at the INL Site

Resource	Units	Value
		Annual
Electricity	MWh	8,300 – 13,300
Water		
Potable	gallons	880,000
Cleaning	gallons	1,000
Total Water	gallons	881,000

MWh = megawatt-hour.
Source: INL 2020f.

4.7.3.2 SRS Reactor Fuel Production Options

4.7.3.2.1 SRS Feedstock Preparation Option

Construction/Facility Modification

Under this option, no new facilities would be constructed at SRS. The capability would be located adjacent to the location for the fuel fabrication capability, in the K Area Complex, primarily at the -20-foot level (20 feet below grade). Key annual resource commitments for the operation of the feedstock preparation facility are provided in **Table 4–25**.

Table 4–25. Resource Requirements for Feedstock Preparation Facility Construction at SRS

Resource	Units	Value	
		Annual Average	Total [a]
For Modifications to Existing Facilities			
Electricity	KWh	minimal	minimal
Diesel Fuel	gallons	1,500	4,500
Gasoline	gallons	2,500	7,500
Water			
Potable	gallons	1,000,000	3,000,000
Construction	gallons	2,000,000	6,000,000
Total Water	gallons	3,000,000	9,000,000

Resource	Units	Value	
		Annual Average	Total [a]
Wastewater Treatment	gallons	1,000,000	3,000,000

KWh = kilowatt-hour.
Source: SRNS 2020.

Operations

The feedstock processing capability at SRS would be located adjacent to the location for the fuel fabrication capability, in the K Area Complex, and the process equipment would be located at the minus-20-foot level at the minus-40-foot level. **Table 4–26** provides a summary of the key resources committed to the feedstock preparation option at SRS.

Table 4–26. Resource Requirements for Feedstock Preparation Facility Operations at SRS

Resource	Units	Value
		Annual Average
For Modifications to Existing Facilities		
Electricity	MWh	6,700
Diesel (Centerra) [a]	gallons	1,500
Diesel (Operations) [a]	gallons	2,000
Water Supply [b]	gallons	1,400,000
Wastewater Treatment	gallons	1,400,000

MWh = megawatt-hour.
[a] Diesel fuel for one additional security vehicle (Centerra) and an additional diesel generator (Operations).
[b] Water use provided as gpm, converted to annual assuming 10-hour workdays, 5 days a week, and 50 weeks per year.
Source: SRNS 2020.

4.7.3.2.2 SRS Fuel Fabrication Option

Construction/Facility Modification

Under this option, no new facilities would be constructed at SRS. The only construction activities would be the build-out of the equipment locations within an existing facility in the K Area Complex and the removal of existing equipment. Construction is assumed to require 3 years. The fuel fabrication facility would be located on the minus-20- and minus-40-foot levels (20 and 40 feet below grade) of the Building 105-K. **Table 4–27** provides a summary of the key resources committed to the construction of a fuel fabrication facility at SRS.

Table 4–27. Resource Requirements for Fuel Fabrication Facility Construction at SRS

Resource	Units	Value	
		Annual Average	Total [a]
For Modifications to Existing Facilities			
Electricity	KWh	minimal	minimal
Diesel Fuel	gallons	1,500	4,500
Gasoline	gallons	2,500	7,500
Water			
Potable	gallons	1,000,000	3,000,000
Construction	gallons	2,000,000	6,000,000
Total Water	gallons	3,000,000	9,000,000

KWh = kilowatt-hour.
Source: SRNS 2020.

Operations

The fuel fabrication facility would be located on the minus-20- and minus-40-foot levels (20 and 40 feet below grade) of the Building 105-K. Although the VTR modifications have not been designed, based on similar K Area upgrade projects, the space needed for support facilities for the needed HVAC, fire suppression, etc., are expected to be substantial. At least one and possibly two of the adjacent 108-K buildings could be needed for these support operations. Key annual resource commitments for the operation of the fuel fabrication facility are provided in **Table 4–28**.

Table 4–28. Fuel Fabrication Facility Resource Requirements at SRS

Resource	*Units*	*Value*
		Annual
Electricity	MWh	8,300 – 13,300
Diesel (Centerra) [a]	gallons	3,000
Diesel (Operations) [a]	gallons	4,000
Water Supply	gallons	1,400,000
Wastewater Treatment	gallons (thousands)	1,400,000

MWh = megawatt-hour.
[a] Diesel fuel for one additional security vehicle (Centerra) and an additional diesel generator (Operations).
Source: SRNS 2020.

4.7.4 Combined INL VTR Alternative and INL Reactor Fuel Production Options Impacts

Table 4–29 outlines the total infrastructure usage for the combined construction of the VTR facility and the addition of fuel production equipment at the MFC. For many resources (e.g., electricity) the contribution of construction for fuel production equipment is negligible when compared to annual allocations for the construction of the VTR.

Table 4–29. Annual Resource Requirements for Combined INL VTR Alternative and Reactor Fuel Production Facility Options Construction at the INL Site

Resource	*Units*	*Annual Average Value*	*Annual Peak Value*	*Total*
Electricity [a]	KWh	1,000,000	2,000,000	4,300,000
Gasoline	gallons	87,000	145,000	370,000
Diesel Fuel				
Road Diesel	gallons	84,000	144,000	360,000
Non-Road Diesel	gallons	447,000	750,000	1,900,152
Total Diesel	gallons	531,000	894,000	2,300,152
Water				
Potable	gallons	8,550,000	16,000,000	24,460,000
Dust control, etc.	gallons	22,003,400	40,000,000	94,010,000
Total Water	gallons	30,553,400	56,000,000	128,470,000

FTE = full-time equivalent (person); KWh = kilowatt-hour.
[a] Negligible increase in electric use from fuel fabrication.
Source: INL 2020f.

Table 4–30 outlines the total infrastructure usage for the combined operations of the VTR facility and the fuel fabrication option at the MFC. For many resources (e.g., electricity) the contribution of fuel fabrication operations negligible when compared to annual allocations for operation of the VTR.

Table 4–30. Annual Resource Requirements for Combined INL VTR Alternative and Reactor Fuel Production Facilities Operations at the INL Site

Resource	Units	Value
		Annual
Electricity	MWh	180,000
Diesel Fuel [a]	gallons	12,700
Propane [b]	cubic feet	18,500
Water		
Potable Water	gallons	4,680,000
Other (e.g., fire, demineralized, cleaning)	gallons	1,950,000
Total Water	gallons	6,630,000

MWh = megawatt-hour.

[a] Diesel generators would operate 1 percent of the time, 88 hours per year.

[b] Current plan is to use electric heaters; propane heaters are included as an alternate.

Source: INL 2020f.

4.8 Noise

To evaluate impacts from noise and vibration, DOE considered the potential for noise and vibration levels to change as a result of the Proposed Action alternatives. Considerations of the potential changes in noise and vibration include new mobile and stationary sources from activities associated with construction and operation of the VTR alternatives and reactor fuel production options. For the purposes of this environmental consequences analysis the Proposed Action alternatives and No Action Alternative would result in adverse noise and vibration effects if the project were to cause any of the following:

- Conflict with any Federal, State, or local noise ordinances;
- Long-term perceptible increase in ambient noise levels above regulatory thresholds at sensitive receptors during operations; or
- Excessive ground-borne vibration to persons or property.

Adverse impacts would occur if noise and vibration from construction or operation were to cause harm or injury to adjacent communities or sensitive receptors (i.e., residences, schools, hospitals), or exceed applicable environmental noise limit guidelines.

This EIS uses aerial mapping to identify the closest noise and vibration sensitive receptors within the ROI. The analysis estimates and assesses the impact of noise and vibrations at these receptors during construction, normal operations, and maintenance activities. **Table 4–31** summarizes potential environmental consequences on noise and vibration.

Table 4–31. Summary of Environmental Consequences on Noise and Vibration

Resource Area	VTR Alternatives	
	INL VTR	***ORNL VTR***
Noise	*Construction*: Estimated noise levels at the INL Site boundary (2.9 miles) and closest receptor (5.0 miles) would not be perceptible and would be consistent with ambient levels. *Operations*: Noise levels at the INL Site boundary (2.9 miles) and closest receptor (5.0 miles) would not be perceptible and would be consistent with ambient levels.	*Construction*: Estimated noise levels at the closest receptor (6,750 feet) would be about 47 dBA. *Operations*: Noise and vibration levels would be similar to other existing equipment at ORNL and would not impact offsite receptors.
	Discussion: Due to the large distance from the site and receptors, impacts would be minimal.	
Vibration	*Construction and Operations*: Ground-borne vibration due to typical construction and operational activities is expected to be below the threshold of human perception	*Construction and Operations*: Ground-borne vibration due to typical construction and operational activities is expected to be below the threshold of human perception
	Discussion: Due to the large distance from the site and receptors, impacts would be minimal.	
	Reactor Fuel Production Options	
	INL Reactor Fuel Production	***SRS Reactor Fuel Production***
Noise and Vibration	**Feedstock Preparation and Fuel Fabrication**	
	Construction: Estimated noise and vibration levels at the INL Site boundary (2.9 miles) and closest receptor (5.0 miles) would not be perceptible and would be consistent with ambient levels.	*Construction*: Estimated noise and vibration levels at the SRS boundary (5.5 miles) would not be perceptible and would be consistent with ambient levels.
	Operations: Operational noise and vibration would be contained within the building and not perceptible at the boundary.	
	Discussion: Due to the large distance from the site and receptors, impacts would be minimal.	
	Combined INL VTR Alternative and INL Reactor Fuel Production Options	
Noise and Vibration	*Construction*: Estimated noise and vibration levels at the INL Site boundary (2.9 miles) and closest receptor (5.0 miles) would not be perceptible and would be consistent with ambient levels. *Operations*: Noise and vibration levels at the INL Site boundary (2.9 miles) and Closest Receptor (5.0 miles) would not be perceptible and would be consistent with ambient levels.	

dBA = decibels A-weighted.

4.8.1 INL VTR Alternative

Implementation of the INL VTR Alternative would result in short-term impacts of noise and vibration from construction of the new VTR facility and spent fuel pad facility modifications required for the post-irradiation examination and spent fuel treatment facilities. Potential operational noise and vibration impacts are described below.

4.8.1.1 Construction/Facility Modification

Construction of the INL VTR Alternative would have temporary adverse effects to noise and vibration. Construction activities would cause temporary increases in ambient noise levels in the immediate vicinity of the construction sites. Construction noise levels are rarely steady in nature, but instead fluctuate depending on the number and type of equipment in use at any given time. There would be times when no large equipment would be operating and noise would be at or near ambient levels. In addition, construction-related sound levels would vary by distance.

DOE anticipates a total duration of 60 months for construction from site mobilization to completion of startup. Major construction activities (e.g., foundations, structures, etc.) would require about 33 months. Onsite construction noise would mainly occur from site preparations, clearing and grading, construction of the new facility, vehicle traffic and other associated construction activities, including the use of heavy-duty construction equipment (e.g., trucks, backhoes, front-end loaders, cranes, etc.). **Table 4–32** presents typical construction equipment (mobile and stationary) and the corresponding typical noise emissions levels.

Table 4–32. Estimated Construction Noise from Construction Activities

Equipment [a]	*Typical Noise Level at 50 Feet (dBA)*	*Typical Noise Level at 500 Feet (dBA)*	*Typical Noise Level at 1,000 Feet (dBA)*	*Typical Noise Level at 1,500 Feet (dBA)*
Front Loaders	85	65	59	55
Backhoes, excavators	80	60	54	50
Tractors, dozers	85	65	59	55
Graders, scrapers	89	69	63	59
Trucks	88	68	62	58
Concrete pumps, mixers	85	65	59	55
Cranes (movable)	83	63	57	53
Generators	81	61	55	51
Compressors	81	61	55	51
Pneumatic tools	85	65	59	55
Compactors	82	62	56	52
Blasting	94	74	68	64
Horizontal Directional Drilling	82	62	56	52

dBA = decibels A-weighted.

Source: FHWA 2006; Lamancusa 2009; DOT 2012.

In general, average equivalent noise levels from typical construction sites range from 79 to 89 decibels A-weighted (dBA) at 50 feet (Bolt et al. 1971). Construction noise levels fluctuate depending on the type, number, and duration of use of heavy equipment for construction activities. Construction noise differs by the type of activity, distance to noise-sensitive uses, existing site conditions (vegetation to buffer sound) and ambient noise levels. With multiple items of construction equipment operating concurrently, noise levels could be relatively high during daytime periods at locations within several hundred feet of active construction sites. Accounting for the concurrent use of the construction equipment, noise levels could be conservatively estimated to about 83 dBA at 100 feet (DOT 2012, 2018). Combined construction noise reduces to about 63 dBA at 1,000 feet (Lamancusa 2009; DOT 2018). Other construction noise would occur from transportation-related activities, including workers' vehicle trips and materials and waste trucks. In addition to the standard construction activities, current project plans anticipate blasting would occur during the construction period. Blasting has a maximum noise level that could potentially reach 94 dBA (FHWA 2006). Using typical noise reductions over a distance, noise levels due to blasting would reduce to 68 dBA at 1,000 feet and 40 dBA at the closest noise-sensitive receptor. The proposed INL VTR Alternative site is about 2.9 miles from the INL Site boundary and 5.0 miles from the closest noise-sensitive receptor (i.e., home/farm site). Given the large distance, estimated construction noise would be indistinguishable to the closest noise-sensitive receptor. As a result, noise levels would remain within applicable noise regulation standards, as described in Section 3.1.8.2.

Similar to human sensitive receptors, wildlife can experience noise and vibration impacts from human activities. Stress, avoidance of feeding, and loss of breeding success can result from elevated noise and vibration exposure to species. Section 4.5.1.1 considers these noise effects on wildlife species in the immediate project area. In addition, because the INL Site is designated as a NERP, construction noise could temporarily disturb research studies and wildlife species if located in proximity to the proposed project. But impacts would be short-term and limited to construction activities.

As discussed in Section 3.1.8.3, the closest Federal and State parks are over 40 miles away from the construction area. The closest recreational area is Middle Butte about 7.5 miles southwest. Due to the long distance between the proposed construction and closest parks, construction noise is anticipated to be imperceptible at these locations.

To reduce potential impacts due to construction noise, contractors would try to limit construction to occur primarily during normal weekday business hours, and would properly maintain construction equipment mufflers.

Ground-borne vibration would be present during construction from site preparations, HDD, blasting, traffic, and other associated construction activities. Construction vibration would be temporary during construction and could be transient (e.g., single impact equipment), random (e.g., heavy construction equipment) or continuous (e.g., HDD). However, due to the distance to the nearest sensitive noise receptors, ground-borne vibration is expected to be below the threshold of human perception (refer to Section 3.1.8.1). As a result, impacts would not be expected.

4.8.1.2 Operations

Operation of the INL VTR Alternative would involve equipment that would emit noise and vibration levels typical of industrial activities. Operation would involve continuously operated equipment such as heat exchanger fans, HVAC condensing units and exhaust fans, in addition to intermittently or infrequently used equipment, such as compressors and standby diesel generators. Most equipment would be indoors or inside noise enclosures to reduce noise levels. Outdoor equipment (i.e., HVAC fans and compressors), employee vehicle trips, and routine maintenance activities involving trucks or other maintenance equipment would be perceptible in the immediate vicinity of the facility. Operation of the proposed VTR would add to baseline noise levels from existing operational equipment resulting in concurrent noise emissions. Section 3.1.8.3 describes the variation in baseline noise levels at the INL Site, including the recent noise measurements for existing facilities that are typically operated at the INL Site (e.g., the nearby MFC) and the estimated noise levels for the surrounding uninhabited, rural land. The noise generated from the proposed VTR would be consistent with other existing industrial equipment at the INL Site and the potential concurrent noise would be similar to existing levels at the INL Site. As a result, operation of the VTR and existing equipment would not impact offsite receptors.

Given the distance from the proposed site to the INL Site boundary (2.9 miles) and to the closest offsite noise-sensitive receptor (5.0 miles), operational noise and vibration would not be perceptible at the closest noise-sensitive receptor. As a result, the INL VTR Alternative would not cause a change in noise environment.

4.8.2 ORNL VTR Alternative

Implementation of the ORNL VTR Alternative would result in short-term impacts on noise and vibration from construction of the new VTR facility, post-irradiation examination facility, and spent fuel storage pad and operational noise and vibration impacts as described below.

4.8.2.1 Construction/Facility Modification

Construction of the ORNL VTR Alternative would have temporary adverse effects to noise and vibration. Construction activities would cause temporary increases in ambient noise levels in the immediate vicinity of the construction sites. Construction noise levels are rarely steady in nature, but instead fluctuate depending on the number and type of equipment in use at any given time. There would be times when no large equipment is operating and noise would be at or near ambient levels. In addition, construction-related sound levels would vary by distance.

Construction activities and associated noise levels would be similar to the levels estimated in Section 4.8.1.1 and Table 4–32. As discussed in Section 4.8.1.1, average equivalent noise levels from typical construction sites range from 79 to 89 dBA at 50 feet (Bolt et al. 1971). Construction noise levels fluctuate depending on the type, number, and duration of use of heavy equipment for construction activities, and differ by the type of activity, distance to noise-sensitive uses, existing site conditions (vegetation to buffer sound), and ambient noise levels. The closest noise-sensitive receptor to the ORNL VTR Alternative is a home site located about 6,750 feet from the construction area. Using typical noise reductions over a distance, this analysis conservatively estimated a combined construction level of about 89 dBA at 50 feet would reduce to about 47 dBA at 6,750 feet (closest receptor) (Lamancusa 2009; DOT 2018). Other construction noise would occur from transportation-related activities, including workers' private vehicle trips and site materials and waste trucks. In addition, if blasting would be required during construction, noise levels due to blasting could reach about 51 dBA at the home site that is 6,750 feet from the construction area.

Similar to human sensitive receptors, wildlife can experience noise and vibration impacts from human activities. Stress, avoidance of feeding and loss of breeding success can result from elevated noise and vibration exposure to species. Section 4.5.2.1 considers these noise effects on wildlife species in the immediate project area.

As described in Section 3.5.1.2, Anderson and Knox Counties have established residential noise level standards of 65 dBA during the daytime. The combined construction noise is estimated to remain below the noise standards at the closest receptor (i.e., 47 dBA at 6,750 feet). Given the distance, estimated construction noise would be minimal at the closest noise-sensitive receptor and noise levels would remain within applicable noise regulation standards, as described in Section 3.1.8.2. The construction noise would be short-term and would diminish, as the construction activity are completed. Typically, there would not be nighttime construction.

As discussed in Section 3.2.8, the closest Federal and State parks are over 17 miles away from the construction area. Due to the large distance between the proposed construction and closest parks, construction noise is anticipated to be imperceptible at these locations.

To reduce potential impacts due to construction noise, contractors would try to limit construction to occur primarily during normal weekday business hours, and would properly maintain construction equipment mufflers.

Ground-borne vibration would be present during construction from site preparations, HDD, blasting, traffic, and other associated construction activities. Construction vibration would be temporary during construction and could be transient (e.g., single impact equipment), random (e.g., heavy construction equipment), or continuous (e.g., HDD). Vibration levels from blasting depends on the blast method and plan. Blasting would be performed in accordance with any applicable State regulations and industry BMPs to minimize ground vibrations. Ground-borne vibration due to typical construction activities is expected to be below the threshold of human perception (refer to Section 3.5.1.1). As a result, impacts would not be expected.

4.8.2.2 Operations

Operation of the ORNL VTR Alternative would involve equipment that would emit noise and vibration typical of industrial activities. Operation would involve a variety of machinery, including continuously operated equipment such as heat exchanger fans, HVAC condensing units, and HVAC exhaust fans. In addition, operation would involve intermittently or infrequently used equipment, such as compressors and standby diesel generators. Most equipment would be indoors or inside noise enclosures to reduce noise levels. Outdoor equipment (i.e., HVAC fans and compressors), employee vehicle trips, and routine maintenance activities involving trucks or other maintenance equipment would be perceptible in the immediate vicinity of the facility, but noise and vibration levels would be similar to other existing equipment at ORNL and would not impact offsite receptors. The ORNL VTR Alternative would involve operating equipment with noise and vibration similar to existing industrial activities already present at ORNL. As a result, the ORNL VTR Alternative would not cause a change to the noise environment at ORNL or at the closest noise sensitive receptor.

4.8.3 Reactor Fuel Production Options

4.8.3.1 INL Reactor Fuel Production Options

Implementation of the INL fuel production options would result in short-term impacts on noise and vibration from construction of the fuel fabrication facility and operational noise and vibration impacts as described below.

Construction

Construction of the INL fuel production options would have temporary adverse effects to noise and vibration. Construction activities for the INL options would be performed within existing buildings and involve modifications to existing infrastructure. Use of large construction equipment is not anticipated but equipment delivery and equipment transport could require limited use of forklifts or cranes; however, such equipment is commonly used at the facility. As a result, the associated noise levels during construction would be consistent with existing background noise. Other construction noise would occur from transportation-related activities, including workers' vehicle trips, but would not result in a noticeable increase in vehicle traffic due to their commute. Construction activities would cause temporary increases in ambient noise levels in the immediate vicinity of the construction sites but due to the large distance to the site boundary (2.9 miles) and nature of the internal construction, potential noise and vibration during construction would not be perceptible to offsite receptors.

Operations

Operational noise would involve workforce vehicles and noise from operation of the fuel fabrication facility.

Operational noise levels would be located within the confines of the facilities. The existing facilities consist of thick walls that would create a noise barrier to reduce and contain noise levels. Operation of the existing operational equipment cannot be heard outside of the building. As a result, the existing building is expected to act as a noise-reduction for the new fuel fabrication equipment. Outdoor equipment (i.e., HVAC fans and compressors), employee vehicle trips, and routine maintenance activities involving trucks or other maintenance equipment would be perceptible outside of the building but noise and vibration levels would be similar to other existing equipment and given the distance to the site boundary (2.9 miles) would not be distinguishable to the offsite receptors.

4.8.3.2 SRS Reactor Fuel Production Options

Implementation of the SRS fuel production options would result in short-term impacts on noise and vibration from construction of the fuel fabrication facility and operational noise and vibration impacts as described below.

Construction

Construction of the SRS fuel production options would have temporary adverse effects to noise and vibration. Construction activities for the SRS fuel production options would be performed within existing buildings and involve modifications to existing infrastructure. Typical construction equipment would be used such as forklifts, cranes, compressors, trucks, etc. Section 4.8.2.1 discusses the estimated noise levels from the various construction equipment present in Table 4–32. Other construction noise would occur from transportation-related activities, including workers' vehicle trips, but would not result in a noticeable increase in vehicle traffic due to their commute. Construction activities would cause temporary increases in ambient noise levels in the immediate vicinity of the construction sites but due to the large distance to the site boundary (5.5 miles) and nature of the internal construction, potential noise and vibration due to construction would not be perceptible to offsite receptors.

Similar to human sensitive receptors, wildlife can experience noise and vibration impacts from human activities. As discussed in Section 4.5.3.2.1, construction noise would not cause significant impacts since the areas planned for development within the K Area are highly disturbed and provide minimal habitat for urban adapted wildlife species.

Operations

Operational noise would involve workforce vehicles and noise from operation of the fuel fabrication facility.

Operational noise levels would be located within the confines of the facilities. The existing facilities consist of thick walls that would create a noise barrier to reduce and contain noise levels. Operation of the existing operational equipment cannot be heard outside of the building. As a result, the existing building is expected to act as a noise-reduction for the new fuel fabrication equipment. Outdoor equipment (i.e., HVAC fans and compressors), employee vehicle trips, and routine maintenance activities involving trucks or other maintenance equipment would be perceptible outside of the building but noise and vibration levels would be similar to other existing equipment and given the distance to the site boundary (5.5 miles) would not be distinguishable to the offsite receptors.

4.8.4 Combined INL VTR Alternative and INL Reactor Fuel Production Options Impacts

Implementation of the Combined INL VTR Alternative and INL Reactor Fuel Production Options would result in short-term impacts on noise and vibration from construction and no long-term impacts due to operation of the facilities. Construction activities would cause temporary increases in ambient noise levels in the immediate vicinity of the construction sites. Construction of the VTR would result in noise from site preparations, clearing and grading, construction of the new facility, vehicle traffic and other associated construction activities, including the use of heavy-duty construction equipment (e.g., trucks, backhoes, front-end loaders, cranes) (refer to Table 4–32). Construction of the reactor fuel production facilities would be performed within existing buildings and involve modifications to existing infrastructure. Depending on the final project schedule, construction of the VTR and reactor fuel production facilities could occur concurrently. Combined noise levels from the construction of the VTR and reactor fuel production facilities would be similar to the noise levels described in Section 4.8.2.1. But given the distance from the proposed VTR site to the INL Site boundary (2.9 miles) and closest noise-sensitive receptor (i.e., home and farm site 5 miles), estimated construction noise would be indistinguishable to the closest noise-sensitive receptor.

Like the construction stage, operation of the VTR and reactor fuel production at the INL Site would not impact offsite receptors. Operational noise would be perceptible in the immediate vicinity of the facility, but noise is expected to be similar to other existing equipment at the INL Site. Given the distance, operational noise and vibration would not be perceptible at the INL Site boundary (2.9 miles away) and at the closest noise-sensitive receptor (i.e., home and/farm site 5.0 miles away). As a result, the Combined

INL VTR Alternative and INL Reactor Fuel Production Options would not cause a change in noise environment.

4.9 Waste Management and Spent Nuclear Fuel Management

This section discusses the potential waste management and spent nuclear fuel management consequences associated with the INL and ORNL VTR Alternatives (the VTR reactor, post-irradiation examination facilities, other support facilities, and SNF management facilities). Waste management is also associated with the construction or facility modifications and operations of reactor fuel production at INL and SRS. Waste management and associated facilities are discussed in Sections 3.1.9, 3.2.9, and 3.3.9 for INL, ORNL, and SRS, respectively. The Proposed Action alternatives and options would provide preparation and packaging capabilities for wastes generated. Wastes would be managed within the current waste management systems and sent offsite for treatment and/or disposal.

Table 4–33 presents a summary of the potential environmental consequences on waste and SNF management for the INL and ORNL VTR Alternatives and INL and SRS Reactor Fuel Production Options.

Table 4–33. Summary of Environmental Consequences on Waste and Spent Nuclear Fuel Management

	VTR Alternatives	
Resource Area	***INL VTR***	***ORNL VTR***
Waste Management	*Construction*: About 9,900 cubic meters of construction waste will be generated during construction activities. This represents less than one (1) percent of the current remaining capacity of 3.4 million cubic meters of the CFA Landfill Complex *Operations*: LLW, MLLW, TRU waste, and hazardous and TSCA wastes will be generated. The waste types' additional annual generation quantities range from 0.89 to 540 cubic meters with associated percentage increases ranging from 0.081 to 16 percent over the baseline average annual generation rates (see Table 4–34). The characteristics of these wastes would be similar to the wastes currently generated by existing activities. All wastes would be packaged for shipment off site. Treatment and disposal of these wastes are well within the current capacities of existing offsite facilities.	*Construction*: About 13,000 cubic meters of construction waste will be generated during construction activities. This represents less than one (1) percent of the current remaining capacity of 2.0 million cubic meters of the three (3) onsite landfills. *Operations*: During operations, LLW, MLLW, TRU waste, and hazardous and TSCA wastes will be generated. The waste types' additional annual generation quantities range from 0.89 to 540 cubic meters with associated percentage increases ranging from 0.6 to 5.4 percent over the baseline average annual generation rates (see Table 4–35). The characteristics of these wastes would be similar to wastes currently generated by existing activities. All wastes would be packaged for shipment off site. Treatment and disposal of these wastes are well within the current capacities of existing offsite facilities.
Spent Fuel Management	*Construction*: No spent fuel is generated during construction. *Operations*: The heavy metal from 45 spent fuel assemblies per refueling (66 for the final core offload at the end of the VTRs operational lifetime) would be treated and packaged as spent nuclear fuel. The total number of spent fuel assemblies over the lifetime of the program represent about 110 metric tons of heavy metal.	*Construction*: No spent fuel is generated during construction. *Operations*: The heavy metal from 45 spent fuel assemblies per refueling (66 for the final core offload at the end of the VTRs operational lifetime) would be treated and packaged as spent nuclear fuel. The total number of spent fuel assemblies over the lifetime of the program represent about 110 metric tons of heavy metal.

	Reactor Fuel Production Options	
	INL Reactor Fuel Production	***SRS Reactor Fuel Production***
Waste Management	**Feedstock Preparation and Fuel Fabrication**	
	Construction: Existing facilities would be modified and existing equipment reallocated, as necessary, to support both feedstock preparation and fuel fabrication activities. Equipment currently in this space would be relocated for use in other facilities. Small volumes of construction waste, LLW, MLLW, and hazardous and TSCA wastes would be generated during the modifications of facilities and the relocation of existing equipment and the installation of the new equipment.	
	Operations: During operations, LLW, MLLW, TRU waste, and hazardous and TSCA wastes will be generated. The waste types' additional annual generation quantities range from 2 to 400 cubic meters with associated percentage increases range from 0.043 to 18 percent over the baseline average annual generation rates for either feedstock preparation or fuel fabrication and 0.087 to 36 percent for the combination of both (see Table 4–36). The characteristics of these wastes would be similar to wastes currently generated by existing activities. These wastes would be managed within the current waste management system and sent offsite for disposal. The Proposed Action alternatives and options would provide preparation and packaging capabilities for the TRU waste that would be generated; TRU waste would be shipped to the WIPP facility for disposal.	*Operations:* During operations, LLW, MLLW, TRU waste, and hazardous and TSCA wastes will be generated. The waste types' additional annual generation quantities range from 2 to 400 cubic meters with associated percentage increases range from 0.077 to 1,800 (TRU waste) percent over the baseline average annual generation rates for either feedstock preparation or fuel fabrication and 0.15 to 3,600 (TRU waste) percent for the combination of both (see Table 4–37). The characteristics of these wastes would be similar to wastes currently generated by existing activities. These wastes would be managed within the current waste management system and sent offsite for disposal. The Proposed Action alternatives and options would provide preparation and packaging capabilities for the TRU waste that would be generated; TRU waste would be shipped to the WIPP facility for disposal. The large percentage increase for TRU waste is due to the very small volumes that have been generated over the last 5 years not the volumes that will be generated which are relatively small quantities.
	Combined INL VTR Alternative and INL Reactor Fuel Production Options	
Waste Management	*Construction*: About 9,900 cubic meters of construction waste will be generated during VTR construction activities. This represents less than one (1) percent of the current remaining capacity of 3.4 million cubic meters of the CFA Landfill Complex. For Reactor Fuel Production, existing facilities would be modified and existing equipment reallocated, as necessary, to support feedstock preparation and fuel fabrication activities. Equipment currently in this space would be relocated for use in other facilities. Small volumes of construction waste, LLW, MLLW, and hazardous and TSCA wastes would be generated during the modifications of facilities and the relocation of existing equipment and the installation of the new equipment would be minimal.	
	Operations: LLW, MLLW, TRU waste, and hazardous and TSCA wastes will be generated during VTR operations (see Table 4–34). The waste types' additional annual generation rates range from 0.081 to 16 percent increases over the baseline average annual generation rates. During reactor fuel production operations, LLW, MLLW, TRU waste, and hazardous and TSCA wastes will be generated (see Table 4–36). The waste types' additional annual generation rates range from 0.043 to 18 percent increases over the baseline average annual generation rates for either feedstock preparation or fuel fabrication and 0.097 to 36 percent for the combination of both. Totals for VTR and Reactor Fuel Production activities would range from 0.91 to 36 percent. The characteristics of most of these wastes would be similar to the wastes currently generated by existing activities and would be managed within the current waste management system. All wastes would be shipped off site for treatment and/or disposal. Treatment and disposal of these wastes are well within the current capacities of existing offsite facilities.	

Spent Nuclear Fuel Management	*Construction*: No spent nuclear fuel is generated during construction. *Operations*: The heavy metal from 45 spent fuel assemblies per refueling (66 for the final core offload at the end of the VTRs operational lifetime) would be treated and packaged as spent nuclear fuel and placed on the VTR spent fuel pad pending offsite shipment. The total number of spent fuel assemblies over the lifetime of the program represent about 110 metric tons of heavy metal.

4.9.1 INL VTR Alternative

Under the INL VTR Alternative, the VTR and associated support facilities and SNF storage pad would be constructed and operated. Existing facilities would be used for post-irradiation examination and spent fuel treatment with some modifications.

4.9.1.1 Construction/Facility Modification

During construction and facility modifications, construction and demolition (C&D) materials would be generated. No radioactive or hazardous wastes are anticipated to be generated. About 9,900 cubic meters (INL 2020f, 2020g) of C&D materials would be generated during construction activities. This represents less than 1 percent of the current remaining capacity of 3.4 million cubic meters of the CFA Landfill Complex discussed previously in Section 3.1.9.3.

4.9.1.2 Operations

During operations, LLW, MLLW, TRU waste, and hazardous and TSCA wastes would be generated. **Table 4–34** provides a comparison to the average annual baseline generation rates for each of those waste types estimated to be generated during operations. The waste types' additional annual generation rates range from 0.081 to 16 percent increases over the baseline average annual generation rates. The characteristics of these wastes would be similar to the wastes currently generated by existing activities and would be managed within the current waste management systems. All wastes would be shipped off site for treatment and/or disposal. Treatment and disposal of these wastes are well within the current capacities of existing offsite facilities.

In addition, the heavy metal from 45 spent fuel assemblies per refueling (66 for the final core offload at the end of the VTRs operational lifetime) would be managed and packaged as spent fuel. The total number of spent fuel assemblies over the lifetime of the program represent about 110 metric tons of heavy metal (MTHM). Spent fuel would be managed in accordance with applicable laws and other requirements.

Table 4–34. Percentage Increase in Waste Generation at the INL Site in Average Annual Generation Rates Due to VTR Operations

Waste Type	*Average Annual Baseline 2015-2019 in Cubic Meters*	*INL VTR Alternative Operations – Average Annual Generation in Cubic Meters*	*INL VTR Percentage of Average Annual Baseline*
LLW	8,600	540	6.3
MLLW	4,600	38	0.82
TRU Waste	1,100	0.89	0.081
Hazardous and TSCA	45	7.2	16

LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; TRU = transuranic; TSCA = Toxic Substances Control Act.
Note: All numbers are rounded to two significant figures. Due to rounding, sums and products may not equal those calculated from table entries.
Sources: INL 2020a, 2020f, 2020g.

4.9.2 ORNL VTR Alternative

Under the ORNL VTR Alternative, the VTR and associated support facilities, post-irradiation examination, spent fuel treatment facilities, and SNF storage pad would be constructed and operated.

4.9.2.1 Construction/Facility Modification

During construction activities, C&D materials would be generated. No radioactive or hazardous wastes are anticipated to be generated. About 13,000 cubic meters (ORNL 2020c) of C&D materials would be generated during construction activities. This represents less than 1 percent of the current remaining capacity of 2.0 million cubic meters of the 3 onsite landfills discussed previously in Section 3.2.9.3.

4.9.2.2 Operations

During operations, LLW, MLLW, TRU waste, and hazardous and TSCA wastes would be generated. **Table 4–35** provides a comparison to the average annual baseline generation rates for each of those waste types estimated to be generated during operations. The waste types' additional annual generation rates range from 0.64 to 5.4 percent increases over the baseline average annual generation rates. The characteristics of these wastes would be similar to the wastes currently generated by existing activities and would be managed within the current waste management systems. All wastes would be shipped off site for treatment and/or disposal. Treatment and disposal of these wastes are well within the current capacities of existing offsite facilities.

In addition, the heavy metal from 45 spent fuel assemblies per refueling (66 for the final core offload at the end of the VTRs operational lifetime) would be managed and packaged as spent fuel. The total number of spent fuel assemblies over the lifetime of the program represent about 110 MTHM. Spent fuel would be managed in accordance with applicable laws and other requirements.

Table 4–35. Percentage Increase in Waste Generation at ORNL in Average Annual Generation Rates Due to VTR Operations

Waste Type	*Average Annual Baseline 2015-2019 in Cubic Meters*	*ORNL VTR Alternative Operations – Average Annual Generation in Cubic Meters*	*ORNL VTR Percentage of Average Annual Baseline*
LLW	81,000	540	0.67
MLLW	700	38	5.4
TRU Waste	140	0.89	0.64
Hazardous and TSCA	610	7.2	1.2

LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; TRU = transuranic; TSCA = Toxic Substances Control Act.
Note: All numbers are rounded to two significant figures. Due to rounding, sums and products may not equal those calculated from table entries.
Source: ORNL 2020c.

4.9.3 Reactor Fuel Production Options

4.9.3.1 INL Reactor Fuel Production Options

Under the INL option, existing facilities would be modified and used for both the feedstock preparation and fuel fabrication activities.

4.9.3.1.1 Feedstock Preparation and Fuel Fabrication

Construction/Facility Modification

Existing facilities would be modified and existing equipment reallocated, as necessary, to support both feedstock preparation and fuel fabrication activities. Equipment currently in this space would be relocated for use in other facilities. Small volumes of C&D, LLW, MLLW, and hazardous and TSCA wastes would be generated during the modifications of facilities and the relocation of existing equipment and the installation of the new equipment would be minimal.

Operations

During operations, LLW, MLLW, TRU waste, and hazardous and TSCA wastes would be generated. **Table 4–36** provides a comparison to the average annual baseline generation rates for each of those waste types estimated to be generated during operations. The waste types' additional annual generation rates range from 0.043 to 18 percent increases over the baseline average annual generation rates for either feedstock preparation or fuel fabrication and 0.087 to 36 percent for the combination of both. The characteristics of these wastes would be similar to the wastes currently generated by existing activities and would be managed within the current waste management systems. All wastes would be shipped off site for treatment and/or disposal. Treatment and disposal of these wastes are well within the current capacities of existing offsite facilities.

Table 4–36. Percentage Increase in Waste Generation at the INL Site in Average Annual Generation Rates Due to Feedstock Preparation and Fuel Fabrication Operations

Waste Type	*Average Annual Baseline 2015-2019 in Cubic Meters*	*INL Feedstock Preparation/Fuel Fabrication Operations – Average Annual Generation in Cubic Meters*	*INL Reactor Fuel Production Percentage of Average Annual Baseline*
LLW	8,600	170 [a] /170 [b]	2.0/2.0
MLLW	4,600	2 [a, c] /2 [b, c]	0.043/0.043
TRU Waste	1,100	200 [a] /200 [b]	18/18
Hazardous and TSCA	45	1 [a] /1 [b]	2.2/2.2

LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; TRU = transuranic; TSCA = Toxic Substances Control Act.
[a] These quantities are estimates and could be different depending on the process for the feedstock.
[b] These quantities are fuel fabrication with no feedstock preparation.
[c] These quantities are included in the LLW quantities.
Note: All numbers are rounded to two significant figures. Due to rounding, sums and products may not equal those calculated from table entries.
Sources: INL 2020a, 2020f, 2020g; SRNL 2020; SRNS 2020.

4.9.3.2 SRS Reactor Fuel Production Options

Under the SRS option, existing facilities would be modified and used for both the feedstock preparation and fuel fabrication activities.

4.9.3.2.1 Feedstock Preparation and Fuel Fabrication

Construction/Facility Modification

Existing facilities would be modified and existing equipment reallocated, as necessary, to support both feedstock preparation and fuel fabrication activities. Equipment currently in this space would be relocated for use to other facilities. Small volumes of C&D, LLW, MLLW, and hazardous and TSCA wastes would be generated during the modifications of facilities and the relocation of existing equipment and the installation of the new equipment would be minimal.

Operations

During operations, LLW, MLLW, TRU waste, and hazardous and TSCA wastes would be generated. **Table 4–37** provides a comparison to the average annual baseline generation rates for each of those waste types estimated to be generated during operations. The waste types' additional annual generation rates range from 0.077 to 1,800 (TRU waste) percent increases over the baseline average annual generation rates for either feedstock preparation or fuel fabrication and 0.15 to 3,600 (TRU waste) percent for the combination of both. The characteristics of these wastes would be similar to the wastes currently generated by existing activities and would be managed within the current waste management systems. All wastes would be shipped off site for treatment and/or disposal. Treatment and disposal of these wastes are well within the current capacities of existing offsite facilities. The large percentage increase for TRU waste is due to the very small volumes that have been generated over the last 5 years not the volumes that will be generated which are relatively small quantities.

Table 4–37. Percentage Increase in Waste Generation at SRS in Average Annual Generation Rates Due to Feedstock Preparation and Fuel Fabrication Operations

Waste Type	*Average Annual Baseline 2015-2019 in Cubic Meters*	*SRS Feedstock Preparation/Fuel Fabrication Operations – Average Annual Generation in Cubic Meters*	*SRS Reactor Fuel Production Percentage of Average Annual Baseline*
LLW	5,300	170 [a]/170 [b]	3.2/3.2
MLLW	55	2 [a, c] /2 [b, c]	3.6/3.6
TRU Waste	11	200 [a] /200 [b]	1,800/1,800
Hazardous and TSCA	1,300	1 [a] /1 [b]	0.077/0.077

LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; TRU = transuranic; TSCA = Toxic Substances Control Act.

[a] These quantities are estimates and could be different depending on the process for the feedstock.

[b] These quantities are fuel fabrication with no feedstock preparation.

[c] These quantities are included in the LLW quantities.

Note: All numbers are rounded to two significant figures. Due to rounding, sums and products may not equal those calculated from table entries.

Sources: SRNL 2020; SRNS 2020.

4.9.4 Combined INL VTR Alternative and INL Reactor Fuel Production Options Impacts

Construction

About 9,900 cubic meters of C&D materials would be generated during VTR construction activities. This represents less than one (1) percent of the current remaining capacity of 3.4 million cubic meters of the CFA Landfill Complex. For the reactor fuel production option, existing facilities would be modified and existing equipment reallocated, as necessary, to support both feedstock preparation and fuel fabrication activities. Equipment currently in this space would be relocated for use in other facilities. Small volumes of C&D, LLW, MLLW, and hazardous and TSCA wastes would be generated during the modifications of facilities and the relocation of existing equipment and the installation of the new equipment would be minimal.

Operations

LLW, MLLW, TRU waste, and hazardous and TSCA wastes would be generated during VTR operations (see Table 4–34). The waste types' additional annual generation rates range from 0.081 to 16 percent increases over the baseline average annual generation rates. During reactor fuel production operations, LLW, MLLW, TRU waste, and hazardous and TSCA wastes would be generated (see Table 4–36). The waste types' additional annual generation rates range from 0.043 to 18 percent increases over the baseline average annual generation rates for either feedstock preparation or fuel fabrication and 0.097 to 36 percent for the combination of both. Totals for VTR and Reactor Fuel Production activities would range from 0.91 to 36 percent. The characteristics of these wastes would be similar to the wastes currently generated by existing activities and would be managed within the current waste management systems.

All wastes would be shipped off site for treatment and/or disposal. Treatment and disposal of these wastes are well within the current capacities of existing offsite facilities.

The heavy metal from 45 spent fuel assemblies per refueling (66 for the final core offload at the end of the VTRs operational lifetime) would be managed and packaged as spent fuel. The total number of spent fuel assemblies over the lifetime of the program represent about 110 MTHM. Spent fuel will be managed in accordance with applicable laws and other requirements.

4.10 Human Health – Normal Operations

This section presents potential radiological impacts on workers and the public from the construction and operation of the VTR; the post-irradiation examination facilities; spent fuel treatment, conditioning, and storage facilities; feedstock preparation facilities; and fuel fabrication facilities. This section also presents potential nonradiological impacts (from accidents and exposure to nonradiological chemicals) to workers from the construction and operation of these facilities. Radiological human health risks are considered for involved workers, a noninvolved worker, the offsite population, a member of the public that is exposed to the average radiological dose, and a member of the public identified as the maximally exposed individual (MEI). Workers and members of the public are protected from exposure to radioactive material and hazardous chemicals by facility design and administrative procedures. DOE regulations and directives include 10 CFR Part 820, "Procedural Rules for DOE Nuclear Facilities," DOE Order 458.1, "Radiation Protection of the Public and the Environment," 10 CFR Part 835, "Occupational Radiation Protection," and 10 CFR Part 851, "Worker Safety and Health Program."

Involved worker (worker): A worker directly or indirectly involved with VTR operations at either the INL MFC or ORNL or fuel production at either INL MFC or SRS who may receive an occupational radiation exposure from direct radiation (i.e., neutron, x-ray, beta, or gamma) or from radionuclides released to the environment. Direct exposure from handling plutonium materials within a facility would be the chief source of occupational exposure for fuel production workers (primarily from gamma radiation emitted by americium -241).

Noninvolved workers: A site worker outside of the facility who would not be subject to direct radiation exposure but could be incidentally exposed to radiological emissions from the VTR or fuel production facility.

Offsite population: Comprises members of the general public who live within 50 miles of the VTR or fuel production facilities.

Maximally exposed individual (MEI): A hypothetical individual who – because of realistically assumed proximity, activities, and living habits – would receive the highest radiation dose, taking into account all pathways, from a given event, process, or facility (DOE Order 458.1). In this EIS, this individual is assumed to be at the site boundary during normal operations.

Average individual: A member of the public who receives the average dose as determined by dividing the offsite population dose by the number of people in the population.

DOE uses both radiation dose, expressed in rem, millirem, or person-rem, and latent cancer fatalities (LCFs) to represent the human health effects of exposure to radiation. In this EIS, a single risk factor is used for all isotopes to convert dose (in rem or person-rem) to an LCF regardless of the source of the dose. A risk factor of 0.0006 LCFs per person-rem or rem is used, consistent with DOE guidance (DOE 2003). An LCF of less than one can be interpreted as the probability of an LCF. For an individual, this would be the probability of the MEI or average individual getting a fatal cancer. For a population, this can be interpreted as the probability of at least one LCF within the population.

DOE Order 458.1 imposes an annual individual dose limit of 10 millirem from airborne pathways (incorporating the requirements of 40 CFR Part 61 Subpart H), 100 millirem from all pathways, and 4 millirem from the drinking-water pathway. Public doses from all pathways are maintained to levels as low as reasonably achievable (ALARA). To protect workers from impacts from radiological exposure, 10 CFR Part 835 imposes an individual dose limit of 5,000 millirem in a year. However, DOE's goal is to maintain radiological exposures ALARA. Therefore, DOE has recommended an administrative control levels for worker doses (DOE 1999c), typically 500 millirem per year.

Additional information on the methodology used to develop radiological impacts from airborne releases can be found in Appendix C.

Table 4–38 summarizes the human health environmental consequences from normal operations for all of the action alternatives and options considered in this EIS.

Table 4–38. Summary of Human Health Environmental Consequences from Normal Operations

Resource Area	*VTR Alternatives*	
	INL VTR	***ORNL VTR***
The Public	*Construction*: No impact *Operations*: **Total population dose:** 0.044 person-rem; No LCFs (3 × 10^{-5}). **Individual Doses**: MEI - 0.0068 millirem; LCF probability 4 × 10^{-9}. Average – 1.2 × 10^{-4} millirem; LCF risk less than 1 × 10^{-10}	*Construction*: No impact *Operations*: **Total population dose:** 0.58 person-rem; No LCFs (3 × 10^{-4}). **Individual Doses**: MEI - 0.031 millirem; LCF probability 2 × 10^{-8}. Average – 3.6 × 10^{-4} millirem LCF risk 2 × 10^{-10}
	Discussion: Construction does not result in any radiological releases. Individual doses from operations would be well below DOE and regulatory limits (10 millirem per year: DOE Order 458.1 and 40 CFR Part 61, Subpart H). No additional LCFs would be anticipated among the general population.	
Workers	*Construction*: **Radiological impacts** – A dose of 1 rem to individual involved workers, 0.0006 LCF risk and a total involved worker dose of 10 person-rem, with no expected LCFs (0.006). **Nonradiological impacts**: 79 worker injuries are possible, but no fatalities. *Operations*: **Radiological impacts** – Annual involved worker dose of 53 person-rem from all VTR activities (reactor operation, test assembly post-irradiation examination, spent fuel treatment and storage, and general support) with no LCFs (0.03). Average individual involved worker dose of 148 millirem per year with an LCF risk of 9 × 10^{-5}. **Nonradiological impacts**: 9 staff injuries per year are possible, but no fatalities.	*Construction*: **Radiological impacts** – None. **Nonradiological impacts** - 100 worker injuries are possible, but no fatalities. *Operations*: **Radiological impacts** - Annual involved worker dose of 44 person-rem from all VTR activities (reactor operation, test assembly post-irradiation examination, and spent fuel treatment and storage) with no LCFs (0.03). Average individual involved worker dose of 147 millirem per year with an LCF risk of 9 × 10^{-5}. **Nonradiological impacts**: 9 staff injuries per year are possible, but no fatalities.
	Discussion: Construction of new facilities does not result in worker radiological exposure. Individual worker doses from facility modifications and operations would be limited to meet DOE administrative worker dose limits (DOE STD-1098-2017).	

	Reactor Fuel Production Options	
	INL Reactor Fuel Production	***SRS Reactor Fuel Production***
The Public	**Feedstock Preparation**	
	Construction: No Impact *Operations*: **Total population dose:** 0.012 person-rem; No LCFs (7×10^{-6}). **Individual Doses**: MEI - 0.0012 millirem; LCF probability 7×10^{-10}. Average – 3.2×10^{-5}; millirem LCF risk less than 1×10^{-10}.	*Construction*: No Impact *Operations*: **Total population dose:** 0.042 person-rem; No LCFs (2×10^{-5}). **Individual Doses**: MEI - 0.0015 millirem; LCF probability 9×10^{-10}. Average – 4.7×10^{-5} millirem; LCF risk less than 1×10^{-10}.
	Fuel Fabrication	
	Construction: No impact *Operations*: **Total population dose:** 0.0053 person-rem; No LCFs (3×10^{-6}). **Individual Doses**: MEI - 0.0016 millirem; LCF probability 1×10^{-9}. Average – 1.5×10^{-5} millirem; LCF risk less than 1×10^{-10}.	*Construction*: No impact *Operations*: **Total population dose:** 0.020 person-rem; No LCFs (1×10^{-5}). **Individual Doses**: MEI - 0.00071 millirem; LCF probability 4×10^{-10}. Average – 2.3×10^{-5} millirem; LCF risk less than 1×10^{-10}.
	Discussion: Construction does not result in any radiological releases. Individual doses would be well below DOE and regulatory limits (10 millirem per year: DOE Order 458.1 and 40 CFR Part 61, Subpart H). No additional LCFs would be anticipated among the general population.	
Workers	**Feedstock Preparation**	
	Construction: **Radiological**– No impact **Nonradiological**– No impact *Operations*: **Radiological impacts** – Annual involved worker dose of 51 person-rem with no LCFs (0.03). Average individual involved worker dose of 170 millirem per year with an LCF risk of 1×10^{-4}. **Nonradiological impacts**: 9 staff injuries per year are possible, but no fatalities.	*Construction*: **Radiological impacts** – Total involved worker dose 1.3 person-rem, no expected LCFs (0.0008). Average involved worker dose of 50 millirem with an LCF risk of 3×10^{-5}. **Nonradiological impacts** – A total of 10 worker injuries are possible, but no fatalities. *Operations*: **Radiological impacts** – Annual involved worker dose of 51 person-rem with no LCFs (0.03). Average individual involved worker dose of 170 millirem per year with an LCF risk of $1 x 10^{-4}$. **Nonradiological impacts**: 9 staff injuries per year are possible, but no fatalities.
	Fuel Fabrication	
	Construction: **Radiological**– Total involved worker dose 21 person-rem, no expected LCFs (0.01). Maximum individual involved worker dose of 3.6 rem with an LCF risk of 0.002. **Nonradiological**– No impacts *Operations*: **Radiological impacts** – Annual involved worker dose of 51 person-rem with no LCFs (0.03). Average individual involved worker dose to workers directly supporting VTR of 170 millirem per year with an LCF risk of $1 x 10^{-4}$. **Nonradiological impacts**: 9 staff injuries per year are possible, but no fatalities	*Construction*: **Radiological**– Total involved worker dose 0.8 person-rem, no expected LCFs (0.0005). Average individual involved worker dose of 30 millirem with an LCF risk of 2×10^{-5}. **Nonradiological**– A total of 10 worker injuries are possible, but no fatalities *Operations*: **Radiological impacts** – Annual involved worker dose of 51 person-rem with no LCFs (0.03). Average individual involved worker dose to workers directly supporting VTR of 170 millirem per year with an LCF risk of 1×10^{-4}. **Nonradiological impacts**: 9 staff injuries per year are possible, but no fatalities
	Discussion: Doses to individual workers from facility modifications and operations would be limited to meet DOE dose limits (DOE STD-1098-2017) and site administrative worker dose controls.	

	Combined INL VTR Alternative and INL Reactor Fuel Production Options
The Public	*Construction*: No Impact. *Operations*: **Total population dose:** 0.06 person-rem. No LCFs (4×10^{-5}). **Individual Doses**: MEI - 0.0096 millirem LCF probability 6×10^{-9} Average – 1.7×10^{-4} millirem LCF 1×10^{-10}
Workers	*Construction*: **Radiological impacts:** A total involved worker dose of 32 person-rem, 0.02 LCF risk. Average annual individual involved worker dose of 760 millirem with an LCF risk of 0.0005. **Nonradiological impacts**: 80 worker injuries are possible, but no fatalities. *Operations*: **Radiological impacts** – Annual worker dose of 160 person-rem with no LCFs (0.09). Average individual involved worker dose of 160 millirem per year with an LCF risk of 0.0001. **Nonradiological impacts**: 26 staff injuries per year are possible, but no fatalities.

4.10.1 INL VTR Alternative

This section presents potential radiological and chemical hazard impacts associated with the construction and operational activities associated with establishing the VTR alternative at the INL Site. Public and worker radiological impacts (doses and LCFs) are presented in the form of individual and population impacts. Additionally, for the public impacts, an MEI impact is presented. Public impacts are from air emissions. The impacts would include those from: construction and operation of the VTR; facility modifications to the Hot Fuel Examination Facility (HFEF) and incremental operational impacts for performing post-irradiation examination of test items; facility modifications to FCF and incremental operational impacts for preparing SNF for long-term storage and disposal; and construction and operation of a new long-term storage pad.

4.10.1.1 Construction/Facility Modification

Public Health

The construction of new facilities associated with the INL VTR Alternative would have no radiological impact on the general public. Construction of the VTR reactor facility and its associated structures (e.g., switchyard, operational support building) and the SNF storage pad would occur outside of the current MFC facilities. No radiological emissions would result from this activity.

Modifications to existing MFC facilities associated with the VTR alternative at the INL Site would have no radiological impact on the general public. Required facility modifications are minimal (equipment replacement within the HFEF and FCF) and are typical activities currently performed in these facilities. No additional radiological emissions would be expected from these activities.

Worker Health

The construction of new facilities associated with the VTR alternative at the INL Site would have no radiological impact on the construction workforce. Construction of the VTR reactor facility and its associated structures (e.g., switchyard, operational support building) and the spent fuel storage pad would occur outside of the current MFC facilities. No radiological impacts would result from this activity.

Modifications to the facilities proposed for post-irradiation examination (i.e., HFEF) and spent fuel treatment and conditioning (i.e., FCF) would require workers to replace equipment within existing hot cells. Such work, while within the range of activities normally performed at these facilities, could result in worker exposure. Most work related to the installation of new equipment within the HFEF hot cell would be performed outside of the hot cell, in radiologically clean areas. Only final assembly and installation would occur within the hot cell. Within the HFEF, this work would be performed remotely and would not result in worker exposure. A hot cell window replacement would be required for the FCF (modified to allow fuel assembly transfer into the cell). At the FCF, the modification effort would require about 10 workers over a 2-year period. The total worker dose associated with this activity would be 10 person-rem (individual worker dose not expected to exceed 1 rem) (INL 2020f). This exposure is not expected to result in any additional LCFs (0.006) among the workers and an individual LCF risk of 0.0006 to each worker.

Nonradiological accidents also pose a risk to site workers. All onsite work would be performed in accordance with BMPs and in accordance with applicable OSHA requirements and DOE Orders and regulations. In particular, worker safety practices would be governed by worker safety requirements in 10 CFR 851, "Worker Safety and Health Program." DOE Order 450.2, "Integrated Safety Management," integrates safety into management and work practices at all levels ensuring protection of workers, the public, and the environment.

The estimated number of accidental worker injuries and fatalities were based on the number of workers that would be involved in construction/facility modification activities and national worker injury and fatality rates. For a construction effort of this size, accidents would be expected. On average, about 640 workers would be involved in the construction of the VTR facilities (INL 2020f) and 10 workers over 2 years would be invovled in FCF modifications. During the 51 months of VTR construction, assuming the peak number of workers for the full duration of construction, there would be no expected fatalities (0.3) based on an average worker fatality rate in the construction industry of 9.5 fatalities per 100,000 worker years (BLS 2018a). In 2018, the national average for construction workers for accidents resulting in lost worker days was 2.9 accident per 100 full time workers (BLS 2018b). This accident rate results in an estimated 79 construction worker injuries per year during VTR construction.

4.10.1.2 Operations

Public Health

Under the INL VTR Alternative, the annual radiological emissions from the VTR facilities would be no more than the quantities listed in **Table 4–39**. For the VTR reactor facility, emissions are anticipated from the gaseous radioactive waste system. These emissions would be released through the radioactive waste area HVAC system and the Reactor Vessel Auxiliary Cooling System (RVACS)[1]. The HVAC includes both charcoal adsorbers and HEPA filters (INL 2019g). No other systems are anticipated to have appreciable releases. Multiple facilities could be used for the post-irradiation examination of test specimens, the releases identified in Table 4–39 are the sum of the potential releases from all of these facilities. All test specimens are transferred to the HFEF for handling and test preparation prior to being transferred to other facilities (such as the Irradiated Materials Classification Laboratory [IMCL]). The specimens within the test assembly would be removed from the test assembly at the HFEF and prepared for examination within the facility hot cells. Releases associated with post-irradiation examination would be released through the HFEF cell exhaust system. All emissions from the decontamination and main cells pass through a series of HEPA filters, additionally the main cell exhaust passes through an activated charcoal filter, before being released through the HFEF stack. Radiological emissions from the FCF are associated with the treatment of the spent fuel. Disassembly, sodium removal, and fuel packaging would all occur within the facility hot cells. All emissions would be through the facility's safety exhaust system, which includes HEPA filters, and out the FCF stack (DOE 2000a).

[1] Only argon-41 (27 of the 27.1 curies) would be released from the RVACS. All others would be released from the gaseous radioactive waste system exhaust.

Table 4–39. INL VTR Alternative – Radiological Emissions During Normal Operations

Nuclide	Emissions (curies per year)		
	VTR Reactor Facility	Post-Irradiation Examination Facilities	FCF
Americium-241	--	8.4×10^{-12}	--
Antimony-125	--	3.2×10^{-5}	1.57×10^{-7}
Argon-41	27.1	--	--
Cadmium-109	--	5.2×10^{-4}	--
Cadmium-113m	--		4.15×10^{-10}
Cadmium-115	--	1.0×10^{-7}	--
Carbon-14	--	3.1×10^{-4}	--
Cerium-144	--		1.41×10^{-6}
Cobalt-60	--	7.9×10^{-13}	2.08×10^{-9}
Cesium-134	--	8.0×10^{-7}	2.62×10^{-7}
Cesium-135	9.0×10^{-16}	--	--
Cesium-137	1.2×10^{-12}	2.5×10^{-2}	1.96×10^{-6}
Cesium-138	2.0×10^{-6}	--	--
Chlorine-36	--	1.0×10^{-5}	--
Europium-154	--	--	1.73×10^{-10}
Europium-155	--	--	2.07×10^{-9}
Hydrogen-3 (Tritium)	1.2	3.7×10^{-2}	510
Iodine-129	--	1.8×10^{-5}	--
Iodine-131	--	8.9×10^{-3}	--
Iron-55	--	--	5.50×10^{-8}
Krypton-83m	1.8×10^{-6}	--	--
Krypton-85	0.70	4.4×10^{-3}	8.25×10^{3}
Krypton-85m	3.5×10^{-6}	--	--
Krypton-87	4.8×10^{-6}	--	--
Krypton-88	8.9×10^{-6}	--	--
Neptunium-237	--	3.2×10^{-9}	--
Nickel-63	--	--	2.76×10^{-10}
Phosphorus-32	--	2.6×10^{-5}	--
Phosphorus-33	--	4.9×10^{-9}	--
Promethium-147	--	--	1.25×10^{-7}
Plutonium-238	--	1.2×10^{-10}	1.24×10^{-10}
Plutonium-239	--	9.5×10^{-8}	2.83×10^{-9}
Plutonium-240	--	3.0×10^{-12}	1.87×10^{-10}
Plutonium-241	--	--	1.17×10^{-9}
Plutonium-242	--	1.8×10^{-9}	--
Ruthenium-106	--	--	5.66×10^{-6}
Samarium-151	--	--	8.97×10^{-10}
Sodium-22	--	3.2×10^{-6}	--
Sodium-24	--	1.7×10^{-8}	--
Strontium-90	--	3.8×10^{-7}	3.47×10^{-8}
Sulfur-35	--	1.2×10^{-4}	--
Xenon-131m	1.6×10^{-2}	--	--
Xenon-133	1.0×10^{-3}	--	--
Xenon-133m	5.4×10^{-7}	--	--
Xenon-135	4.2×10^{-5}	--	--
Xenon-135m	1.5×10^{-6}	--	--
Xenon-137	7.4×10^{-7}	--	--
Xenon-138	4.4×10^{-6}	--	--

FCF = Fuel Conditioning Facility; VTR = Versatile Test Reactor.
Source: INL 2020f.

The movement of spent fuel from the VTR to the spent fuel storage pad, from the storage pad to the FCF, and from the FCF (treated and conditioned spent fuel) back to the storage pad would all be performed in sealed transfer/storage casks. Under normal conditions, no radiological releases are expected from these casks. All of these activities occur well away from the general public. The nearest offsite member of the public would be about 3 miles from the VTR facilities. There would be no risk of exposure to the general public from direct exposure. Therefore, the storage and movement of spent fuel would have no radiological impact on the public.

Radiological impacts were estimated for the general public living within 50 miles of the VTR located at the MFC of the INL Site. **Table 4–40** shows the annual radiological impacts on the population projected to be living within a 50-mile radius of the VTR in 2050, a population of about 364,000, and two individuals. Impacts are generated for an average member of the public and an offsite MEI (a hypothetical member of the public, who receives the maximum dose while residing at the INL Site boundary, in this instance, the boundary south of the facility. (See Appendix C for additional information about the methodology used to generate these dose estimates.)

Table 4–40 shows the estimated population dose associated with VTR operations to be 0.044 person-rem per year. The MEI would receive an estimated annual dose of 0.0068 millirem and the average annual dose to an individual in the population would be 1.2×10^{-4} millirem under this alternative. EPA and DOE have established an annual limit of 10 millirem to the individual via the air pathway from all DOE sources. Both the average individual and MEI dose from VTR operation would be less than 0.1 percent of this limit. For comparison, the population dose and individual doses from exposure to natural background radiation levels for the INL Site are given. As shown in Table 4–40 the population and individual doses from VTR operation are well below 0.01 percent of the dose from natural background radiation.

Table 4–40. INL VTR Alternative – Annual Radiological Impacts on the Public

	Maximally Exposed Individual	***Population Within 50 Miles*** [a]	***Average Individual within 50 Miles***
Dose	0.0068 millirem	0.044 person-rem	1.2×10^{-4} millirem
Cancer fatality risk [b]	4×10^{-9}	0 (3×10^{-5})	less than 1×10^{-10}
Regulatory dose limit [c]	10 millirem	Not applicable	10 millirem
Dose as a percentage of the regulatory limit	0.07	Not applicable	0.001
Dose from natural background radiation [d]	383 millirem	139,000 person-rem	383 millirem
Dose as a percentage of background dose	0.002	3×10^{-5}	3×10^{-5}

[a] The population dose for this table was based on a projected 2050 population estimate of 364,000 within 50 miles of the VTR at MFC.

[b] Based on a risk estimator of 0.0006 LCFs per person-rem (DOE 2003).)

[c] 40 CFR Part 61, Subpart H, establishes an annual limit of 10 millirem via the air pathway to any member of the public from DOE operations.

[d] Based on an individual annual dose of 383 millirem from natural background radiation to the projected population of about 364,000.

No LCFs would be expected within the general population. This population dose would increase the annual risk of a latent fatal cancer in the population by 3×10^{-5}. Another way of stating this is that the likelihood that one fatal cancer would occur in the population because of radiological releases associated with this alternative is about 1 chance in 40,000 per year. The corresponding increased risk of an individual developing a latent fatal cancer would be less than 1×10^{-10}, or less than 1 chance in 10 billion per year. For the MEI an increased annual risk of developing a latent fatal cancer would be about 4×10^{-9}. In other words, the likelihood that the MEI would develop a fatal cancer is about 1 chance in 250 million for each year of operations.

Worker Health

Involved worker exposures would result from operations in the VTR facility, post-irradiation examination in the HFEF, and spent fuel treatment in the FCF. Additional worker exposure would result from the transfer of spent fuel between these three facilities and during storage at the spent fuel storage pad. Worker doses from this activity are expected to be a small percentage of the doses received from activities within the three facilities.

Transfer operations are an intermittent activity. During steady state operation of the facilities, the equivalent of up to 45 reactor fuel assemblies would be transferred from the VTR Reactor Facility to the storage pad, from the storage pad to the FCF, and from the FCF (in the form of treated and diluted spent fuel) to the storage pad. The number of transfers would be significantly less as multiple fuel assemblies could be transferred in the same cask. During transfer and storage, the spent fuel would be contained in transportation/storage casks, limiting exposure to workers. DOE limits the dose resulting from the handling of these casks to 10 millirem per hour at a distance of 2 meters from the cask. Spent fuel handling would not appreciably add to the total involved worker exposure.

VTR operations are projected to require 200 staff (INL 2020f). This would include operators, maintenance personnel, radiological controls personnel, supervisors, and management. All would be radiation workers. Based on historical Fast Flux Test Facility operational dose and estimates for PRISM operations, the average individual occupational dose would be 100 millirem per year. The total dose to the work force would be 20 person-rem/year.

No additional staff would be required to support post-irradiation examination operations within the MFC facilities identified for this activity. However, post-irradiation examination operations at HFEF would be expected to result in an increase in the occupational exposure to the current involved workers from 11 to 15.4 person-rem, an increase of 4.4 person-rem per year (INL 2020g). While no additional HFEF staff would be required, all 80 existing staff would be expected to support VTR operations. This would result in an increase to the average dose to these workers of 55 millirem per year. This would raise the average dose to an involved worker to 190 millirem per year.

Spent fuel treatment and conditioning activities would be expected to result in an increase in the occupational exposure to involved workers of 8.8 person-rem per year (INL 2020g). The 18 new staff at FCF would support spent fuel treatment of VTR fuel (INL 2020f). The increase in total worker dose would result in a dose of 490 millirem per year to the average worker.

In addition to the staff that would be tasked to the VTR project, other MFC personnel would provide support to the VTR as part of their work. INL has estimated that the each individual MFC worker would receive an additional 5.71 millirem per year, and a total workforce dose of 9.3 person-rem per year from supporting VTR.

For all four activities (VTR operation, post-irradiation examination, spent fuel treatment and conditioning, and general support) the total annual involved worker dose would be about 53 person-rem (assuming the entire worker dose at HFEF results from VTR associated activities), with an average individual worker dose of 148 millirem per year for those workers directly supporting the VTR. This exposure is not expected to result in any additional LCFs (calculated value of 0.03) among the workforce and result in a 9×10^{-5} increase in an individual workers LCF risk.

To protect workers from impacts from radiological exposure, 10 CFR Part 835 imposes an individual dose limit of 5,000 millirem in a year. In addition, worker doses are monitored and controlled below the regulatory limit to ensure that individual doses are less than an INL administrative limit of 700 millirem per year, and maintained at ALARA levels (DOE 2017f). INL would monitor worker doses and take appropriate action to limit individual worker doses below this administrative level.

The VTR facilities would be located within the MFC (in HFEF, FCF, FMF, and ZPPR) or adjacent to MFC (the VTR Reactor Facility). Other workers (noninvolved workers) within the MFC would be exposed to the radiological emissions associated with the VTR facilities. Based on the radiological emissions identified previously (Table 4–38) the dose to a worker within the MFC was estimated. This noninvolved worker would receive a dose of about 2×10^{-3} millirem per year. This exposure is not expected to result in an additional LCF, and results in a low risk of an LCF (calculated risk value of 1×10^{-9}).

Safety and health requirements for DOE workers are governed by 10 CFR Part 851 that establishes requirements for a worker safety and health program to ensure that DOE workers have a safe work environment. Included are provisions to protect against hazardous chemicals. VTR workers could be exposed to hazardous chemicals during operation of the VTR facilities. For example, hazardous chemicals used in the HFEF include hydrochloric acid, sulfuric acid, acetone, and alcohol (INL 2020f). Generally, the quantity of material would be small, and in many cases their use would be within areas not inhabited by workers (inside hot cells). Worker safety would not be impacted by the use of these hazardous chemicals.

Operational staff would also be susceptible to industrial accidents that could result in injury or death. The estimated number of accidental worker injuries and fatalities were based on the number of staff involved in operational activities and national worker injury and fatality rates. For an operation of this size, accidents would be expected. On average about 300 staff would be involved in VTR, post-irradiation, and spent fuel treatment operations (INL 2020f). During each year of operation, there would be no expected fatalities (0.007) based on an average worker fatality rate in the manufacturing industry of 2.2 fatalities per 100,000 worker years (BLS 2018a). In 2018, the national average for manufacturing workers for accidents resulting in lost worker days was 3.1 accident per 100 full time workers (BLS 2018b). This accident rate results in an estimated nine staff injuries per year during operation.

4.10.2 ORNL VTR Alternative

This section presents potential radiological and chemical hazard impacts associated with the construction and operational activities associated with establishing the VTR alternative at ORNL. Public and worker radiological impacts (doses and LCFs) are presented in the form of individual and population impacts. Additionally for the public impacts, an MEI impact is presented. Public impacts are from air emissions. The impacts would include those from construction and operation of

- The VTR,
- A combined test article post-irradiation examination and spent fuel treatment facility, and
- The fuel storage pad.

All of these facilities would be located within a new Perimeter Intrusion Detection Assessment System (PIDAS) for the VTR complex.

4.10.2.1 Construction/Facility Modification

Public Health

The construction of new facilities associated with the ORNL VTR Alternative would have no radiological impact on the general public. Construction of a VTR reactor facility and its associated structures (e.g., switchyard, operational support building), the post-irradiation examination and spent fuel treatment facility, and the spent fuel storage pad would occur outside of current ORNL facilities. Modifications to existing ORNL facilities have not been identified. No radiological emissions would result from this activity.

Worker Health

The construction of new facilities associated with the VTR at ORNL Alternative would have no radiological impact on the construction workforce. Construction of the VTR Reactor Facility and its associated structures (e.g., switchyard, operational support building), the test article post-irradiation examination and spent fuel treatment facility, and the spent fuel storage pad would occur outside of the current ORNL

Nonradiological accidents also pose a risk to site workers. All onsite work would be performed in accordance with BMPs and in accordance with applicable OSHA requirements and DOE Orders and regulations. In particular, worker safety practices would be governed by worker safety requirements in 10 CFR 851, "Worker Safety and Health Program." DOE Order 450.2, "Integrated Safety Management," integrates safety into management and work practices at all levels ensuring protection of workers, the public, and the environment.

The estimated number of accidental worker injuries and fatalities were based on the number of workers that would be involved in construction/facility modification activities and national worker injury and fatality rates. For a construction effort of this size, worker accidents would be expected. The site selected for the VTR facilities at ORNL is a wooded undeveloped site. Prior to facility construction, the land would be cleared and graded. This effort is expected to require 48 workers individually working for periods of a few days to several months over about a year (16 full-time, equivalent workers). At the peak of construction, about 500 to 750 workers would be involved in the construction of the VTR facilities (INL 2020f). Construction of the post-irradiation examination/spent fuel treatment and conditioning facility would require an additional 230 workers during peak construction periods. Construction of both facilities is projected to take 51 months. On average, an additional 14 workers would be involved in construction of the spent fuel storage pad over a 6-month span (7 full-time equivalent workers) (Leidos 2020). During the 51 months of construction, assuming the peak number of workers for the full duration of construction, there would be no expected fatalities (0.4) based on an average worker fatality rate in the construction industry of 9.5 fatalities per 100,000 worker years (BLS 2018a). In 2018, the national average for construction workers for accidents resulting in lost worker days was 2.9 accidents per 100 full-time workers (BLS 2018b). This accident rate results in an estimated 120 construction worker injuries during construction.

4.10.2.2 Operations

Public Health

Under the VTR at ORNL alternative, the annual radiological emissions from the VTR facilities would be no more than the quantities listed in **Table 4–41**. The difference between these facilities and those at the INL Site is that the entire radiological emissions from the new post-irradiation examination facility would be attributable to VTR related activities. While multiple facilities could be used for the post-irradiation examination of test specimens, most releases are expected to be from the new post-irradiation examination facility. All test specimens are transferred to this facility for handling and test preparation prior to being transferred to other facilities (such as the hot cells in Buildings 3025E and 3525 and the LAMDA facility). The specimens within the test assemblies would be removed from the test assembly at the new post-irradiation examination facility and prepared for examination within the facility hot cells. Releases associated with post-irradiation examination would be released through the new facility cell exhaust system. All emissions from the decontamination and main cells pass through a series of HEPA filters, additionally the main cell exhaust passes through an activated charcoal filter, before being released through the facility stack. Radiological emissions from the Spent Fuel Treatment and Conditioning Facility are associated with the treatment of the spent reactor fuel. Disassembly, sodium removal, and fuel packaging all occur within the facility hot cells. All emissions would be through the safety exhaust system, which includes HEPA filters, and out the facility stack (Leidos 2020).

Table 4–41. ORNL VTR Alternative – Radiological Emissions During Normal Operations

Nuclide	Emissions (curies per year)		
	VTR Reactor Facility	Post-Irradiation Examination Facility [a]	Spent Fuel Treatment and Conditioning Facility [a]
Americium-241	--	8.4×10^{-12}	--
Antimony-125	--	3.2×10^{-5}	1.57×10^{-7}
Argon-41	27.1	--	--
Cadmium-109	--	5.2×10^{-4}	--
Cadmium-113m	--		4.15×10^{-10}
Cadmium-115	--	1.0×10^{-7}	--
Carbon-14	--	3.1×10^{-4}	--
Cerium-144	--		1.41×10^{-6}
Cobalt-60	--	7.9×10^{-13}	2.08×10^{-9}
Cesium-134	--	8.0×10^{-7}	2.62×10^{-7}
Cesium-135	9.0×10^{-16}	--	--
Cesium-137	1.2×10^{-12}	2.5×10^{-2}	1.96×10^{-6}
Cesium-138	2.0×10^{-6}	--	--
Chlorine-36	--	1.0×10^{-5}	--
Europium-154	--	--	1.73×10^{-10}
Europium-155	--	--	2.07×10^{-9}
Hydrogen-3 (Tritium)	1.2	3.7×10^{-2}	510
Iodine-129	--	1.8×10^{-5}	--
Iodine-131	--	8.9×10^{-3}	--
Iron-55	--	--	5.50×10^{-8}
Krypton-83m	1.8×10^{-6}	--	--
Krypton-85	0.70	4.4×10^{-3}	8.25×10^{3}
Krypton-85m	3.5×10^{-6}	--	--
Krypton-87	4.8×10^{-6}	--	--
Krypton-88	8.9×10^{-6}	--	--
Neptunium-237	--	3.2×10^{-9}	--
Nickel-63	--	--	2.76×10^{-10}
Phosphorus-32	--	2.6×10^{-5}	--
Phosphorus-33	--	4.9×10^{-9}	--
Promethium-147	--	--	1.25×10^{-7}
Plutonium-238	--	1.2×10^{-10}	1.24×10^{-10}
Plutonium-239	--	9.5×10^{-8}	2.83×10^{-9}
Plutonium-240	--	3.0×10^{-12}	1.87×10^{-10}
Plutonium-241	--	--	1.17×10^{-9}
Plutonium-242	--	1.8×10^{-9}	--
Ruthenium-106	--	--	5.66×10^{-6}
Samarium-151	--	--	8.97×10^{-10}
Sodium-22	--	3.2×10^{-6}	--
Sodium-24	--	1.7×10^{-8}	--
Strontium-90	--	3.8×10^{-7}	3.47×10^{-8}
Sulfur-35	--	1.2×10^{-4}	--
Xenon-131m	1.6×10^{-2}	--	--
Xenon-133	1.0×10^{-3}	--	--
Xenon-133m	5.4×10^{-7}	--	--
Xenon-135	4.2×10^{-5}	--	--
Xenon-135m	1.5×10^{-6}	--	--
Xenon-137	7.4×10^{-7}	--	--
Xenon-138	4.4×10^{-6}	--	--

[a] Isotopes listed are generally limited to release of 10^{-10} curies or more. Both facilities are housed within the same structure.
Source: INL 2020f, SRNS 2020.

The movement of spent fuel from the VTR to the spent fuel storage pad, from the storage pad to the fuel treatment and conditioning facility, and from the fuel treatment and conditioning facility (treated and conditioned spent fuel) back to the storage pad would all be performed in sealed transfer/storage casks. Under normal conditions, no radiological releases would be expected from these casks. All of these activities occur well away from the general public, the nearest offsite member of the public would be at about a mile from the VTR facilities. There would be no risk of exposure to the public from direct exposure. Therefore, the storage and movement of spent fuel would have no radiological impact on the public.

Radiological impacts were estimated for the public living within 50 miles of the VTR located at the site near ORNL. **Table 4–42** shows the annual radiological impacts on the population projected to be living within a 50-mile radius of the VTR in 2050 (a population of about 1,618,000), and two individuals. Impacts are shown for an average member of the public and an offsite MEI (a hypothetical member of the public, who receives the maximum dose living at the ORNL VTR Alternative site boundary, in this instance, the site boundary southeast of the facility). (See Appendix C for additional information about the methodology used to generate these dose estimates.)

Table 4–42. ORNL VTR Alternative – Annual Radiological Impacts on the Public

	Maximally Exposed Individual	***Population Within 50 Miles [a]***	***Average Individual within 50 Miles***
Dose	0.031 millirem	0.58 person-rem	3.6×10^{-4} millirem
Cancer fatality risk [b]	2×10^{-8}	0 (3×10^{-4})	2×10^{-10}
Regulatory dose limit [c]	10 millirem	Not applicable	10 millirem
Dose as a percentage of the regulatory limit	0.3	Not applicable	0.004
Dose from natural background radiation [d]	300 millirem	485,000 person-rem	300 millirem
Dose as a percentage of background dose	0.01	1×10^{-4}	1×10^{-4}

[a] The population dose for this table was based on a projected 2050 population estimate of 1,618,000 within 50 miles of the VTR at ORNL.

[b] Based on a risk estimator of 0.0006 LCFs per person-rem (DOE 2003).

[c] 40 CFR Part 61, Subpart H, establishes an annual limit of 10 millirem via the air pathway to any member of the public from DOE operations.

[d] Based on an individual annual dose of 300 millirem from natural background radiation to the projected population of about 1,618,000.

Table 4–42 shows the estimated population dose associated with VTR operations to be 0.58 person-rem per year. The MEI would receive an estimated annual dose of 0.031 millirem and the average annual dose to an individual in the population would be 3.6×10^{-4} millirem under this alternative. EPA and DOE have established an annual limit of 10 millirem to the individual via the air pathway from all DOE sources. Both the average individual and MEI doses from VTR operations would be about or less than 1 percent of this limit. Additionally, for comparison, the population and individual doses from exposure to natural background radiation levels for the INL Site are given. As shown in Table 4–42 the population and individual doses from VTR operation are below 0.01 percent of the dose from natural background radiation.

No LCFs would be expected within the general population. This population dose would increase the annual risk of a latent fatal cancer in the population by 3×10^{-4}. Another way of stating this is that the likelihood that one fatal cancer would occur in the population because of radiological releases associated with this alternative is about 1 chance in 3,000 per year. The corresponding increased risk of an individual developing a latent fatal cancer would be less than 1×10^{-10}, or less than 1 chance in 10 billion per year. For the MEI, an increased annual risk of developing a latent fatal cancer would be about 2×10^{-8}. In other words, the likelihood that the MEI would develop a fatal cancer is about 1 chance in 50 million for each year of operations.

Worker Health

Worker exposures would result from operations in the VTR facility, post-irradiation examination and spent fuel treatment in the new test article post-irradiation examination and spent fuel treatment and conditioning facility (hot cell facility). Additional worker exposure would result from the transfer of spent fuel between these three facilities and during storage at the spent fuel storage pad. Worker doses from this activity are expected to be a small percentage of the doses received from activities within the three facilities.

Transfer operations are an intermittent activity. During steady state operation of the facilities, the equivalent of up to 45 reactor fuel assemblies would be transferred from the VTR Reactor Facility to the storage pad, from the storage pad to the hot cell facility, and from the hot cell facility (in the form of treated and diluted spent fuel) back to the storage pad. Multiple reactor fuel assemblies would be placed in a single transfer/storage cask. The number of transfers would be significantly less than the number of assemblies moved. During transfer and storage, the spent fuel would be contained in transportation/ storage casks, limiting exposure to workers. DOE limits the dose resulting from the handling of these casks to 10 millirem per hour at a distance of 2 meters from the cask. Spent fuel handling would not impact the total worker exposure.

VTR operations are projected to require 200 staff (INL 2020f). This would include operators, maintenance personnel, radiological controls personnel, supervisors, and management. All would be radiation workers. Based on historical Fast Flux Test Facility operational dose and estimates for PRISM operations, the average individual occupational dose would be 100 millirem per year. The total dose to the work force would 20 person-rem per year.

Post-irradiation examination and spent fuel treatment and conditioning operations within the new facilities are projected to require 100 staff (full-time equivalents) (Leidos 2020).[2] Based on the total worker dose of 24 person-rem for these activities (assumed to be the same as for the equivalent operations at the INL Site), this would result in an average individual worker dose of 240 millirem per year.

The involved worker exposure from all VTR-related activities (reactor operation, post-irradiation examination, and spent fuel treatment) would result in a total annual worker dose of 44 person-rem per year with an average individual worker dose of 147 millirem per year for those workers directly supporting the VTR. This dose is not expected to result in any additional LCFs (calculated value of 0.03) among the workforce.

To protect workers from impacts from radiological exposure, 10 CFR Part 835 imposes an individual dose limit of 5,000 millirem in a year. In addition, worker doses are monitored and controlled below the regulatory limit to ensure that individual doses are less than an administrative limit of 2,000 millirem per year, and maintained at ALARA levels (DOE 2017f). ORNL would monitor worker doses and take appropriate action to limit individual worker doses below this administrative level.

The VTR facilities would be located about between 4,000 and 5,800 feet from the nearest permanently occupied ORNL facility. While other workers at ORNL would be exposed to the radiological emissions associated with the VTR facilities, the noninvolved worker dose would be minimal. Based on the radiological emissions identified previously (Table 4–41) the largest dose to a worker at other ORNL facilities was estimated. This noninvolved worker, located at the High Flux Irradiation Reactor (HFIR) complex, would receive a dose of 4.8×10^{-3} millirem per year. This exposure is not expected to result in an additional LCF and results in a small risk of an LCF (calculated value less than 3×10^{-9}).

[2] Totals do not include personnel, such as security, expected to receive negligible doses.

Safety and health requirements for DOE workers are governed by 10 CFR Part 851, which establishes requirements for a worker safety and health program to ensure that DOE workers have a safe work environment. Included are provisions to protect against hazardous chemicals. VTR workers could be exposed to hazardous chemicals during operation of the VTR facilities. For example, hazardous chemicals used in the post-irradiation examination facility include hydrochloric acid, sulfuric acid, acetone, and alcohol (INL 2020f). Generally, the quantity of material would be small, and in many cases, their use would be within areas not inhabited by workers (inside hot cells). Worker safety would not be impacted by the use of these hazardous chemicals.

Operational staff would also be susceptible to industrial accidents that could result in injury or death. The estimated number of accidental worker injuries and fatalities were based on the number of staff involved in operational activities and national worker injury and fatality rates. For an operation of this size, accidents would be expected. On average about 300 staff would be involved in VTR, post-irradiation, and spent fuel treatment operations (Leidos 2020). During each year of operation, there would be no expected fatalities (0.006) based on an average worker fatality rate in the manufacturing industry of 2.2 fatalities per 100,000 worker years (BLS 2018a). In 2018, the national average for manufacturing workers for accidents resulting in lost worker days was 3.1 accident per 100 full time workers (BLS 2018b). This accident rate results in an estimated nine staff injuries per year during operation.

4.10.3 Reactor Fuel Production Options

Two sites are being considered for reactor fuel production in support of the VTR. Reactor fuel production could be located within the MFC at the INL Site. Equipment would be installed in existing space, with minimal removal of existing equipment. Alternatively, reactor fuel production could be located in the K-Reactor Building at SRS. As at the INL Site, new equipment would be installed for fuel production.

For each site, two phases of reactor fuel production are evaluated. The first phase is a feedstock preparation capability. This phase involves the receipt of plutonium, which contains impurities, e.g., americium-241 (present as the result of the decay of plutonium-241 in 'older' plutonium) that would make the plutonium unsuitable for use as VTR driver fuel or plutonium in other than metal form (e.g., plutonium oxide). The presence of impurities impacts worker dose during operation and could impact the radiological emissions from the fuel fabrication facility. Potential additional impurities in emissions would influence public health. The feedstock preparation facility would address these issues by polishing the plutonium to meet VTR fuel specifications and reduce the involved worker dose rate and potential radiological emissions prior to fuel fabrication. The second phase of reactor fuel production would involve the alloying of plutonium with uranium and zirconium, and fabricating fuel pins and fuel assemblies.

4.10.3.1 INL Reactor Fuel Production Options

This section presents the impacts from establishing the reactor fuel production at the INL Site. Impacts would be from facility construction or modifications to the FCF, which provides the necessary capability for feedstock preparation and to the FMF and ZPPR facilities, which makes possible the fabrication of an alloy uranium-plutonium-zirconium (U-Pu-Zr) reactor fuel for the VTR. Impacts would also result from the operation of the feedstock preparation and fuel fabrication capabilities. Facility modifications and operations are described in Appendix B.

4.10.3.1.1 INL Feedstock Preparation Option

Construction/Facility Modification

Public Health

Modifications to FCF would have no radiological impact on the public. Required facility modifications in FCF involve the installation of new equipment, not major facility construction. No additional radiological emissions would be expected from these activities.

Worker Health

Modifications to the FCF would include the installation of the gloveboxes required for plutonium conversion (e.g., from oxide to metal) and plutonium polishing. (Equipment to be installed in the facilities have been described in Appendix B.) The area identified for the feedstock preparation equipment is a clean area (FCF Operating Floor/High Bay, the Mockup Area, and Workshop) (INL 2020g). Therefore, there would be no radiological impact on the workers installing the equipment.

Using the nonradiological fatality and injury rates provided in Section 4.10.2.1, no nonradiological impacts (fatalities or injuries) would be anticipated. This is due to the limited number of workers involved and the relatively short timeframe for construction.

Operations

Public Health

Under the INL Feedstock Preparation Option, the annual radiological emissions from FCF are expected to be no more than the quantities listed in **Table 4–43**. Radiological emissions would be expected to include americium-241, because this isotope builds up as plutonium-241 decays. Feedstocks of plutonium are assumed to have aged and not been polished. All emissions would be through the FCF exhaust system, which includes HEPA filters, and out the facility stack.

Table 4–43. INL Feedstock Preparation Option – Radiological Emissions During Normal Operations

Nuclide	*Emissions (curies per year)*	*Nuclide*	*Emissions (curies per year)*
Americium-241	6.6×10^{-4}	Uranium-232	5.8×10^{-12}
Plutonium-238	9.5×10^{-6}	Uranium-234	1.7×10^{-9}
Plutonium-239	9.6×10^{-6}	Uranium-235	1.5×10^{-11}
Plutonium-240	1.4×10^{-5}	Uranium-236	2.2×10^{-10}
Plutonium-241	2.0×10^{-4}	Uranium-238	4.3×10^{-11}
Plutonium-242	2.2×10^{-8}		

Source: SRNS 2020.

Radiological impacts were estimated for the public living within 50 miles of the spent fuel facility located in the FMF. **Table 4–44** shows the annual radiological impacts on the population projected to be living within a 50-mile radius of the fuel fabrication facility in 2050, a population of about 364,000, and two individuals. Impacts are shown for an average member of the public, and an offsite MEI (a hypothetical member of the public, who receives the maximum dose residing at the INL Site boundary, in this instance, the site boundary south of the facility). (See Appendix C for additional information about the methodology used to generate these dose estimates.)

Table 4–44. INL Feedstock Preparation Option – Annual Radiological Impacts on the Public

	Maximally Exposed Individual	*Population within 50 Miles* [a]	*Average Individual within 50 Miles*
Dose	0.0012 millirem	0.012 person-rem	3.2×10^{-5} millirem
Cancer fatality risk [b]	7×10^{-10}	0 (7×10^{-6})	less than 10^{-10}
Regulatory dose limit [c]	10 millirem	Not applicable	10 millirem
Dose as a percentage of the regulatory limit	0.01	Not applicable	3×10^{-4}
Dose from natural background radiation [d]	383 millirem	139,000 person-rem	383 millirem
Dose as a percentage of background dose	0.0003	0.000008	0.000008

[a] The population dose for this table was based on a projected 2050 population estimate of about 364,000 within 50 miles of the VTR at the INL Site.
[b] Based on a risk estimator of 0.0006 LCFs per person-rem (DOE 2003).
[c] 40 CFR Part 61, Subpart H, establishes an annual limit of 10 millirem via the air pathway to any member of the public from DOE operations.
[d] Based on an individual annual dose of 383 millirem from natural background radiation to the projected population of about 364,000.

Table 4–44 shows the estimated population dose associated with feedstock preparation operations to be 0.012 person-rem per year. The MEI would receive an estimated annual dose of 0.0012 millirem and the average annual dose to an individual in the population would be 3.2×10^{-5} millirem under this alternative. EPA and DOE have established an annual limit of 10 millirem to the individual via the air pathway from all DOE sources. Both the average individual and MEI dose from feedstock preparation would be less than 0.1 percent of this limit. Additionally, the population and individual doses from exposure to natural background radiation levels for the INL Site are compared. As shown in Table 4–44 the population and individual doses from feedstock preparation operations are well below 0.001 percent of the dose from natural background radiation.

No LCFs would be expected within the general population. This population dose would increase the annual risk of a latent fatal cancer in the population by 7×10^{-6}. Another way of stating this is that the likelihood that one fatal cancer would occur in the population because of radiological releases associated with this INL Feedstock Preparation Option is about 1 chance in 140,000 per year. The corresponding increased risk of an individual developing a latent fatal cancer would be less than 1×10^{-10}, or about 1 chance in 10 billion] per year. For the MEI, an increased annual risk of developing a latent fatal cancer would be about 7×10^{-10}. In other words, the likelihood that the MEI would develop a fatal cancer is about 1 chance in a billion for each year of operations.

Worker Health

Staffing projections estimate about 300 additional operations staff, which includes workers for feedstock preparation and waste handling. All would be radiation workers (SRNS 2020). The gloveboxes to be used during fuel fabrication would use shielding and radiological designs adequate to limit operator radiological exposure. The final design would consider additional/alternative shielding concepts and automation opportunities to further reduce projected worker doses. Additionally, the site may rotate workers between higher and lower dose activities to limit individual exposures. Estimates of individual worker doses would range from 0.05 rem per year for supporting personnel to 0.2 rem per year per person to 0.75 rem per year per glovebox operator (SRNS 2020). Based on this range of worker doses, the total worker dose would be 51 person-rem per year. The annual individual risk of cancer from the average worker dose of about 170 millirem would not result in an LCF (probability of 1×10^{-4}) and the 0.75 rem per year maximum individual worker dose also would not result in an LCF (probability of 0.0005). The total worker dose would not result in an LCF among the worker population (calculated value of 0.03).

The feedstock preparation facilities would be located within the MFC (in FCF). Other workers within the MFC would be exposed to the radiological emissions associated with the VTR facilities. Based on the radiological emissions identified previously (Table 4–43) the dose to a noninvolved worker within the MFC was estimated. This noninvolved worker would receive a dose of about 0.002 millirem per year. This exposure is not expected to result in an additional LCF and results in a low risk of an LCF (calculated risk value of 1×10^{-9}).

Safety and health requirements for DOE workers are governed by 10 CFR Part 851, which establishes requirements for a worker safety and health program to ensure that DOE workers have a safe work environment. Included are provisions to protect against hazardous chemicals. Workers within the FCF facility are protected by the majority of chemical hazards to which they are exposed by the use of gloveboxes and other enclosures. In the rare instance that these devices fail, workers could potentially be exposed to sodium, toxic metals (such as uranium and plutonium), and inert gases such as argon, which poses an asphyxiant concern.

Operational staff would also be susceptible to industrial accidents that could result in injury or death. The estimated number of accidental worker injuries and fatalities were based on the number of staff involved in feedstock preparation activities and national worker injury and fatality rates. For an operation of this size, accidents would be expected. On average about 300 staff would be involved in feedstock preparation operations (SRNS 2020). During each year of operation, there would be no expected fatalities (0.007) based on an average worker fatality rate in the manufacturing industry of 2.2 fatalities per 100,000 worker years (BLS 2018a). In 2018, the national average for manufacturing workers for accidents resulting in lost worker days was 3.1 accident per 100 full time workers (BLS 2018b). This accident rate results in an estimated nine staff injuries per year during operation.

4.10.3.1.2 INL Fuel Fabrication Option

Construction/Facility Modification

Public Health

Modifications to existing FMF and ZPPR MFC facilities would have no radiological impact on the public. Required facility modifications in the FMF and ZPPR involve the installation of new equipment, not major facility construction. No additional radiological emissions would be expected from these activities.

Required modifications are described in Appendix B.

Worker Health

Modifications to the FMF and ZPPR would include the installation of the gloveboxes required for fuel alloying and fuel pin assembly in FMF and assembly fabrication in ZPPR. (Equipment to be installed in the facilities have been described in Appendix B.) These modifications have a construction timeline of 3 years and would involve about 6 construction workers. Modifications would require a variety of different workers with varying levels of effort within the facility dependent upon particular construction tasks. Typically, these workers would be anticipated to work a standard, 40-hour workweek, with up to 20 percent overtime if needed to meet construction schedules. The radiation environment in the areas where the work would be performed is typically less than 0.5 millirem per hour (INL 2020f).

The average annual individual worker dose would be less than 1.2 rem and the total annual worker dose would be less than 7.2 person-rem. Average individual and total worker doses for the modification effort would be less than 3.6 rem and 21 person-rem. No additional LCFs (0.01) would be anticipated from this modification effort. This estimate of worker dose is likely conservative in that no INL Site worker during the years 2014 to 2018 received an individual dose in excess of 750 millirem (see Chapter 3, Section 3.1.10.1).

Using the nonradiological fatality and injury rates given in Section 4.10.2.1, no nonradiological impacts (fatalities or injuries) would be anticipated. This is due to the limited number of workers involved and the relatively short time frame for construction.

Operations

Public Health

Under the INL fuel fabrication option, the annual radiological emissions from the fuel fabrication facility within the FMF are expected to be no more than the quantities listed in **Table 4–45**. Plutonium feedstock under this option is assumed to have been recently polished (e.g., during feedstock preparation). Therefore, little or no americium-241 would be in the radiological emissions. Radiological emissions would primarily come from operations in the FMF, not in the ZPPR. Only fully assembled fuel pins are transferred to ZPPR. The fuel pins are completely sealed and assembly fabrication does not involve mechanically altering (e.g., cutting) the fuel pins. All emissions would be through the FMF exhaust system, which includes HEPA filters, and out the facility stack.

Table 4–45. INL Fuel Fabrication Option – Radiological Emissions During Normal Operations

Nuclide	***Emissions (curies per year)***	***Nuclide***	***Emissions (curies per year)***
Americium-241	3.3×10^{-4}	Uranium-232	7.3×10^{-12}
Plutonium-238	2.3×10^{-6}	Uranium-234	2.2×10^{-9}
Plutonium-239	3.7×10^{-6}	Uranium-235	1.9×10^{-11}
Plutonium-240	2.4×10^{-6}	Uranium-236	2.8×10^{-10}
Plutonium-241	5.7×10^{-5}	Uranium-238	5.4×10^{-11}
Plutonium-242	1.7×10^{-9}		

Source: SRNS 2020.

Radiological impacts were estimated for the public living within 50 miles of the fuel fabrication facility located in the FMF. **Table 4–46** shows the annual radiological impacts on the population projected to be living within a 50-mile radius of the fuel fabrication facility in 2050 (a population of about 364,000) and two individuals. Impacts generated for an average member of the public and an offsite MEI (a hypothetical member of the public, who receives the maximum dose while residing at the INL Site boundary, in this instance, south of the facility). (See Appendix C for additional information about the methodology used to generate these dose estimates.)

Table 4–46. INL Fuel Fabrication Option – Annual Radiological Impacts on the Public

	Maximally Exposed Individual	***Population within 50 Miles [a]***	***Average Individual within 50 Miles***
Dose	0.0016 millirem	0.0053 person-rem	1.5×10^{-5} millirem
Cancer fatality risk [b]	1×10^{-9}	0 (3×10^{-6})	less than 1×10^{-10}
Regulatory dose limit [c]	10 millirem	Not applicable	10 millirem
Dose as a percentage of the regulatory limit	0.02	Not applicable	0.0002
Dose from natural background radiation [d]	383 millirem	139,000 person-rem	383 millirem
Dose as a percentage of background dose	0.0004	0.000004	0.000004

[a] The population dose for this table was based on a projected 2050 population estimate of 364,300 within 50 miles of the VTR at the INL Site.

[b] Based on a risk estimator of 0.0006 LCFs per person-rem (DOE 2003).

[c] 40 CFR Part 61, Subpart H, establishes an annual limit of 10 millirem via the air pathway to any member of the public from DOE operations.

[d] Based on an individual annual dose of 383 millirem from natural background radiation to the projected population of 364,000.

Table 4–46 shows the estimated population dose associated with fuel fabrication facility operations to be 0.0053 person-rem per year. The MEI would receive an estimated annual dose of 0.0016 millirem and the average annual dose to an individual in the population would be 1.5×10^{-5} millirem under this alternative. EPA and DOE have established an annual limit of 10 millirem to the individual via the air pathway from all DOE sources. Both the average individual and MEI dose from fuel fabrication operation would be less than 0.1 percent of this limit. Additionally, the population and individual doses from exposure to natural background radiation levels for the INL Site are compared. As shown in Table 4–46, the population and individual doses from operating the fuel fabrication facility are well below 0.01 percent of the dose from natural background radiation.

No LCFs would be expected within the general population, this population dose would increase the annual risk of a latent fatal cancer in the population by 3×10^{-6}. Another way of stating this is that the likelihood that one fatal cancer would occur in the population because of radiological releases associated with this option is about 1 chance in 300,000 per year. The corresponding increased risk of an individual developing a latent fatal cancer would be less than 1×10^{-10}, or less than 1 chance in 10 billion per year. For the MEI an increased annual risk of developing a latent fatal cancer would be about 1×10^{-9}. In other words, the likelihood that the MEI would develop a fatal cancer is about 1 chance in a billion for each year of operations.

Worker Health

Staffing projections estimate about 70 additional operations staff, of which 61 are involved in VTR fuel fabrication and 9 are associated with the additional analytical chemistry efforts. These staff positions would be in addition to current staffing levels, and all would be radiation workers (INL 2020f). An estimated total of 300 existing and new staff would be involved with fuel fabrication (SRNS 2020). The gloveboxes to be used during fuel fabrication would use shielding and radiological designs adequate to limit operator radiological exposure. The final design would consider additional or different shielding concepts and automation opportunities to further reduce projected worker doses. Estimates of individual worker doses would range from 0.05 rem per year for supporting personnel to 0.2 to 0.75 rem per year per glovebox operator (SRNS 2020). Based on this range of worker doses, the total worker dose would be 51 person-rem per year. The annual individual risk of cancer from the average worker dose of about 170 millirem would not result in an LCF (probability of 0.0001) and the 0.75 rem per year maximum individual worker dose also would not result in an LCF (probability of 0.0005). The total annual worker dose would not result in an LCF among the worker population (calculated value of 0.03).

Some of the worker dose would be incurred by current workers and would not result in a cumulative increase in worker dose. It has been assumed that the 70 new workers would be among those receiving the highest dose from fuel fabrication activities. In that case, these workers would receive a total dose of about 32 person-rem (out of the 51 person-rem dose received by all workers). This annual dose would not result in an LCF (0.02) among these workers. The average worker dose for these employees would be 460 millirem.

The fuel fabrication facilities would be located within the MFC (in the FMF and ZPPR facilities). Other workers within the MFC would be exposed to the radiological emissions associated with the VTR facilities. Based on the radiological emissions identified previously (Table 4–45) the dose to a noninvolved worker within the MFC was estimated. This noninvolved worker would receive a dose of about 0.067 millirem per year. This exposure is not expected to result in an additional LCF, and results in a low risk of an LCF (calculated risk value of 4×10^{-8}).

Section 4.10.3.1.1 discusses worker protection from chemical hazards.

Operational staff would also be susceptible to industrial accidents that could result in injury or death. The estimated number of accidental worker injuries and fatalities were based on the number of staff involved in fuel fabrication activities and national worker injury and fatality rates. For an operation of this size, accidents would be expected. On average about 300 staff would be involved in fuel fabrication operations (SRNS 2020). During each year of operation, there would be no expected fatalities (0. 007) based on an average worker fatality rate in the manufacturing industry of 2.2 fatalities per 100,000 worker years (BLS 2018a). In 2018, the national average for manufacturing workers for accidents resulting in lost worker days was 3.1 accident per 100 full time workers (BLS 2018b). This accident rate results in an estimated 9 staff injuries per year during operation.

4.10.3.2 SRS Reactor Fuel Production Options

This section presents the possible impacts of establishing feedstock preparation and fuel fabrication capabilities at SRS. Impacts would be from facility modifications (equipment installation) to the 105-K Building to offer the necessary technologies for feedstock preparation (conversion and polishing) and fuel fabrication of a metal uranium-plutonium-zirconium fuel for the VTR. (Modifications required for the 105-K Building are described in Appendix B.) Additionally, existing equipment would have to be removed.

4.10.3.2.1 SRS Feedstock Preparation Option

Construction/Facility Modification

Public Health

Modifications to the 105-K Building would have no radiological impact on the public. Required facility modifications in the building involve the installation of new equipment, not major facility construction. No additional radiological emissions would be expected from these activities. Modifications are described in Appendix B.

Worker Health

The majority of the K Area Complex being considered for use for feedstock preparation is clean. However, there is the potential of using some footprint that is slightly contaminated (e.g., K-Assembly basement). Based upon an analysis for a similar space in K Area, the construction effort to decontaminate and roll back contaminated space could result in a dose of 50 millirem per person for a crew of 25 construction and radiological controls personnel over a 3-year period. The total worker dose for the entire decontamination effort would be 1.3 person-rem. No LCFs (0.0008) would be expected among the construction workforce.

After the areas are decontaminated, equipment installation would not be expected to result in radiological exposure to the installation workers.

Nonradiological injuries and fatalities during construction are based on the duration of construction and the number of workers involved. Construction for feedstock preparation at SRS is estimated to take 3 years and the number of workers would be expected to rapidly reach the peak number of workers (120) and remain at this level for the duration of construction. Using the nonradiological fatality and injury rates provided in Section 4.10.2.1, there would be no expected fatalities (0.003) and an estimated 10 construction worker injuries during construction.

Operations

Public Health

Under the feedstock preparation at SRS option, the annual radiological emissions from the fuel fabrication facility within the 105-K Building are expected to be as shown in **Table 4–47**. All emissions would be through a new 105-K Building exhaust system, which includes HEPA filters, and out a new facility stack (SRNS 2020). The existing K area exhaust system would not be used.

Table 4–47. SRS Feedstock Preparation Option – Radiological Emissions During Normal Operations

Nuclide	Emissions (curies per year)	Nuclide	Emissions (curies per year)
Americium-241	6.6×10^{-4}	Uranium-232	5.8×10^{-12}
Plutonium-238	9.5×10^{-6}	Uranium-234	1.7×10^{-9}
Plutonium-239	9.6×10^{-6}	Uranium-235	1.5×10^{-11}
Plutonium-240	1.4×10^{-5}	Uranium-236	2.2×10^{-10}
Plutonium-241	2.0×10^{-4}	Uranium-238	4.3×10^{-11}
Plutonium-242	2.2×10^{-8}		

Source: SRNS 2020.

Radiological impacts were estimated for the public living within 50 miles of the reactor fuel production capabilities located in the 105-K Building. **Table 4–48** shows the annual radiological impacts on the population projected to be living within a 50-mile radius of the facility in 2050, a population of about 889,000, and two individuals. Impacts are generated for an average member of the public and an offsite MEI (a hypothetical member of the public who receives the maximum dose residing at the SRS site boundary, in this instance, the site boundary south-southwest of the facility). (See Appendix C for additional information about the methodology used to generate these dose estimates.)

Table 4–48. SRS Feedstock Preparation Option – Annual Radiological Impacts on the Public

	Maximally Exposed Individual	Population within 50 Miles [a]	Average Individual within 50 Miles
Dose	0.0015 millirem	0.042 person-rem	4.7×10^{-5} millirem
Cancer fatality risk [b]	9×10^{-10}	0 (2×10^{-5})	less than 1×0^{-10}
Regulatory dose limit [c]	10 millirem	Not applicable	10 millirem
Dose as a percentage of the regulatory limit	0.02	Not applicable	0.0004
Dose from natural background radiation [d]	311 millirem	276,000 person-rem	311 millirem
Dose as a percentage of background dose	0.0005	0.00002	0.00002

[a] The population dose for this table was based on a projected 2050 population estimate of about 889,000 within 50 miles of the K Area Complex at the Savannah River Site.
[b] Based on a risk estimator of 0.0006 LCFs per person-rem (DOE 2003).
[c] 40 CFR Part 61, Subpart H, establishes an annual limit of 10 millirem via the air pathway to any member of the public from DOE operations.
[d] Based on an individual annual dose of 311 millirem from natural background radiation to the projected population of about 889,000.

Table 4–48 shows the estimated population dose associated with feedstock preparation operations to be 0.042 person-rem per year. The MEI would receive an estimated annual dose of 0.0015 millirem and the average annual dose to an individual in the population would be 4.7×10^{-5} millirem. EPA and DOE have established an annual limit of 10 millirem to the individual via the air pathway from all DOE sources. Both the average individual and MEI doses from feedstock preparation operations would be less than 0.1 percent of this limit. Additionally, the population and individual doses from exposure to natural background radiation levels for SRS area are compared. As shown in Table 4–48 the population and individual doses from feedstock preparation operations are well below 0.001 percent of the dose from natural background radiation.

No LCFs would be expected within the general population; the population dose from feedstock preparation would increase the annual risk of a latent fatal cancer in the population by about 2×10^{-5}. Another way of stating this is that the likelihood that one fatal cancer would occur in the population because of radiological releases would be about 1 chance in 40,000 per year. The corresponding increased risk of an individual developing a latent fatal cancer would be less than 1×10^{-10} or less than 1 chance in 10 billion per year. For the MEI an increased annual risk of developing a latent fatal cancer would be about 9×10^{-10}. In other words, the likelihood that the MEI would develop a fatal cancer is about 1 chance in a billion for each year of operations.

***Worker Health*[3]**

Staffing projections estimate about 300 additional operations staff, which includes workers for feedstock preparation and waste handling. All would be radiation workers (SRNS 2020). The gloveboxes to be used during fuel fabrication would use shielding and radiological designs adequate to limit operator radiological exposure. The final design would consider additional/alternative shielding concepts and automation opportunities to further reduce projected worker doses. Additionally, the site may rotate workers between higher and lower dose activities to limit individual exposures. Estimates of individual worker doses would range from 0.05 rem per year for supporting personnel to 0.2 rem per year per person to 0.75 rem per year per glovebox operator (SRNS 2020). Based on this range of worker doses, the total worker dose would be 51 person-rem per year. The annual individual risk of cancer from the average worker dose of about 170 millirem would not result in an LCF (probability of 1×10^{-4}) and the 0.75 rem per year maximum individual worker dose also would not result in an LCF (probability of 0.0005). The total worker dose would not result in an LCF among the worker population (calculated value of 0.03).

The feedstock preparation facilities would be located within the K-Reactor Building. Other workers within the K Area would be exposed to the radiological emissions associated with the VTR facilities. Based on the radiological emissions identified previously (Table 4–47) the dose to a worker within the MFC was estimated. This noninvolved worker would receive a dose of about 0.0061 millirem per year. This exposure is not expected to result in an additional LCF, and results in a low risk of an LCF (calculated risk value of 4×10^{-9}).

Section 4.10.3.1.1 discusses worker protection from chemical hazards.

Operational staff would also be susceptible to industrial accidents that could result in injury or death. The estimated number of accidental worker injuries and fatalities were based on the number of staff involved in feedstock preparation activities and national worker injury and fatality rates. For an operation of this size, accidents would be expected. On average about 300 staff would be involved in feedstock preparation operations (SRNS 2020). During each year of operation, there would be no expected fatalities (0.007) based on an average worker fatality rate in the manufacturing industry of 2.2 fatalities per 100,000 worker years (BLS 2018a). In 2018, the national average for manufacturing workers for accidents resulting in lost worker days was 3.1 accident per 100 full time workers (BLS 2018b). This accident rate results in an estimated nine staff injuries per year during operation.

4.10.3.2.2 SRS Fuel Fabrication Option

Construction/Facility Modification

Public Health

Modifications to the 105-K Building would have no radiological impact on the public. Required facility modifications in the building involve the installation of new equipment, not major facility construction. No additional radiological emissions would be expected from these activities.

Worker Health

The majority of the K Area Complex being considered for use for VTR fuel fabrication is clean. However, there is the potential of using some footprint that is slightly contaminated (e.g., K-Assembly basement).

[3] In addition to the DOE administrative limit of 2 rem per year per worker, SRS has a site administrative limit of 500 millirem per year per worker (SRNS 2020).

Based upon an analysis for a similar space in K Area, the construction effort to decontaminate and roll back contaminated space could result in a dose of 30 millirem per person for a crew of 25 construction and radiological control personnel over a three-year period (SRNS 2020). The total worker dose for the entire decontamination effort would be 0.8 person-rem. No LCFs (0.0005) would be expected among the construction workforce.

Once the areas are decontaminated, equipment installation would not be expected to result in radiological exposure to the installation workers.

Nonradiological injuries and fatalities during construction are based on the duration of construction and the number of workers involved. Construction for fuel fabrication at SRS is estimated to take three years and the number of workers would be expected to rapidly reach the peak number of workers (120) and remain at this level for the duration of construction. Using the nonradiological fatality and injury rates provided in Section 4.10.2.1, there would be no expected fatalities (0.003) and an estimated 10 construction worker injuries during construction.

Operations

Public Health

Under the SRS fuel fabrication option, the annual radiological emissions from the fuel fabrication within the 105-K Building are expected to be the same as those estimated for the INL Site fuel fabrication option, see Table 4–45. All emissions would be through a new 105-K Building exhaust system, which includes HEPA filters, and out a new facility stack. The existing K area exhaust system would not be used.

Radiological impacts were estimated for the public living within 50 miles of the fuel fabrication capability located in the 105-K Building. **Table 4–49** shows the annual radiological impacts on the population projected to be living within a 50-mile radius of the facility in 2050, a population of about 889,000, and two individuals. Impacts are generated for an average member of the public and an offsite MEI (a hypothetical member of the public who receives the maximum dose while residing at the SRS site boundary, in this instance, the site boundary south-southwest of the facility). (See Appendix C for additional information about the methodology used to generate these dose estimates.)

Table 4–49. SRS Fuel Fabrication Option – Annual Radiological Impacts on the Public

	Maximally Exposed Individual	***Population Within 50 Miles*** [a]	***Average Individual within 50 Miles***
Dose	0.00071 millirem	0.020 person-rem	2.3×10^{-5} millirem
Cancer fatality risk [b]	4×10^{-10}	0 (1×10^{-5})	less than 1×10^{-10}
Regulatory dose limit [c]	10 millirem	Not applicable	10 millirem
Dose as a percentage of the regulatory limit	0.007	Not applicable	2×10^{-4}
Dose from natural background radiation [d]	311 millirem	276,000 person-rem	311 millirem
Dose as a percentage of background dose	0.0002	0.000007	0.000007

[a] The population dose for this table was based on a projected 2050 population estimate of about 889,000 within 50 miles of the K Area Complex at the Savannah River Site.

[b] Based on a risk estimator of 0.0006 LCFs per person-rem (DOE 2003).

[c] 40 CFR Part 61, Subpart H, establishes an annual limit of 10 millirem via the air pathway to any member of the public from DOE operations.

[d] Based on an individual annual dose of 311 millirem from natural background radiation to the projected population of about 889,000.

Table 4–49 shows the estimated population dose associated with fuel fabrication facility operations to be 0.020 person-rem per year. The MEI would receive an estimated annual dose of 0.00071 millirem and the average annual dose to an individual in the population would be 2.3×10^{-5} millirem under this alternative. EPA and DOE have established an annual limit of 10 millirem to the individual via the air pathway from all DOE sources. Both the average individual and MEI doses from fuel fabrication operation would be less than 0.1 percent of this limit. Additionally, for comparison, the population and individual doses from exposure to natural background radiation levels for the INL Site are provided. As shown in Table 4–49 the population and individual doses from operating the fuel fabrication facility are well below 0.001 percent of the dose from natural background radiation.

No LCFs would be expected within the general population, this population dose would increase the annual risk of a latent fatal cancer in the population by 1×10^{-5}. Another way of stating this is that the likelihood that one fatal cancer would occur in the population because of radiological releases associated with this option is about 1 chance in 80,000 per year. The corresponding increased risk of an individual developing a latent fatal cancer would be less than 1×10^{-10}, or less than 1 chance in 10 billion per year. For the MEI an increased annual risk of developing a latent fatal cancer would be about 4×10^{-10}. In other words, the likelihood that the MEI would develop a fatal cancer is about 1 chance in 2 billion for each year of operations.

***Worker Health*[4]**

Staffing projections estimate about 300 additional operations staff, which includes workers for fuel fabrication and waste handling. All would be radiation workers (SRNS 2020). The gloveboxes to be used during fuel fabrication would use shielding and radiological designs adequate to limit operator radiological exposure. The final design would consider additional/alternative shielding concepts and automation opportunities to further reduce projected worker doses. Additionally, the site may rotate workers between higher and lower dose activities to limit individual exposures. Estimates of individual worker doses would range from 0.05 rem per year for supporting personnel to 0.2 to 0.75 rem per year per glovebox operator (SRNS 2020). Based on this range of worker doses, the total worker dose would be 51 person-rem per year. The annual individual risk of cancer from the average worker dose of about 170 millirem would not result in an LCF (probability of 1×10^{-4}) and the 0.75 rem per year maximum individual worker dose also would not result in an LCF (probability of 0.0005). The total worker dose would not result in an LCF among the worker population (calculated value of 0.03).

The fuel fabrication facilities would be located within the K-Reactor Building. Other workers within the K Area would be exposed to the radiological emissions associated with the VTR facilities. Based on the radiological emissions identified previously (Table 4–45) the dose to a worker within the MFC was estimated. This noninvolved worker would receive a dose of about 0.0030 millirem per year. This exposure is not expected to result in an additional LCF and results in a low risk of an LCF (calculated risk value of 2×10^{-9}).

Section 4.10.3.1.1 discusses worker protection from chemical hazards.

Operational staff would also be susceptible to industrial accidents that could result in injury or death. The estimated number of accidental worker injuries and fatalities were based on the number of staff involved in fuel fabrication activities and national worker injury and fatality rates. For an operation of this size, accidents would be expected. On average about 300 staff would be involved in fuel fabrication operations (SRNS 2020). During each year of operation, there would be no expected fatalities (0.007) based on an

[4] In addition to the DOE administrative limit of 2 rem per year per worker, SRS has a site administrative limit of 500 millirem per year per worker.

average worker fatality rate in the manufacturing industry of 2.2 fatalities per 100,000 worker years (BLS 2018a). In 2018, the national average for manufacturing workers for accidents resulting in lost worker days was 3.1 accident per 100 full time workers (BLS 2018b). This accident rate results in an estimated 9 staff injuries per year during operation.

4.10.4 Combined INL VTR Alternative and INL Reactor Fuel Production Impacts

This section presents the total human health impacts from normal operations that would occur at the INL Site if the INL VTR Alternative and the INL option for both phases of reactor fuel production (feedstock preparation and fuel fabrication) were implemented at the INL Site. **Table 4–50** provides a summary of the individual impacts and a summation of impacts from the INL VTR Alternative and the two phases of reactor fuel production.

Table 4–50. Human Health Impacts for the Combined INL VTR Alternative and Reactor Fuel Production Options

Impact		*VTR Alternative*		*Feedstock Preparation Option*		*Fuel Fabrication Option*		*Total*	
		Construction	*Operation*	*Construction*	*Operation*	*Construction*	*Operation*	*Construction*	*Operation*
Public Health									
Population	Dose (person-rem)	NA	0.044	NA	0.012	NA	0.0053	NA	0.060
	LCF	NA	0 (3×10^{-5})	NA	0 (7×10^{-6})	NA	0 (3×10^{-6})	NA	0 (4×10^{-5})
MEI	Dose (millirem)	NA	0.0068	NA	0.0012	NA	0.0016	NA	0.0096
	LCF	NA	4×10^{-9}	NA	7×10^{-10}	NA	1×10^{-9}	NA	6×10^{-9}
Average Individual	Dose (millirem)	NA	0.00012	NA	3.2×10^{-5}	NA	1.5×10^{-5}	NA	0.00017
	LCF [a]	NA	0	NA	0	NA	0	NA	1×10^{-10}
Involved Worker Health									
Average individual worker - Annual	Dose (millirem)	500	150	NA	170	1,200	170	760	160
	LCF	0.0003	9×10^{-5}	NA	0.0001	0.0007	0.0001	0.0005	0.0001
Total Worker – Annual	Dose (person-rem)	5	53	NA	51	7.2	51	12	160
	LCF	0.003	0.03	NA	0.03	0.004	0. 03	0.007	0.1
Total Worker – Construction Duration	Dose (person-rem)	10	NA	NA	NA	21	NA	31	NA
	LCF	0.006	NA	NA	NA	0.01	NA	0.02	NA
Noninvolved Worker Health									
Noninvolved Worker [b]	Dose (millirem)	NA	0.0021	NA	0.0017	NA	0.067	NA	0.071
	LCF	NA	1×10^{-9}	NA	1×10^{-9}	NA	4×10^{-8}	NA	4×10^{-8}

[a] Individually the LCF for each alternative/option is less than 1×10^{-10}.

[b] Doses to noninvolved workers have been conservatively assumed to impact the same noninvolved worker. Emissions from the activities are from 3 different locations, the noninvolved worker for each activity is located at different locations within the MFC.

4.11 Human Health – Facility Accidents

This section contains analysis of radiological impacts from postulated accidents on workers and the general population. Hazardous material releases are not addressed in this section but are presented in Appendix D. Intentional destructive acts are enveloped by the beyond-design-basis accident discussed in Appendix D and not discussed in this section. Details about the assumptions and methods used to evaluate the impacts on human health from postulated accidents at DOE facilities are summarized in Appendix D of this VTR EIS.

Human health risks from construction, normal operations, and facility accidents are considered for individual receptors and population groups. Depending on the source of radiation exposure (and whether normal or accidental conditions are being considered), these receptors and population groups include involved and noninvolved workers, the offsite population, and an MEI member of the public within the offsite population.

> **Involved worker** is someone directly or indirectly involved with VTR operations at either the INL MFC or ORNL or fuel fabrication at either INL MFC or SRS who may receive an occupational radiation dose from direct radiation (i.e., neutron, x-ray, beta, or gamma) or from radionuclides released to the environment. Direct exposure from handling plutonium materials within a facility would be the chief source of occupational exposure for onsite workers (primarily from gamma radiation emitted by americium-241).
>
> **Noninvolved worker (NIW)** is a site worker outside of the facility who would not be subject to direct radiation exposure but could be incidentally exposed to emissions from the VTR or fuel fabrication related accidents if they occurred.
>
> **Offsite population** comprises members of the general public who live within 50 miles of the facility being evaluated.
>
> **Maximally exposed individual (MEI)** is a hypothetical individual at a location of public access that would result in the highest exposure; considered to be located at Highway 20 at INL MFC, the nearest public access on Melton Lake at ORNL, and the site boundary at SRS.

DOE uses the term "latent cancer fatality" or LCF to represent the potential human health impacts of exposure to radiation. LCFs are estimated by multiplying the radiation dose by a factor (risk estimator) representing the rate at which radiation exposure could result in latent mortality. Estimates of potential LCFs are provided in this VTR EIS using a risk estimator of 0.0006 LCFs per rem or person-rem (DOE 2003). For doses equal to or greater than 20 rem resulting from an acute exposure, the risk estimator is doubled (ICRP 1991).[5]

Potential accident scenarios have been identified for the INL MFC, ORNL, and SRS facilities, including the VTR at the INL MFC and ORNL; the VTR fuel fabrication facility at the INL MFC and the SRS; and the post-irradiation examination facility, the spent fuel treatment facility, and the spent fuel storage pad at the INL MFC and ORNL. The analysis in this EIS includes accident scenarios and consequences. The analysis includes accidents that have a low frequency of occurrence, but large consequences, and a spectrum of other accidents that have higher frequencies of occurrence and smaller consequences.

Each of the facilities addressed in this EIS in which VTR reactor or supporting activities would occur have been (or would be) designed and operated to reduce the likelihood of these accidents. For these facilities, sufficient safety controls are expected to be in place so that the probability of accidental releases would be "extremely unlikely" or lower; and if the accidents were initiated, the consequences would likely be much less than those reported in this VTR EIS. Accident frequencies are generally grouped into the bins of "anticipated," "unlikely," "extremely unlikely," and "beyond extremely unlikely," with estimated

[5] DOE considers LCFs less than 0.5 to be 0. The rounded LCF value is provided in the tables and the text, followed by the calculated value in parentheses.

frequencies of greater than 1×10^{-2}, 1×10^{-2} to 1×10^{-4}, 1×10^{-4} to 1×10^{-6}, and less than 1×10^{-6} per year, respectively.

For each potential accident, impacts are estimated for three receptors: a noninvolved worker, an MEI, and the offsite population within 50 miles projected to the year 2050. Consequences for these receptors were estimated without regard for emergency response measures (e.g., evacuation, sheltering). Consequences to the public were evaluated for both the near-term due to passage of a plume of radioactive materials following an accident and over the longer term after the plume has passed. Potential longer-term impacts due to chronic exposures to radionuclides remaining after the plume passage due to various pathways, including resuspension of remaining particulates and ingestion of contaminated food presented in Appendix D. The food pathway could be the largest source of longer-term dose from accidents releasing fission products unless mitigated by the interdiction of the nearby food chain

Consequences for workers directly involved in the processes under consideration are not quantified. The uncertainties involved in quantifying accident consequences for an involved worker are quite large because of the high sensitivity of results to assumptions (e.g., plume dispersion within a short distance). No major consequences for the involved worker are expected from leaks, spills, and smaller fires because involved workers should be able to evacuate immediately or be unaffected by the events. Explosions could result in immediate injuries from flying debris, as well as the uptake of radioactive materials. If an accidental criticality occurred, workers in the immediate vicinity could receive high to fatal radiation exposures from the initial burst. The dose would depend on the magnitude of the criticality, the worker's distance from the criticality, and amount of shielding created by intervening structures and equipment. Earthquakes could also have substantial consequences, ranging from workers being killed by debris from collapsing structures to high radiation doses from uptake of radionuclides.

The following sections present the consequences of "bounding accidents," which are the highest consequence events resulting from operational and natural phenomena-related accidents for both alternatives and reactor fuel production options. Most of these accidents fall within the overall group of "design-basis" accidents and as such, safety systems should restrict releases to the atmosphere. Other accidents in which the safety systems fail could also occur. Because of their extremely low probability, these events are designated as beyond-design-basis events. For the VTR facilities, beyond-design-basis accidents would most likely be initiated by a major earthquake so severe as to cause major damage to structures throughout the region. All these events are included in Appendix D.

Impacts are presented in terms of the number of LCFs that are estimated. Impacts are generated for all of the locations where VTR-related activities would occur for each of the three receptors (50-mile population, MEI, and a noninvolved worker). The potential environmental consequences of bounding postulated operational and natural phenomena-caused radiological accidents/external events at INL, ORNL, and SRS are presented in **Table 4–51** for the offsite population, the MEI, and the noninvolved. More details are provided in Appendix D.

Table 4–51. Summary of Human Health Consequences from Facility Accidents

		VTR Alternatives			
		INL VTR		***ORNL VTR***	
	Bounding Event [a,b]	***MEI (LCF)*** [c]	***Population (LCFs)*** [c]	***MEI (LCF)*** [c]	***Population (LCFs)*** [c]
Construction		NA	NA	NA	NA
Operations	*VTR-Specific Operations: Bounding Operational and Natural Phenomena/External Events*				
	Operational (Fire involving VTR spent fuel assemblies)	$1{\times}10^{-4}$	$0\ (2{\times}10^{-2})$	$9{\times}10^{-3}$	$1\ (9{\times}10^{-1})$
	NPH/External (BDBE)	$4{\times}10^{-5}$	$0\ (8{\times}10^{-3})$	$3{\times}10^{-3}$	$0\ (3{\times}10^{-1})$
	VTR Support Operations-Post-Irradiation Examination: Bounding Operational and Natural Phenomena/External Events				
	Operational (None)	0	0	0	0
	NPH (Fire)	$1{\times}10^{-8}$	$0\ (2{\times}10^{-6})$	$8{\times}10^{-7}$	$0\ (8{\times}10^{-5})$
	VTR Support Operations-Spent Fuel Treatment: Bounding Operational and Natural Phenomena/ External Events				
	Operational (Criticality)	$2{\times}10^{-6}$	$0\ (8{\times}10^{-5})$	$9{\times}10^{-5}$	$0\ (3{\times}10^{-3})$
	NPH (Sodium fire with spent fuel)	$7{\times}10^{-6}$	$0\ (1{\times}10^{-3})$	$5{\times}10^{-4}$	$0\ (5{\times}10^{-2})$
	VTR Support Operations-Spent Fuel Storage: Bounding Operational and Natural Phenomena/ External Events				
	Operational (Cask drop)	$1{\times}10^{-6}$	$0\ (2{\times}10^{-4})$	$8{\times}10^{-5}$	$0\ (8{\times}10^{-3})$
	NPH (Seismic failure)	$2{\times}10^{-6}$	$0\ (4{\times}10^{-4})$	$2{\times}10^{-4}$	$0\ (2{\times}10^{-2})$
	Combined VTR and Support Operations: Bounding Operational and Natural Phenomena/External Events [d]				
	Operational (Fire involving VTR spent fuel assemblies)	$1{\times}10^{-4}$	$0\ (2{\times}10^{-2})$	$9{\times}10^{-3}$	$1\ (9{\times}10^{-1})$
	NPH/External (BDBE)	$4{\times}10^{-5}$	$0\ (8{\times}10^{-3})$	$3{\times}10^{-3}$	$0\ (3{\times}10^{-1})$
Discussion	For the VTR at INL or ORNL, operational accidents would be managed so that no fuel melts and resulting releases would be negligible. A fire involving VTR spent fuel assemblies in the VTR Experiment Hall is postulated as the bounding operational accident at the VTR. This accident is in the extremely unlikely category and may not be credible. A beyond-design-basis seismic event resulting in collapse of the Experiment Hall, damage to spent fuel, and loss of confinement is also postulated. For the VTR support activities, including post-irradiation examination and spent fuel handling, conditioning, and storage, the bounding operational accidents are a criticality, which results in unfiltered releases and a filtered release from fire, and a dropped cask of fuel. In a severe seismic event, building structures, process enclosures, and process equipment could be damaged enough that unfiltered releases could occur. This event has lower impacts than the fire involving VTR spent fuel assemblies in the VTR Experiment Hall. Results differ between the INL VTR Alternative and the ORNL VTR Alternative because of meteorology, receptor distance, and population distribution, but are similar in characteristics and magnitude. Construction accidents are discussed in Section 4.10 of this VTR EIS.				

		Reactor Fuel Production Options			
		INL Reactor Fuel Production		SRS Reactor Fuel Production	
	Bounding Event [a,b]	MEI (LCF) [c]	Population (LCFs) [c]	MEI (LCF) [c]	Population (LCFs) [c]
Construction		NA	NA	NA	NA
Feedstock Preparation Operations	*VTR Fuel Feedstock Preparation Operations: Bounding Operational and Natural/External Events*				
	Operational (Uncontrolled reaction)	01×10^{-7}	0 (2×10^{-5})	05×10^{-8}	0 (1×10^{-4})
	NPH (Am-241 waste)	07×10^{-8}	0 (1×10^{-5})	03×10^{-8}	0 (7×10^{-5})
Fuel Fabrication Operations	*VTR Fuel Fabrication Operations: Bounding Operational and Natural/External Events*				
	Operational (3013 explosion)	06×10^{-5}	0 (1×10^{-2})	02×10^{-5}	0 (7×10^{-2})
	NPH (Spill molten Pu)	07×10^{-6}	0 (1×10^{-3})	03×10^{-6}	0 (8×10^{-3})
Combined Feedstock Preparation and Fuel Fabrication	*VTR Fuel Feedstock Preparation and Fuel Fabrication Operations: Bounding Operational and Natural/External Events*				
	Operational (3013 explosion)	6×10^{-5}	0 (1×10^{-2})	0 2×10^{-5}	0 (7×10^{-2})
	BDBE (with all Pu)	7×10^{-4}	0 (1×10^{-1})	03×10^{-4}	1 (7×10^{-1})
Discussion	For the VTR fuel fabrication activities at either INL or SRS, the bounding operational accident would be a high-pressure explosion of a 3013 container of plutonium oxide. Although this event is considered extremely unlikely, it does have the potential for a large release. Releases from other accidents involving liquid, oxide, or molten forms of plutonium would be filtered before release to the environment. In a severe, beyond-design-basis earthquake, severe damage to the structures and process equipment was postulated. This could result in spillage and unfiltered release from liquid, oxide and molten forms of plutonium. In a severe seismic event, the building and glovebox structures could be damaged enough that an unfiltered release could occur. Even so, most of the material not specifically being processed at the time of the earthquake would be in metal form and would not result in a substantial release even with loss of glovebox and building integrity. Results differ between the INL option and the SRS option because of meteorology, receptor distance, and population distribution. Construction accidents are discussed in Section 4.10 of this VTR EIS.				
	Combined INL VTR and Reactor Fuel Production Impacts				
		MEI (LCF) [c]	***Population (LCFs)*** [c]		
Construction	Not applicable				
Operations	*VTR Combined Operations with Fuel Production at INL/MFC: Bounding Operational and Natural/External Events* [d]				
	Operational (Fire involving VTR spent fuel assemblies)	1×10^{-4}	0 (2×10^{-2})		
	NPH/External (BDBE)	7×10^{-4}	0 (1×10^{-1})		
Discussion	The results presented are for the combined reactor and support operations plus reactor fuel production at INL. The highest operational accident is a fire involving VTR spent fuel assemblies in the VTR Experiment Hall. The beyond-design-basis earthquake would cause severe damage and loss of confinement of the VTR, support facilities, and reactor fuel production facilities. The impacts would be dominated by releases of plutonium from reactor fuel production. Construction accidents are discussed in Section 4.10 of this VTR EIS.				

BDBE = beyond-design-basis earthquake; LCF = latent cancer fatality; MEI = maximally exposed individual; NPH = natural phenomena hazard; Pu = plutonium.

[a] Impacts, in terms of potential LCFs, are presented for the bounding operational accident and a bounding NPH (typically a beyond-design-basis earthquake). For these purposes, the term bounding means the highest consequence, credible event.

For NEPA purposes, events with an estimated frequency of less than one in 10 million per year are not considered unless they contribute significantly to the overall accident risk.

[b] Bounding operational and NPH/External events are identified and quantified in Appendix D.

[c] LCF (latent cancer fatality) represents the potential human health impacts of exposure to radiation in terms of excess cancers. The reported value represents the risk of an LCF for the MEI and the number of LCFs that would be expected in the offsite population within 50 miles of the facility. For population impacts, the calculated value is presented in appendices.

[d] For the combined facilities at INL and ORNL NPH/External event, a beyond-design-basis earthquake is assumed to be of sufficient magnitude to damage both the reactor and the support facilities. The impacts are summed over all the VTR-relate facilities that might release radionuclides in the seismic event. Releases from the rest of INL and ORNL are not included.

Sources: Appendix D.

4.11.1 INL VTR Alternative

This section presents the impacts from facility accidents with establishing the VTR at INL. The impacts would include those from construction and operation of the VTR; facility modifications and incremental operational impacts for performing post-irradiation examination of test items; facility modifications and incremental operational impacts for preparing SNF for long-term storage and disposal; and construction and operation of a new long-term storage pad near ZPPR.

4.11.1.1 Construction/Facility Modification

Facility accidents associated with construction of the VTR, facility modifications for post-irradiation examination, facility modifications for spent fuel treatment, and construction of a new spent fuel storage pad are discussed in Section 4.10.1.1 of this VTR EIS.

4.11.1.2 Operations

Radiological Impacts

This section presents potential radiological impacts on the public and a noninvolved onsite worker due to accidents during operation of the VTR and the operation of the post-irradiation examination facility. Those potential impacts along with those from the operation of the SNF treatment facility (including transuranic waste accidents) and that of the spent fuel storage pad are also presented and summarized in Table 4–51. Appendix D presents a detailed analysis of facility accidents, with the associated assumptions.

The detailed analysis considered a wide spectrum of potential accident scenarios, including fire, spills, criticality, earthquake, and aircraft crash. **Table 4–52** presents the frequencies and consequences of the postulated set of accidents to the maximally exposed member of the public, the offsite population residing within 50 miles of the facility, and a noninvolved worker located 330 feet from the facility. Receptor doses were calculated for the mean meteorological conditions.

For the VTR at INL, results of the VTR probabilistic risk analysis and other safety analyses indicate that all operational accidents would be controlled and not result in fuel melting. This includes the typical reactor accidents associated with light water reactors, including loss of offsite power, transient overpower events, experiment malfunctions, and seismic events. The passive heat removal systems are sufficiently robust that all of the conventional reactor accidents are either prevented or mitigated and no radioactive releases would be expected. No fuel would melt and the releases from the gaseous cooling systems have very small radiological consequences. Within the Experiment Hall of the VTR building, spent fuel is washed and handled and is potentially vulnerable for operational accidents. A fire involving VTR spent fuel assemblies in the VTR Experiment Hall is postulated as the bounding operational accident at the VTR. This accident is certainly in the extremely unlikely category and may not be credible.

Table 4–52. Accident Frequency and Radiological Impacts from VTR-Related Accidents at INL

Accident	*Frequency [e] (per year)*	*Impacts on Noninvolved Worker (100 meters)*		*Impacts on an MEI at 5 Kilometers [a]*		*Near-Term Impacts on Population within 50 Miles [b]*	
		Dose (rem)	*Probability of an LCF [c]*	*Dose (rem)*	*Probability of an LCF*	*Dose (person-rem)*	*LCFs [d]*
VTR Accident Impacts							
Test Assembly Failure following Seismically Induced Fire	Extremely Unlikely	5×10^{-2}	3×10^{-5}	6.5×10^{-5}	4×10^{-8}	1.2×10^{-2}	0 (7×10^{-6})
Fire Involving VTR Spent Fuel Assemblies	Extremely Unlikely to Beyond Extremely Unlikely	160	2×10^{-1}	2.4×10^{-1}	1×10^{-4}	36	0 (2×10^{-2})
VTR Fuel Assembly Drop in Experiment Hall	Extremely Unlikely	7.3×10^{-4}	4×10^{-7}	1.3×10^{-6}	8×10^{-10}	1.7×10^{-4}	0 (1×10^{-7})
VTR Seismic Event Resulting in Collapse of the Experiment Hall	Extremely Unlikely	58	7×10^{-2}	7.1×10^{-2}	4×10^{-5}	13	0 (8×10^{-3})
Spent Fuel Handling and Treatment							
Criticality Involving Melted Spent Fuel (failed containment)	Extremely Unlikely	1.0	6×10^{-4}	3.9×10^{-3}	2×10^{-6}	1.3×10^{-1}	0 (8×10^{-5})
Spill of Melted Spent Fuel with Seismically Induced Confinement Failure	Extremely Unlikely	0.66	4×10^{-4}	8.0×10^{-4}	5×10^{-7}	0.14	0 (9×10^{-5})
Na Fire Involving Spent Fuel with Cladding and Confinement Failure	Extremely Unlikely	9.0	5×10^{-3}	1.1×10^{-2}	7×10^{-6}	2.0	0 (1×10^{-3})
Transuranic Waste Accident Impacts							
Fire Outside Confinement (waste from fuel fabrication or spent fuel treatment)	Extremely Unlikely	6.0×10^{-5}	4×10^{-8}	7.4×10^{-8}	4×10^{-11}	1.3×10^{-6}	0 (8×10^{-10})
Fire Outside Involving a Waste Drum with 23 g of Am-241	Extremely Unlikely	8.2×10^{-2}	5×10^{-5}	1.1×10^{-4}	7×10^{-8}	1.8×10^{-2}	0 (1×10^{-5})
Post-Irradiation Examination Accident Impacts							
Fire Involving Test Assembly (Seismically Induced Confinement Failure)	Extremely Unlikely	1.6×10^{-2}	9×10^{-6}	1.9×10^{-5}	1×10^{-8}	3.5×10^{-3}	0 (2×10^{-6})
Spent Fuel Storage Accident Impacts							
Seismic Event Causes Failure of Storage Structure and Failure of Spent Fuel Storage Casks with Fuel Release	Beyond Extremely Unlikely	3.1	2×10^{-3}	3.9×10^{-3}	2×10^{-6}	6.9×10^{-1}	0 (4×10^{-4})
Seismic Event Causes Failure of Storage Structure and Failure of Spent Fuel Storage Casks with Criticality	Beyond Extremely Unlikely	1.0	6×10^{-4}	3.9×10^{-3}	2×10^{-6}	1.3×10^{-1}	0 (8×10^{-5})
Drop of Fuel-Loaded Cask	Extremely Unlikely	1.6	9×10^{-4}	1.9×10^{-3}	1×10^{-6}	3.5×10^{-1}	0 (2×10^{-4})

Accident	Frequency [e] (per year)	Impacts on Noninvolved Worker (100 meters)		Impacts on an MEI at 5 Kilometers [a]		Near-Term Impacts on Population within 50 Miles [b]	
		Dose (rem)	Probability of an LCF [c]	Dose (rem)	Probability of an LCF	Dose (person-rem)	LCFs [d]

HRS = heat removal system; LCF = latent cancer fatality; MEI = maximally exposed individual; Na = sodium; of PuO_2 = plutonium oxide; rem = roentgen equivalent man; RVACS = Reactor Vessel Auxiliary Cooling System; TRU = transuranic.

a An MEI was assumed to be on Highway 20, 5 kilometers from the VTR complex at MFC. Assumptions and methods for the evaluation of consequences are presented in Section D.1.4.

b Potential longer-term impacts due to chronic exposures to radionuclides remaining after the plume passage due to various pathways, including resuspension of remaining particulates and ingestion of contaminated food, were also calculated and presented in Appendix D. The food pathway could be the largest source of longer-term dose from accidents releasing fission products unless mitigated by the interdiction of the nearby food chain.

c For hypothetical individual doses equal to or greater than 20 rem, the probability of an LCF was doubled.

d Numbers of LCFs in the population are whole numbers; the statistically calculated values are provided in parentheses for when the reported result is 1 or less. The LCF value presented represents the risk of an LCF for the MEI and the number of LCFs that would be expected in the offsite population within 50 miles of the facility.

e Accident frequencies are generally grouped into the bins of "anticipated," "unlikely," "extremely unlikely," and "beyond extremely unlikely," with estimated frequencies of greater than 1×10^{-2}, 1×10^{-2} to 1×10^{-4}, 1×10^{-4} to 1×10^{-6}, and less than 1×10^{-6} per year, respectively.

A beyond-design-basis seismic event could damage the building structure and equipment enough to threaten any spent fuel assemblies in the Experiment Hall that are not in a protective cask. Such an event could result in a fire in the exposed spent fuel and release radioactive material through the damaged building structure. An event of this magnitude would also cause extensive damage to buildings and infrastructure throughout the area. Such an event is estimated to require a seismic event much above the design-basis earthquake (with a return interval of 2,500 years).

For the VTR support activities, including the post-irradiation examination and spent fuel handling, conditioning, and storage, the bounding operational accidents are a criticality, which results in unfiltered releases and a filtered release from fire and spill involving molten spent fuel. In a severe seismic event, building structures, process enclosures, and process equipment could be damaged enough that unfiltered releases could occur. This event has lower impacts than the fire involving VTR spent fuel assemblies in the VTR Experiment Hall. During all of the VTR support operations, the radiological materials are either in a cask designed to contain the radionuclides in virtually all accidents or in a heavily shielded hot cell. As such, only controlled, filtered releases would be expected. Workers would be protected from accidents within the hot cells by the heavy shielding and the ventilation system that direct hot cell releases through HEPA filters and to an outside stack.

In a severe seismic event, the building and hot cell structures could be damaged enough that an unfiltered release could occur. Even so, most of the material not specifically being processed at the time of the earthquake would be in metal form and would not result in a substantial release even with loss of hot cell integrity and loss of the inert hot cell argon atmosphere. Since a severe seismic event could affect multiple VTR support operations, the results presented for the NPH/Ext event represent the sum of the potential impacts from the beyond design-basis earthquake from all of the VTR support activities.

Hazardous Material Impacts

Nonradiological impacts are evaluated in terms of comparison to Emergency Response Planning Guideline (ERPG) values. ERPG values are estimates of airborne concentration thresholds above which one can reasonably anticipate observing adverse effects. The hazardous material impacts of potential facility accidents associated with the INL VTR Alternative are shown in Appendix D.

4.11.2 ORNL VTR Alternative

This section presents the impacts from establishing the VTR at ORNL. The impacts would include those from operation of the VTR; operation of a new hot cell facility for performing post-irradiation examination of test items and for preparing SNF for long-term storage and disposal; and operation of a new long-term storage pad within the VTR complex at ORNL.

4.11.2.1 Construction/Facility Modification

Facility accidents associated with construction of the VTR, facility modifications for post-irradiation examination, facility modifications for spent fuel treatment, and construction of a spent fuel storage facility are discussed in Section 4.10.2 of this VTR EIS.

4.11.2.2 Operations

Radiological Impacts

Presented in this section are potential radiological impacts on the public and a noninvolved, onsite worker from accidents during operation of the VTR and operations of the post-irradiation examination facility and the SNF treatment facility (including transuranic waste accidents). Impacts from operations of the spent fuel storage facility, summarized in Table 4–51, are also presented in this section. The detailed analysis of facility accidents, with the associated assumptions, is presented in Appendix D.

The detailed analysis considered a wide spectrum of potential accident scenarios, including fire, spills, criticality, earthquake, and aircraft crash. **Table 4–53** presents the frequencies and consequences of the postulated set of accidents to the maximally exposed member of the public, assumed to be a boater on an arm of Melton Lake about 800 meters from the VTR complex, the offsite population residing within 50 miles of the facility, and a noninvolved worker located 330 feet from the facility. Receptor doses were calculated for the mean meteorological conditions.

Table 4–53. Accident Frequency and Radiological Impacts from VTR-Related Accidents at ORNL

		Impacts on Noninvolved Worker (100 meters)		*Impacts on an MEI at 0.8 Kilometers* [a]		*Near-Term Impacts on Population within 50 Miles* [d]	
Accident	***Frequency* [e] *(per year)***	***Dose (rem)***	***Probability of an LCF* [b]**	***Dose (rem)***	***Probability of an LCF***	***Dose (person-rem)***	***LCFs* [c]**
VTR Accident Impacts							
Test Assembly Failure following Seismically Induced Fire	Extremely Unlikely	1.3×10^{-1}	8×10^{-5}	4.6×10^{-3}	3×10^{-6}	4.5×10^{-1}	0 (3×10^{-4})
Fire Involving VTR Spent Fuel Assemblies	Extremely Unlikely to Beyond Extremely Unlikely	400	5×10^{-1}	14	9×10^{-3}	1,400	1 (9×10^{-1})
VTR Fuel Assembly Drop in Experiment Hall	Beyond Extremely Unlikely	1.9×10^{-3}	1×10^{-6}	6.7×10^{-5}	4×10^{-8}	6.9×10^{-3}	0 (4×10^{-6})
VTR Seismic Event Resulting in Collapse of the Experiment Hall	Beyond Extremely Unlikely	150	2×10^{-1}	5.1	3×10^{-3}	500	0 (3×10^{-1})
Spent Fuel Handling and Treatment							
Criticality Involving Melted Spent Fuel (failed containment)	Extremely Unlikely	2.5	2×10^{-3}	1.5×10^{-1}	9×10^{-5}	4.8	0 (3×10^{-3})

Accident	Frequency [e] (per year)	Impacts on Noninvolved Worker (100 meters)		Impacts on an MEI at 0.8 Kilometers [a]		Near-Term Impacts on Population within 50 Miles [d]	
		Dose (rem)	Probability of an LCF [b]	Dose (rem)	Probability of an LCF	Dose (person-rem)	LCFs [c]
Spill of Melted Spent Fuel with Seismically Induced Confinement Failure	Extremely Unlikely	1.7	1×10^{-3}	5.8×10^{-2}	4×10^{-5}	5.6	0 (3×10^{-3})
Na Fire Involving Spent Fuel with Cladding and Confinement Failure	Extremely Unlikely	23	3×10^{-2}	0.80	5×10^{-4}	77	0 (5×10^{-2})
Transuranic Waste Accident Impacts							
Fire Outside Confinement (waste from fuel fabrication or spent fuel treatment)	Extremely Unlikely	1.5×10^{-4}	9×10^{-8}	5.4×10^{-6}	3×10^{-9}	5.2×10^{-4}	0 (3×10^{-7})
Fire Outside Involving a Waste Drum with 23 g Am-241	Extremely Unlikely	0.21	1×10^{-4}	7.2×10^{-3}	4×10^{-4}	0.69	0 (4×10^{-4})
Post-Irradiation Examination Accident Impacts							
Fire Involving Test Assembly (seismically induced containment failure)	Extremely Unlikely	4.0×10^{-2}	2×10^{-5}	1.4×10^{-3}	8×10^{-7}	1.3×10^{-1}	0 (8×10^{-5})
Spent Fuel Storage Accident Impacts							
Seismic Event Causes Failure of Storage Structure and Failure of Spent Fuel Storage Casks with Fuel Release	Beyond Extremely Unlikely	8	5×10^{-3}	2.8×10^{-1}	2×10^{-4}	27	0 (2×10^{-2})
Seismic Event Causes Failure of Storage Structure and Failure of Spent Fuel Storage Casks with Criticality	Beyond Extremely Unlikely	2.5	2×10^{-3}	1.5×10^{-1}	9×10^{-5}	4.8	0 (3×10^{-3})
Drop of Fuel-Loaded Cask	Extremely Unlikely	4	2×10^{-3}	1.4×10^{-1}	8×10^{-5}	13	0 (8×10^{-3})

HRS = heat removal system; LCF = latent cancer fatality; MEI = maximally exposed individual; Na = sodium; rem = roentgen equivalent man; RVACS = Reactor Vessel Auxiliary Cooling System.

[a] An MEI was assumed to be on an arm of Melton Lake 800 meters from the VTR complex at ORNL. Assumptions and methods for the evaluation of consequences are presented in Section D.1.4.

[b] For hypothetical individual doses equal to or greater than 20 rem, the probability of an LCF was doubled.

[c] Numbers of LCFs in the population are whole numbers; the statistically calculated values are provided in parentheses for when the reported result is 1 or less. The LCF value presented represents the risk of an LCF for the MEI and the number of LCFs that would be expected in the offsite population within 50 miles of the facility.

[d] Potential longer-term impacts due to chronic exposures to radionuclides remaining after the plume passage due to various pathways, including resuspension of remaining particulates and ingestion of contaminated food, were also calculated and presented in Appendix D. The food pathway could be the largest source of longer-term dose from accidents releasing fission products unless mitigated by the interdiction of the nearby food chain.

[e] Accident frequencies are generally grouped into the bins of "anticipated," "unlikely," "extremely unlikely," and "beyond extremely unlikely," with estimated frequencies of greater than 1×10^{-2}, 1×10^{-2} to 1×10^{-4}, 1×10^{-4} to 1×10^{-6}, and less than 1×10^{-6} per year, respectively.

The accident scenarios for the VTR alternative and supporting operations at ORNL are identical to those presented for the comparable facilities at INL. No new or substantially different accident scenarios were identified with the placement of the facilities at ORNL. While there are differences in the sites that could affect the probabilities of certain scenarios, particularly natural phenomena-initiate events such as wind, flooding, seismic, and volcanism, the dominant accident scenarios remain the same.

There are, however, differences in potential impacts due to population distributions around the VTR location, distances to the nearest potential offsite individual, and differences in meteorological conditions. The effects of these differences on impacts are summarized in Table 4–50 and presented in detail in Table 4–53.

Hazardous Material Impacts

Nonradiological impacts are evaluated in terms of comparison to ERPG values. ERPG values are estimates of airborne concentration thresholds above which one can reasonably anticipate observing adverse effects. The hazardous material impacts of potential facility accidents associated with the ORNL VTR alternative are shown in Appendix D.

4.11.3 Reactor Fuel Production Options

This section addresses health effects from facility accidents for VTR reactor fuel production at the INL Site and SRS. The accident scenarios for reactor fuel production at SRS are identical to those presented for the comparable facilities at INL. While there are differences in the sites that could affect the probabilities of certain scenarios, particularly natural phenomena-initiate events such as wind, flooding, seismic, and volcanism, the dominant accident scenarios remain the same.

4.11.3.1 INL Reactor Fuel Production Options

Two phases of reactor fuel production are evaluated. The first phase is a feedstock preparation capability. This phase involves the receipt of plutonium that contains high levels of impurities, e.g., americium-241 (which is present as the result of the decay of plutonium-241 in 'older' plutonium) or plutonium in other than metal form (e.g., plutonium oxide). The feedstock preparation capability would address the issues of plutonium polishing and conversion to metal. The second phase of reactor fuel production would involve the alloying of plutonium with uranium and zirconium, and fabricating fuel pins and fuel assemblies.

4.11.3.1.1 Construction/Facility Modification

Facility accidents associated with facility modifications for reactor fuel production are discussed in Section 4.10.3.1 of this VTR EIS.

4.11.3.1.2 Operations

Radiological Impacts

Potential radiological impacts on the public and a noninvolved onsite worker due to accidents during VTR fuel fabrication operations at MFC are summarized in Table 4–51 and are presented in this section. The detailed analysis of facility accidents, with the associated assumptions, is presented in Appendix D.

The detailed analysis considered a wide spectrum of potential accident scenarios, including fire, spills, criticality, earthquake, and aircraft crash. **Table 4–54** presents the frequencies and consequences of the postulated set of accidents to the maximally exposed offsite member of the public (assumed to be on Highway 20 about 5 kilometers from the VTR complex), the offsite population residing within 50 miles of the facility, and a noninvolved worker located 330 feet from the facility. Receptor doses were calculated for the mean meteorological conditions.

Table 4–54. Accident Frequency and Radiological Impacts from VTR-Related Fuel Fabrication Activities at the Materials and Fuels Complex

		Impacts on an MEI at 5 Kilometers [a]		Near-Term Impacts on Population within 50 Miles [b]	
Accident [f]	***Frequency*** [c] ***(per year)***	***Dose (rem)***	***Probability of an LCF***	***Dose (person-rem)***	***LCFs*** [d]
Fuel Fabrication – Accident Impacts					
Criticality while alloying the three components of the metal fuel, uranium, plutonium, and zirconium	Extremely Unlikely	3.6×10^{-3}	2×10^{-6}	1.3×10^{-1}	0 (8×10^{-5})
Fire Impingement on Fuel Material (intact containment)	Extremely Unlikely	6.4×10^{-6}	4×10^{-9}	1.1×10^{-3}	0 (7×10^{-7})
Fire Impingement on Fuel Material (seismically induced containment failure)	Extremely Unlikely to Beyond Extremely Unlikely	6.5×10^{-5}	4×10^{-8}	1.0×10^{-2}	0 (6×10^{-6})
Spill and Oxidation of Molten Pu-U Mixture while Heating or Casting with Seismically Induced Confinement Failure	Extremely Unlikely to Beyond Extremely Unlikely	1.2×10^{-2}	7×10^{-6}	2.0	0 (1×10^{-3})
Plutonium Oxide-to-Metal Conversion (3013 explosion)	Extremely Unlikely to Beyond Extremely Unlikely	0.11	6×10^{-5}	18	0 (1×10^{-2})
Beyond-Design-Basis Fire Involving a TRU Waste Drum with 450 g of PuO_2	Extremely Unlikely to Beyond Extremely Unlikely	2×10^{-3}	1×10^{-6}	3×10^{-1}	0 (2×10^{-4})
Feedstock Preparation – Accident Impacts					
Aqueous/Electrorefining Fuel Preparation (uncontrolled reaction)	Extremely Unlikely	2.0×10^{-4}	1×10^{-7}	3.4×10^{-2}	0 (2×10^{-5})
Fire Outside Involving a Waste Drum with 23 g Am-241	Extremely Unlikely	1.1×10^{-4}	7×10^{-8}	1.8×10^{-2}	0 (1×10^{-5})
Feedstock Preparation and Fuel Fabrication: Combined Beyond-Design-Basis Earthquake Accident Impacts					
Aircraft Crash into VTR Fuel Fabrication and Feedstock Preparation Facility	Beyond Extremely Unlikely	1.1	7×10^{-4}	180	0 (0.1)
Beyond-Design-Basis Earthquake Involving all VTR Fuel Fabrication and Preparation MAR	Extremely Unlikely to Beyond Extremely Unlikely	1.1	7×10^{-4}	180	0 (0.1)

Am = americium; LCF = latent cancer fatality; MAR = material-at-risk; MEI = maximally exposed individual; Pu = plutonium; PuO_2 = plutonium oxide; rem = roentgen equivalent man; TRU = transuranic; U = uranium.

[a] An MEI was assumed to be on Highway 20, 5 kilometers from the VTR complex at MFC. Assumptions and methods for the evaluation of consequences are presented in Section D.1.4.

[b] Potential longer-term impacts due to chronic exposures to radionuclides remaining after the plume passage due to various pathways, including resuspension of remaining particulates and ingestion of contaminated food, were also calculated and presented in Appendix D. The food pathway could be the largest source of longer-term dose from accidents releasing fission products unless mitigated by the interdiction of the nearby food chain.

[c] Accident frequencies are generally grouped into the bins of "anticipated," "unlikely," "extremely unlikely," and "beyond extremely unlikely," with estimated frequencies of greater than 1×10^{-2}, 1×10^{-2} to 1×10^{-4}, 1×10^{-4} to 1×10^{-6}, and less than 1×10^{-6} per year, respectively.

[d] Numbers of LCFs in the population are whole numbers; the statistically calculated values are provided in parentheses for when the reported result is 1 or less. The LCF value presented represents the risk of an LCF for the MEI and the number of LCFs that would be expected in the offsite population within 50 miles of the facility.

For the VTR fuel fabrication activities at either the INL Site or SRS, the bounding operational accident is a fire that results in heating and over pressurization of a 3013 can of plutonium oxide. Releases from other accidents such as a fire and spill involving molten uranium and plutonium while being cast into fuel would be filtered before release to the environment. During all of the VTR fuel fabrication operations, the radiological materials are either in metal form in a container designed to contain the radionuclides in virtually all accidents or in an inert glove box. As such, only controlled, filtered releases would be expected. Workers would be protected from routine accidents within the glove boxes and the ventilation system that directs glove box releases through HEPA filters and to an outside stack.

For accidents associated with the INL VTR metal preparation portion of the fuel fabrication option, the bounding accident from plutonium “polishing” operations would be an uncontrolled reaction during portions of the aqueous operations. This could release radioactive materials to the glovebox, but any releases from the glovebox or room to the environment would be filtered and have low impacts. If plutonium oxide were used as a feed material, the bounding operational event is a high-pressure rupture of a welded, DOE standard 3013, plutonium-oxide storage container. This could occur if the container were exposed to a fire that burns sufficiently long to raise the internal pressure of the container to the point of rupture. This scenario, while theoretically possible, would be extremely unlikely and normal fire prevention and mitigation practices should reduce the chance of it occurring.

In a severe seismic event, the building and glove box structures could be damaged enough that an unfiltered release could occur. Even so, most of the material not specifically being processed at the time of the earthquake would be in metal form and would not result in a substantial release even with loss of glove box and building integrity.

A beyond design-basis earthquake was also postulated that could threaten unfiltered releases of all of the MAR in the Fuel Preparation and Fabrication area, including the molten plutonium in casting, liquid plutonium in the polishing operation, and plutonium oxide in the conversion operations. In a severe seismic event, the building and glove box structures could be damaged enough that an unfiltered release could occur. Even so, most of the material not specifically being processed at the time of the earthquake would be in metal form and would not result in a substantial release even with loss of glove box and building integrity.

Hazardous Material Impacts

Nonradiological impacts are evaluated in terms of comparison to ERPG values. ERPG values are estimates of airborne concentration thresholds above which one can reasonably anticipate observing adverse effects. The hazardous material impacts of potential facility accidents associated with the INL VTR Alternative are shown in Appendix D.

4.11.3.2 SRS Reactor Fuel Production Options

This section presents the impacts from establishing the reactor fuel production at SRS. Facility construction or modifications and operations would be similar to those described in Section 4.11.3.1, but would occur in the K Area Complex at SRS.

4.11.3.2.1 Construction/Facility Modification

Facility accidents associated with facility modifications for fuel fabrication are discussed in Section 4.10.3.2 of this VTR EIS.

4.11.3.2.2 Operations

Radiological Impacts

Potential radiological impacts on the public and a noninvolved onsite worker resulting from accidents during VTR fuel fabrication at the K Area Complex at SRS are summarized in Table 4–51 and are presented in this section. The detailed analysis of facility accidents, with the associated assumptions, is presented in Appendix D.

The detailed analysis considered a wide spectrum of potential accident scenarios, including fire, spills, criticality, earthquake, and aircraft crash. **Table 4–55** presents the frequencies and consequences of the postulated set of accidents to the maximally exposed offsite individual, the offsite population residing within 50 miles of the facility, and a noninvolved worker located 330 feet from the facility. Receptor doses were calculated for the mean meteorological conditions.

Table 4–55. Radiological Impacts from VTR-Related Fuel Fabrication Activities at K Area Complex

Accident	*Frequency [c] (per year)*	*Impacts on an MEI at the Site Boundary [a]*		*Near-Term Impacts on Population within 50 Miles [b]*	
		Dose (rem)	*Probability of an LCF*	*Dose (person-rem)*	*LCFs [d]*
Fuel Fabrication – Accident Impacts					
Criticality while alloying the three components of the metal fuel, uranium, plutonium, and zirconium	Extremely Unlikely	1.6×10^{-3}	9×10^{-7}	8.8×10^{-1}	0 (5×10^{-4})
Fire Impingement on Fuel Material (intact containment)	Extremely Unlikely	2.5×10^{-6}	2×10^{-9}	6.9×10^{-3}	0 (4×10^{-6})
Fire Impingement on Fuel Material (seismically induced containment failure)	Extremely Unlikely to Beyond Extremely Unlikely	2.5×10^{-5}	1×10^{-8}	6.8×10^{-2}	0 (4×10^{-5})
Spill and Oxidation of Molten Pu-U Mixture while Heating or Casting with Seismically Induced Confinement Failure	Extremely Unlikely to Beyond Extremely Unlikely	4.6×10^{-3}	3×10^{-6}	13	0 (8×10^{-3})
Plutonium Oxide-to-Metal Conversion (3013 explosion)	Extremely Unlikely to Beyond Extremely Unlikely	4.2×10^{-2}	2×10^{-5}	110	0 (7×10^{-2})
Beyond-Design-Basis Fire Involving a TRU Waste Drum with 450 g PuO_2	Extremely Unlikely to Beyond Extremely Unlikely	8.2×10^{-4}	5×10^{-7}	2.2	0 (1×10^{-3})
Feedstock Preparation – Accident Impacts					
Aqueous/Electrorefining Fuel Preparation (uncontrolled reaction)	Extremely Unlikely	7.9×10^{-5}	5×10^{-8}	2.2×10^{-1}	0 (1×10^{-4})
Fire Outside Involving a Waste Drum with 23 g Am-241	Extremely Unlikely	4.2×10^{-5}	3×10^{-8}	1.2×10^{-1}	0 (7×10^{-5})
Feedstock Preparation and Fuel Fabrication: Combined Beyond-Design-Basis Earthquake Accident Impacts					
Aircraft Crash into VTR Fuel Fabrication and Feedstock Preparation Facility	Beyond Extremely Unlikely	4.3×10^{-1}	3×10^{-4}	1,200	1.0
Beyond-Design-Basis Earthquake Involving all VTR Fuel Fabrication MAR	Beyond Extremely Unlikely	4.3×10^{-1}	3×10^{-4}	1,200	1.0

Am = americium; LCF = latent cancer fatality; MAR = material-at-risk; MEI = maximally exposed individual; Pu = plutonium; PuO_2 = plutonium oxide; rem = roentgen equivalent man; TRU = transuranic; U = uranium.

[a] An MEI at the nearest site boundary distance of 8.85 kilometers was used. Assumptions and methods for the evaluation of consequences are presented in Appendix D, Section D.1.4.

[b] Potential longer-term impacts due to chronic exposures to radionuclides remaining after the plume passage due to various pathways, including resuspension of remaining particulates and ingestion of contaminated food, were also calculated and

Accident	Frequency [c] (per year)	Impacts on an MEI at the Site Boundary [a]		Near-Term Impacts on Population within 50 Miles [b]	
		Dose (rem)	Probability of an LCF	Dose (person-rem)	LCFs [d]

presented in Appendix D. The food pathway could be the largest source of longer-term dose from accidents releasing fission products unless mitigated by the interdiction of the nearby food chain.

[c] Accident frequencies are generally grouped into the bins of "anticipated," "unlikely," "extremely unlikely," and "beyond extremely unlikely," with estimated frequencies of greater than 1×10^{-2}, 1×10^{-2} to 1×10^{-4}, 1×10^{-4} to 1×10^{-6}, and less than 1×10^{-6} per year, respectively.

[d] Numbers of LCFs in the population are whole numbers; the statistically calculated values are provided in parentheses for when the reported result is 1 or less.

The accident scenarios for the VTR fuel fabrication operations at SRS are identical to those presented for the comparable facilities at INL. No new or substantially different accident scenarios were identified with the placement of the facilities at SRS. While there are differences in the sites that could affect the probabilities of certain scenarios, particularly natural phenomena-initiate events such as wind, flooding, seismic, and volcanism, the dominant accident scenarios remain the same.

There are, however, differences in potential impacts due to population distributions around the VTR location, distances to the nearest potential offsite individual, and differences in meteorological conditions.

Hazardous Material Impacts

Nonradiological impacts are evaluated in terms of comparison to ERPG values. ERPG values are estimates of airborne concentration thresholds above which one can reasonably anticipate observing adverse effects. The hazardous material impacts of potential facility accidents associated with the INL VTR Alternative are shown in Appendix D.

4.11.4 Combined INL VTR Alternative and INL Reactor Fuel Production Options Impacts

This section presents the total impacts that would occur if the VTR alternative and the fuel production options were both established at the INL. The combined impacts developed earlier under the Combined INL VTR Alternative and INL Reactor Fuel Production Options are summarized in **Table 4–56**. The detailed analysis of facility accidents, with the associated assumptions, is presented in Appendix D.

Table 4–56. Radiological Impacts from Combined INL VTR Alternative and INL Reactor Fuel Production Options Activities

Accident	Frequency [c] (per year)	Impacts on an MEI at 5 Kilometers [a]		Near-Term Impacts on Population within 50 Miles [b]	
		Dose (rem)	Probability of an LCF	Dose (person-rem)	LCFs [d]
VTR Accident Impacts					
Test Assembly Failure following Seismically Induced Fire	Extremely Unlikely	1.8×10^{-3}	1×10^{-6}	3.3×10^{-1}	0 (2×10^{-4})
Fire involving VTR Spent Fuel Assemblies	Extremely Unlikely	8.2×10^{-2}	5×10^{-5}	13	0 (8×10^{-3})
VTR Fuel Assembly Drop in Experiment Hall	Extremely Unlikely	1.3×10^{-6}	8×10^{-10}	1.7×10^{-4}	0 (1×10^{-7})
VTR Seismic Event Resulting in Collapse of the Experiment Hall	Extremely Unlikely	7.1×10^{-2}	4×10^{-5}	13	0 (8×10^{-3})

Accident	Frequency [c] (per year)	Impacts on an MEI at 5 Kilometers [a]		Near-Term Impacts on Population within 50 Miles [b]	
		Dose (rem)	Probability of an LCF	Dose (person-rem)	LCFs [d]
Spent Fuel Handling and Treatment					
Criticality Involving Melted Spent Fuel (Failed Confinement)	Extremely Unlikely	3.9×10^{-3}	2×10^{-6}	1.3×10^{-1}	0 (8×10^{-5})
Spill of Melted Spent Fuel with Seismically Induced Confinement Failure	Extremely Unlikely	8.0×10^{-4}	5×10^{-7}	0.14	0 (9×10^{-5})
Na Fire Involving Spent Fuel with Cladding and Confinement Failure	Extremely Unlikely	1.1×10^{-2}	7×10^{-6}	2.0	0 (1×10^{-3})
Transuranic Waste Accident Impacts					
Fire Outside Confinement (waste from fuel fabrication or spent fuel treatment)	Extremely Unlikely	1.8×10^{-7}	1×10^{-10}	3.3×10^{-5}	0 (2×10^{-8})
Fire Outside Involving a Waste Drum with 23 g of Am-241	Extremely Unlikely	1.1×10^{-4}	7×10^{-8}	1.8×10^{-2}	0 (1×10^{-5})
Post-Irradiation Examination Accident Impacts					
Fire Involving Test Assembly (seismically induced containment failure)	Extremely Unlikely	5.6×10^{-3}	3×10^{-6}	0.99	0 (6×10^{-4})
Spent Fuel Storage Accident Impacts					
Seismic Event Causes Failure of Storage Structure and Failure of Spent Fuel Storage Casks with Fuel Release	Beyond Extremely Unlikely	1.3×10^{-2}	8×10^{-6}	2.3	0 (1×10^{-3})
Seismic Event Causes Failure of Storage Structure and Failure of Spent Fuel Storage Casks with Criticality	Beyond Extremely Unlikely	3.9×10^{-3}	2×10^{-6}	1.3×10^{-1}	0 (8×10^{-5})
Drop of Fuel-Loaded Cask	Extremely Unlikely	6.3×10^{-3}	4×10^{-6}	1.1	0 (7×10^{-4})
Fuel Fabrication – Accident Impacts					
Criticality while alloying the three components of the metal fuel, uranium, plutonium, and zirconium	Extremely Unlikely	3.6×10^{-3}	2×10^{-6}	1.3×10^{-1}	0 (8×10^{-5})
Fire Impingement on Fuel Material (intact containment)	Extremely Unlikely	6.4×10^{-6}	4×10^{-9}	1.1×10^{-3}	0 (7×10^{-7})
Fire Impingement on Fuel Material (seismically induced containment failure)	Extremely Unlikely to Beyond Extremely Unlikely	6.6×10^{-5}	4×10^{-8}	1.1×10^{-2}	0 (6×10^{-6})
Spill and Oxidation of Molten Pu-U Mixture while Heating or Casting with Seismically Induced Confinement Failure	Extremely Unlikely to Beyond Extremely Unlikely	1.2×10^{-2}	7×10^{-6}	2.0	0 (1×10^{-3})
Plutonium Oxide-to-Metal Conversion (3013 explosion)	Extremely Unlikely	0.11	6×10^{-5}	18	0 (1×10^{-2})
Feedstock Preparation – Accident Impacts					
Aqueous Electrorefining Fuel Preparation (uncontrolled reaction)	Extremely Unlikely	2.0×10^{-4}	1×10^{-7}	3.4×10^{-2}	0 (2×10^{-5})
Fire Outside Involving a Waste Drum with 23 g Am-241	Extremely Unlikely	1.1×10^{-4}	7×10^{-8}	1.8×10^{-2}	0 (1×10^{-5})
Feedstock Preparation and Fuel Fabrication: Combined Beyond-Design-Basis Earthquake Accident Impacts					
Aircraft Crash into VTR Fuel Fabrication and Feedstock Preparation Facility	Beyond Extremely Unlikely	1.1	7×10^{-4}	180	1 (7×10^{-1})
Beyond-Design-Basis Earthquake Involving All VTR Fuel Fabrication MAR	Extremely Unlikely to Beyond Extremely Unlikely	1.1	7×10^{-4}	180	1 (7×10^{-1})

Accident	Frequency [c] (per year)	Impacts on an MEI at 5 Kilometers [a]		Near-Term Impacts on Population within 50 Miles [b]	
		Dose (rem)	Probability of an LCF	Dose (person-rem)	LCFs [d]

Am = americium; LCF = latent cancer fatality; MAR = material-at-risk; MEI = maximally exposed individual; Na = sodium; Pu = plutonium; PuO_2 = plutonium oxide; rem = roentgen equivalent man; U = uranium.

[a] An MEI was assumed to be on Highway 20, 5 kilometers from the VTR complex at MFC.

[b] Potential longer-term impacts due to chronic exposures to radionuclides remaining after the plume passage due to various pathways, including resuspension of remaining particulates and ingestion of contaminated food, were also calculated and presented in Appendix D. The food pathway could be the largest source of longer-term dose from accidents releasing fission products unless mitigated by the interdiction of the nearby food chain.

[c] Accident frequencies are generally grouped into the bins of "anticipated," "unlikely," "extremely unlikely," and "beyond extremely unlikely," with estimated frequencies of greater than 1×10^{-2}, 1×10^{-2} to 1×10^{-4}, 1×10^{-4} to 1×10^{-6}, and less than 1×10^{-6} per year, respectively.

[d] Numbers of LCFs in the population are whole numbers; the statistically calculated values are provided in parentheses for when the reported result is 1 or less.

4.11.5 Potential Impacts of a Hypothetical Beyond Design-Basis Reactor Accident

In order to fulfill the requirements of NEPA and for VTR EIS purposes, the potential impacts are evaluated for a hypothetical beyond-design-basis reactor accident of unknown cause in which all active (heat removal system [HRS]) and passive (RVACS) cooling systems are disrupted. The hypothetical accident is chosen to envelope consequences for any accident that may be postulated as the reactor design and analysis evolves. For the sequence of events with total loss of heat removal capabilities, that is loss of both RVACS and HRS or the loss of heat sink, bulk sodium boiling and release of radionuclides from melted fuel in the reactor core is assumed. Because both the VTR reactor vessel and reactor room are not designed to withstand pressurization due to sodium bulk boiling, the confinement systems are assumed to fail.

The potential accident sequences associated with a hypothetical beyond-design-basis reactor accident that ultimately leads to loss of reactor fuel cooling, sodium boiling, fuel failure, and ultimately, release to the environment are highly speculative. Potential accident initiators are an aircraft impact or a seismic event. Many mechanisms are in place to reduce the likelihood of a large release even with a direct impact by a large aircraft or an extreme seismic event. While it may be physically possible for such releases, many reactor and safety engineers think that the likelihood or conditional probability of all the events occurring such that there would be substantial releases to the environment is negligible. As discussed in Sections D.3.3.2 to 3.3.4, many characteristics of the VTR and PRISM designs make the conditional probability of a LWR-type core melt accident with containment failure infinitesimally small following an initiating event such as direct impact by a large aircraft or a beyond-design-basis seismic event. The conditional probability of a large release following either of these initiating events is expected to range from 0.01 to 0.001 or lower than the initiating event probability. Thus, the overall probability of the hypothetical accident is expected to be beyond extremely unlikely and much less than the 10^{-6} to 10^{-7} per year range. In contrast, the current mean reactor core damage frequency for NRC regulated, commercial LWRs is 3.1×10^{-5} per year (NRC 2019). As the VTR design evolves past the conceptual design phase, additional event initiators and subsequent accident sequences may be developed but this postulated, hypothetical event is expected to provide a reasonable estimate of the impacts of such an event.

If this accident were to occur, the impacts could be high, similar but less than commercial LWRs. Potential radiological impacts and risks to the MEI and public from the hypothetical beyond design-basis accident are presented in Tables D-33 and D-34. As expected, without allowing for pre-release decay and emergency actions, the results of the MACCS modeling indicate very high doses, likely fatal doses near the reactor site. An individual at the assumed location of the MEI would receive a fatal dose if he remained at that location for the entire plume passage. Individuals, including members of the public that remained near the reactor site could receive very high, and potentially fatal doses. Over the long term and without mitigation, the projected LCFs among the population within 50 miles is 260 for INL and 8,400 for ORNL. The major difference in the projected impacts between INL and ORNL are the much larger population residing close to ORNL.

As discussed in Section D.4.9.2, the annual population risks from operation of the VTR would be at least one to two orders of magnitude smaller than that of commercial LWRs. It is important to note that the VTR risks are based on conservative assumptions and take no credit for evacuation. In contrast, the current mean reactor core damage frequency for NRC regulated, commercial LWRs is 3.1×10^{-5} per year (NRC 2019). As the VTR design evolves past the conceptual design phase, additional event initiators and subsequent accident sequences may be developed but this postulated, hypothetical event is expected to envelope the consequences from any event that may be postulated as the VTR project evolves.

If this accident were to occur, the impacts could be high. Potential radiological impacts and risks to the MEI and public from the hypothetical beyond design-basis accident are presented in Tables D–33 and D–34. The economic impacts of the hypothetical accident are discussed in Section D.4.9.4. As expected, without allowing for pre-release decay and emergency actions, the results of the MACCS modeling indicate very high and potentially lethal doses near the reactor site. An individual at the assumed location of the MEI would receive a fatal dose if exposed to the entire plume passage. Individuals, including members of the public that remained near the reactor site could receive very high, and potentially lethal doses. Over the long term and without mitigation, 260 and 8,400 LCFs are calculated for the population within 50 miles of the INL and ORNL sites, respectively. The major difference in the projected impacts between INL and ORNL is the much large population residing close to ORNL.

As discussed in Section D.4.9.2, the annual population risks from operation of the VTR would be at least one to two orders of magnitude less than for commercial LWRs. It is important to note that the VTR risks are based on conservative assumptions that do not consider decay of short-lived isotopes, mitigation to limit releases, or emergency actions such as evacuation or sheltering-in-place. Thus the potential VTR impacts are likely over stated. The NRC-evaluated risks for LWRs are based on more realistic assumptions for as-built LWRs and consider preventative and mitigation features of the LWRs, including evacuation of persons within the typical 10-mile radius emergency planning zones surrounding the LWRs. Severe accident modeling for LWRs also considers radioisotope decay for releases that occur hours or days after the reactor shuts down.

As demonstrated in Section D.4.9.3 for the hypothetical VTR accident, the VTR sited at either INL or ORNL would meet the NRC safety goals for prompt fatalities or latent cancers by a wide margin, even with the many conservative assumptions used in the accident analysis. The hypothetical, beyond-design-basis reactor accident with loss of cooling is included in this VTR EIS to provide a reasonable but bounding estimate of the potential impacts from very low probability, high consequence accidents. As the VTR design evolves past the conceptual design phase, additional event initiators and subsequent accident sequences may be developed but this postulated, hypothetical event is expected to envelope the consequences of any accident that may be postulated as the design evolves.

4.12 Human Health – Transportation Impacts

Both radiological and nonradiological transportation impacts would result from shipment of radioactive materials and waste. Only nonradiological impacts would result from shipment of nonradioactive wastes. Radiological impacts are those associated with the effects from low levels of radiation emitted during incident-free transportation and from the accidental release of radioactive materials, and are expressed as additional LCFs. Nonradiological impacts are independent of the nature of the cargo being transported, and are expressed as traffic accident fatalities resulting only from the physical forces that accidents could impart to humans.

Appendix E contains detailed descriptions of the transportation analysis and results.

Methodology and Assumptions

Transportation packages containing radioactive materials emit low levels of radiation; the amount of radiation depends on the characteristics of the transported materials. U.S. Department of Transportation (DOT) regulations require that transportation packages containing radioactive materials have sufficient radiation shielding to limit the radiation dose rate to 10 millirem per hour at a distance of 6.6 feet from the transporter.

For incident-free transportation, the potential human health impacts of the radiation field surrounding the transportation packages were estimated for transportation workers and the general population along the route (termed off-traffic or off-link). Human health impacts are also estimated for people sharing the route (termed in-traffic or on-link), at rest areas, and at other stops along the route. This EIS used the RADTRAN 6 [Radioactive Material Transportation Risk Assessment] computer code (Weiner et al. 2013, 2014) to estimate the impacts on transportation workers and the population along the route. RADTRAN 6 also was used to help estimate the impacts on an MEI (e.g., a person stuck in traffic, a gas station attendant, an inspector).

Transportation accidents involving radioactive materials present both nonradiological and radiological risks to workers and the public. Nonradiological impacts of transportation accidents include traffic accident fatalities. Radioactive material would be released during transportation accidents only when the transport package carrying the material is subjected to forces that exceed its design standard. Only a severe fire or a powerful collision, both events of extremely low probability, could lead to a transportation package of the type (Type B) used to transport highly radioactive material being damaged to the extent that there could be a significant release of radioactive material to the environment.

The radiological impact of a specific accident is expressed in terms of probabilistic risk (i.e., dose-risk). Dose risk is defined as the accident probability (i.e., accident frequency) multiplied by the accident consequences (i.e., dose). The overall radiological risk is obtained by summing the individual radiological risks from all reasonably conceivable accidents. The analysis of accident risks takes into account a spectrum of accident severities ranging from high-probability accidents of low severity (e.g., a fender bender) to hypothetical high-severity accidents having low probabilities of occurrence.

In addition to calculating the radiological risks that would result from all reasonably conceivable accidents during transportation of radioactive materials and wastes, this EIS assesses the highest consequences of a maximum reasonably foreseeable accident having a radioactive release frequency greater than 1×10^{-7} (1 chance in 10 million) per year in an urban or suburban population area along the route. This latter analysis used the RISKIND [Risks and Consequences of Radioactive Material Transport] computer code, Version 2.0, to estimate doses to individuals and populations (Yuan et al. 1995). The results of this analysis are presented in Appendix E, Section E.8.

Incident-free radiological health impacts are expressed in terms of additional LCFs. Radiological health impacts from accidents are also expressed as additional LCFs. Nonradiological accident risk is expressed as additional immediate (traffic) fatalities. LCFs associated with radiological exposure were estimated by multiplying the occupational (worker) and public dose by a dose conversion factor of 0.0006 LCFs per rem or person-rem of exposure (DOE 2003). The health impacts associated with shipment of special nuclear material and unirradiated VTR fuel were calculated assuming that all transportation packages would be transported by escorted commercial truck or NNSA secure transportation assets (STAs).

In determining transportation risks, per-shipment risk factors were calculated for incident-free and accident conditions using the RADTRAN 6 code (Weiner et al. 2013, 2014) in conjunction with the Web Transportation Routing Analysis Geographic Information System (WebTRAGIS) code (Peterson 2018), which was used to identify transportation routes in accordance with DOT regulations and other parameters. The WebTRAGIS program currently provides population density estimates along the routes based on the 2010 U.S. census data for determining population radiological risk factors. For incident-free operations, the affected population includes individuals living within 0.5 miles of each side of the road or rail line. For accident conditions, the affected population includes individuals living within 50 miles of the accident, and the MEI was assumed to be a receptor located 330 feet directly downwind from the accident. Additional details on the analytical approach and on modeling and parameter selections are provided in Appendix E. The estimated population for which incident-free and accident doses are calculated was increased to account for population growth through the year 2050.

Accident and fatality rates for commercial truck transports are used for determining traffic accident fatalities (Saricks and Tompkins 1999). Statistics specific to STA shipments, which would be used for shipment of special nuclear material, are also used for escorted commercial truck shipments (see Appendix E, Section E.7.2). The methodology for obtaining and using accident and fatality rates is provided in Appendix E, Section E.7.2, "Accident Rates."

For each alternative, transportation impacts were evaluated for the transport of the following (as applicable to each alternative):

- plutonium (weapon grade) materials from either Los Alamos National Laboratory (LANL) to SRS or INL, or from SRS to INL[6]
- plutonium (reactor grade in oxide form) materials from Europe (France, United Kingdom, or both, through Joint Base Charleston-Weapons Station in South Carolina to SRS or INL)
- TRU waste from SRS, ORNL, or the INL Site to the Waste Isolation Pilot Plant (WIPP) facility
- Unirradiated VTR Fuel from SRS to ORNL or the INL Site, or from the INL Site to ORNL
- LLW and MLLW from SRS, INL, or ORNL to offsite Federal or commercial disposal facilities; for purposes of analysis in this EIS, the disposal site was assumed to be the Nevada National Security Site (NNSS) near Las Vegas, Nevada; Energy*Solutions* near Clive, Utah; and Waste Control Specialists, near Andrews, Texas
- Low-enriched uranium (5 percent) from a commercial fuel fabrication facility (Nuclear Fuel Services, Inc. in Erwin, Tennessee) to SRS or the INL Site
- Adulterant/diluent from a commercial vendor from an assumed distance of 3,000 miles or from a DOE site to the INL Site or SRS, for dilution of plutonium wastes in critically controlled overpacks for transport to the WIPP facility
- Construction materials from commercial vendors to INL, ORNL, and SRS (nonradiological impacts only)
- Hazardous wastes from INL, SRS, and ORNL to an offsite treatment, storage, and disposal facility (nonradiological impacts only)

Route characteristics are determined for shipments to assess incident-free and transportation accident impacts related to radioactive material and waste shipments. The number of shipments of plutonium and

[6] The weapon grade plutonium would be available from LANL or SRS after the surplus pit disassembly at either site. The impacts of transporting surplus pit to either site, and its related activities are evaluated in the *Final Surplus Plutonium Disposition Supplemental Environmental Impact Statement* (DOE 2015a).

low-enriched uranium were based on the required quantities of these materials to support the VTR fuel fabrication (SRNS 2020). The compositions and the transportation packages needed for different radioactive materials are estimated using unclassified information that provides a conservative estimate that would be reflective of the material or waste being transported. All shipments were assumed to be conducted by truck. Transports of plutonium materials, low-enriched uranium, and VTR fuel assemblies were assumed to be conducted by STAs (see Appendix E, Section E.2.4, for more information regarding STA vehicle requirements). Truck routes between specific origination and destination sites are analyzed, as shown in Appendix E, Table E–1 and Figures E–2 through E–4.

As indicate above, the sources of plutonium range from domestic to foreign locations. The transportation impact analysis is based on the weapon grade (lowest risk) and European (French: the highest risk) plutonium materials, as these provide an enveloping risk for all other potential domestic plutonium that could be transported between the affected sites. Because the weapon grade plutonium could be available at either LANL or SRS sites, two sets of the analyses were performed. Tables E–6 and E–7 in Appendix E summarize the assumed destinations and estimated number of truck shipments for each type of radioactive waste or nuclear material. Both tables show similar maximum impacts, and when plutonium is available at the SRS site, then a VTR fuel fabrication option at the SRS would lead to a smaller number of shipments of weapon grade plutonium, (see Appendix E, Section E.8).

Summary of Impacts

Table 4–57 summarizes transportation impacts under each alternative for shipments of radioactive materials and waste.[7] The accident impacts presented in this table are those that could result from all reasonably conceivable impacts during transport of radioactive materials and waste. These impacts are also presented in Appendix E, Section E.8.

Table 4–57. Annual Risk of Transporting Radioactive Materials and Waste under Each Alternative [a]

			Incident-Free				*Accident*	
			Crew		*Population*			
Route	*Number of Shipments*	*One-way Kilometers Traveled*	*Dose (person-rem)*	*Risk [b]*	*Dose (person-rem)*	*Risk [b]*	*Radiological Risk [b]*	*Non-radiological Risk [b]*
INL VTR Alternative								
INL VTR and Support Facility Operations								
Transuranic (CH and RH) waste to WIPP	0.23	534	0.02		0.02	0.00001	1×10^{-6}	0.00002
Low-level (CH and RH) waste transport								
INL to Energy*Solutions*	130	66,491	2.1	0.001	1.9	0.001	2×10^{-8}	0.008
INL to NNSS	130	172,837	3.9	0.002	4.3	0.003	2×10^{-8}	0.007
INL to WCS	130	307,511	7.0	0.004	7.9	0.005	4×10^{-8}	0.01
Subtotal [c]	**130**	**308,046**	**7.0**	**0.004**	**8.0**	**0.005**	$\mathbf{2 \times 10^{-6}}$	**0.01**
INL VTR Operations plus Reactor Fuel Production options								
Total 1 = INL VTR/Support Facility Operations plus INL Reactor Fuel Production								
Total 1 – Fab only [d]-WG Pu	**187**	**444,586**	**10.3**	**0.006**	**11.5**	**0.007**	$\mathbf{2 \times 10^{-6}}$	**0.02**
Total 1 – Prep and Fab-WG Pu (Case 1)	**204**	**483,178**	**12.0**	**0.007**	**12.8**	**0.008**	$\mathbf{3 \times 10^{-6}}$	**0.02**
Total 1 – Prep and Fab-WG Pu (Case 3)	**197**	**467,181**	**11.4**	**0.007**	**12.3**	**0.007**	$\mathbf{3 \times 10^{-6}}$	**0.02**
Total 1 – Fab only-RG Pu [e]	**195**	**461,142**	**10.5**	**0.006**	**12.2**	**0.007**	$\mathbf{9 \times 10^{-6}}$	**0.02**
Total 1 – Prep and Fab-RG Pu (Case 1)	**415**	**963,636**	**29.8**	**0.02**	**28.2**	**0.02**	$\mathbf{2 \times 10^{-5}}$	**0.04**
Total 1 – Prep and Fab-RG Pu (Case 3)	**325**	**757,965**	**22.0**	**0.01**	**21.7**	**0.01**	$\mathbf{1 \times 10^{-5}}$	**0.03**

[7] This table is based on the assumption that the weapon grade plutonium is sourced from LANL. For the impacts, where weapon grade plutonium is available at SRS, See Table E–7, in Appendix E.

Route	Number of Shipments	One-way Kilometers Traveled	Incident-Free				Accident	
			Crew		Population			
			Dose (person-rem)	Risk [b]	Dose (person-rem)	Risk [b]	Radiological Risk [b]	Non-radiological Risk [b]
Total 2 = INL VTR/Support Facility Operations plus SRS Reactor Fuel Production								
Total 2 – Fab only-WG Pu	**202**	**520,996**	**11.2**	**0.007**	**12.3**	**0.007**	**3×10^{-6}**	**0.02**
Total 2 – Prep and Fab-WG Pu (Case 1)	**219**	**550,768**	**12.6**	**0.008**	**13.4**	**0.008**	**3×10^{-6}**	**0.02**
Total 2 – Prep and Fab-WG Pu (Case 3)	**212**	**534,622**	**11.9**	**0.007**	**12.8**	**0.008**	**3×10^{-6}**	**0.02**
Total 2 – Fab only-RG Pu	**203**	**679,460**	**14.5**	**0.009**	**15.3**	**0.009**	**4×10^{-6}**	**0.03**
Total 2 – Prep and Fab-RG Pu (Case 1)	**423**	**1,001,621**	**30.4**	**0.02**	**27.9**	**0.02**	**1×10^{-5}**	**0.05**
Total 2 – Prep and Fab-RG Pu (Case 3)	**333**	**794,028**	**22.4**	**0.01**	**21.1**	**0.01**	**6×10^{-6}**	**0.04**
ORNL VTR Alternative								
ORNL VTR and Support Facility Operations								
Transuranic (CH and RH) waste to WIPP	0.23	487	0.02	0.00001	0.02	0.00001	2×10^{-6}	0.00003
Low-level (CH and RH) waste transport								
ORNL to Energy*Solutions*	130	408,852	9.3	0.006	11.1	0.007	7×10^{-8}	0.02
ORNL to NNSS	130	450,619	10.2	0.006	11.7	0.007	2×10^{-8}	0.02
ORNL to WCS	130	255,208	5.8	0.004	7.3	0.004	5×10^{-8}	0.01
Sub-Total [c]	**130**	**451,106**	**10.2**	**0.006**	**11.8**	**0.007**	**2×10^{-6}**	**0.02**
ORNL VTR Operations plus Reactor Fuel Production Options								
Total 1 – Fab only-WG Pu	**202**	**616,966**	**13.2**	**0.008**	**15.0**	**0.009**	**3×10^{-6}**	**0.03**
Total 1 – Prep and Fab-WG Pu (Case 1)	**219**	**676,042**	**15.3**	**0.009**	**16.8**	**0.01**	**3×10^{-6}**	**0.03**
Total 1 – Prep and Fab-WG Pu (Case 3)	**212**	**660,045**	**14.7**	**0.009**	**16.3**	**0.01**	**3×10^{-6}**	**0.03**
Total 1 – Fab only-RG Pu	**210**	**654,006**	**13.8**	**0.008**	**16.2**	**0.01**	**9×10^{-6}**	**0.03**
Total 1 – Prep and Fab-RG Pu (Case 1)	**430**	**1,156,500**	**33.1**	**0.02**	**32.1**	**0.02**	**2×10^{-5}**	**0.05**
Total 1 – Prep and Fab-RG Pu (Case 3)	**340**	**950,829**	**25.3**	**0.02**	**25.7**	**0.02**	**1×10^{-5}**	**0.04**
Total 2 – Fab only-WG Pu	**202**	**617,072**	**14.4**	**0.009**	**15.9**	**0.01**	**3×10^{-6}**	**0.03**
Total 2 – Prep and Fab-WG Pu (Case 1)	**219**	**646,844**	**15.8**	**0.009**	**17.1**	**0.01**	**3×10^{-6}**	**0.03**
Total 2 – Prep and Fab-WG Pu (Case 3)	**212**	**630,698**	**15.1**	**0.009**	**16.5**	**0.01**	**3×10^{-6}**	**0.03**
Total 2 – Fab only-RG Pu	**203**	**775,536**	**17.7**	**0.01**	**19.0**	**0.01**	**4×10^{-6}**	**0.04**
Total 2 – Prep and Fab-RG Pu (Case 1)	**423**	**1,097,697**	**33.6**	**0.02**	**31.5**	**0.02**	**1×10^{-5}**	**0.06**
Total 2 – Prep and Fab-RG Pu (Case 3)	**333**	**890,104**	**25.6**	**0.02**	**24.8**	**0.01**	**6×10^{-6}**	**0.05**
INL Reactor Fuel Production Option								
STA transport								
All STA routes (with U.S. WG Pu)	13	34,530	0.29	0.0002	0.9	0.0006	5×10^{-7}	0.0007
All STA routes (with European RG Pu) [e]	21	51,086	0.49	0.0003	1.7	0.001	7×10^{-6}	0.001
Low-level waste transport								
INL to NNSS	15	19,943	0.40	0.0002	0.4	0.0002	2×10^{-9}	0.0008
INL to Energy*Solutions*	15	7,672	0.15	0.00009	0.2	0.0001	2×10^{-9}	0.0009
INL to WCS	15	35,482	0.71	0.0004	0.7	0.0004	4×10^{-9}	0.002
Transuranic waste transport								
INL to WIPP (Secondary waste)	4	9,141	0.35	0.0002	0.3	0.0002	8×10^{-8}	0.0004
INL to WIPP (POCs) Fab only [d]-WG Pu	13	29,708	1.13	0.0007	0.9	0.0006	2×10^{-7}	0.001
INL to WIPP (diluted PuO_2 in CCOs) [f] – Fab only- WG Pu	12	27,679	0.87	0.0005	0.7	0.0004	2×10^{-7}	0.001
INL to WIPP (Diluted PuO_2 in CCOs) [g]– Fab only-WG Pu	10	23,530	0.87	0.0005	0.7	0.0004	2×10^{-7}	0.001
INL to WIPP – Prep and Fab-WG Pu (Case 1)	42	95,980	3.65	0.002	3.0	0.002	8×10^{-7}	0.004
INL to WIPP – Prep and Fab-WG Pu (Case 3)	35	79,983	3.04	0.002	2.5	0.002	5×10^{-7}	0.003

Route	Number of Shipments	One-way Kilometers Traveled	Incident-Free				Accident	
			Crew		Population			
			Dose (person-rem)	Risk [b]	Dose (person-rem)	Risk [b]	Radiological Risk [b]	Non-radiological Risk [b]
INL to WIPP – Prep and Fab-RG Pu (Case 1)	245	559,881	21.28	0.01	17.6	0.01	9×10^{-6}	0.02
INL to WIPP – Prep and Fab-RG Pu (Case 3)	155	354,211	13.47	0.008	11.1	0.007	5×10^{-6}	0.01
Total reactor fuel production transport								
Total – Fab only-WG Pu	**57**	57	136,540	3.34	0.002	3.5	0.002	1×10^{-6}
Total – Prep and Fab-WG Pu (Case 1)	**74**	**175,132**	**4.99**	**0.003**	**4.9**	**0.003**	1×10^{-6}	**0.007**
Total – Prep and Fab-WG Pu (Case 3)	**67**	**159,136**	**4.38**	**0.003**	**4.4**	**0.003**	1×10^{-6}	**0.006**
Total – Fab only-RG Pu [e]	**65**	**153,096**	**3.54**	**0.002**	**4.3**	**0.003**	8×10^{-6}	**0.005**
Total – Prep and Fab-RG Pu (Case 1)	**285**	**655,590**	**22.83**	**0.01**	**20.2**	**0.01**	2×10^{-5}	**0.03**
Total – Prep and Fab-RG Pu (Case 3)	**195**	**449,919**	**15.01**	**0.009**	**13.7**	**0.008**	1×10^{-5}	**0.02**
VTR Fuel Assemblies to ORNL	**15**	**49,804**	**0.05**	**0.00003**	**0.2**	**0.0001**	5×10^{-8}	**0.001**
SRS Reactor Fuel Production Option								
STA transport								
All STA routes (with U.S. WG Pu)	13	21,976	0.3	0.0002	0.9	0.0005	7×10^{-7}	0.0006
All STA routes (with European RG Pu)	14	4,593	0.04	0.00002	0.12	0.00007	5×10^{-7}	0.0001
Low-level waste transport								
SRS to NNSS	15	58,343	1.2	0.0007	1.1	0.0007	6×10^{-9}	0.003
SRS to Energy*Solutions*	15	53,578	1.1	0.0006	1.1	0.0007	1×10^{-9}	0.003
SRS to WCS	15	32,723	0.7	0.0004	0.7	0.0004	6×10^{-10}	0.002
Transuranic waste transport								
SRS to WIPP (secondary waste)	4	9,226	0.4	0.0002	0.1	0.00005	2×10^{-8}	0.0006
SRS to WIPP (POCs) Fab only [d]-WG Pu	13	29.986	1.2	0.0007	1.0	0.0006	2×10^{-7}	0.002
SRS to WIPP (diluted PuO_2 in CCOs) [f] – Fab only WG Pu	12	27,893	0.9	0.0005	0.8	0.0005	2×10^{-7}	0.002
SRS to WIPP (diluted PuO_2 in CCOs) [g] – Fab-WG Pu	10	23,255	0.9	0.0005	0.8	0.0005	2×10^{-7}	0.001
SRS to WIPP – Prep and Fab-WG Pu (Case 1)	42	96,876	3.74	0.002	3.15	0.002	8×10^{-7}	0.006
SRS to WIPP – Prep and Fab-WG Pu (Case 3)	35	80,730	3.06	0.002	2.55	0.002	8×10^{-7}	0.004
SRS to WIPP – Prep and Fab-RG Pu (Case 1)	245	565,113	21.81	0.01	18.39	0.01	8×10^{-6}	0.03
SRS to WIPP – Prep and Fab-RG Pu (Case 3)	155	357,520	13.80	0.008	11.63	0.007	4×10^{-6}	0.02
Total reactor fuel production transport								
Total – Fab only-WG Pu	**57**	**156,650**	**4.2**	**0.003**	**4.2**	**0.002**	2×10^{-6}	**0.008**
Total – Prep and Fab-WG Pu (Case 1)	**74**	**186,422**	**5.52**	**0.003**	**5.28**	**0.003**	2×10^{-6}	**0.01**
Total – Prep and Fab-WG Pu (Case 3)	**67**	**170,276**	**4.84**	**0.003**	**4.67**	**0.003**	2×10^{-6}	**0.008**
Total – Fab only-RG Pu) [e]	**58**	**315,114**	**7.49**	**0.004**	**7.18**	**0.004**	2×10^{-6}	**0.02**
Total – Prep and Fab-RG Pu (Case 1)	**278**	**637,275**	**23.37**	**0.01**	**19.73**	**0.01**	8×10^{-6}	**0.04**
Total – Prep and Fab-RG Pu (Case 3)	**188**	**429,682**	**15.36**	**0.009**	**12.97**	**0.008**	5×10^{-6}	**0.03**
VTR Fuel Assemblies to INL	**15**	**56,300**	**0.06**	**0.00004**	**0.21**	**0.0001**	6×10^{-8}	**0.001**
VTR Fuel Assemblies to ORNL	**15**	**9,316**	**0.010**	**0.000006**	**0.041**	**0.00002**	2×10^{-8}	**0.0002**

Case 1 = aqueous plutonium processing; Case 3 = pyro-chemical plutonium processing; CCO = criticality control overpack; CH = contact-handled; Fab = fuel fabrication; NNSS = Nevada National Security Site; POC = pipe overpack container; Prep and Fab = feedstock preparation (processing) and fuel fabrication; RG = reactor grade (European) feed; RH = remote-handled; SRS = Savannah River Site; STA = Secure Transportation Asset; VTR = Versatile Test Reactor; WCS = Waste Control Specialists; WG = weapon grade feed; WIPP = Waste Isolation Pilot Plant.

Route	Number of Shipments	One-way Kilometers Traveled	Incident-Free				Accident	
			Crew		Population			
			Dose (person-rem)	Risk [b]	Dose (person-rem)	Risk [b]	Radiological Risk [b]	Non-radiological Risk [b]

[a] For each shipment category, the cited values are annual impact values. The reactor fuel production facilities are to be operational three years before the start of the VTR. The VTR requires about 110 driver fuel assemblies (a full load plus one year of refueling needs) prior to start of its operation.

[b] Risk is expressed in terms of LCFs, except for the nonradiological risk, where it refers to the number of traffic accident fatalities. Radiological risk is calculated for one-way travel while nonradiological risk is calculated for two-way travel. Accident dose-risk can be calculated by dividing the risk values by 0.0006 (DOE 2003b). The values are rounded to one non-zero digit.

[c] This subtotal reflects the maximum risk from transporting the LLW/MLLW to either NNSS, EnergySolutions, or WCS

[d] Fabrication only is used for the clean weapon grade plutonium feed materials.

[e] Includes impacts from transporting the reactor grade (European [French or United Kingdom]) plutonium materials, which are assumed to be transported to SRS for repackaging and then transported to INL, if applicable.

[f] Includes impacts from transport of two shipments of adulterants from an assumed distance of 4,800 kilometers (3,000 miles) to the INL Site or SRS for dilution of plutonium in CCOs.

[g] Includes impacts from transport of a shipment every 5 years of a diluent from a DOE site to the INL Site or SRS for dilution of plutonium in CCOs.

Notes: Totals may differ from the sum of individual entries due to rounding.
All STA routes is the sum of the plutonium and low-enriched uranium transports.
Annual waste shipment numbers could be less than one.
To convert kilometers to miles, multiply by 0.62137.
Bolded entries are sums.

Appendix E, Section E.9 provides the impacts from transporting construction materials and hazardous wastes related to construction and operations. **Table 4–58** summarizes the impacts from transporting these materials.

The results in Tables 4–57 and 4–58 are discussed further in Sections 4.12.1 and 4.12.2. Route-specific impacts are presented in Appendix E, Table E–5.

Table 4–58. Estimated Total Impacts from Hazardous Waste and Construction Material Transport

Number of Shipments	*Total Distance Traveled (two-way kilometers)*	*Number of Accidents*	*Traffic Fatality Risk*
INL VTR Alternative			
18,460	24,300,000	14	0.6
ORNL VTR Alternative			
23,786	31,548,000	17	0.7
INL VTR Fuel Production Options			
0.0 [a]			
SRS VTR Fuel Production Options			
2,454	490,800	0.4	0.02

[a] INL existing facilities do not require major construction to accommodate the equipment (e.g., glove boxes) for the fuel production activities.

Note: To convert kilometers to miles, multiply by 0.62137.
Source: INL 2020f, SRNS 2020.

4.12.1 INL VTR Alternative

Under the INL VTR Alternative, transportation impacts from radioactive and nonradioactive (hazardous and construction wastes) generated in support of the facility construction and operation activities to various locations are summarized.

As shown in Table 4–57, under this alternative, there would be 187 to 423 truck shipments of radioactive materials and waste, annually. This includes 15 shipments of unirradiated VTR fuel assemblies to INL, if the SRS VTR fuel production option is used. These types of transports would occur for about 63 years, 3 years of fuel production prior to the start of VTR operation and 60 years of VTR operation afterward.

Impacts of Incident-Free Transportation

Crew[8] – The highest annual crew dose of about 30 person rem and an expected LCF of 0.018 would occur if the foreign (European) plutonium fuel were to be used along with the aqueous feedstock preparation as part of the VTR fuel production at INL. Assuming that the same individual crew would be responsible for all shipments for a period of 20 years, the transport of radioactive materials, waste, and unirradiated VTR fuel likely would not result in any LCFs among crew members.

Public – The highest cumulative annual population dose of about 28 person-rem and an expected LCF of 0.017 amongst the exposed population would occur if the foreign plutonium fuel were to be used along with the aqueous feedstock preparation as part of the VTR fuel production at INL. Given the various transport routes and the exposed population groups along these routes, the cumulative dose to the general population over the 63 years likely would not result in any LCFs from transport of radioactive materials, waste, and unirradiated VTR fuel.

Impacts of Transportation Accidents

As described previously, two sets of analyses were performed for the evaluation of radiological transportation accident impacts: impacts of maximum reasonably foreseeable accidents (accidents having radioactive release probabilities greater than 1×10^{-7} [1 chance in 10 million] per year), and impacts of all conceivable accidents (total transportation accidents).

For maximum reasonably foreseeable transportation accidents probabilities were calculated for all route segments (i.e., rural, suburban, and urban), and maximum consequences were determined for those route shipments having a likelihood-of-release frequency exceeding 1 in 10 million per year. For the INL VTR Alternative, the maximum reasonably foreseeable transportation accident having the highest consequence would involve truck transport of plutonium (assumed to be in powder form)[9] to SRS for the VTR fuel production (see Appendix E, Table E–9), if a weapon grade plutonium is used, and to the INL Site for fuel production if the European (French fuel) is used.

The maximum reasonably foreseeable probability of a truck accident involving the weapon grade material would be up to 2.5×10^{-6} per year in a rural area, or 1 chance in 400,000 each year; and that for the European fuel would be 1.2×10^{-7} per year in a suburban area, or 1 chance in 8.3 million each year. The consequences of the truck transport accident in terms of population dose would be about 348 person-rem, resulting in 0 (0.21) additional LCFs among the exposed population for the weapon grade fuel, and for the European fuel would be about 61,500 person rem, resulting in 37 additional LCF among the exposed population. Considering the likelihood of these accidents, the maximum expected additional LCF among the exposed population would be 0 (0.0000044), annually.

Estimates of total transportation accident dose-risks for all projected accidents involving all materials and waste shipments, regardless of material or waste type, and unirradiated VTR fuel assemblies likely would not result in any LCFs. Transport activities under this alternative would result in 4 (3.8) nonradiological fatalities due to traffic accidents, over 63 years of operation. For comparison, in the United States in 2017 there were over 37,133 traffic fatalities due to all vehicular crashes (DOT 2019). The incremental increase

[8] Crew are the truck drivers; assumed to be two drivers per transport.

[9] European plutonium is in oxide form, and there is a potential that domestic weapon grade plutonium would also be in oxide form, as well. The assumption that all source materials would be in oxide form maximizes the accident risk. Therefore, the assumption that all feedstock plutonium is in oxide for transportation analysis envelopes the accident risks.

in risk to the general population from shipments associated with the VTR program would therefore be very small.

Impacts of Construction Materials and Hazardous Waste Transport

As shown in Table 4–58, the impacts from transporting construction materials to the INL Site and hazardous waste from the INL Site to an offsite disposal or recycle facility would result in 1 (0.6) traffic fatalities.

4.12.2 ORNL VTR Alternative

Under the ORNL VTR Alternative, transportation impacts from radioactive and nonradioactive (hazardous and construction wastes) generated in support of the facility construction and operation activities to various locations are summarized.

As shown in Table 4–57, under this alternative, there would be 202 to 430 truck shipments of radioactive materials and waste, annually. This includes 15 shipments of unirradiated VTR fuel assemblies to ORNL from either INL, or SRS.

Impacts of Incident-Free Transportation

Crew – The highest annual crew dose of about 34 person rem and an expected LCF of 0.020 would occur if the foreign plutonium fuel were to be used along with the aqueous feedstock preparation as part of the VTR fuel production at SRS. Assuming that the same individual crew is responsible for all shipments for a period of 20 years, the transport of radioactive materials, waste, and unirradiated VTR fuel likely would not result in any LCFs among crew members.

Public – The highest cumulative annual population dose of about 32 person-rem and an expected LCF of 0.019 amongst the exposed population would occur if the foreign plutonium fuel were to be used along with the aqueous feedstock preparation as part of the VTR fuel production at SRS. Given the various transport routes and the exposed population groups along these routes, the cumulative dose to the general population over the 63 years likely would not result in any LCFs from transport of radioactive materials, waste, and unirradiated VTR fuel.

Impacts of Transportation Accidents

As described previously, two sets of analyses were performed for the evaluation of radiological transportation accident impacts: impacts of maximum reasonably foreseeable accidents (accidents having radioactive release probabilities greater than 1×10^{-7} [1 chance in 10 million] per year), and impacts of all conceivable accidents (total transportation accidents).

Maximum reasonably foreseeable transportation accident probabilities were calculated for all route segments (i.e., rural, suburban, and urban), and maximum consequences were determined for those route shipments having a likelihood-of-release frequency exceeding 1 in 10 million per year. For the ORNL VTR Alternative, the maximum reasonably foreseeable transportation accident having the highest consequence would involve truck transport of plutonium (assumed to be in powder form) to SRS for the VTR fuel production (see Appendix E, Table E–9), if a weapon grade plutonium is used, and to the INL Site for fuel production if the European (French fuel) is used.

The maximum reasonably foreseeable probability of a truck accident involving the weapon grade material would be up to 2.5×10^{-6} per year in a rural area, or 1 chance in 400,000 each year; and that for the European fuel would be 1.2×10^{-7} per year in a suburban area, or 1 chance in 8.3 million each year. The consequences of the truck transport accident in terms of population dose would be about 348 person-rem, resulting in 0 (0.21) additional LCFs among the exposed population for the weapon grade fuel, and for the European fuel would be about 61,500 person rem, resulting in 37 additional LCF among the exposed population. Considering the likelihood of these accidents, the maximum expected additional LCF among the exposed population would be 0 (0.0000044), annually.

Estimates of total transportation accident dose-risks for all projected accidents involving all materials and waste shipments, regardless of material or waste type, and unirradiated VTR fuel assemblies likely would not result in any LCFs. Transport activities under this alternative would result in 4 (3.8) nonradiological fatalities due to traffic accidents, over 63 years of operation. For comparison, in the United States in 2017 there were over 37,133 traffic fatalities due to all vehicular crashes (DOT 2019). The incremental increase in risk to the general population from shipments associated with the VTR program would therefore be very small.

Impacts of Construction Materials and Hazardous Waste Transport

As shown in Table 4–58, the impacts from transporting construction materials to ORNL and hazardous waste from ORNL to an offsite disposal or recycle facility would result in 1 (0.7) traffic fatalities.

4.12.3 Reactor Fuel Production Options

Two options for the location of fuel fabrication facility are considered: at the INL Site and at SRS. Each fuel option includes plutonium fuel feedstock preparation. The processing cases considered include, Aqueous, Pyro-chemical plus a small aqueous, and Pyro-chemical only, see Appendix B to this VTR EIS, for details. The transportation impacts are enveloped by the Aqueous (Case-1) and the Pyro-chemical (Case-3) processes.

4.12.3.1 INL Reactor Fuel Production

Under this option, the impact of transporting the needed source materials (e.g., Pu, U, Zr, steel, NA, etc.) to the INL Site for the fabrication of the VTR fuel assemblies along with the generated waste transports to the disposal facilities, and the needed equipment and construction materials for the facility operation are evaluated.

As shown in Table 4–57, under this option, there would be 57 to 285 truck shipments of radioactive materials and waste annually, for the INL VTR Alternative. There would be additional 15 shipments for transport of VTR fuel under the VTR ORNL Alternative

Impacts of Incident-Free Transportation

Crew – The highest annual crew dose of about 23 person rem and an expected LCF of 0.01 would occur if the foreign plutonium fuel were to be used along with the aqueous feedstock preparation as part of the VTR fuel production at INL. Assuming that the same individual crew is responsible for all shipments for a period of 20 years, the transport of radioactive materials and waste associated with this option likely would result in no LCFs among crew members.

Public – The highest cumulative annual population dose of about 20 person-rem and an expected LCF of 0.01 amongst the exposed population would occur if the foreign plutonium fuel were to be used along with the aqueous feedstock preparation as part of the VTR fuel production at INL. Given the various transport routes and the exposed population groups along these routes, the cumulative dose to the general population associated with this option likely would result in no LCFs from transport of radioactive materials and waste.

Impacts of Transportation Accidents

For radioactive materials and waste shipped under this option, the maximum reasonably foreseeable offsite truck transportation accident having the highest consequence would involve truck transport of plutonium (assumed to be in powder form) to the INL Site (see Appendix E, Table E–9). The maximum reasonably foreseeable probability of a truck accident involving this material would be up to 1.9×10^{-6} per year in a rural area, or 1 chance in about 500,000 each year for the weapon grade; and 1.2×10^{-7} per year in a suburban area, or 1 chance in 8.3 million each year, for the European fuel. The consequences of the truck transport accident in terms of population dose would be about 286 person-rem, resulting in 0 LCFs (0.17) among the exposed population for the weapon grade fuel. For the European fuel, the consequences would be about 61,500 person rem, resulting in 37 additional LCF among the exposed population. Considering the likelihood of these accidents, the maximum expected additional LCF among the exposed population would be 0 (0.0000044), annually.

Estimates of total transportation accident dose-risks for all projected accidents involving all materials and waste shipments, regardless of material and waste type likely would result in no LCFs. Transport activities under this alternative would result in 2 (1.9) nonradiological fatalities due to a traffic accident, over 63 years. For comparison, in the United States in 2017 there were over 37,133 traffic fatalities due to all vehicular crashes (DOT 2019). The incremental increase in risk to the general population from shipments associated with the VTR program would therefore be very small.

Impacts of Construction Materials and Hazardous Waste Transport

As shown in Table 4–58, the impacts from transporting construction materials to the INL Site and hazardous waste from the INL Site to an offsite disposal or recycle facility would result in no traffic fatalities.

4.12.3.2 SRS Reactor Fuel Production

Under this option, the impact of transporting the needed equipment, construction materials, and source materials (e.g., plutonium, uranium, zirconium, steel, sodium) to SRS for the fabrication of the VTR fuel assemblies is evaluated. The option also evaluates generated waste transportation to disposal facilities.

As shown in Table 4–57, under this alternative, there would be 57 to 278 truck shipments of radioactive materials and waste. Transport of the fabricated VTR fuel assemblies would add 15 truck shipments to the INL Site or ORNL, annually,

Impacts of Incident-Free Transportation

Crew – The highest annual crew dose of about 23 person rem and an expected LCF of 0.01 would occur if the foreign plutonium fuel were to be used along with the aqueous feedstock preparation the VTR fuel production at SRS. Assuming that the same individual crew is responsible for all shipments for a period of 20 years, the transport of radioactive materials and waste associated with this option likely would result in no LCFs among crew members.

Public – The highest cumulative annual population dose of about 20 person-rem and an expected LCF of 0.01 amongst the exposed population would occur if the foreign plutonium fuel were to be used along with the aqueous feedstock preparation and the VTR fuel production at INL. Given the various transport routes and the exposed population groups along these routes, the cumulative dose to the general population associated with this option likely would result in no LCFs from transport of radioactive materials and waste.

Impacts of Transportation Accidents

For radioactive materials and waste shipped under this option, the maximum reasonably foreseeable offsite truck transportation accident having the highest consequence would involve truck transport of plutonium (assumed to be in powder form) to the INL Site (see Appendix E, Table E–9). The maximum reasonably foreseeable probability of a truck accident involving this material would be up to 2.5×10^{-6} per year in a rural area, or 1 chance in 400,000 each year. The consequences of the truck transport accident in terms of population dose would be about 348 person-rem, resulting in 0 (0.21) LCFs among the exposed population.

Estimated total transportation accident dose-risks for all projected accidents involving all materials and waste shipments, regardless of material and waste type likely would not result in any LCFs. Transport activities under this alternative would result in 3 (2.6) nonradiological fatalities due to traffic accidents, over 63 years. For comparison, in the United States in 2017 there were over 37,133 traffic fatalities due to all vehicular crashes (DOT 2019). The incremental increase in risk to the general population from shipments associated with the VTR program would therefore be very small.

Impacts of Construction Materials and Hazardous Waste Transport

As shown in Table 4–58, the impacts from transporting construction materials to SRS and hazardous waste from SRS to an offsite disposal or recycle facility would result in no traffic fatalities.

4.12.4 Combined INL VTR Alternative and INL Reactor Fuel Production Options Impacts

This section presents the total impacts that would occur if the VTR and the fuel production capability were both established at INL. The combined impacts developed earlier under the Combined INL VTR Alternative and the INL Reactor Fuel Production Option are summarized in Table 4–57 under the INL VTR Alternative in conjunction with the entries designated as "Total-1."

As shown in Table 4–57, under this alternative, there would be 187 to 415 truck shipments of radioactive materials and waste, annually. These types of transports would occur for about 63 years, 3 years of fuel production prior to the start of VTR operation and 60 years of VTR operation.

Impacts of Incident-Free Transportation

Crew – The highest annual crew dose of about 30 person rem and an expected LCF of 0.018 would occur if the foreign (European) plutonium fuel were to be used along with the aqueous feedstock preparation. Assuming that the same individual crew is responsible for all shipments for a period of 20 years, the transport of radioactive materials and waste likely would not result in any LCFs among crew members.

Public – The highest cumulative annual population dose of about 28 person rem and an expected LCF of 0.017 amongst the exposed population would occur if the foreign plutonium fuel were to be used along with the aqueous feedstock preparation. Given the various transport routes and the exposed population groups along these routes, the cumulative dose to the general population over the 63 years likely would not result in any LCFs from transport of radioactive materials or waste.

Impacts of Transportation Accidents

As described previously, two sets of analyses were performed for the evaluation of radiological transportation accident impacts: impacts of maximum reasonably foreseeable accidents (accidents having radioactive release probabilities greater than 1×10^{-7} [1 chance in 10 million] per year), and impacts of all conceivable accidents (total transportation accidents).

For maximum reasonably foreseeable transportation accidents probabilities were calculated for all route segments (i.e., rural, suburban, and urban), and maximum consequences were determined for those route shipments having a likelihood-of-release frequency exceeding 1 in 10 million per year. For the INL VTR Alternative, the maximum reasonably foreseeable transportation accident having the highest consequence would involve truck transport of plutonium (assumed to be in powder form) to the INL Site for the VTR fuel production (see Appendix E, Table E–9). The maximum reasonably foreseeable probability of a truck accident involving this material would be up to 1.9×10^{-6} per year in a rural area, or 1 chance in about 500,000 each year for the weapon grade; and 1.2×10^{-7} per year in a suburban area, or 1 chance in 8.3 million each year, for the European fuel. The consequences of the truck transport accident in terms of population dose would be about 286 person-rem, resulting in 0 LCFs (0.17) among the exposed population, for the weapon grade, and for the European fuel would be about 61,500 person rem, resulting in 37 additional LCF among the exposed population. Considering the likelihood of these accidents, the maximum expected additional LCF among the exposed population would be 0 (0.0000044), annually.

Estimates of total transportation accident dose-risks for all projected accidents involving all materials and waste shipments, regardless of material or waste type, and unirradiated VTR fuel assemblies likely would not result in any LCFs. Transport activities under this alternative would result in 3 (2.52) nonradiological fatalities due to traffic accidents, over 63 years of operation. For comparison, in the United States in 2017 there were over 37,133 traffic fatalities due to all vehicular crashes (DOT 2019). The incremental increase in risk to the general population from shipments associated with the VTR program would therefore be very small.

Impacts of Construction Materials and Hazardous Waste Transport

As shown in Table 4–58, the impacts from transporting construction materials to the INL Site and hazardous waste from the INL Site to an offsite disposal or recycle facility would result in 1 (0.6) traffic fatalities.

4.13 Traffic

This section discusses the potential effects to roadway and railroad networks that could occur from the construction and operation of the VTR, as well as the associated infrastructure, including construction of the Post-Irradiation Examination and Spent Nuclear Fuel Storage facilities (where applicable).

Table 4–59 summarizes the overall environmental impacts on traffic for the INL and ORNL VTR Alternatives and INL and SRS Reactor Fuel Production Options.

Table 4–59. Summary of Environmental Consequences on Traffic

Resource Area	***VTR Alternatives***	
	INL VTR	***ORNL VTR***
Traffic	***Construction***: The average increases in daily traffic at the INL Site during construction is not expected to exceed existing LOS of offsite roads, and no upgrades or improvements to onsite roads are anticipated. A maximum of 1,300 construction personnel would arrive during peak construction, with an overall average of about 640 construction personnel over the entire construction period.	***Construction***: The average increases in daily traffic at the ORNL Site during construction is not expected to exceed existing LOS of offsite roads, and no upgrades or improvements to onsite roads are anticipated. The construction of the Hot Cell Facility will result in about 30 percent higher traffic volumes at ORNL compared to INL. A maximum of about 1,700 construction personnel would arrive during peak construction, with an overall average of about 830 construction personnel over the entire construction period. Truck traffic would be directed specifically to avoid the main roadway through the center of campus.
	Operations: Operations at each facility are expected to result in an increase of about 218 employees. The changes would represent a minor increase in traffic at each facility (about 5 percent). Operations traffic is not expected to cause a change in the existing LOS of offsite roads, and no upgrades or improvements to onsite roads are anticipated.	***Operations:*** Operations at each facility are expected to result in an increase of about 300 employees. The changes would represent a minor increase in traffic at each facility (about 5 percent). Operations traffic is not expected to cause a change in the existing LOS of offsite roads, and no upgrades or improvements to onsite roads are anticipated.

<table>
<tr><th rowspan="2"></th><th colspan="2">Reactor Fuel Production Options</th></tr>
<tr><th>INL Reactor Fuel Production</th><th>SRS Reactor Fuel Production</th></tr>
<tr><td rowspan="6">Traffic</td><td colspan="2">Feedstock Preparation</td></tr>
<tr><td>Construction: The increase in traffic from both material shipments and construction workers are not expected to exceed existing LOS of offsite roads at either site, and no upgrades or improvements to onsite roads are anticipated Construction workers would average a total of 6 over the 3-year construction period, with a maximum of 18 workers during peak construction.</td><td>Construction: The increase in traffic from both material shipments and construction workers are not expected to exceed existing LOS of offsite roads at either site, and no upgrades or improvements to onsite roads are anticipated. This option would require approximately 120 new employees at SRS.</td></tr>
<tr><td colspan="2">Operations: The increase in traffic from new (300 at either of the two sites) combined with existing employee traffic is not expected to exceed existing LOS of offsite roads at either site, and no upgrades or improvements to onsite roads are anticipated to be needed. The increase in workforce would be about 2 percent at the INL Site and about 3 percent at SRS.</td></tr>
<tr><td colspan="2">Fuel Fabrication</td></tr>
<tr><td>Construction: The increase in traffic from both material shipments and construction workers are not expected to exceed existing LOS of offsite roads at either site, and no upgrades or improvements to onsite roads are anticipated Construction workers would average a total of 6 over the 3-year construction period, with a maximum of 18 workers during peak construction.</td><td>Construction: The increase in traffic from both material shipments and construction workers are not expected to exceed existing LOS of offsite roads at either site, and no upgrades or improvements to onsite roads are anticipated. This option would require approximately 120 new employees at SRS.</td></tr>
<tr><td>Operations: Approximately 70 new employees would be required to support fuel fabrication activities. The increase in traffic from new combined with existing employee traffic is not expected to exceed existing LOS of offsite roads at either site, and no upgrades or improvements to onsite roads are anticipated to be needed. The increase in workforce would be about 2 percent at the INL Site.</td><td>Operations: Approximately 300 new employees would be required to support fuel fabrication activities. The increase in traffic from new combined with existing employee traffic is not expected to exceed existing LOS of offsite roads at either site, and no upgrades or improvements to onsite roads are anticipated to be needed. The increase in workforce would be about 3 percent at the SRS Site.</td></tr>
<tr><th></th><th colspan="2">Combined INL VTR Alternative and INL Reactor Fuel Production Options</th></tr>
<tr><td rowspan="2">Traffic</td><td colspan="2">Construction: If all three options were to occur at INL (VTR, Feedstock Preparation, and Fuel Fabrication), the total number of new commuters (construction workers and employees) to INL would be approximately 1,400 during peak construction.</td></tr>
<tr><td colspan="2">Operations: If all three options were to occur at INL (VTR, Feedstock Preparation, and Fuel Fabrication), the total number of new employees required would be approximately 600.</td></tr>
</table>

LOS = Level of Service.

4.13.1 INL VTR Alternative

The following sections present the impacts from establishing the VTR at the INL Site. The impacts would include construction and operation of the VTR and facility modifications and incremental operational impacts for performing post-irradiation examination of test items. Facility modifications and incremental operational impacts for preparing SNF for long-term storage and disposal and construction and operation of a new long-term storage facility near ZPPR are also presented.

4.13.1.1 Construction/Facility Modification

Materials

From site mobilization to startup (about 60 months), an estimated 15,500 deliveries are anticipated, including a combination of standard delivery and flatbed tractor-trailer trucks. Estimated quantities of materials for VTR construction are included in Appendix B, Table B–8.

It is assumed that manufactured goods (permanent equipment) transported to the INL Site, including specialty components, would arrive via the Port of Wilmington, North Carolina, and be transported by truck to the INL Site, a distance of about 2,500 miles. The primary route from Wilmington to the INL Site would include Interstates 40 west, 24 west, 57 north, 64 west, 70 west, 29 north, 80 west, and 84 west; U.S. Routes 74 west and 26 west; and Nebraska State Route 2 west. It is assumed that about 35 percent of the 15,500 estimated deliveries (5,400 to 5,500 total) would be brought via this route.

Aggregates and other materials would be brought in from local sources located about 50 miles or less from the INL Site. It is assumed that about 65 percent of the 15,500 estimated deliveries (10,000 to 10,100) would come from these local sources.

Since the bulk of the routes involved include U.S. and Interstate Highways, it is anticipated that the addition of 16 trucks per day, on average, to these roadways would result in negligible to minor impacts on traffic volumes.

No other expected modes of transportation would be anticipated, except for the reactor vessel module. The reactor vessel module is about 1,200 tons and 20 feet in diameter. Shipment would likely require multiple modes of transport (road and/or rail). This will not be known until a transportation study is completed.

Personnel

The estimated number of persons commuting to/from site each day during construction is depicted in **Figure 4–1** and would range from less than 100 persons initially to a maximum of about 1,300 persons during peak construction. Figure 4–1 includes craft labor personnel and non-manual personnel for the Phase 2 EPC contractor and subcontractor personnel. Figure 4–1 does not include BEA or DOE non-manual personnel. For estimation purposes, it is assumed that the workers commuting to the INL Site would be split evenly between Idaho Falls, Idaho (about 50 miles east of the INL Site) via U.S. Route 20; and Blackfoot, Idaho (about 40 miles southeast of the INL Site) via U.S. Route 26.

The base work schedule is expected to be:

- Four (4) workdays per week (Monday – Thursday); 10 hours per day; day shift only; no work on scheduled holidays
- Overtime would be used for critical items identified in the schedule and for schedule recovery. Overtime is Friday, Saturday, and Sunday. The estimated order of magnitude of overtime as a portion of the overall scheduled work is 10 percent.

As indicated in Table 4–3, it is estimated that the maximum number of workers onsite during the peak construction period would be 1,300. Within that total, the rough estimated range for peak craft personnel at the construction site is anticipated to be 500 to 750.

Overall, using a high-end scenario (i.e., all workers commute separately), the average number of worker annual commuter trips during construction would be about 10,000, ranging from about 3,050 in 2022 to a peak of 12,600 in 2024. The addition of about 640 vehicles commuting to the site daily, on average, during construction would have a minor impact on local traffic conditions, increasing traffic to the site by about 17 percent compared to current baseline traffic volumes. Traffic would increase by about 33 percent during peak construction in 2024 as compared to current conditions.

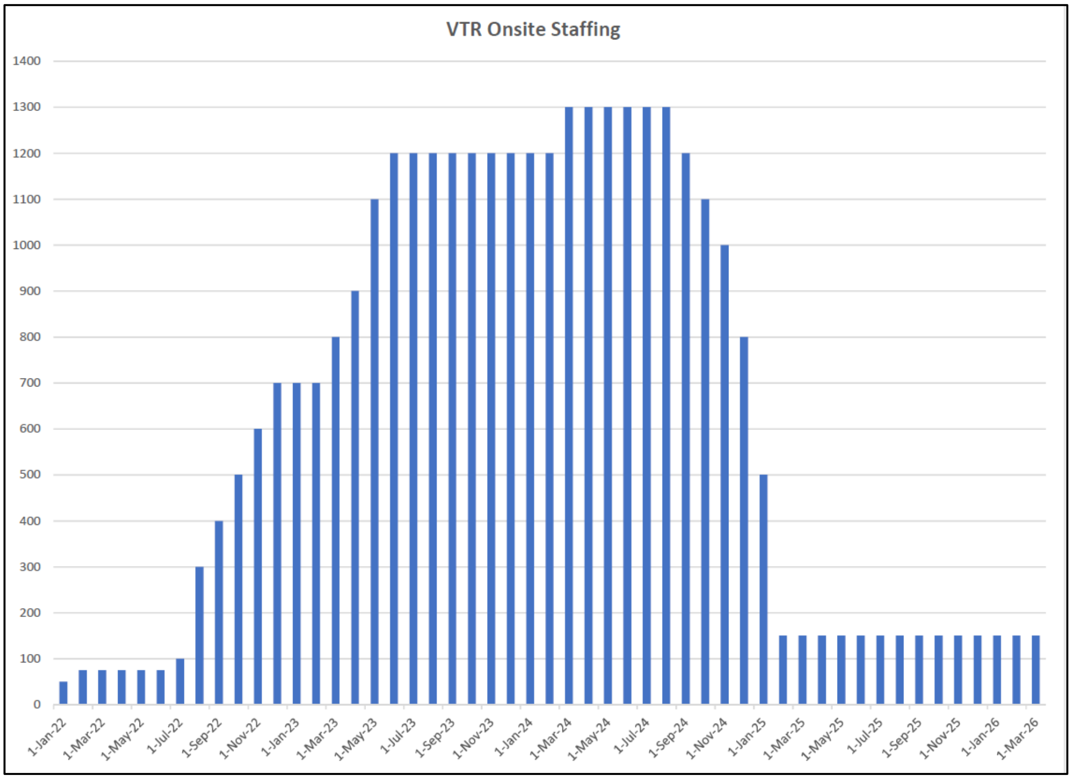

Figure 4–1. Estimated Number of Persons Commuting To/From Idaho National Laboratory Each Day During Construction

Waste

From site mobilization to startup (about 60 months), an estimated 2,250 waste shipments are anticipated. Of the 2,250 shipments, about 115 shipments would be hazardous waste. All waste shipments would be transported via road. The INL Site has onsite facilities for the disposal of nonhazardous waste. Estimated quantities of waste requiring shipment during construction are included in Appendix B, Table B–10.

No construction activities are anticipated. Any new handling equipment built would be handled by current MFC personnel. Likewise, no radioactive or hazardous waste generation is anticipated.

A new spent fuel storage facility would be constructed within the PIDAS in the open space near ZPPR. The facility would consist of a concrete pad, enclosed by a steel frame and siding weather enclosure.

4.13.1.2 Operations

It is anticipated that an individual cycle re-load could require two shipments, so annual shipment quantities would be six shipments. Initial core loading (maximum 66 assemblies) could require 10 shipments.

The number of new employees commuting to the site each day to support VTR operations is about 218.

Operations – Test Assembly Examination Facility

Waste shipments from post-irradiation examination activities would involve discarded material from fuel assemblies and experiments. LLW items associated with cask operations and operator personal protective equipment (PPE) would also be anticipated. Together they would be about one shipment of TRU waste and two shipments of LLW per year (i.e., about one 36-gallon can ([5-gallon overpack] of RH-TRU waste and three 4 × 4 × 4 boxes of LLW).

4.13.2 ORNL VTR Alternative

The following sections present the impacts from establishing the VTR at ORNL. The impacts would include establishment of a new PIDAS for the VTR complex and construction and operation of the VTR. Impacts would also result from construction and operation of a hot cell facility for performing post-irradiation examination of test items and for preparing SNF for long-term storage and disposal, extension of existing infrastructure to the VTR complex, and construction and operation of a long-term storage facility.

4.13.2.1 Construction/Facility Modification

Materials

From site mobilization to startup (about 60 months), an estimated 20,150 deliveries are anticipated, including a combination of standard delivery and tractor-trailer trucks. Estimated quantities of materials for VTR construction are included in Appendix B, Table B–8.

It is assumed that about 35 percent of the 20,150 estimated deliveries (7,000 to 7,100 total) would be transported from distant locations. Since most of these routes would be over U.S. and Interstate Highways, the addition of 16 trucks per day, on average, to these roadways would result in negligible impacts on traffic volumes.

Aggregates and other materials would be brought from local sources. It is assumed that about 65 percent of the 20,150 estimated deliveries (13,000 to 13,100) would come from these local sources. Construction materials from both distant and local sources would largely travel on the same roads in the region. The preferred route for access to the proposed project location by construction vehicles is to exit State Route 62 onto Bethel Valley Road, then use EGCR Access Road to Melton Valley Drive to the site. This would minimize the amount of traffic along Bethel Valley Road further south and to lessen traffic impacts through the most developed portion of the area. The addition of 16 trucks per day, on average, on these regional and local roadways would result in negligible to minor impacts on traffic volumes.

No other expected modes of transportation would be anticipated, except for the reactor vessel module. The reactor vessel module is about 1,200 tons and 20 feet in diameter. Shipment would likely require multiple modes of transport (road and/or rail). This will not be known until a transportation study is completed.

Personnel

The estimated number of persons commuting to and from site each day during construction, depicted in Figure 4–1, would range from less than 100 persons initially to a maximum of approximately 1,700 persons during peak construction. Figure 4–1 includes craft labor personnel and non-manual personnel for the Phase 2 EPC contractor and subcontractor personnel. Figure 4–1 does not include contractor (UTB) or DOE non-manual personnel. For estimation purposes, it is assumed that the workers commuting to ORNL would originate from Knoxville, the nearest urbanized area/population center. Depending on their exact work location at ORNL, commuters would have the option of taking Interstate 40 west to State Route 162 west to State Route 62 west to Bethel Valley Road; or Interstate 40 west to State Route 95 north to Bethel Valley Road.

The base work schedule is expected to be:

- Four workdays per week (Monday – Thursday); 10 hours per day; day shift only; no work on scheduled holidays
- Overtime would be used for critical items identified in the schedule and for schedule recovery. Overtime is Friday, Saturday, and Sunday. The estimated order of magnitude of overtime as a portion of the overall scheduled work is 10 percent.

As indicated in Table 4–3, it is estimated that the maximum number of workers onsite during the peak construction period would be 1,700. Within that total, the rough estimated range for peak craft personnel at the construction site is anticipated to be 500 to 750.

Overall, using a high-end scenario (i.e., all workers commute separately), the average number of worker annual commuter trips during construction would be about 10,000, ranging from about 3,400 in 2022 to a peak of 13,000 in 2024. The addition of about 660 vehicles commuting to the site daily, on average, during construction would have a minor impact on local traffic conditions, increasing traffic to the site by about 15 percent compared to current baseline traffic volumes. Traffic would increase by about 30 percent during peak construction in 2024 as compared to current conditions.

Waste

From site mobilization to completion of startup (about 60 months), a rough estimate is about 2,925 waste shipments. Of the 2,925 shipments, it is estimated that about 115 shipments would be hazardous waste. All waste shipments would be transported via road. Estimated quantities of waste requiring shipment during construction are included in Appendix B, Table B-10.

4.13.2.2 Operations

An average of 40 trucks per week making deliveries of material. Most of these carriers would be making deliveries as well as receiving tendered material for outgoing shipments.

It is anticipated that an individual cycle re-load could be shipped in two shipments, so annual shipment quantities would be six shipments while initial core loading (maximum 66 assemblies) could be shipped in 10 shipments.

The number of new employees commuting to the site each day to support VTR operations is about 200. An additional 100 new employees will also be required to support hot cell operations.

Waste shipments from post-irradiation examination activities would involve discarded material from fuel assemblies and experiments. However, this will likely include less than 5 shipments per year and will have a negligible effect on traffic.

4.13.3 Reactor Fuel Production Options

4.13.3.1 INL Reactor Fuel Production Options

The following sections present the impacts from establishing the fuel production capability at the INL Site. Impacts would be from facility construction or modifications to offer the necessary technologies for fabricating a U-Pu-Zr metal fuel for the VTR. Two options are evaluated.

The fuel fabrication option assumes that uranium and plutonium feedstock would be received in forms that could be used directly for creating the U-Pu-Zr alloy from which the fuel would be fabricated. The feed materials would include plutonium without high levels of impurities, such as americium-241.

Under the feedstock preparation option, capabilities would be installed to handle a wide variety of plutonium feedstock. Gloveboxes and equipment would be installed to remove impurities from the plutonium, to polish plutonium by removing ingrowth isotopes (e.g., americium-241), and to convert plutonium to a metal form (e.g., reducing plutonium oxide to metal). These steps would yield a plutonium metal that would then be used to create the U-Pu-Zr alloy and fabricate the VTR fuel.

4.13.3.1.1 INL Feedstock Preparation Option

Construction/Facility Modification

Construction materials anticipated in support of the project include new gloveboxes and process equipment. Planners anticipate two deliveries per new piece of process equipment plus one delivery of supporting supplies. These deliveries would yield 3 deliveries per each piece of equipment or station (5 new stations) resulting in 15 deliveries during construction. Other equipment and delivery needs are anticipated to arrive in existing freight schedules.

Onsite work would typically be performed by a small construction crew focused in installing facility modifications as well as new equipment hookups. Average construction worker requirements for these activities would be about six workers over 2 years. Peak construction numbers for equipment installation and facility modifications would be as many as 18 workers at any given time (with an average of 6 over 3 years).

Operations

Radioactive material feedstock for fuel fabrication is anticipated to be received in batches supporting continual fuel production schedules. Feedstock shipments would be anticipated to average three per operating year. Estimated quantities of materials for construction are included in Appendix B, Table B–8.

The number of new employees commuting to the site each day to support VTR feedstock preparation if performed at the INL Site is 70.

4.13.3.1.2 INL Fuel Fabrication Option

Construction/Facility Modification

Construction materials anticipated in support of the project include new gloveboxes and process equipment. Planners anticipate two deliveries per new piece of process equipment plus one delivery of supporting supplies. These deliveries would yield 3 deliveries per each piece of equipment or station (5 new stations) resulting in 15 deliveries during construction. Other equipment and delivery needs are anticipated to arrive in existing freight schedules.

Onsite work would typically be performed by a small construction crew focused in installing facility modifications as well as new equipment hookups. Average construction worker requirements for these activities would be about six workers over 2 years. Peak construction numbers for equipment installation and facility modifications would be as many as 18 workers at any given time (with an average of 6 over 3 years).

Operations

The number of new employees commuting to the site each day to support VTR fuel fabrication operations if performed at the INL Site is 300.

4.13.3.2 SRS Reactor Fuel Production Options

The following sections present the construction impacts from establishing the fuel production options at SRS. Impacts would be from facility construction or modifications to offer the necessary technologies for fabricating a U-Pu-Zr metal fuel for the VTR. Two options are evaluated.

The fuel fabrication option assumes that uranium and plutonium feedstock would be received in forms that could be used directly for creating the U-Pu-Zr alloy from which the fuel would be fabricated. The feed materials would include plutonium without high levels of impurities, such as americium-241.

Under the feedstock preparation option, capabilities would be installed to handle a wide variety of plutonium feedstock. Gloveboxes and equipment would be installed to remove impurities from the plutonium, to polish plutonium by removing ingrowth isotopes (e.g., americium-241), and to convert plutonium to a metal form (e.g., reducing plutonium oxide to metal). These steps would yield a plutonium metal that would then be used to create the U-Pu-Zr alloy and fabricate the VTR fuel.

4.13.3.2.1 SRS Feedstock Preparation Option

Construction/Facility Modification

Waste

In order to prepare the existing building to support reactor fuel production, D&R would be required. D&R activities would generate large amounts of materials and waste for offsite shipment. The main items that would require removal include larger AC and DC motors, motor control centers, moderator storage and overflow tanks, and several hundred feet of process, cooling, and effluent piping (24-, 36-, 42-, and 48-inch diameter). Other tanks, equipment, and piping would also require removal from these areas. All waste shipments would be transported via road. Estimated quantities of waste requiring shipment during construction are included in Appendix B, Table B–43 and B–48.

In addition, stainless steel drums would be required to drain the contents of three heavy water tanks, which could contain up 58,760 gallons of heavy water; the actual current volume of heavy water contained within the tanks is unknown. Based on a total capacity of 58,760 gallons of heavy water, it would require up to about 1,780 drums (33 gallons per drum) to completely drain all three tanks prior to removing the tanks. Assuming 24 drums per shipment (stacked two high), this process would require about 75 shipments of new stainless steel drums to the facility. Due to uncertainty in the actual heavy water content of the existing tanks, additional work is required to identify the actual number of new heavy water drums that may be required for draining of existing K Area Complex equipment.

The relocation of an additional about 2,000 heavy water drums to another storage location at SRS would be required to facilitate installation of VTR fuel fabrication equipment. Based on an assumption of 24 drums per shipment, it is estimated that it would require 158 shipments to completely remove the estimated quantity of drums (about 3,780 total) from the K Area Complex.

Materials

While no “new” construction is proposed, renovation activities at the site would be required. These construction activities would require the transport of structural components (concrete, steel rebar, aggregates, rebar, etc.), stainless steel drums (for emptying the contents of three heavy water tanks, and fabrication process components (gloveboxes, furnaces, gloveboxes, furnaces, ducting, air balance equipment, filtration equipment, and other equipment). All waste shipments would be transported via road.

Major infrastructure to be provided includes material control and accountability equipment, analytical support for process control, electrical switchgear for furnace power supply, and exhaust ventilation. Redundant exhaust fans and HEPA filtration would be required for both glovebox and room exhaust. In addition, fire suppression equipment, high volume air monitoring, and new National Incident Management System are required.

During renovation, it is anticipated that 2 deliveries per new piece of process equipment plus 1 delivery of supporting supplies yields 3 deliveries per each piece of equipment or station (5 new stations) would be required, resulting in 15 deliveries. Other equipment and delivery needs are anticipated to arrive in existing freight schedules.

It is assumed that manufactured goods (permanent equipment) transported to SRS, including specialty components, would arrive via the Port of Wilmington, North Carolina, and be transported by truck to SRS, a distance of about 500 miles. The primary route from Wilmington to SRS would include Interstate 95 south to Interstate 20 west to U.S Route 1 south. It is assumed that about 35 percent of the estimated deliveries would be brought via this route.

Aggregates and other materials would be brought in from local sources located about 50 miles or less from SRS. It is assumed that about 65 percent of the estimated deliveries would come from these local sources.

Personnel

The construction staff is expected to top out at 120 full-time employees working five, 10-hour days a week. This will include 100 craft and 20 non-manual employees.

Operations

Materials Shipments (Incoming)

Radioactive material feedstock for feedstock preparation is anticipated to be received in batches supporting continual fuel production schedules. Feedstock shipments would be anticipated to average three per operating year.

Waste Shipments (Outgoing)

New waste shipments from proposed feedstock preparation activities would involve the typical nonhazardous wastes from worker activities. LLW items associated with glovebox operations, crucible scraps, cleaning rags and operator PPE are also anticipated. Estimated quantities of waste requiring shipment during construction are included in Appendix B, Table B–46.

Personnel

The number of new employees commuting to the site each day to support VTR feedstock preparation, if performed at SRS, is about 300.

4.13.3.2.2 SRS Fuel Fabrication Option

Construction/Facility Modification

The construction staff is expected to top out at 120 full-time employees working five, 10-hour days a week. This will include 100 craft and 20 non-manual employees.

Operations

Waste Shipments (Outgoing)

New waste shipments from proposed fuel fabrication activities would involve the typical nonhazardous waste from worker activities. LLW items associated with glovebox operations, casting mold scraps, cleaning rags and operator PPE are also anticipated. Estimated quantities of waste requiring shipment during construction are included in Appendix B, Table B–50.

Personnel

The number of new employees commuting to the site each day to support VTR fuel fabrication, if performed at SRS, is about 300.

4.13.4 Combined INL VTR Alternative and INL Reactor Fuel Production Options Impacts

This section presents the total impacts that would occur at the INL Site if the VTR alternative and the fuel production options were all established at the site. It is a short summary of the combined impacts developed earlier under the Combined INL VTR Alternative and the INL Reactor Fuel Production Options.

The impacts on traffic from construction and operation of facilities under the INL VTR Alternative are anticipated to be minor. The added impacts on traffic from the INL Feedstock Preparation and Fuel Fabrication Options, if executed, are anticipated to be negligible.

4.14 Socioeconomics

Socioeconomic impacts result from the direct employment of construction and operations workers and the impacts on regional economic characteristics, population, housing, and community resources within the ROI. An important consideration in assessing potential impacts of the proposed facilities is the number of workers, families, and children who might move into the ROI (in-migrate), either temporarily or permanently, with construction and operation of the proposed facilities. Impacts on population are described in terms of total number of in-migrants (and their families) arriving in the region in the peak year of construction and first year of operation. The resulting population influx would have the potential to substantially affect the housing market in the ROI, with potential increases in demand for both rental and owner-occupied housing units. It could also increase demand for educational services and for other public services such as police and fire protection and health services. Finally, the increases in jobs and income from construction and operation of the proposed facilities would have both direct and indirect impacts on the local and regional economy. To the extent these increases would help reduce existing unemployment levels and boost the economy, they are considered to be beneficial.

The following analysis evaluates projected socioeconomic impacts relative to population, housing, labor, income, other economic characteristics, and community services within several project regions. In particular, this section discusses the potential impacts on socioeconomics of the VTR alternatives and reactor fuel production options. The INL, ORNL, and SRS ROIs for socioeconomics would include the counties within which the majority of onsite employees at each DOE facility reside, including the host counties and adjacent counties or nearby counties containing the largest population centers. The impacts analysis considers aspects of the social and economic environment that are sensitive to change and that may be adversely or beneficially affected by activities associated with the Proposed Action. Adverse impacts on socioeconomic resources would occur if any of the alternatives had the potential to cause the following:

- Alter local economies on a substantial basis without the capacity to absorb a decrease or increase,

  Changes housing characteristics (types of units, occupancy, housing values, etc.) or residential development patterns in a substantial way,
- Alters population growth or demographic patterns in a way that changes the overall character of communities,
- Displaces populations, residents, or businesses to accommodate construction,
- Requires an amount of public or private resources (time and/or money) that interferes with the performance of other local government functions or the viability of proposed projects, and
- Induces growth without adequate supporting community services (e.g., education, public health, and safety).

Staffing estimates used in the socioeconomic analysis are derived from Appendix B (Detailed Project Information) and are consistent with the onsite staffing estimates used in the human health impact assessment (see Section 4.10), although the socioeconomic analysis focuses on that portion of the projected workforce that would not be local but rather would in-migrate into each site's ROI.

Table 4–60 presents a summary of the potential environmental consequences on socioeconomics for the INL and ORNL VTR Alternatives and the INL and SRS Reactor Fuel Production Options. A more detailed summary of site-specific impacts on each of the main socioeconomic resource areas is included in Tables 4–62 (INL), 4–64 (ORNL), 4–65 (SRS), and 4–66 (Combined, INL).

Table 4–60. Summary of Environmental Consequences on Socioeconomics

Resource Area	VTR Alternatives	
	INL VTR	***ORNL VTR***
Socioeconomics	*Construction*: Negligible adverse impact; small and beneficial economic impact. In the peak year of construction (civil/structural in the 2023-2025 timeframe), construction of the VTR at the INL Site would create direct employment of 1,300 (660 annual) construction workers and generate another 660 indirect jobs in the region. The increase in jobs and income from construction would have a short-term beneficial impact on the local and regional economy. The population influx associated with an in-migrating workforce (80 percent) and their families would be about 2,787 persons. This is considered relatively small – representing less than 1 percent of the population in the ROI – and would have no major adverse impacts on the region in terms of population, employment, income levels, housing, or community services (Table 4–66).	*Construction*: Negligible adverse impact; small and beneficial economic impact. In the peak year of construction (civil/structural in the 2023-2025 timeframe), construction of the VTR at ORNL would create direct employment of 1,598 (858 annual) construction workers and generate another 1,185 indirect jobs (peak) in the region (636 indirect annual jobs). The increase in jobs and income from construction would have a short-term potential beneficial impact on the area. The population influx associated with an in-migrating workforce (30 percent) and their families would be 1,214 persons. This is considered relatively small and would have no major adverse impacts on the region in terms of population, employment, income levels, housing, or community services (Table 4–68).
	Operations: No adverse impact. Operation of the VTR at the INL Site would create annual direct employment of 218, \$20.9 million in annual income, an additional 373 indirect jobs, and \$10.6 million in income annually. The increase in jobs and income would have a potential beneficial impact on the local and regional economy. The population influx associated with an in-migrating workforce (30 percent) and their families would be about 190 persons. In-migration would require less than 5 percent of vacant owner-occupied housing during facility operations (or less than 1 percent of total vacant housing units in the ROI). These numbers are considered relatively small and would have no major adverse impacts on the region in terms of population, housing, or community services (see Table 4–66).	*Operations*: No adverse impact. Operation of the VTR at ORNL would create annual direct employment of 300, \$24.3 million in annual income, an additional 520 indirect jobs, and \$22.4 million in income annually. The increase in jobs and income would have a potential beneficial impact on the local and regional economy. The population influx associated with an in-migrating workforce (30 percent) and their families would be about 230 additional persons. In-migration would require less than 1 percent of vacant owner-occupied housing during facility operations. These numbers are considered relatively small and would have no major adverse impacts on the region in terms of population, employment, income levels, housing, or community services (see Table 4–68).

	Reactor Fuel Production Options	
	INL Reactor Fuel Production	**SRS Reactor Fuel Production**
Socioeconomics	**Fuel Fabrication**	
	Construction: Negligible adverse impact; small and beneficial economic impact. VTR fuel fabrication process would be located in existing buildings (FMF and ZPPR) and could use existing infrastructure with modifications. Construction workforce requirements would be minimal (peak of 18 and annual workforce of 6). Given the small staffing requirements, no population influx associated with in-migrating workers would be expected and there would be no adverse socioeconomic impacts from project construction or operation on the local housing market or community services in the ROI.	*Construction*: Negligible adverse impact; small and beneficial economic impact. Fuel fabrication would be performed in an existing facility in the K Area Complex, but construction activities would be associated with the build-out of the equipment locations within 105-K Building and the new infrastructure required (e.g., material storage areas, special nuclear material measurement equipment, analytical support). Workforce requirements include 120 workers (annual peak). Given the small projected construction workforce, it is assumed there would be minimal to no in-migration of any maintenance or operations personnel, and therefore no adverse effects on the ROI in terms of population, employment, income levels, housing, or community services.
	Operations: No adverse impact. Annual operations workforce of 300 FTEs but, only 70 FTEs would be new hires. Given the small staffing requirements, minimal to no population influx associated with in-migrating workers would be expected, and there would be no adverse socioeconomic impacts from project construction or operation on the local housing market or community services in the ROI.	*Operations*: No adverse impact. Projected operations workforce would be 300 with no in-migration of workers. Therefore, the Project would have negligible effect on population growth. As a result, there would be no adverse effects on the ROI in terms of population, employment, income levels, housing, or community services.
	Discussion: For both sites, the increase in jobs and income from plant construction and operation, however small, would have a long-term small and beneficial impact on the economy of each area. Employee spending would create an additional positive induced effect on the economy and generate additional State and local revenues. The positive economic impacts would be expected to be slightly greater at SRS because of the larger workforce requirements compared to INL.	
	Feedstock Preparation	
	No adverse impact. Feedstock preparation activities could be required to prepare the plutonium for fuel fabrication. These activities would require a separate, but similar construction and operations workforce as that estimated for fuel fabrication, with the exception of the INL Site where feedstock preparation activities would require up to 300 workers for operations, similar to operations projected at the INL Site for fuel fabrication). The majority of these workers are expected to be available locally, with minimal worker in-migration or population influx to the ROI. Therefore, no adverse effects would be expected on the ROI in terms of housing, schools, or community services. The potential increase in employment and income would be considered a beneficial impact on the local and regional economies.	
	Combined INL VTR Alternative and INL Reactor Fuel Production Options	
Socioeconomics	*Construction*: The incremental increase in the reactor fuel production workforce as compared to the VTR workforce analyzed for the INL VTR Alternative would be very small, even if the feedstock preparation workforce is added in, and the combined workforce requirements for the VTR and reactor fuel production activities would be essentially as described above for the INL VTR Alternative. *Operations*: The incremental increase in the reactor fuel production workforce as compared to the VTR workforce analyzed for the INL VTR Alternative would be small, even with the feedstock preparation activities are added in, given the assumptions made regarding a small in-migrating workforce. The combined workforce requirements for the VTR and reactor fuel production activities would be essentially as described above for the INL VTR Alternative.	

4.14.1 INL VTR Alternative

4.14.1.1 Construction/Facility Modification

Construction at the INL Site would include construction of the VTR and a spent fuel storage pad at MFC. DOE would use existing, co-located facilities at INL's MFC (with modifications as necessary) for the post-irradiation examination of test assemblies and the treatment or conditioning of SNF to prepare it for storage and eventual disposal. **Table 4–61** shows that projected staffing for project construction is tied primarily to the VTR itself. VTR activities associated with construction requirements for test assembly examination would be encompassed by current activities at INL. No additional plant staff would be required during construction and any changes to resource requirements would be minimal.

Table 4–61. Projected Organization Staffing at INL

Estimated Workforce				
	Construction			*Operation*
Organization	*Peak*	*Average Annual*	*Total*	*Annual*
VTR	1,300	650	3,200	200
Hot Cell Building (no new hires)	0	0	0	0
Spent Fuel Treatment Facility	10	10	10	18
Total	**1,310**	**660**	**3,210**	**218**

Staffing estimates are obtained from Appendix B (Detailed Project Information) of this EIS.

In the peak year of construction (civil/structural in the 2023-2025 timeframe), construction of the VTR at the INL Site would create direct employment of 1,310 (660 annual) construction workers and generate another 890 indirect jobs in the region, including jobs relating to suppliers (provide materials and supplies) and induced jobs (jobs in goods and services where construction workers spend their money). They would also generate $40.6 million in income annually during construction from direct and indirect jobs (up to $81.2 million during peak year). These are based on the following multipliers: 1.68 for construction employment and 1.45 for labor income (Idaho Policy Institute et al. 2019).

The total peak employment (direct and indirect) requirement of 2,200 direct and indirect jobs represents 1.4 percent of the projected ROI workforce in 2018 (157,398); the direct employment of 1,310 construction workers represents 11.4 percent of the construction workforce in the ROI (11,470), and 1.8 percent of construction workforce in the State of Idaho (72,421) in 2018. The ROI had a low unemployment rate of 1.4 percent in 2018. While the estimated project construction workforce under the INL VTR Alternative is low compared to the total labor force in the ROI, it does represent over 10 percent of the total construction workforce in the ROI and would require some specialty crafts and skill sets that may not be found locally. It is assumed that 20 percent of the construction workforce would be found within the ROI at the time construction starts, and 80 percent is assumed to in-migrate into the ROI (about 1,050 for peak). This would result in a population influx of about 2,810 additional persons, representing less than 1 percent (0.87 percent) of the population in the ROI in 2018 (322,434). This population increase is based on the conservative assumption that every new household would have 2.68 people, based on the average household size in Idaho (between 2014 and 2018) – where the average household occupant can also include one person living alone (Census 2020a).

These numbers, as summarized in **Table 4–62**, are considered relatively small and would have no major adverse impacts on the ROI in terms of population, employment, income levels, housing, or community services. The increase in jobs and income would be considered a potential beneficial impact on the area.

Table 4–62. Effects of VTR on Socioeconomics within INL's ROI

Impact Category	***VTR Staffing Requirements***	
	Construction (annual)	***Operation (annual)***
Employment (Number of jobs)		
Direct	1,310 (peak); 660 (average) 3,200 total (based on 51-month construction period)	218
Indirect	890 (peak) 450 (average)	373
Total	2,200 (peak) 1,110 (annual)	591
Income ($ in millions) [a]		
Direct	$56 (peak) $28.4 (annual)	$20.9
Indirect	$25.2 (peak) $12.8 (annual)	$10.6
Total	$81.2 (peak) $41.2 (annual)	$31.5
Population (# new residents)	2,810 Including up to 715 additional children which is 1 percent [65,268] increase in school children in ROI	190 46 additional children Less than 0.1 percent increase in school children in ROI
Housing (# units required)	1,040 (9.7 percent of total vacant rental units (10,692) and 8.9 percent of total vacant housing units in ROI in 2017) (11,706 rental and owned)	65 (3.3 percent of vacant owner-occupied housing units in ROI in 2017 – 1,984) Or under 1 percent of total vacant housing units in ROI in 2017
Public finances (Percent impacts on expenditures)		
Cities and Counties	< 1	< 1
Schools	< 1	< 1
Public Service Employment (# new employees)		
Local government employees	0	0
Teachers	0	0

[a] Based on average salary of $43,040 for construction worker (BLS 2020d), and $95,768 average base salary of INL employee in FY 2017 (INL 2018d).

The percentage of housing units that would be required for an in-migrating construction workforce would be around 10 percent, which represents the peak workforce and are compared to the number of total vacant housing units in the ROI in 2017. The increase would represent less than 1 percent of the total housing market in the ROI in 2017. Such impacts would be short-term in nature, and the number of housing units in the ROI would be expected to be higher at the start of construction in 2024. Therefore, these numbers indicate there would be sufficient housing available to accommodate the in-migrating workforce, assuming there are no other major strains on the housing market. The analysis includes a conservative assumption that 80 percent of the construction workforce would relocate to the ROI (a lower percentage would result in fewer impacts). Beneficial impacts would be due to increased jobs, tax revenue, and income. The small population influx would not be expected to have adverse impacts existing schools and community services. In addition, increased tax revenues could be utilized to offset increased strains on community services and recreational facilities by funding enhancements to appropriate services and facilities if and where needed.

4.14.1.2 Operation

Tables 4–61 and 4–62 also show that projected staffing for project operation as they relate to the VTR and VTR activities associated with test assembly examination (no new hires required) and spent fuel treatment and storage operation. Operation of the VTR at the INL Site would create annual direct employment of

218 and $20.9 million in annual income and an additional 373 indirect jobs and about $10.6 million in income annually. The indirect impacts are based on the following multipliers: 2.71 for employment and 1.51 for labor income (INL 2018d).

Similar to the construction workforce, it is assumed that some of the special skill sets required for VTR operation would not be found locally. It is conservatively assumed that about 30 percent of plant maintenance (nuclear pipeline craftsmen pipefitters) and operations (reactor operators) personnel, or about 65 workers, would in-migrate to the area at the beginning of operations and all would bring their families. This would result in a population influx of about 175 additional persons, based on an average household size in Idaho of 2.68 persons (includes singles as described for construction in Section 4.14.1.1) (Census 2020a). In-migration would have a small effect on population growth and would require less than 5 percent of vacant owner-occupied housing during facility operations (or less than 1 percent of total vacant housing units in the ROI). No significant impact on public finances would occur because of in-migration, and no new local public service employees would be required to maintain existing levels of service in the various local public service jurisdictions in the ROI.

These numbers are considered relatively small and therefore would have no major adverse impacts on the ROI in terms of population, employment, income levels, housing, or community services.

The potential increase in jobs and income from plant operation would be a long-term beneficial impact on the economy of the area, similar to the short-term beneficial impacts from project construction. As indicated in Section 3.1.14 and further summarized below, INL significantly impacts Idaho's economy. An increase in INL employment associated with the Proposed Action would further benefit the local, regional, and State economy. For purposes of comparison the 218 projected operations workforce personnel would represent about 3.2 percent of the 6,836 directly employed INL workers in 2020.

In addition to the increases in employment and income, overall economic activity generated by the manufacture and construction activities at the INL Site would increase. As reported in the 2017 INL Economic Summary Report (INL 2018d), for every $100 in direct economic activity at INL, an additional $93 of activity is created or sustained throughout the State's economy (outlier multiplier of 1.93). In FY2017, INL operations added $1.94 billion in Idaho's gross economic output, including just over $1 billion in INL direct spending); this represented more than 2.9 percent of Idaho's total output or gross State product. These impacts also would result in increased tax revenues for the local, regional, and State governments in Idaho. These would include local property taxes annually over the construction period. Added revenues from sales, excise individual, and corporate income taxes would further increase tax revenues in the State.

In summary, construction and manufacture activities from the project would increase eastern Idaho employment and labor income and generate increases in economic output in the region. Annual operations of the project would provide ongoing additions of about 590 jobs (direct and indirect) to the eastern Idaho region and over $31.5 million in labor income annually for the life of the project. The project's ongoing operations and maintenance activities would result in increases in overall economic output and tax revenues throughout the region and in Idaho would increase.

In addition to increased employment, labor income, economic output and tax revenues stemming from the construction and operation of the project, the facility would provide an ongoing stabilizing force to the eastern Idaho economy. Given the nature of personnel hired for plant operations, for example, the project would add to the highly skilled workforce already at the INL Site. In short, the added economic benefits to the region, added tax revenues, and other benefits stemming from the sustained presence of the facility are anticipated to be beneficial contributors to the quality of life in the communities surrounding the facility and across Idaho.

4.14.2 ORNL VTR Alternative

4.14.2.1 Construction/Facility Modification

The major structures for the VTR component at ORNL would be the same as those described under the INL VTR Alternative, and construction of the VTR itself at ORNL would have the same staffing requirements. However, there would be additional staffing requirements associated with site preparation work required to clear and level the selected site, and construction of the hot cell building (post irradiation examination and spent fuel treatment facilities) and spent fuel pad; the new hot cell building would only be required at ORNL.

In addition, under the conceptual design, the existing ORNL infrastructure would be extended to the VTR site. The location selected for the VTR is relatively undeveloped and does not have sufficient infrastructure (roads, utilities, security, etc.) to support construction and operation of the VTR.

Table 4–63 shows the projected staffing for VTR and associated construction activities at ORNL.

Table 4–63. Projected Organization Staffing at ORNL

Estimated Workforce				
	Construction			*Operation*
Organization	*Peak*	*Average Annual*	*Total*	*Annual*
VTR	1,300	650	3,200	200
Hot Cell Building (combined test assembly examination and spent fuel storage and treatment facility)	290	200	985	100
Fuel Storage Pad	8	8	8	0
Total	**1,598**	**858**	**4,193**	**300**

Note: Staffing estimates are pulled from Appendix B (Detailed Project Information) of this EIS. Estimate does not include 16 workers estimated for site clearing and excavation work during the first 10 months of project construction, given their minimal impact compared to that occurring during peak construction year(s).

In the peak year of construction (civil/structural in the 2023-2025 timeframe), construction of the VTR at ORNL would create direct employment of 1,598 (858 annual) construction workers and generate another 1,185 indirect jobs (peak) in the region (636 indirect annual jobs), including jobs relating to suppliers (provide materials and supplies) and induced jobs (jobs in goods and services where construction workers spend their money). They would also generate $62.7 million in income annually during construction from direct and indirect jobs (up to $116.8 million during peak year). These are based on the following regional multipliers for the industry employment and earnings: 1.742 for construction employment and 1.6998 for labor income developed from Bureau of Economic Analysis's Regional Input-Output Modeling System (NRC 2019).

The total employment requirement of 2,783 direct and indirect jobs (peak) represents less than 1 percent (0.9 percent) of the projected ROI workforce in 2018 (320,327). The estimated 1,598 direct construction employment represents about 9 percent of the construction workforce in the ROI (17,922) and less than 1 percent (0.7 percent) of the construction workforce in the State of Tennessee in 2018 (226,412). The ROI had a low unemployment rate of 3.1 percent in 2018. Table 4–63 shows the projected construction staffing for the project. While the estimated project construction workforce under the ORNL alternative is low compared to the total labor force in the ROI, it represents over 5 percent of the total construction workforce in the ROI and would require some specialty crafts and skill sets that may not be found locally. It is assumed that 70 percent of the construction workforce would be found within the ROI at the time construction starts, and 30 percent is assumed to in-migrate into the ROI (480 for peak). This would result in a population influx of about 1,214 additional persons, representing less than 1 percent (0.19 percent) of the population in the ROI in 2018 (647,965). This population increase is based on the conservative assumption that every new household would have 2.53 people, based on the average household size in Tennessee (from 2014 through 2018) – where the average household occupant can also include one person living alone (Census 2020a).

These numbers, as summarized in **Table 4–64**, are considered relatively small and would have no major adverse impacts on the ROI in terms of population, employment, income levels, housing, or community services. A comparison to the in-migrating construction workforce (direct jobs) and the available rental housing in 2018 would indicate a low impact on the local rental housing market (2.2 percent increase in vacant rental units during peak construction period). Additional demand on housing could come from an in-migrating workforce resulting from the indirect jobs created. However, this number is expected to be low and any combined impacts on available housing would be minor, especially if you add in the number of vacant owner-occupied units and assuming additional housing units would be available at the time of peak construction. The increase in jobs and income would be considered a potential beneficial impact on the area. Construction activities from the Project would provide increases in East Tennessee employment and labor income, and generate increases in economic output and tax revenues in the region. Over the longer term, increased tax revenues also could be utilized to offset increased strains on local housing by funding enhancements to appropriate supplies/markets.

Table 4–64. Effects of VTR Project on Socioeconomics at the ROI for the ORNL Site

Impact Category	***VTR Staffing Requirements***	
	Construction (annual)	***Operation (annual)***
Employment (number of jobs)		
Direct	1,598 (peak); 858 (annual) 51-month period	300
Indirect	1,185 (peak); 636 (annual)	520
Total	2,783 (peak); 1,494 (annual)	820
Income ($ in millions) [a]		
Direct	$68.7 (peak); $36.9 (annual)	$24.3
Indirect	$48.1 (peak); $25.8 (annual)	$21.9
Total	$116.8 (peak); $62.7 (annual)	$46.7
Population (# new residents)	1,214 0.19 percent increase in population ROI, including about 260 additional children which is 0.3 percent increase in school children in ROI	230 20 additional children Essentially 0 percent increase in school children in ROI
Housing (# units required)	480 (2.9 percent of total vacant rental units in ROI in 2018 (16,827), or 2.1 percent of total vacant units in the ROI in 2018 (22,491 rental and owned)	90 (1.6 percent of vacant owner-occupied housing units in ROI in 2018), (5,664); or less than 1 percent of total vacant units in the ROI in 2018 (29,166)
Public Finances (percent impacts on expenditures)		
Cities and Counties	< 1	< 1
Schools	< 1	< 1
Public Service Employment (# new employees)		
Local government employees	0	0
Teachers	0	0

[a] Based on average salary of $43,000 for construction worker (BLS 2020d), and $81,000 average base salary of DOE-related employee in Oak Ridge in FY 2017 (DOE 2018g).

4.14.2.2 Operation

Operation of the VTR facility itself at ORNL would be the same as that described for INL. However, ORNL would have additional staffing requirements associated with the following activities:

- Single facility for test assembly examination and spent fuel treatment and
- Facility for storage.

Tables 4–63 and 4–64 also show the projected staffing for project operation as it relates to the VTR and VTR activities associated with test assembly examination and spent fuel treatment and storage operation; operation of the fuel storage pad would be drawn from existing facility staff. Operation of the VTR at ORNL would create annual direct employment of 300 and $24.3 million in annual income. An additional 520 indirect jobs and $22.4 million in income annually would be created. The indirect impacts are based on the following multipliers: 2.73 for employment and 1.90 for labor income (DOE 2018g).

Similar to the construction workforce, it is assumed that some of the special skill sets required for VTR operation would not be found locally. It is conservatively assumed that about 30 percent of plant maintenance (nuclear pipeline craftsmen pipefitters) and operations (reactor operators) personnel, or about 90 workers, would in-migrate to the area at the beginning of operations and all would bring their families. This would result in a population influx of about 230 additional persons, based on an average household size in Tennessee of 2.53 persons (including singles, as described for construction in Section 4.14.2.1) (Census 2020a).

In-migration would have a small effect on population growth and would require less than 1 percent of vacant owner-occupied housing during facility operations. No significant impact on public finances would occur because of in-migration, and no new local public service employees would be required to maintain existing levels of service in the various local public service jurisdictions in the ROI.

These numbers are considered relatively small and would have no major adverse impacts on the ROI in terms of population, employment, income levels, housing, or community services (see also Table 4–64).

Similar to construction, the increase in jobs and income for plant operation would be a long-term beneficial impact on the economy of the area. As indicated in Section 3.2.14 and further summarized below, ORR, including ORNL, drives a significant impact on Tennessee's economy. An increase in ORNL employment associated with the Proposed Action would further benefit the local, regional and State economy; for purposes of comparison the 300 projected operations workforce personnel would represent about 2.4 percent of the 12,530 directly employed ORR workers in 2018, or 6.8 percent of the 4,400 directly employed at ORNL workers in 2018 (OREM 2019).

In addition to the increases in employment and income, overall economic activity generated by the manufacture and construction activities at ORNL site would increase. As reported in the 2017 DOE's Economic Impact in Tennessee (DOE 2018g), the total economic impact from DOE and its major contractors' activities (contribution to State GDP and income benefits) – based on 2017 ORNL employment levels – was nearly $5.6 billion. This included about nearly $3.4 billion because of direct and indirect effects of DOE expenditures and nearly $2.2 billion in total personal income generated by DOE-related activities in the State. DOE and contractor spending exceeded $943 million on procurement of raw materials, services, and supplies from Tennessee businesses, and more than $1.1 billion on non-payroll expenditures (direct procurement spending). Noteworthy regarding DOE and contractor spending is that the majority of it occurred in Anderson, Knox, and Roane Counties within the ROI.

Project impacts also would result in increased tax revenues for the local, regional, and State governments in Tennessee. These would include local property taxes annually over the construction period. Added revenues from sales, excise individual, and corporate income taxes would further increase tax revenues in the State.

In summary, construction and manufacture activities from the project would provide increases in East Tennessee employment and labor income, and generate increases in economic output in the region. Annual operations of the project would produce ongoing additions of 748 jobs to East Tennessee and nearly $42.2 million in labor income annually over the life of the project. The project's ongoing operations and maintenance activities would result in increases in overall economic output and tax revenues throughout the region and in Tennessee would increase.

In addition to increased employment, labor income, economic output and tax revenues stemming from the construction and operation of the project, the facility would create an ongoing stabilizing force to the East Tennessee economy. Given the nature of personnel hired for plant operations, for example, the project would add to the highly skilled workforce already at the ORNL site. In short, the added economic benefits to the region, added tax revenues, and other benefits stemming from the sustained presence of the facility are anticipated to be beneficial contributors to the quality of life in the communities surrounding the facility and across Tennessee.

4.14.3 Reactor Fuel Production Options

4.14.3.1 INL Reactor Fuel Production Options

Under the INL reactor fuel production options, the VTR fuel production would be located in existing buildings (primarily FCF, FMF, and ZPPR) and could use existing infrastructure with modifications. Construction workforce requirements would be minimal. There are sufficient engineering and startup organizations to staff these needs, and fabrication is specifically planned to allow transport to the site from other states if needed. VTR activities associated with fuel fabrication construction at the INL Site would require a peak workforce (on site at one time, but not FTEs) of 18 workers and an annual workforce of 6 workers during an about 3-year construction period (Appendix B, Table B–35); and an annual operations workforce of 300 FTEs, although 230 of these workers are expected to be drawn from the existing workforce already onsite at INL. Only 70 FTEs would be considered new hires with the potential to impact existing socioeconomic resources in the region (Appendix B, Table B–38). It is expected that all construction workers and 90 percent of the 70 new hires for the operational workforce would be pulled from the local area (6 workers would in-migrate) (INL 2020f; Nelson 2020).

In addition, depending on the source, some feedstock may require special preparation to put it in a form that can be fabricated. At this level of scope development, the estimated construction workforce associated with feedstock preparation would be the same as that for fuel fabrication, with a total peak workforce of 36 and annual workforce of 12 during the 3-year construction period for both fuel fabrication and feedstock preparation activities. Given the small staffing requirements for construction, no in-migrating workers and associated population influx would be expected, and there would be no adverse socioeconomic impacts from project construction on the local housing market or community services in the ROI.

With respect to operations, the number of workers required for feedstock preparation at the INL Site is estimated at 300, which would bring the total operations workforce to 370 for both fuel fabrication and feedstock preparation activities. It is estimated that the majority of workers would be local hires or taken from existing jobs at INL, and a small percentage of workers (10 percent or 37) would in-migrate and bring their families. Based on an average household size of 2.68, the total population influx would be about 100 persons. This represents 0.01 percent of the total ROI population.

Given the relatively small staffing requirements and projected population influx, no adverse socioeconomic impacts would be expected from project construction or operation on the local housing market or community services in the ROI. The potential increase in jobs and income would be considered a small and beneficial impact on the local economy. The combined impacts of fuel fabrication, feedstock preparation, and VTR construction and operation are addressed in Section 4.14.5.

4.14.3.2 SRS Reactor Fuel Production Options

Construction

Under the SRS Reactor Fuel Production Options, no new facilities would be constructed at SRS. Fuel fabrication would be performed in an existing facility in the K Area Complex. All equipment necessary to support fuel alloying and homogenization, fuel slug casting, fuel pin assembly, and fuel assembly fabrication would be located on two below ground levels within the building. The only construction activities would be the build-out of the equipment locations within 105-K Building and the removal of existing equipment. However, new infrastructure would be required, including material storage areas, special nuclear material measurement equipment, analytical support, and other infrastructure services such as glovebox and room ventilation and electrical distribution. The space needed for support facilities are expected to be substantial. At least one and possibly two of the adjacent 108-K buildings could be needed for these support operations. Construction is assumed to require 3 years (SRNS 2020).

VTR activities associated with fuel fabrication construction at SRS would require a larger workforce than at INL, as follows: 120 (peak and annual average), for a total of 360 workers over a 3-year construction period (see Appendix B, Table B–41). The majority of workers would be local. In addition, the direct employment would generate another 76 indirect jobs in the region. They would also generate about $8.3 million annually during the period of construction from direct and indirect jobs. The employment totals are based on a regional multiplier for the (construction) industry employment of 1.63 (DOE 2015a, 2020a). Earnings are based on the number of direct and indirect employees, the average construction worker's salary of $43,620 in Georgia and South Carolina (BLS 2020d), and a 2018 per capita income of $40,886 for the ROI (BEA 2019a).

Regarding the potential need for feedstock preparation, the number of workers required for construction for feedstock preparation activities at this level of scope development would be considered equivalent to that of fuel fabrication (120). It is assumed that the majority of these workers also would be local. The total employment (direct and indirect) requirement of 196 jobs related to fuel fabrication, or 392 with feedstock preparation activities, represents a very small percentage (0.08 percent to 0.16 percent) of the ROI workforce in 2018, and 1.3 percent to 2.6 percent of the of the construction workforce in the ROI. The ROI had a relatively low unemployment rate of 4.1 percent in 2018. **Table 4–65** shows the projected construction staffing for the project.

Socioeconomic projections assume 10 percent of the 240 combined fuel production options' workforce, or 24 construction workers, would in-migrate to the SRS area and bring their families. The total population influx would be about 65 persons, based on an average household size of 2.63 in South Carolina. This is about 0.01 percent of the total ROI population in 2018. Given the relatively small staffing requirements and projected population influx, no adverse socioeconomic impacts would be expected from project operation on the local housing market or community services in the ROI. The potential increase in jobs and income would be considered a small and beneficial impact on the local economy.

Table 4–65. Effects of VTR Project-Fuel Fabrication and Feedstock Preparation on Socioeconomics at the Region of Influence for Savannah River Site

Impact Category	*Fuel Fabrication Staffing Requirements*	
	Construction (annual) Fuel Fabrication/Fuel Fabrication and Feedstock Preparation	*Operation (annual) Fuel Fabrication/Fuel Fabrication and Feedstock Preparation*
Employment (number of jobs)		
Direct	120 / 240 3-year period	300 / 600
Indirect	76 / 152	360 / 715
Total	196 / 392	660 / 1,315
Income ($ in millions) [a]		
Direct	$5.2 / $10.5	$25.5 / $51.0
Indirect	$3.1 / $6.2	$14.7 / $29.2
Total	$8.3 / $16.6	$40.2 / $80.2
Population (# new residents)	Negligible	Negligible
Housing (# units required)	Negligible	Negligible
Public finances (Percent impacts on expenditures)		
Cities and Counties	< 1	< 1
Schools	< 1	< 1
Public Service Employment (# new employees)		
Local government employees	0	0
Teachers	0	0

[a] Based on average salary of $43,620 for construction worker in GA/SC (BLS 2020d); $40,886 per capita income in ROI used for indirect workers salary (BEA 2019a); and $85,000 average worker salary at SRS (Noah et al. 2011).

Operation

Based on the projected staffing requirements, the potential socioeconomic impacts from operating the fuel fabrication facility would be small. Operational activities would create a maximum of 300 direct jobs during the first year of operation (2026) and about $25.5 million in income annually, starting in 2028. Up to an additional 360 indirect jobs and another $14.7 million in income annually during operations from indirect jobs would be possible. This is based on an employment multiplier (operations) of 2.19 (DOE 2020); see also Table 4–65. The total additional employment (direct and indirect workers) associated with the Project would be very small (about 0.1 percent of the total civilian workforce in the ROI) and have negligible impact on the SRS ROI labor force, based on levels in 2018.

It is further assumed that there would be no in-migration of any maintenance or operations personnel at the beginning of operations and therefore the project would have negligible effect on population growth. As a result, there would be no adverse effects on the ROI in terms of population, employment, income levels, housing, or community services.

Similar to construction, the increase in jobs and income from plant operation, however small, would have a small, beneficial long-term impact on the economy of the area. As indicated in Chapter 3, Section 3.14.3, SRS significantly influences the economy of both Georgia and South Carolina. An increase in SRS employment associated with the Proposed Action would further benefit the local, regional, and State economy. SRS employees' spending would create an additional positive effect on the economy and generate additional State and local revenues and taxes.

The inclusion of feedstock preparation activities would increase the workforce by an additional 300 workers, bringing the total combined workforce to 600. Similar to the analysis for INL, it is assumed that all new hires would be local or pulled from existing jobs at SRS, and no workers would migrate into the area.

Combining the fuel fabrication and feedstock preparation workforce would result in a total employment (direct and indirect) requirement of just over 1,300 workers. However, this higher number would still represent a very small percentage (0.6 percent) of the total ROI workforce in 2018. The ROI had a relatively low unemployment rate of 4.1 percent in 2018. Table 4–65 shows the projected operations staffing for the project. In addition, given the expectation that all hires would be local, the socioeconomic impacts from project operation on the local housing market or community services in the ROI would be expected to be negligible. The potential increase in jobs and income would be considered a small and beneficial impact on the local economy.

4.14.4 Combined INL VTR Alternative and INL Reactor Fuel Production Options Impacts

4.14.4.1 Construction/Facility Modification

Table 4–66 shows the combined construction workforce requirements for VTR alternative and reactor fuel production at INL. The fuel fabrication activities assume that feedstock preparation would be required to provide a bounding analysis, and the workforce estimates reflect this. The incremental increase in the fuel fabrication/feedstock preparation workforce (36 peak, 12 annual average), as compared to the VTR workforce analyzed in Section 4.14.2, is very small, and the combined workforce requirements for the VTR and fuel fabrication activities would be essentially the same as those analyzed just for the VTR in Section 4.14.2. There would be no major adverse impacts on the ROI in terms of population, employment, income levels, housing, or community services from the combined set of construction activities. Section 4.14.1.1 describes the change in housing requirements during construction. The increase in jobs and income would be considered a small and beneficial impact on the area.

4.14.4.2 Operation

Table 4–66 shows the combined operations workforce requirements for VTR and fuel fabrication activities at INL. The incremental increase in the fuel fabrication and feedstock preparation workforce (about 600 total, 370 of which would be new hires), as compared to the VTR workforce analyzed in Section 4.14.2, would result in minimal in-migration of workers and their families. Most new hires would be from the local area. Therefore, the impacts of the combined workforce on the ROI, with respect to population, housing, and community services would be essentially the same as those analyzed for the VTR alone in Section 4.14.2. There would be no major adverse impacts on the ROI in terms of population, employment, income levels, housing, or community services from the combined set of activities. The increase in jobs and income would be considered a small and beneficial impact on the area.

Table 4–66. Combined Effects of VTR and Fuel Fabrication/Feedstock Preparation Activities on Socioeconomics within the Idaho National Laboratory Region of Influence

	VTR and Fuel Fabrication - Feedstock Preparation Staffing Requirements	
Impact Category	***Construction (annual)***	***Operation (annual)***
Employment (number of jobs)		
Direct	1,340 (peak); 672 (average) 3,200 total (based on 51-month construction period)	590 (new workers)[b]
Indirect	910 (peak); 457 (annual)	1,010
Total	2,250 (peak); 1,130(annual)	1,600
Income ($ in millions) [a]		
Direct	$57.7(peak year); $28.9 (annual)	$56.5

Impact Category	VTR and Fuel Fabrication - Feedstock Preparation Staffing Requirements	
	Construction (annual)	Operation (annual)
Indirect	$26 (peak); $13 (annual)	$28.8
Total	$83.7 (peak); $41.9(annual)	$85.3
Population (# new residents)	2,787 (peak) Including up to 700 additional children which is just over a 1 percent(65,268) increase in school children in ROI	290 75 additional children Less than 0.1 percent increase in school children in ROI
Housing (# units required)	1,040 (about 9.7 percent of total vacant rental units (10,692) and about 8.9 percent of total vacant housing units in ROI in 2018) (11,706 rental and owned)	102 (5.1 percent of vacant owner-occupied housing units in ROI in 2018) (1,984); and less than 1 percent of total vacant housing units in ROI in 2018
Public finances (Percent impacts on expenditures)		
Cities and Counties	< 1	< 1
Schools	< 1	< 1
Public Service Employment (# new employees)		
Local government employees	0	0
Teachers	0	0

[a] Based on average salary of $43,040 for construction worker (BLS 2020d), and $95,768 average base salary of INL employee in FY 2017 (INL 2018fd).

[b] 590 new workers but an additional 230 fuel fabrication workers would be drawn from the existing workforce at the INL Site, which results in a total of 820 workers.

4.15 Environmental Justice

This section discusses impacts on environmental justice populations within the respective 50-mile radius of the MFC at the INL Site, ORNL, and K Area at SRS. The 50-mile radius was selected because it is consistent with the ROI for air emissions and because it includes portions of the counties that constitute the respective ROIs for socioeconomics as described in Sections 3.1.15, 3.2.15, and 3.3.15.

Executive Order 12898 established the need to identify and address disproportionately high and adverse human health or environmental effects of Federal activities on environmental justice populations. CEQ (1997) defines disproportionately high and adverse human health or environmental effects as:

- Health or environmental effects that may be measured in risks and rates that are significant or above generally accepted norms;
- Risk or rate of hazard exposure by a minority, low-income population, or Native American Tribe to an environmental hazard that is significant and appreciably exceeds, or is likely to appreciably exceed, the risk or rate to the general population or other appropriate comparison group;
- Health or environmental effects that occur in a minority population, low-income population, or Native American Tribe affected by cumulative or multiple adverse exposures from environmental hazards; or
- Impact on the natural or physical environment that significantly and adversely affects a minority population, low-income population, or Native Americans.

To have disproportionately high and adverse human health or environmental effects on minority and low-income populations from the project, minority or low-income populations would need to be concentrated in geographic areas with high risk of exposure to radiation, hazardous chemicals, or potential accidents. Areas considered include geographic areas downwind from air emissions, or areas in close proximity to pollution sources. Additionally, high risk or exposure could occur through subsistence consumption of contaminated vegetation, fish, or wildlife. Impacts on Native American populations could occur from interrelated impacts (e.g., ecological, cultural, and traditional use areas) to the natural or physical environment.

Sections 3.1.14, 3.2.14, and 3.3.14 describe the existing environmental justice characteristics for the ROIs for each of the respective project locations, including census units for minority, low-income populations, and Native American Tribes. **Table 4–67** provides a summary of environmental consequences on Environmental Justice.

Table 4–67. Summary of Environmental Consequences on Environmental Justice

Resource Area	*VTR Alternatives*	
	INL VTR	***ORNL VTR***
Environmental Justice	*Construction:* No disproportionately high and adverse impacts on minority or low-income populations are expected. *Operations:* No disproportionately high and adverse impacts on minority or low-income populations are expected.	*Construction:* Same as INL VTR construction. *Operations:* Same as INL VTR operation.
	Discussion: Construction or operations of the VTR would not result in any disproportionately high and adverse human health or environmental effects on any minority or low-income populations. Increased risks of minority, low-income individuals, or Native American populations exposed to radiation would be negligible. There would be no other impacts on the natural or physical environment that would result in significant and adverse impacts on minority or low-income populations.	
	Reactor Fuel Production Options	
	INL Reactor Fuel Production	***SRS Reactor Fuel Production***
Environmental Justice	**Feedstock Preparation**	
	Construction: No disproportionately high and adverse impacts on minority or low-income populations are expected. *Operations:* No disproportionately high and adverse impacts on minority or low-income populations are expected.	*Construction:* Same as INL feedstock preparation construction. *Operations:* Same as INL feedstock preparation operation.
	Fuel Fabrication	
	Construction: Same as INL feedstock preparation construction. *Operations:* Same as INL feedstock preparation operation.	*Construction:* Same as INL feedstock preparation construction. *Operations:* Same as INL feedstock preparation operation.
	Discussion: Construction or operations for either feedstock preparation or fuel fabrication would not result in any disproportionately high and adverse human health or environmental effects on any minority or low-income populations. Increased risks of minority, low-income individuals, or Native American populations exposed to radiation would be negligible. There would be no other impacts on the natural or physical environment that would result in significant and adverse impacts on minority or low-income populations.	
	Combined INL VTR Alternative and INL Reactor Fuel Production Options	
Environmental Justice	*Construction:* No disproportionately high and adverse impacts on minority, low-income, or Native American populations are expected. *Operations:* No disproportionately high and adverse impacts on minority, low-income, or Native American populations are expected.	

4.15.1 INL VTR Alternative

In accordance with DOE Orders, environmental sampling is performed at several locations on the INL Site, at the INL Site boundary, and at various distances from the INL Site. Environmental sampling is also conducted at locations at Blackfoot and on the Fort Hall Indian Reservation to monitor for possible impacts on the Shoshone-Bannock Tribes. Potential pathways for contaminants to reach humans are sampled and monitored, and include air, water, precipitation, soil, agricultural products, and wildlife as it relates to ingestion (INL 2018a). To address possible impacts from consumption, including subsistence consumption, DOE routinely samples game species residing on the INL Site as well as regional agriculture products. Large game animals (pronghorn, mule deer, and elk) are sampled whenever they are killed from vehicle collisions on site or at the INL Site boundary. Waterfowl are also collected at ponds on the INL Site and at a location offsite (i.e., the American Falls Reservoir in 2017), and sampled. Data from monitoring programs are reported and published annually. Monitoring locations for milk, potatoes, and wheat products include traditional use areas of the Shoshone-Bannock Tribes and are located near Blackfoot and Fort Hall (INL 2018a).

4.15.1.1 Construction/Facility Modification

No disproportionately high or adverse impacts on environmental justice populations are anticipated during construction. The short-term socioeconomic impacts during any construction activities would be positive and not result in any disproportionately high and adverse effects on minority populations, low-income, or Native American populations. Regarding human health, there would be no additional radiological risks to the public during construction. Regarding other health or environmental effects, construction would occur about 2 miles from the nearest identified environmental justice block group, which is at such distance that is not anticipated to result in significant adverse effects to these populations. Therefore, no disproportionately high and adverse effects on minority, low-income, or Native American populations would be expected during construction of the VTR at the INL Site.

4.15.1.2 Operations

As discussed in Sections 4.10, routine operations under operations of the VTR alternative at the INL Site would pose no significant health risks to the public. **Table 4–68** shows the annual impacts on the total and subset populations within 5, 10, 20, and 50 miles of the facilities at the INL Site used under this alternative.

Table 4–68. Comparison of Annual Doses to Average Individual of Minority and Low-Income Populations Near the INL Site During VTR Operations in 2050 (millirem)

Population Group	*Within 5 Miles*	*Within 10 Miles*	*Within 20 Miles*	*Within 50 Miles*
Average Individual of the Total Population	0.0019	7.9×10^{-4}	4.5×10^{-4}	1.2×10^{-4}
Nonminority Individual	0.0016	8.7×10^{-4}	4.9×10^{-4}	1.2×10^{-4}
Average Individual of Total Minorities	0.0020	5.2×10^{-4}	3.3×10^{-4}	1.1×10^{-4}
White - Hispanic/Latino Individual	0.0019	9.1×10^{-4}	5.2×10^{-4}	1.4×10^{-4}
Black/African American Individual [a]	ND	ND	3.7×10^{-4}	1.3×10^{-4}
American Indian or Alaska Native Individual [b]	ND	ND	5.2×10^{-4}	1.6×10^{-4}
Other Minority Individual [a, b]	ND	5.5×10^{-4}	3.6×10^{-4}	1.2×10^{-4}
Non-low-income Individual	0.0019 0.0016	8.2×10^{-4}	4.6×10^{-4}	1.2×10^{-4}
Low-income Individual	ND	5.1×10^{-4}	3.5×10^{-4}	1.1×10^{-4}

ND = No dose; there are no recorded individuals of this population group within this radial distance

[a] Includes persons who also indicated Hispanic or Latino origin.

[b] Other Minority includes all combined individuals of Asian, Native Hawaiian and Other Pacific Islander, Some Other Race, or Two or More Races.

Note: Dose calculations are based on 2050 population projections.

Impacts are summarized as follows:

- Within all radial distances, the annual dose for any racial or ethnic minority individual does not exceed more than 1.2×10^{-4} millirem than that of the average nonminority individual. This difference is so small that it represents no appreciable change in the risk to the exposed individual of developing a latent fatal cancer.
- The annual dose to the average low-income individual does not exceed the annual dose for the non-low-income individual at any radius.

Impacts on the Shoshone-Bannock Tribes on the Fort Hall Reservation, and their use on the INL Site of sacred and traditional-use areas, natural landscapes, water, and ecological resources that are of special significance to them are further evaluated in this EIS in Section 4.6.

Considering the above analysis and the very low levels of risk exposure by each minority or low-income population compared to non-minority or non-low-income populations, operations of the VTR at the INL Site would not result in disproportionately high and adverse impacts on minority or low-income populations near the INL Site. Environmental sampling would continue to occur at the INL Site to ensure operations, including from the VTR, do not impact offsite populations.

4.15.2 ORNL VTR Alternative

Similar to at the INL Site, environmental sampling is performed at several locations on the ORNL, at the ORNL boundary, and at various distances from the ORNL per DOE Orders. Potential pathways for contaminants to reach humans are sampled and monitored, and include air, water (surface water and groundwater), precipitation, agricultural products, and fish and wildlife as it relates to ingestion (ORO 2019). To address possible impacts from consumption, DOE routinely samples game species residing on ORNL as well as regional agriculture products. Game animals (i.e., white-tailed deer, turkey) and waterfowl (i.e., Canada geese) are collected and sampled. Data from monitoring programs are reported and published annually (ORO 2019).

4.15.2.1 Construction/Facility Modification

Impacts for construction/facility modification at ORNL would be similar to what is described in Section 4.15.1.1 for the INL Site, and no disproportionately high or adverse impacts on environmental justice populations are anticipated. Regarding human health, there would be no additional radiological risks to the public during construction. Regarding other health or environmental effects, construction would occur about 3 miles from the nearest identified environmental justice block group, which is at such distance that is not anticipated to result in significant adverse effects to these populations. Therefore, no disproportionately high and adverse effects on minority or low-income populations would be expected during construction of the VTR at ORNL.

4.15.2.2 Operations

As discussed in Sections 4.10, routine operations under the VTR alternative at ORNL would pose no significant health risks to the public. **Table 4–69** shows the annual impacts on the total and subset populations within 5, 10, 20, and 50 miles of the facilities at ORNL used under this alternative.

Table 4–69. Comparison of Annual Doses to Average Individuals of Minority and Low-Income Populations Near ORNL During VTR Operations in 2050 (millirem)

Population Group	*Within 5 Miles*	*Within 10 Miles*	*Within 20 Miles*	*Within 50 Miles*
Average Individual of the Total Population	0.0028	0.0012	6.2×10^{-4}	3.6×10^{-4}
Nonminority Individual	0.0028	0.0012	6.3×10^{-4}	3.7×10^{-4}
Average Individual of Total Minorities	0.0028	0.0013	6.0×10^{-4}	3.1×10^{-4}
White – Hispanic/Latino Individual	0.0022	0.0013	6.9×10^{-4}	4.2×10^{-4}
Black/African American Individual [a]	0.0036	0.0014	5.0×10^{-4}	3.3×10^{-4}
American Indian or Alaska Native Individual [b]	0.0052	0.0012	5.4×10^{-4}	2.7×10^{-4}
Other Minority Individual [a, b]	0.0027	0.0013	6.3×10^{-4}	2.8×10^{-4}
Non-low-income Individual	0.0027	0.0012	6.2×10^{-4}	3.6×10^{-4}
Low-income Individual	0.0033	0.0015	6.3×10^{-4}	3.4×10^{-4}

[a] Includes persons who also indicated Hispanic or Latino origin.
[b] Other Minority includes all combined individuals of Asian, Native Hawaiian and Other Pacific Islander, Some Other Race, or Two or More Races.
Note: Dose calculations are based on 2050 population projections.

Impacts are summarized as follows:

- Within the 5-mile radius, the annual dose to an average individual of the American Indian or Alaska Native population would be about 0.0024 millirem higher than that of the average nonminority individual. Annual doses for the average individual of the Black/African American population would be about 8.1×10^{-4} millirem higher than that of the average nonminority individual. These differences represent a negligible increased risk to the exposed individual of developing a latent fatal cancer (respectively, 1×10^{-9}, or 1 chance in 1 billion; and 5×10^{-10}, or 1 chance in 2 billion, annually).
- Within the 10-mile radius, the annual dose to an average individual of the Black/African American population would be about 1.6×10^{-4} millirem higher than that of the average nonminority individual. These differences represent a negligible increased risk to the exposed individual of developing a latent fatal cancer (9×10^{-11}, or 1 chance in 11.1 billion)
- In all other instances where average individual dose for any racial or ethnic group exceeds that of non-minorities, the exceedance would be no more than 8.2×10^{-5} millirem, which does not represent an appreciable change in the risk to the exposed individual of developing a latent fatal cancer.
- For low-income populations, the annual doses to the average low-income individual is 6×10^{-4} millirem higher within 5 miles, and 2.6×10^{-4} millirem higher within 10 miles of the non-low-income average individual. These differences represent a negligible increased risk to the exposed individual of developing a latent fatal cancer (respectively, 4×10^{-10}, or 1 chance in 2.5 billion; and 2×10^{-10}, or 1 chance in 5 billion, annually). Within 20 miles, the annual dose to the average low-income individual is 2.1×10^{-6} millirem higher than the average non-low-income individual, which does not represent an appreciable change in the risk to the exposed individual of developing a latent fatal cancer. Within 50 miles, the annual dose to the average low-income individual does not exceed the annual dose for the non-low-income individual.

Considering the above analysis and the very low levels of risk exposure by each minority or low-income population compared to non-minority or non-low-income populations, operations of the VTR at ORNL would not result in disproportionately high and adverse impacts on minority or low-income populations near ORNL. Environmental sampling would continue to occur at ORNL to ensure operations, including from the VTR, do not impact offsite populations.

4.15.3 Reactor Fuel Production Options

4.15.3.1 INL Reactor Fuel Production Options

4.15.3.1.1 INL Feedstock Preparation Option

Construction/Facility Modification

Impacts for construction/facility modification for a feedstock preparation facility at the INL Site would be similar to those described in Section 4.15.1.1 for VTR construction at the INL Site. No disproportionately high or adverse impacts on environmental justice populations are anticipated. Regarding human health, there would be no additional radiological risks to the public during construction. Construction activities would occur within existing facilities directly adjacent to the proposed VTR construction site (i.e., about 2 miles from the nearest identified environmental justice block group), and no new land disturbance would occur that would result in substantial health or environmental effects. Therefore, no disproportionately high and adverse effects on minority populations, low-income, or Native American populations would be expected during construction for the feedstock preparation at the INL Site.

Operations

As discussed in Section 4.10, routine operations of feedstock preparation at the INL Site would pose no significant health risks to the public. **Table 4–70** shows the annual impacts on the total and subset populations within 5, 10, 20, and 50 miles of the facilities at the INL Site utilized under this alternative.

Table 4–70. Comparison of Annual Doses to Average Individuals of Minority and Low-Income Populations Near the INL Site During Feedstock Preparation in 2050 (millirem)

Population Group	*Within 5 Miles*	*Within 10 Miles*	*Within 20 Miles*	*Within 50 Miles*
Average Individual of the Total Population	5.6×10^{-4}	2.4×10^{-4}	1.4×10^{-4}	3.2×10^{-5}
Nonminority Individual	5.6×10^{-4}	2.5×10^{-4}	1.4×10^{-4}	3.1×10^{-5}
Average Individual of Total Minorities	5.9×10^{-4}	2.0×10^{-4}	1.2×10^{-4}	3.5×10^{-5}
White - Hispanic/Latino Individual	5.9×10^{-4}	2.7×10^{-4}	1.5×10^{-4}	3.7×10^{-5}
Black/African American Individual [a]	ND	ND	1.1×10^{-4}	3.4×10^{-5}
American Indian or Alaska Native Individual [b]	ND	ND	1.5×10^{-4}	4.3×10^{-5}
Other Minority Individual [a, b]	ND	1.7×10^{-4}	1.1×10^{-4}	3.3×10^{-5}
Non-low-income Individual	5.6×10^{-4}	2.5×10^{-4}	1.4×10^{-4}	3.3×10^{-5}
Low-income Individual	ND	1.6×10^{-4}	1.1×10^{-4}	2.9×10^{-5}

ND = No dose; there are no recorded individuals of this population group within this radial distance.
[a] Includes persons who also indicated Hispanic or Latino origin.
[b] Other Minority includes all combined individuals of Asian, Native Hawaiian and Other Pacific Islander, Some Other Race, or Two or More Races.
Note: Dose calculations are based on 2050 population projections.

Impacts are summarized as follows:

- In all instances where average individual dose for any racial or ethnic group exceeds that of non-minorities, the exceedance would be no more than 3.2×10^{-5} millirem, which does not represent an appreciable change in the risk to the exposed individual of developing a latent fatal cancer.
- The annual dose to the average low-income individual does not exceed the annual dose for the non-low-income individual at any radial distance.

Considering the above analysis and the very low levels of risk exposure by each minority or low-income population compared to non-minority or non-low-income populations, operations of a feedstock preparation scenario at the INL Site would not result in disproportionately high and adverse impacts on minority or low-income populations near the INL Site. Environmental sampling would continue to occur at the INL Site to ensure operations, including from feedstock preparation, do not impact offsite populations.

4.15.3.1.2 INL Fuel Fabrication Option

Construction/Facility Modification

Impacts for construction/facility modification for a fuel fabrication at the INL Site would be the same as described for the feedstock preparation facility. There would be no differences in human health impacts, and facility modification would occur within the same footprint as for the feedstock preparation. Therefore, no disproportionately high and adverse effects on minority, low-income, or Native American populations would be expected during construction.

Operations

Fuel fabrication operations at the INL Site would present a comparable but slightly higher increase in risk to what is described for operations of feedstock preparation. **Table 4–71** shows the annual impacts on the total and subset populations within 5, 10, 20, and 50 miles of the facilities at the INL Site utilized under this alternative.

Table 4–71. Comparison of Annual Doses to Average Individuals of Minority and Low-Income Populations Near the INL Site During Fuel Fabrication in 2050 (millirem)

Population Group	*Within 5 Miles*	*Within 10 Miles*	*Within 20 Miles*	*Within 50 Miles*
Average Individual of the Total Population	6.4×10^{-4}	2.0×10^{-4}	8.5×10^{-5}	1.5×10^{-5}
Nonminority Individual	6.4×10^{-4}	2.2×10^{-4}	9.0×10^{-5}	1.4×10^{-5}
Average Individual of Total Minorities	6.8×10^{-4}	1.6×10^{-4}	7.6×10^{-5}	1.6×10^{-5}
White – Hispanic/Latino Individual	6.8×10^{-4}	2.3×10^{-4}	9.5×10^{-5}	1.7×10^{-5}
Black/African American Individual [a]	ND	ND	6.7×10^{-5}	1.5×10^{-5}
American Indian or Alaska Native Individual [b]	ND	ND	8.6×10^{-5}	1.9×10^{-5}
Other Minority Individual [a, b]	ND	1.3×10^{-4}	6.6×10^{-5}	1.5×10^{-5}
Non-low-income Individual	6.4×10^{-4}	2.1×10^{-4}	8.7×10^{-5}	1.5×10^{-5}
Low-income Individual	ND	1.2×10^{-4}	6.6×10^{-5}	1.3×10^{-5}

ND = No dose; there are no recorded individuals of this population group within this radial distance.
[a] Includes persons who also indicated Hispanic or Latino origin.
[b] Other Minority includes all combined individuals of Asian, Native Hawaiian and Other Pacific Islander, Some Other Race, or Two or More Races.
Note: Dose calculations are based on 2050 population projections.

Impacts are summarized as follows:

- In all instances where average individual dose for any racial or ethnic group exceeds that of non-minorities, the exceedance would be no more than 4.5×10^{-5} millirem, which does not represent an appreciable change in the risk to the exposed individual of developing a latent fatal cancer.
- The annual dose to the average low-income individual does not exceed the annual dose for the non-low-income individual at any radial distance.

Considering the above analysis and the very low levels of risk exposure by each minority or low-income population compared to non-minority or non-low-income populations, operations of a fuel fabrication option at the INL Site would not result in disproportionately high and adverse impacts on minority or low-income populations near the INL Site. Environmental sampling would continue to occur at the INL Site to ensure operations, including from fuel fabrication, do not impact offsite populations.

4.15.3.2 SRS Reactor Fuel Production Options

Similar to at the INL Site, environmental sampling is performed at several locations on the SRS, at the SRS boundary, and at various distances from the SRS per DOE Orders. Potential pathways for contaminants to reach humans are sampled and monitored, and include air, surface water, drinking water, precipitation, vegetation, soil and stream sediment, agricultural products, and fish and wildlife as it relates to ingestion (SRNS 2019a). To address possible impacts from consumption, DOE routinely samples game species residing on ORNL as well as regional agriculture products. Game animals (i.e., white-tailed deer, turkey) and waterfowl (i.e., Canada geese) are collected and are sampled. Data from monitoring programs are reported and published annually (SRNS 2019a).

4.15.3.2.1 SRS Feedstock Preparation Option

Construction/Facility Modification

No disproportionately high or adverse impacts on environmental justice populations are anticipated during construction for feedstock preparation at SRS. Impacts would be similar to those described for construction required for feedstock preparation at the INL Site (i.e., similar socioeconomic and human health impacts). Construction would occur about 5 miles from the nearest identified environmental justice block group, which is at such distance that is not anticipated to result in significant adverse effects to these populations. Therefore, no disproportionately high and adverse effects on minority, low-income, or Native American populations would be expected during construction.

Operations

As discussed in Section 4.10, routine operations of a feedstock preparation facility at SRS would pose no significant health risks to the public. **Table 4–72** shows the annual impacts on the total and subset populations within 10, 20, and 50 miles of the facilities at SRS used under this option.

Table 4–72. Comparison of Annual Doses to Average Individuals of Minority and Low-Income Populations Near SRS During Feedstock Preparation in 2050 (millirem)

Population Group	*Within 10 Miles*	*Within 20 Miles*	*Within 50 Miles*
Average Individual of the Total Population	4.3×10^{-4}	1.2×10^{-4}	4.7×10^{-5}
Nonminority Individual	4.3×10^{-4}	1.1×10^{-4}	4.4×10^{-5}
Average Individual of Total Minorities	4.3×10^{-4}	1.3×10^{-4}	5.0×10^{-5}
White – Hispanic/Latino Individual	4.4×10^{-4}	9.8×10^{-5}	4.3×10^{-5}
Black/African American Individual [a]	4.4×10^{-4}	1.3×10^{-4}	5.2×10^{-5}
American Indian or Alaska Native Individual [b]	3.5×10^{-4}	1.3×10^{-4}	5.0×10^{-5}
Other Minority Individual [a, b]	3.4×10^{-4}	1.0×10^{-4}	4.1×10^{-5}
Non-low-income Individual	4.3×10^{-4}	1.1×10^{-4}	4.6×10^{-5}
Low-income Individual	4.5×10^{-4}	1.4×10^{-4}	5.1×10^{-5}

[a] Includes persons who also indicated Hispanic or Latino origin.
[b] Other Minority includes all combined individuals of Asian, Native Hawaiian and Other Pacific Islander, Some Other Race, or Two or More Races.
Note: Dose calculations are based on 2050 population projections.

Within all radial distances, the annual dose for any racial or ethnic minority individual does not exceed more than 2.5×10^{-5} millirem than that of the average nonminority individual. This difference is so small that it represents no appreciable change in the risk to the exposed individual of developing a latent fatal cancer. The annual dose for any low-income individual is comparably small and the difference between low-income and non-low-income individual does not represent an appreciable change in the risk to the exposed individual of developing a latent fatal cancer.

Considering the above analysis and the very low levels of risk exposure by each minority or low-income population compared to non-minority or non-low-income populations, operations of a feedstock preparation option at SRS would not result in disproportionately high and adverse impacts on minority or low-income populations near SRS. Environmental sampling would continue to be conducted at SRS to ensure operations, including from feedstock preparation, do not impact offsite populations.

4.15.3.2.2 SRS Fuel Fabrication Option

Construction/Facility Modification

Impacts for construction/facility modification for a fuel fabrication facility at SRS would be similar to as described for the feedstock preparation facility. There would be no differences in human health impacts, and facility modification would occur within the same footprint as for the feedstock preparation facility. Therefore, no disproportionately high and adverse effects on minority or low-income populations would be expected during construction.

Operations

Operations of a fuel fabrication facility at SRS would present a smaller increase in risk than as described for operations of a feedstock preparation facility. Therefore, no disproportionately high and adverse effects on minority or low-income populations would be expected during operations.

4.15.4 Combined INL VTR Alternative and INL Reactor Fuel Production Options Impacts

As discussed in Section 4.10, routine operations under operations of the Combined INL VTR Alternative and INL Reactor Fuel Production Options would pose no significant health risks to the public. **Table 4–73** shows the annual impacts on the total and subset populations within 5, 10, 20, and 50 miles of the facilities at the INL Site utilized under this alternative.

Table 4–73. Comparison of Annual Doses to Average Individuals of Minority and Low-Income Populations Near the INL Site During Combined INL VTR Alternative and INL Reactor Fuel Production in 2050 (millirem)

Population Group	*Within 5 Miles*	*Within 10 Miles*	*Within 20 Miles*	*Within 50 Miles*
Average Individual of the Total Population	0.0031	0.0012	6.7×10^{-4}	1.7×10^{-4}
Nonminority Individual	0.0031	0.0013	7.2×10^{-4}	1.7×10^{-4}
Average Individual of Total Minorities	0.0028	8.7×10^{-4}	5.3×10^{-4}	1.6×10^{-4}
White – Hispanic/Latino Individual	0.0033	0.0014	7.7×10^{-4}	1.9×10^{-4}
Black/African American Individual [a]	ND	ND	5.5×10^{-4}	1.7×10^{-4}
American Indian or Alaska Native Individual [b]	ND	ND	7.6×10^{-4}	2.3×10^{-4}
Other Minority Individual [a, b]	ND	8.5×10^{-4}	5.3×10^{-4}	1.7×10^{-4}
Non-low-income Individual	0.0031	0.0013	6.8×10^{-4}	1.7×10^{-4}
Low-income Individual	ND	8.0×10^{-4}	5.3×10^{-4}	1.6×10^{-4}

ND = No dose; there are no recorded individuals of this population group within this radial distance.

[a] Includes persons who also indicated Hispanic or Latino origin.

[b] Other Minority includes all combined individuals of Asian, Native Hawaiian and Other Pacific Islander, Some Other Race, or Two or More Races.

Note: Dose calculations are based on 2050 population projections.

Impacts are summarized as follows:

- Within the 5-mile radius, the annual dose to an average individual of the White – Hispanic/Latino population would be about 1.7×10^{-4} millirem higher than that of the average nonminority individual. This difference represents a negligible increased risk to the exposed individual of developing a latent fatal cancer (1×10^{-10}, or about 1 chance in 10 billion, annually).
- In all other instances where the average individual dose for any racial or ethnic group exceeds that of non-minorities, the exceedance is no more than 7.3×10^{-5} millirem, which does not represent an appreciable change in the risk to the exposed individual of developing a latent fatal cancer.
- The annual dose to the average low-income individual does not exceed the annual dose for the non-low-income individual for any radius.

Considering the above analysis and the very low levels of risk exposure by each minority or low-income population compared to non-minority or non-low-income populations, operations of the combined INL VTR, feedstock preparation, and fuel fabrication alternative at the INL Site would not result in disproportionately high and adverse impacts on minority or low-income populations near the INL Site. Environmental sampling would continue to be conducted at the INL Site to ensure operations, including from this alternative, do not impact offsite populations.

4.16 No Action Alternative

As described in Chapter 2, Section 2.3, under the No Action Alternative, DOE would not construct and operate a VTR and associated facilities. DOE would continue to make use of the limited capabilities and availabilities of existing facilities, both domestic and foreign for testing in the fast-neutron-flux spectrum. Domestic reactor facilities that could be used include the ORNL HFIR, the INL ATR, and their associated post-irradiation examination and SNF management facilities. The HFIR and ATR reactors and fuel fabrication facilities would continue to be used as they currently exist consistent with their current programs. DOE would not construct new facilities or modify any existing reactors, post-irradiation examination, SNF management, or reactor fuel production facilities. Conditions at INL, ORNL, and SRS would remain as described in Chapter 3 for each of the 15 resource areas.

4.17 Deactivation, Decommissioning, and Demolition

Following the completion of operations and shutdown of the VTR and associated facilities, the first disposition activity is to deactivate the facilities. The purpose of deactivation is to place potentially contaminated nuclear, radiological, and radioactive facilities in safe shutdown conditions. Safe shutdown minimizes risks by protecting workers, the public, and the environment. Safe shutdown is economical to monitor and is maintained for the period of time until the facilities are decommissioned and demolished. Decommissioning includes decontamination and dismantling facilities to the ultimate end state of demolition. During decommissioning, hazardous and radioactive materials and contamination are removed or fixed in place to ensure protection of workers, public health and safety, and the environment. Demolition is construction in reverse and includes the recycling of demolition materials to the extent practical and the disposal of non-recyclable materials. The specifics of deactivation, decommissioning, and demolition of the VTR and associated facilities are decades in the future. Therefore, this discussion reflects the general process and not the specifics which are not ripe for evaluation at this time given the length of proposed operations and the potential for changes in future DOE Program needs.

4.18 Mitigation Measures

No potential adverse impacts were identified that would require additional mitigation measures beyond those required by regulation or achieved through design features or BMPs. However, the Action Alternatives and Options have the potential to affect one or more resource areas. If during implementation, mitigation measures above and beyond those required by regulations would be identified to reduce impacts, they will be developed, documented, and executed.

Chapter 5
Cumulative Impacts

5.0 CUMULATIVE IMPACTS

The National Environmental Policy Act (NEPA) established the Council on Environmental Quality (CEQ) to oversee Federal environmental impact regulations. CEQ defines cumulative impacts as "the impact on the environment which results from the incremental impact when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions" (40 CFR 1508.7). Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time. Cumulative impacts can also result from spatial (geographic) or temporal (time) crowding of environmental perturbations (i.e., concurrent human activities and the resulting impacts on the environment are additive if there is insufficient time for the environment to recover) (Spaling 1994). The region of influence (ROI) is the geographic area over which past, present, and reasonably foreseeable future actions (activities) could contribute to cumulative impacts, and is dependent on the type of resource analyzed.

This chapter's analysis of cumulative impacts does not include an evaluation of activities at facilities preparing experiments for the Versatile Test Reactor (VTR). As described in Chapter 2, Section 2.2.3, preparation of the test packages would be performed in existing facilities across the United States, and potentially internationally, in accordance with applicable regulations and permits. Although not all types of experiments that would be performed in the VTR can be foreseen at this time, preparation of an experimental test package would likely be a small-scale activity that would not consume large quantities of resources or result in extensive emissions. Therefore, these experiments would not substantially contribute to cumulative impacts.

In addition, the cumulative impacts of offsite waste management and disposal are not included in this *Versatile Test Reactor Environmental Impact Statement* (VTR EIS). As described in Chapter 4, Section 4.9, the management of wastes at offsite facilities would not exceed the facilities' capacities. The impacts of these activities were already evaluated in the licensing or permitting processes for these facilities and would not result in an additional cumulative impact. Furthermore, there are a number of options available for the disposal of U.S. Department of Energy (DOE) generated low-level radioactive waste (LLW) and mixed low-level radioactive waste (MLLW). DOE's Idaho National Laboratory (INL), Oak Ridge Reservation (ORR), and Savannah River Site (SRS) allow for disposal of onsite generated LLW. Two other DOE sites, the Hanford Site and the Nevada National Security Site (NNSS), allow for disposal of both onsite and offsite generated LLW and MLLW, as long as the waste meets each sites' waste acceptance criteria. In addition, there are two commercial facilities that can accept government-owned LLW: Energy*Solutions* LLW Disposal Facility near Clive, Utah; and Waste Control Specialists (WCS) near Andrews, Texas. Therefore, there are a number of available waste disposal options to address the relatively small volumes of LLW and MLLW generated by the proposed VTR activities.

The cumulative impacts methodology and assumptions are briefly described in Section 5.1. Reasonably foreseeable actions are listed in Section 5.2. Cumulative impacts are evaluated for activities at INL in Section 5.3, for the Oak Ridge National Laboratory (ORNL) in Section 5.4, and for SRS in Section 5.5. Cumulative impacts on transportation are analyzed in Section 5.6, and cumulative impacts on the global commons are analyzed in Section 5.7.

5.1 Methodology and Assumptions

In general, the following approach was used to estimate cumulative impacts for this VTR EIS:

- The ROIs were described for each resource area where impacts from the alternatives and options analyzed in this VTR EIS may occur. (See Chapter 3.)

- The affected environment and baseline conditions were identified, including the effects of past actions. (See Chapter 3.)
- Past, present, and reasonably foreseeable future actions were identified. (See Section 5.2.)
- The impacts of the activities described in Chapter 4 were assessed in combination with the aggregate (additive) effects of past, present, and reasonably foreseeable actions. (See Sections 5.3 through 5.7.)

Cumulative impacts were evaluated by combining the effects of activities at the INL Site, ORNL, and SRS for each of the alternatives assessed in this VTR EIS with the effects of other past, present, and reasonably foreseeable future actions in the ROI. Many of these actions occur at different times and locations and may not be truly additive. For example, actions affecting human health may occur at different times and locations across the ROI. Therefore, the maximum impacts described in the NEPA documents for the activities are unlikely to be truly additive. However, the effects were combined regardless of the time and location of the impact, to encompass any uncertainties in the projected activities and their effects. This approach produces a conservative estimate of cumulative impacts for the activities analyzed.

5.2 Reasonably Foreseeable Actions

In addition to actions related to the alternatives evaluated in this VTR EIS, other actions may contribute to cumulative impacts at the INL Site, ORNL, and SRS. These actions include onsite and offsite projects conducted by Federal, State, and local governments, the private sector, or individuals who are within the ROIs of the actions examined in this VTR EIS. Information about present and future actions was obtained from a review of site-specific plans and NEPA documents to determine if ongoing or reasonably foreseeable future projects could contribute to environmental impacts at the potentially affected sites. Reasonably foreseeable future actions, as defined in 43 CFR Part 46, are "federal and non-federal activities not yet undertaken, but sufficiently likely to occur, that a responsible official of ordinary prudence would take such activities into account in reaching a decision."[1] Ongoing and reasonably foreseeable projects at the INL Site, ORR, and SRS are listed in **Table 5–1**.

Two applications to the U.S. Nuclear Regulatory Commission (NRC) for Consolidated Interim Storage Facilities (CISF) have been submitted. On November 14, 2016, the NRC published the Notice of Intent (NOI) to prepare an EIS for the construction and operation of a CISF at Waste Control Specialists LLC (WCS) in Andrews County, Texas (81 FR 79531). In May 2020, NRC issued the *Environmental Impact Statement for Interim Storage Partners LLC's License Application for a Consolidated Interim Storage Facility for Spent Nuclear Fuel in Andrews County, Texas* (NRC 2020b) for public comment. On March 30, 2018, the NRC published the NOI to prepare an EIS for the construction and operation of Holtec International Inc's (Holtec's) proposed CISF in Lea County, New Mexico (83 FR 13802). In March 2020, NRC issued the *Environmental Impact Statement for the Holtec International's License Application for a Consolidated Interim Storage Facility for Spent Nuclear Fuel and High Level Waste* (NRC 2020a) for public comment. If constructed and operated, CISFs would store spent fuel from commercial nuclear reactors and would contribute to cumulative transportation impacts. Therefore, DOE has evaluated the environmental impacts of these activities in the cumulative transportation impact analysis for this VTR EIS.

[1] In this VTR EIS, reasonably foreseeable actions are generally understood to be those that have been identified in a NEPA document or are from another environmental impact analysis that is available and for which the effects can be meaningfully evaluated. These include actions unrelated to DOE.

Table 5–1. Other Actions Considered in the Cumulative Impacts Analyses [a]

Name	***Description***	***Location(s) [b]***	***Status***	***Source Document(s)***
Multiple DOE Sites				
Plutonium-238 Production for Radioisotope Power Systems (DOE/EIS-0310 and DOE/EIS-0310-SA-02)	This project evaluated alternatives for enhancement of DOE's nuclear infrastructure. In the ROD published on January 26, 2001 (66 FR 7877), among other things, DOE decided to reestablish domestic production of Pu-238 to support U.S. space exploration. For this purpose, ATR at the INL Site and HFIR at ORNL will be used to irradiate neptunium-237 targets. REDC at ORNL will be used for fabricating targets and isolating Pu-238 from the irradiated targets. In the Amended ROD issued on August 13, 2004 (69 FR 50180), DOE decided to transport neptunium-237, after conversion to neptunium oxide, from SRS to REDC at ORNL for use in production of Pu-238 in the future. The *Supplemental Analysis for the Nuclear Infrastructure Programmatic Environmental Impact Statement for Plutonium-238 Production for Radioisotope Power Systems* (DOE 2013a), determined that there are no significant new circumstances or information relevant to environmental concerns that warrant preparation of a Supplemental EIS or a new EIS. The 2001 decision referenced above (66 FR 7877) can be implemented without further NEPA review.	INL and ORNL	Ongoing	DOE 2000b 66 FR 7877 69 FR 50180 DOE 2013a
National Nuclear Security Administration Complex Transformation (DOE/EIS-0236-S4)	This action would transform the DOE nuclear weapons complex by reducing its size, increasing efficiency and security, and improving the ability to respond to changes in national security requirements. In the ROD, NNSA decided to consolidate tritium research and development at SRS (73 FR 77656) and keep uranium manufacturing and research and development at Y-12 on ORR, including construction and operation of a Uranium Processing Facility (73 FR 77644).	ORR, SRS, and other sites	Ongoing	DOE 2008a 73 FR 77644 73 FR 77656
Disposal of Greater-Than-Class C (GTCC) LLW and GTCC-Like Waste (DOE/EIS-0375 and DOE/EA-2082)	This project would construct and operate a new facility or facilities or use an existing facility or facilities for the disposal of GTCC LLW and GTCC-like waste. DOE has not issued a ROD for this action.	INL, SRS, and other sites	Proposed	DOE 2016a DOE 2018d
Construction and Demonstration of a Prototype Advanced Mobile Nuclear Reactor	This Department of Defense project would construct and demonstrate a prototype microreactor capable of producing 1 to 10 megawatts of electrical power. The INL Site and ORR are the two alternative locations being evaluated. The NOI was published in the *Federal Register* on March 2, 2020 (85 FR 12274).	INL and ORR	Proposed	85 FR 12274
Idaho National Laboratory				
Treatment and Management of Sodium-Bonded Spent Nuclear Fuel (DOE/EIS-0306)	This action treats and manages sodium-bonded SNF in facilities located at MFC at the INL Site. DOE identified electrometallurgical treatment as its preferred method for the treatment and management of all sodium-bonded SNF.	MFC	Ongoing	DOE 2000a 65 FR 56565
Sample Preparation Laboratory	The Proposed Action includes constructing a 44,000-square-foot 3-story building. This project includes a shielded cell(s) to support sample preparation of non-alpha bearing materials with the ability to receive small- and medium-sized casks, and to sort, size, polish, mount, and conduct initial analysis of materials specimens. A categorical exclusion for this action was issued on September 4, 2019 (DOE 2019b).	MFC	Ongoing	DOE 2019b

Name	Description	Location(s) [b]	Status	Source Document(s)
The Resumption of Transient Testing of Nuclear Fuels and Materials (DOE/EA-1954)	This project provides for the resumption of transient testing of nuclear fuels and materials. As a result, restart activities were conducted at TREAT at the INL Site, including refurbishment or replacement of systems and equipment. A FONSI was issued on February 26, 2014 (DOE 2014b). Restarted in 2017, TREAT is now operational.	MFC	Ongoing	DOE 2014b
Use of DOE-Owned High-Assay Low-Enriched Uranium (DOE/EA-2087)	DOE proposes to produce about 10 metric tons of HALEU through the electrometallurgical treatment process. This HALEU and other small quantities of HALEU stored at the INL Site will be available for research and development in support of the commercial nuclear industry and government agencies, including use in advanced reactors. HALEU is uranium that is enriched in the uranium-235 isotope to a value that is 5 to 20 percent of the total uranium. The production requires expansion of the fuel fabrication capability, including the purchase of new equipment and use of facilities at MFC and possibly also at INTEC. A FONSI was issued on January 10, 2019.	MFC and INTEC	Proposed	DOE 2019b
Multipurpose Haul Road (DOE/EA-1772)	This project was to construct and operate an alternative route between MFC and other INL Site facilities, other than the public highway, to transport several thousand shipments of materials and wastes expected over the next 10 years. The action was needed to reduce shipment costs, improve operational efficiency, improve highway safety, and reduce impacts on the public by minimizing road closures. A FONSI was issued on August 4, 2010 (DOE 2010d). The upgrades have been completed, and the roadway is operating.	INL	Completed	DOE 2010c DOE 2010d
Expanding Capabilities at the Power Grid Test Bed (DOE/EA-2097)	This action would include (1) installing a new 138-kilovolt overhead power line from INL's Central Facilities Area through the Critical Infrastructure Test Range Complex to MFC, (2) increasing the size of the fenced area at the Scoville substation, (3) enlarging old and establishing new test pads for expanded testing, and (4) expanding authorized uses of the Haul Road. A FONSI was issued on July 30, 2019.	INL	Ongoing	DOE 2019c
Expanding Capabilities at the National Security Test Range and Radiological Response Training Range (DOE/EA-2063)	The Proposed Action would expand the capabilities at NSTR and RRTR. Both ranges support the training of first responders from defense and homeland security organizations who are charged with safeguarding the public and protecting U.S. national security. DOE proposes to allow for the use of unmanned aerial systems, additional explosive materials, and additional radioisotopes for testing and training purposes. DOE proposes installation of permanent structures and utilities, an increase in the frequency of range activities, and an increase in testing capabilities. DOE proposes to equip NSTR with permanent infrastructure, which may include offices, classrooms, conference rooms, restrooms and kitchen facilities. Fixed utility infrastructure providing electricity, roadways, testing pads, and fencing are also proposed. A FONSI was issued on December 10, 2019.	NSTR and RRTR	Proposed	DOE 2019h

Name	Description	Location(s) [b]	Status	Source Document(s)
Recapitalization of Infrastructure Supporting Naval SNF Handling (DOE/EIS-0453-F)	Consistent with the ROD for the *Department of Energy Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE/EIS-0203-F), naval SNF is shipped by rail from shipyards and prototypes to the Expended Core Facility at the INL Site for processing. Significant upgrades are necessary to the Expended Core Facility infrastructure to allow NNPP to continue to safely unload, transfer, prepare, and package naval SNF for disposal. In the ROD (81 FR 87912), DOE decided to recapitalize the infrastructure supporting naval SNF handling at the INL Site by constructing a new facility in the northeast section of NRF.	NRF	Ongoing	DOE 2016b 81 FR 87912
Recapitalization of Naval Nuclear Propulsion Program Examination Capabilities	This project would upgrade or build new examination facilities to give NNPP the ongoing capability to examine naval SNF, components, and irradiated test specimens. This action will be evaluated in a separate NEPA document.	NRF or ATR	Planned	DOE 2016b
DOE Idaho Spent Fuel Facility/ Independent SNF Storage Installation (NUREG-1773)	Under this action, the DOE Idaho Spent Fuel Facility would receive SNF from INTEC and the Fort Saint Vrain storage facility for conditioning (e.g., drying) and packaging in canisters for offsite shipment. The SNF would be packaged to meet interim storage, transportation, and Yucca Mountain disposal criteria. Yucca Mountain disposal criteria are a bounding assumption for packaging. Limited storage to accommodate offsite transfers is included in the project.	INTEC	Ongoing	NRC 2004
Idaho HLW and Facilities Disposition (DOE/EIS-0287 and DOE/EIS-0287-SA-01)	This action is for the management and disposition of sodium-bearing waste, HLW calcine, and HLW facilities at INTEC. In the first ROD (70 FR 75165), DOE decided to treat sodium-bearing waste using a steam-reforming technology. DOE's preferred disposal for this waste is as TRU waste at the WIPP facility. For facilities disposition, DOE decided to conduct performance-based closure (depending on risk) of existing facilities directly related to the HLW program once their missions are complete. DOE's strategy for HLW calcine is to retrieve the calcine for disposal outside of Idaho. In the second ROD (71 FR 68811), DOE decided to conduct performance-based closure of the INTEC Tank Farm Facility. In the third ROD (75 FR 137), DOE decided to select hot isostatic pressing as the technology to treat calcine to create a volume-reduced monolithic waste form that is suitable for transport outside Idaho.	INTEC	Ongoing	DOE 2002a DOE 2005d 70 FR 75165 71 FR 68811 75 FR 137
New Remote-Handled LLW Disposal Facility (DOE/EA-1793)	This action would replace the existing RWMC disposal capability with a new capability for disposal of remote-handled LLW generated at the INL Site that would last up to 50 years. DOE expects to generate an estimated average of 150 cubic meters of remote-handled LLW each year at the INL Site. A FONSI was issued on December 21, 2011 (DOE 2011f).	Southwest of ATR	Ongoing	DOE 2011a DOE 2011f
Utah Associated Municipal Power Systems Small Modular Reactors	This project would construct and operate up to 12 small modular reactors, rated at 50 to 60 megawatts each, at the INL Site. In 2016, DOE issued a site use permit granting access to the INL Site for the purposes of identifying potential locations for the reactors. Currently, the project is focusing on an area near Highway 33 and Road T-11 within the Sage Grouse Conservation Area. The project may disturb up to 2,000 acres if constructed. UAMPS plans to commence site preparation in 2021, with nuclear construction commencing in 2023, and commercial operations in 2026 and 2027.	INL	Proposed	DOE-ID 2016 DOE-ID 2019a NuScale 2019 UAMPS 2019

Name	Description	Location(s) [b]	Status	Source Document(s)
Oklo Power LLC, AURORA Micro-reactor at the INL Site	Oklo Power LLC (Oklo) is proposing to build the Aurora, a 4-megawatt thermal advanced fission micro-reactor, near MFC at the INL Site. There are currently five sites that are under consideration for the exact location of the Aurora. All candidate sites are greenfield sites outside of any security fence. On March 11, 2020, Oklo submitted a combined license application to the NRC. The NRC accepted the application allowing Oklo to move forward with plans for the reactor at the INL Site.	MFC	Proposed	NRC 2020c Oklo Power 2020
Idaho National Laboratory – Offsite Actions				
NA	None identified within the Region of Influence.	NA	NA	NA
Oak Ridge Reservation				
ORNL Modernization Initiative (DOE/EA-1618)	This initiative would result in infrastructure replacement and upgrades at ORNL. The action would enhance the health and safety of workers, reduce operating costs, and accommodate projected program growth. It would allow relocation of staff and certain support services (e.g., emergency response and maintenance) out of the central campus and from other facilities that are in less than "mission ready" condition. A FONSI was issued on July 28, 2008.	ORNL	Ongoing	DOE 2008b
Oak Ridge Science and Technology Project at ORNL (DOE/EA-1575)	The Proposed Action would advance technology transfer and other missions of the DOE Office of Science at ORNL through the establishment of the ORSTP. The ORSTP would support technology commercialization, facilitate the creation of new companies, and stimulate technology-based recruitment as a part of its core purpose. To establish the ORSTP, DOE would lease underused facilities and land parcels at the ORNL Central Campus area. A FONSI was issued on February 20, 2008 (DOE 2008e).	ORNL	Ongoing	DOE 2008c DOE 2008e
U-233 Material Downblending and Disposition Project (DOE/EA-1651)	The Proposed Action would modify selected ORNL facilities, process the ORNL inventory of uranium-233, and transport the processed material to a long-term disposal facility. A FONSI was issued on January 13, 2010 (DOE 2010e).	ORNL	Ongoing	DOE 2010e
Oak Ridge Integrated Facility Disposition Project	Activities under the IFDP would dispose of legacy materials and facilities at ORNL and Y-12 using an integrated approach that reduces risk. The activities would eliminate $70 million to $90 million per year in operating costs. Under the IFDP, the decontamination and decommissioning of about 188 facilities at ORNL, 112 facilities at Y-12, and remediation of soil and groundwater contamination would occur over the next 30 to 40 years. The IFDP will be conducted as a remedial action under CERCLA.	ORR	Ongoing	DOE 2011c
Environmental Management Disposal Facility	Because the existing onsite Environmental Management Waste Management Facility is above 70 percent capacity and will soon be full. A new disposal facility is needed in the mid-2020s to complete critical cleanup projects at Y-12 and ORNL. The onsite disposal alternative located at Central Bear Creek Valley is the preferred remedy for disposal of waste from DOE's ORR CERCLA cleanup program. The final capacity assumed to be needed for completion of ORR clean-up is estimated at 2.2 million cubic yards. Waste types will include soil, sediment, and sludge, along with demolition debris. The majority of the waste (more than two-thirds) is anticipated to be debris.	ORR	Proposed	DOE 2017c DOE 2018e OREM 2018

Name	Description	Location(s) [b]	Status	Source Document(s)
Ongoing and Future Operations at Y-12 (DOE/EIS-0387, and DOE/EIS-0387-SA-01)	The Proposed Action is for ongoing and future operations at Y-12, including changes to site infrastructure and levels of operation using production capacity as the key metric. In the ROD dated July 20, 2011 (76 FR 43319), NNSA decided to construct and operate a capability-sized Uranium Processing Facility at Y-12 as a replacement for certain enriched uranium processing facilities that were more than 50 years old. In DOE/EIS-0387-SA-01, NNSA evaluated meeting uranium processing requirements using a hybrid approach of upgrading existing facilities and building new Uranium Processing Facility facilities. In the Amended ROD dated July 12, 2016 (81 FR 45138), NNSA decided to implement a revised approach for meeting enriched uranium requirements, by upgrading existing enriched uranium processing buildings and constructing a new Uranium Processing Facility. Additionally, NNSA decided to separate the single-structure Uranium Processing Facility design concept into a new design consisting of multiple buildings, with each constructed to safety and security requirements appropriate to the building's function.	Y-12	Ongoing	DOE 2011c 76 FR 43319 DOE 2016e 81 FR 45138
Y-12 Emergency Operations Center Project (DOE/EA-2014)	This project would design and build a new emergency response facility that would support the Y-12 missions more effectively and efficiently by consolidating the Plant Shift Superintendent's Office, the Emergency Command Center, the Technical Support Center, and the Fire Department Alarm Room from their present locations to a single facility. A FONSI was issued on October 26, 2015 (DOE 2015d).	Y-12	Ongoing	DOE 2015b DOE 2015d
Property Transfer to Develop a General Aviation Airport at East Tennessee Technology Park (DOE/EA-2000)	This action would transfer 170 acres of DOE property located at ETTP to the Metropolitan Knoxville Airport Authority for the purpose of constructing and operating a general aviation airport. A FONSI was issued on February 24, 2016 (DOE 2016d).	ETTP	Proposed	DOE 2016d DOE 2016h
Stable Isotope Production and Research Center	The Proposed Action would construct a facility south of White Oak Avenue in the 6,000 area of the ORNL campus that expands the ability to perform multiple isotope production campaigns. The project includes: (1) site preparation activities that include clearing and grading the land, and installing site utilities; (2) constructing a 43,000-square-foot facility that will house the equipment to produce the stable isotopes required; and (3) fabricating, installing, and initial testing of electromagnetic isotope separators and gas centrifuge equipment. The facility will consist of a main production area for the equipment generating the stable isotopes but will also have support rooms (including a maintenance shop, spare parts storage, control rooms, breakroom, and bathroom) to support the operation. Preparation of an EA is planned.	ORNL	Proposed	DOE-ORNL 2020b
Transformational Challenge Reactor	The Proposed Action would involve assembly, operation, and decommissioning of a 3-megawatt, helium-cooled reactor. The Transformational Challenge Reactor (TCR) would operate for a short period (days vs. months). The proposed location of the TCR is at the Health Physics Research Reactor site. The fuel for the TCR would be high-assay low-enriched uranium (< 20 percent enriched in uranium-235). The reactor core would be assembled and disassembled on site. The facility would be a Hazard Category 2 nuclear facility during initial core assembly, operation of the reactor, and core disassembly and inspection. After disassembly, the core would be shipped to a vendor for recovery of the	ORNL	Proposed	DOE-ORNL 2020c

Name	***Description***	***Location(s)*** [b]	***Status***	***Source Document(s)***
	uranium. A small portion of the core may be relocated to an existing nuclear facility within ORNL for inspection and evaluation. An EA is being prepared for this action.			
Supplement Analysis for Construction of the Second Target Station at the Spallation Neutron Source	This action would construct and operate a Second Target Station for the Spallation Neutron Source. The Second Target Station project would fulfill the original master plan through the construction of 10 new structures. The Second Target Station was covered in the original Spallation Neutron Source EIS (DOE 1999a). The entire complex would include about 400,000 square feet of new construction. Preparation of an SA is planned.	ORNL	Proposed	DOE 1999a DOE-ORNL 2020a
Oak Ridge Reservation – Offsite Actions				
Clinch River Site for Small Modular Reactors	The Proposed Action would construct and operate small modular reactors at the Clinch River site. On December 17, 2019, TVA obtained approval for an early site permit from the NRC. The 20-year permit--referred to as an Early Site Permit--approves the 935-acre Clinch River site near Oak Ridge, Tennessee for a nuclear facility that can produce up to 800 megawatts total.	Oak Ridge, TN 4 miles west	Proposed	NRC 2019 TVA 2019
Energy*Solutions* – Bear Creek Processing Facility	This action is the continued operation of Energy*Solutions* – Bear Creek Processing Facility, including the processing and packaging of radioactive material for permanent disposal. The facility houses radioactive materials processing capabilities, including bulk waste assay, decontamination, recycle, compaction, incineration, metals melting, and a variety of specialty waste stream management options. The facility operates under regulatory authority of the Tennessee Department of Environmental Control, Division of Radiological Health, in agreement with NRC.	ORR 4.5 miles west	Ongoing	ES 2020
Manufacturing Sciences Corporation	This action is the continued operation of the Manufacturing Sciences Corporation facility, including uranium and specialty metals design, casting, rolling, fabrication, welding, and precision machining. Manufacturing Sciences Corporation operates the only depleted uranium rolling mill for commercial use in the United States. All of the work is performed under a Radioactive Material Operating License issued by the State of Tennessee, under NRC guidelines.	Oak Ridge, TN 5.5 miles northeast	Ongoing	MSC 2020
Centrus Energy Corporation	This action is the continued operation of Centrus' Oak Ridge facility, which is home to experts in gas centrifuge uranium enrichment technology, engineering, and advanced manufacturing. Centrus' Technology and Manufacturing Center facility has more than 440,000 square feet of space for advanced manufacturing, engineering, and testing work.	Oak Ridge, TN 6 miles northeast	Ongoing	Centrus 2020
TOXCO Inc. - Materials Management Center	This action is the continued operation of the TOXCO processing facility for materials and equipment previously used in a radioactive environment. TOXCO's processes minimize or eliminate high-cost disposal volumes, create opportunities for lower-cost, regulated, and licensed disposal, and greatly reduce radioactive waste disposal and decommissioning costs.	Oak Ridge, TN 6.5 miles northeast	Ongoing	TOXCO 2020
Bull Run Fossil Plant	Bull Run Fossil Plant is located on Bull Run Creek near Oak Ridge. The plant has a summer net capability of 865 megawatts and generates about 6 billion kilowatt-hours of electricity per year, which is enough to supply 400,000 homes. On February 14, 2019 following a review of public input and a detailed examination of fuel, transmission, economic and	Clifton, TN 8.5 miles northeast	Ongoing	TVA 2020a TVA 2020b

Name	***Description***	***Location(s)* [b]**	***Status***	***Source Document(s)***
	environmental impacts, TVA approved the retirement of the Bull Run Fossil Plant by December 2023.			
Kingston Fossil Plant	Kingston Fossil Plant is located on Watts Bar Reservoir on the Tennessee River near Kingston, Tennessee. Kingston's 9 units boast a summer net capability of 1,398 megawatts and can generate about 10 billion kilowatt-hours per year, which is enough electricity to power about 700,000 homes. To meet the demand, Kingston burns about 14,000 tons of low-sulfur blend coal per day, an amount that would fill 140 railroad cars. Emissions-reducing features include the installation of selective catalytic reduction systems, which reduced nitrogen oxide emissions by 90 percent, and 2 scrubbers, which reduced sulfur dioxide emissions by 95 percent. TVA has cleaned up a coal ash spill that occurred in December of 2008.	Kingston, TN 11.5 miles west	Ongoing	TVA 2020c TVA 2020d
Savannah River Site				
Surplus Plutonium Disposition Program – Disposition 34 metric tons of surplus plutonium (DOE/EIS-0283 and DOE/EIS-0283-S2)	The Surplus Plutonium Disposition EIS (DOE 1999b) examined options for pit[c] disassembly and conversion of the plutonium to an oxide form, and options for disposition of the surplus plutonium. In 2015, DOE completed the Surplus Plutonium Disposition Supplemental EIS (DOE 2015a), which refreshed the analyses in the 1999 EIS and evaluated four options for pit disassembly and conversion using facilities at F, H, and K Areas at SRS and at TA-55 at Los Alamos National Laboratory (LANL) in New Mexico. After partial construction of the MFFF at SRS, DOE cancelled the project. On August 28, 2020, in an amended ROD for the Surplus Plutonium Disposition EIS (85 FR 53350), DOE decided to process 7.1 metric tons of non-pit plutonium for disposal as TRU waste at the WIPP facility. DOE now has an approved disposition path for 7.1 metric tons of the non-pit plutonium and is proceeding with establishing a new program of record for the remaining plutonium. DOE has not made a decision about pit disassembly and conversion.	F Area, H Area, and K Area	Proposed	DOE 1999b 65 FR 1608 67 FR 19432 68 FR 20134 DOE 2015a DOE 2020d 85 FR 53350
Surplus Plutonium Disposition Program - Process 13.1 metric tons of surplus non-pit plutonium in K Area for disposal at the WIPP facility (DOE/EIS-0283-S2)	This action would modify existing facilities and process up to 13.1 metric tons of surplus plutonium for disposal as TRU waste at the WIPP facility. On April 5, 2016, in a ROD for the Surplus Plutonium Disposition Supplemental EIS (81 FR 19588), DOE decided to process 6 metric tons of non-pit plutonium for disposal as TRU waste at the WIPP facility. DOE is proceeding with establishing a new program of record for the remaining plutonium.	K Area	Ongoing	DOE 2015a 81 FR 19588 SRNS 2020
SNF from Germany Containing U.S.-Origin Highly Enriched Uranium (DOE/EA-1977)	This action would receive, store, process, and dispose of German SNF packaged in casks. A FONSI was issued on December 20, 2017 (DOE 2017e).	H Area and L Area	Proposed	DOE 2017d DOE 2017e
H-Canyon Processing of Target Residue Material (DOE/EIS-0218-SA-07)	This action would receive liquid highly enriched uranium and process it in H-Canyon. An SA was prepared for this action, but an amended ROD was not needed.	H Area	Ongoing	DOE 2015e SRNS 2020

Name	***Description***	***Location(s)*** [b]	***Status***	***Source Document(s)***
H-Canyon Processing of SNF (DOE/EIS-0279, DOE/EIS-0279-SA-01 and DOE/EIS-0218-SA-06)	This program, projected to operate through 2024 or possibly longer, would receive, dissolve, and process SNF in H-Canyon. In the ROD (65 FR 48224) DOE decided to implement the melt and dilute technology to manage about 97 percent by volume and 60 percent by mass of the aluminum-based SNF. DOE also decided to use conventional processing (i.e., the existing canyons) to stabilize about 3 percent by volume and 40 percent by mass of the aluminum-based SNF. DOE planned to ship about 20 MTHM of nonaluminum-based SNF from SRS to the INL Site. In an Amended ROD (78 FR 20625) DOE decided to manage about 3.3 MTHM of 22 MTHM at SRS using conventional processing at H-Canyon. DOE will continue to safely store the aluminum-clad SNF not addressed in this Amended ROD in L-Basin at SRS, pending future decisions.	H Area	Ongoing	DOE 2000c 65 FR 48224 DOE 2013b 78 FR 20625 SRNS 2020
Pit Manufacturing (DOE/EIS-0541)	Under this project, DOE would repurpose the former MFFF to produce a minimum of 50 war reserve pits per year at SRS and to develop the ability, beginning in 2030, to implement a short-term surge capacity to enable NNSA to meet the requirements of producing pits at a rate of not less than 80 war reserve pits per year for the nuclear weapons stockpile. In September 2020, the *Final Environmental Impact Statement for Plutonium Pit Production at the Savannah River Site in South Carolina* (DOE 2020a) was published. The Proposed Action includes, but is not limited to, reconfiguring (disassembly and removal of equipment) the MFFF and installing the equipment necessary for activities supporting pit production (disassembly/metal preparation, pit assembly, machining, aqueous processing, foundry operations, material characterization, and analytical chemistry operations for certification). It also includes constructing and repurposing other facilities surrounding the MFFF for support activities (waste handling, training, office space, roads, storage, and parking), making security and nuclear safety upgrades to support pit production, and providing reliable utilities and infrastructure. On November 5, 2020, in a ROD for the plutonium pit production EIS (85 FR 70601), DOE decided to implement the Proposed Action.	F Area	Proposed	Public Law 115-232 DOE 2020a 85 FR 70601
HLW Salt Processing (DOE/EIS-0082-S2)	Under this Proposed Action, DOE would implement a process to separate the high-activity and low-activity waste fractions in HLW solutions. This process would replace the in-tank precipitation process evaluated in the *Defense Waste Processing Facility Supplemental Environmental Impact Statement* (DOE/EIS-0082-S) (DOE 1994). The *Savannah River Site Salt Processing Alternatives Final Supplemental Environmental Impact Statement* (Salt Processing EIS) (DOE/EIS-0082-S2) (DOE 2001) evaluated four alternatives. The solvent extraction process was selected in the ROD (66 FR 52752). In a revised ROD (71 FR 3834), DOE adopted an approach that implements interim salt processing until the solvent extraction process becomes operational.	S Area	Ongoing	DOE 2001 66 FR 52752 71 FR 3834
Mark-18A Target Material Recovery Program (DOE/EIS-0220-SA-02 and DOE/EIS-0279-SA-06)	This action would process the 65 Mark-18A targets at SRS to recover the plutonium-244 and other valued isotopes in the form of solid oxides. Processing activities at SRS will occur at the Savannah River National Laboratory, Shielded Cells Facility in A Area. The oxides will be transported to ORNL for further processing and material recovery.	A Area	Ongoing	DOE 2016f 83 FR 9847

Name	***Description***	***Location(s)*** [b]	***Status***	***Source Document(s)***
	Processing activities at ORNL will take place in accordance with its continuing research and development mission. An Amended ROD (83 FR 9847) was issued on March 8, 2018.			
Use of Savannah River Site Lands for Military Training (DOE/EA-1606)	The Proposed Action would enable the Army to conduct low intensity, nonlive-fire tactical maneuver training activities on SRS to support current and future Army mission requirements. A FONSI was issued on December 15, 2011 (DOE 2011h), and the revised FONSI was issued on July 26, 2012 (DOE 2012b).	SRS	Ongoing	DOE 2011g DOE 2011h DOE 2012b
Tritium Finishing Facility	This action would construct and operate a new Tritium Finishing Facility to replace SRS's HAOM, which currently houses the assembly, inspection, and packaging processes for tritium production. Built in the 1950s, the HAOM facility has potential problems inherent to its age that could pose a risk of negatively affecting tritium operations. Replacing HAOM would ensure safe, reliable, and efficient operations for the future. NNSA approved a cost range of $305 million to $640 million with a completion date expected from Fiscal Years 2029 to 2031. The Tritium Finishing Facility's construction would enable the continued safe and secure execution of this national security mission.	H Area	Proposed	NNSA 2020
Commercial Disposal of Defense Waste Processing Facility Recycle Wastewater (DOE/EA-2115)	This action would dispose of up to 10,000 gallons of stabilized (grouted) DWPF recycle wastewater at a commercial LLW disposal facility located outside of South Carolina. This effort would analyze capabilities for alternative treatment and disposal options using existing, permitted, offsite commercial treatment and disposal facilities. The DWPF recycle wastewater would be treated, characterized, and if the performance objectives and waste acceptance criteria of a specific disposal facility were met, DOE could evaluate whether to dispose of the waste as LLW under DOE's HLW interpretation. A FONSI was signed on August 5, 2020 (85 FR 48236).	S Area	Ongoing	DOE 2020e 85 FR 48236
Savannah River Site – Offsite Actions				
Vogtle Electric Generating Plant	This action is the continued operation of Vogtle Electric Generating Plant Units 1 and 2, and construction and operation of Units 3 and 4: two Westinghouse AP1000 nuclear reactors, 1,117 megawatts each. Units 3 and 4 are expected to be online in November 2021 (Unit 3) and November 2022 (Unit 4).	6.5 miles southwest of K Area	Ongoing	Georgia Power 2018 DOE 2015a:4-119 SRNS 2020
American Zinc Recycling LLC	This action is the continued operation of the American Zinc Recycling facility, a producer of zinc, zinc oxide, and zinc powder from recycled sources. It recycles thousands of tons of zinc-containing electric arc furnace dust and secondary materials, batteries, nickel bearing waste, and other metals. The Barnwell, South Carolina, facility has the capacity to process up to 180,000 tons per year of electric arc furnace dust.	10 miles northeast of K Area	Ongoing	AZR 2020a AZR 2020b
Energy*Solutions* LLW Disposal Facility	This action is the continued operation of the Barnwell Disposal Facility, owned by the State of South Carolina and operated by Energy*Solutions*. The Facility began operations in 1971. The facility is the host disposal site for the Atlantic Compact, which is composed of South Carolina, New Jersey, and Connecticut. The site is licensed to dispose of Class A, B, and C LLW.	11 miles northeast of K Area	Ongoing	DOE 2015a:4-119 SRNS 2020

ATR = Advanced Test Reactor; CERCLA = Comprehensive Environmental Response, Compensation and Liability Act; DWPF = Defense Waste Processing Facility; EA = environmental assessment; EIS = environmental impact statement; ETTP = East Tennessee Technology Park; FONSI = Finding of No Significant Impact; HALEU = High-Assay Low-Enriched Uranium;

Name	Description	Location(s) [b]	Status	Source Document(s)

HAOM = H Area Old Manufacturing Facility; HFIR = High-Flux Isotope Reactor; HLW = high-level radioactive waste; IFDP = Integrated Facility Disposition Project; INL = Idaho National Laboratory; INTEC = Idaho Nuclear Technology and Engineering Center; LLW = low-level radioactive waste; MFC = Materials and Fuels Complex; MFFF = Mixed Oxide Fuel Fabrication Facility; MTHM = metric tons of heavy metal; NEPA = National Environmental Policy Act; NNPP = Naval Nuclear Propulsion Program; NNSA = National Nuclear Security Administration; NOI = notice of intent; NRC = U.S. Nuclear Regulatory Commission; NRF = Naval Reactor Facility; NSTR = National Security Test Range; ORNL = Oak Ridge National Laboratory; ORR = Oak Ridge Reservation; ORSTP = Oak Ridge Science and Technology Project; REDC = Radiochemical Engineering Development Center; ROD = Record of Decision; RRTR = Radiological Response Training Range; RWMC = Radioactive Waste Management Complex; SA = Supplement Analysis; SNF = spent nuclear fuel; SRS = Savannah River Site; TAN = Test Area North; TCR = Transformational Challenge Reactor; TREAT = Transient Reactor Test Facility; TRU = transuranic; UAMPS = Utah Associated Municipal Power Systems; TVA = Tennessee Valley Authority; WIPP = Waste Isolation Pilot Plant.

[a] In this VTR EIS, reasonably foreseeable actions are generally understood to be those that have been identified in a NEPA document or are from another environmental impact analysis that is available and for which the effects can be meaningfully evaluated. These include actions unrelated to DOE. Applicable actions within the boundaries of the DOE sites (i.e., the INL Site, ORR, and SRS) were considered regardless of their locations. Actions outside the DOE site boundaries were examined if they were within about 10 miles of the specific locations at the DOE sites (i.e., MFC at the INL Site, Melton Valley Site at ORNL, and K Area at SRS) and might contribute to cumulative effects.

[b] Indicates locations analyzed in the alternatives evaluated in the referenced source document. Only those locations that are analyzed in this EIS (i.e., INL, ORR or ORNL, and SRS) are listed; other locations are indicated as “other sites.”

[c] A pit is the central core of a nuclear weapon that principally contains plutonium or enriched uranium.

Maintenance and repair of buildings and infrastructure (e.g., utilities and roads) at DOE sites are ongoing processes. Therefore, maintenance and repair activities at the INL Site, ORR, and SRS could contribute to cumulative impacts. However, most of these activities would be of limited size and of short duration and are generally covered by one of the categorical exclusions in the DOE NEPA Implementing Procedures (10 CFR Part 1021, Appendix B). Therefore, they would be unlikely to substantially contribute to cumulative impacts and are not evaluated further in this EIS.

5.3 Idaho National Laboratory

5.3.1 Land Use and Aesthetics

Land Use – Cumulative impacts on land use at the INL Site are presented in **Table 5–2**. Cumulative actions could occupy 48,500 to 48,700 acres of land, would be generally compatible with existing land use plans and allowable uses and would not affect offsite land uses. Existing activities at the primary facility areas at the INL Site currently occupy about 11,400 acres. Utility right-of-way corridors and public roadways at the INL Site represent a combined land use commitment of about 34,000 acres. Many of the other present and reasonably foreseeable future actions identified in Table 5–1 and included in Table 5–2 would occur in industrial or otherwise developed areas at the INL Site (e.g., ATR, MFC, and NRF) and would result in minor or no new land disturbance.

Table 5–2. Cumulative Land Use Impacts at Idaho National Laboratory

Activity		*Land Use Commitment (acres)* [a]
Past, Present, and Reasonably Foreseeable Future Actions		
Existing Site Activities [b]	Developed Areas	11,400 [c]
	Utility Rights-of-Way and Public Roads	34,000
Plutonium-238 Production for Radioisotope Power Systems (DOE 2000b:2-92)		10-66 [d]
Disposal of GTCC LLW and GTCC-Like Waste (DOE 2016a:2-22)		50-110 [d]
Expanding Capabilities at the Power Grid Test Bed (DOE 2019a:10)		400
Expand Capabilities at NSTR and RRTR (DOE 2019h:13)		460
Recapitalization of Infrastructure Supporting Naval SNF Handling (DOE 2016b:2-24)		50-150 [d]
DOE Idaho Spent Fuel Facility (NRC 2004:2-10)		18
Idaho HLW and Facilities Disposition (DOE 2002a:3-51)		22
UAMPS Small Modular Reactors (DOE-ID 2016:1)		up to 2,000
	Subtotal – Baseline Plus Other DOE Actions	**48,400–48,600**
VTR	INL VTR Alternative	100 [e]
	INL Reactor Fuel Production Options	0
Subtotal for VTR		**100**
Total [f]		**48,500-48,700**
Site Capacity		569,600 [b, g]

GTCC = greater-than-Class C; HLW = high-level radioactive waste; LLW = low-level radioactive waste; NSTR = National Security Test Range; RRTR = Radiological Response Training Range; SNF = spent nuclear fuel; UAMPS = Utah Associated Municipal Power Systems.

[a] Acreages include areas cleared or used for construction staging areas in addition to operational areas.
[b] From Chapter 3, Section 3.1.1.1
[c] Represents developed areas at primary facility areas located within an about 230,000 acre central core of the INL Site. A 45,000-acre security and safety buffer surrounds the developed area.
[d] Includes the minimum and maximum values from various alternatives of the proposed actions.
[e] From Chapter 2, Section 2.4
[f] Total rounded to three significant figures.
[g] Majority of this land is undeveloped.

Within the boundaries of the INL Site, the cumulative land use of 48,500 to 48,700 acres would involve about 8.5 percent of the 569,600 acres that comprise the INL Site. Activities evaluated in this EIS for the maximum INL VTR Alternative (including the INL Reactor Fuel Production Options) would disturb 100 acres, or about 0.2 percent of the 45,400 acres of currently developed land at the INL Site and about 0.02 percent of the 569,600 acres of land available at the INL Site. Therefore, the land used for construction and operation of the VTR and associated facilities at the INL Site would not substantially contribute to cumulative land use impacts.

Aesthetics – Several of the actions identified in Table 5–1 involve the alteration of existing ground conditions or the construction of new facilities at the INL Site with the potential to change the overall visual character of areas within the viewshed (see **Table 5–3**). For many of the actions identified in Table 5–3, construction activities would create short-term visual impacts, but would not be out of character for an industrial site or would not be visible from public areas outside the INL Site. The information in Table 5–3 indicates that because of the geographic separation between the various activities, location of many of the activities in industrial areas, and the nature of the activities, there would be little cumulative impacts on aesthetics at the INL Site. Only one of the activities listed in Table 5–3 (Sample Preparation Laboratory) involves the construction of a new facility at MFC, which once completed, would be consistent with the industrialized character of the area. Because construction of the VTR and associated facilities would disturb only 100 acres located adjacent to industrial areas at MFC and geographically separated from most of the other activities at the INL Site, the Proposed Action would not substantially contribute to cumulative aesthetics impacts at the INL Site.

Table 5–3. Reasonably Foreseeable Actions with the Potential to Affect Aesthetics at Idaho National Laboratory

Activity	***Location***	***Acres***	***Potential Visual Resources/Aesthetic Impact as Assessed in NEPA document***
Plutonium-238 Production for Radioisotope Power Systems (DOE 2000b:2-91)	ATR	10-66 [a]	If alternatives involving construction were chosen, a site-specific evaluation of visual resources would be conducted before site selection. This could result in reclassification under BLM guidelines.
Disposal of GTCC LLW and GTCC-Like Waste (DOE 2016a:2-22)	Near ATR	50-110 [a]	Under one alternative, 12 vault structures would be constructed; each would be 36 feet wide, 310 feet long, and 26 feet tall.
Sample Preparation Laboratory (DOE 2019b:3)	MFC	0.7	This laboratory will be a three story, slab-on-grade, masonry block structure with steel. The first floor will be reinforced, cast-in-place concrete; second and third floors will be steel deck with reinforced concrete.
Expanding Capabilities at the Power Grid Test Bed (DOE 2019a:26)	CFA to MTR	400	The proposed overhead power line traverses areas of the INL Site that are, in general, out of view of public roads and public vantage points. The Proposed Action uses dark poles to reduce contrast with natural surroundings.
Expand Capabilities at NSTR and RRTR (DOE 2019h:42)	NTSR RRTR	460	Implementing the Proposed Action would not degrade the visual character or quality of the INL Site or its surroundings.
Recapitalization of Infrastructure Supporting Naval SNF Handling (DOE 2016b:2-53)	NRF	150	There would be no impact on visual/scenic resources from landscape contrast since the new facility would be consistent with the current visual character of NRF.
DOE Idaho Spent Fuel Facility (NRC 2004:2-13)	INTEC	18	Because of its smaller scale compared to adjacent INTEC facilities, construction and operation of the proposed facility would not cause significant visual impacts on the BLM Class IV rating for INTEC.
Idaho HLW and Facilities Disposition (DOE 2002a:3-54; 5-18)	Adjacent to INTEC	22	There would be negligible change in the visual setting. From U.S. 20, the nearest public access, the new facility would blend in with the rolling topography of the area and would not be visible.

ATR = Advanced Test Reactor; BLM = Bureau of Land Management; CFA = Central Facilities Area; GTCC = greater-than-Class C; HLW = high-level radioactive waste; INTEC = Idaho Nuclear Technology and Engineering Center; LLW = low-level radioactive waste; NRF = Naval Reactors Facility; NSTR = National Security Test Range; RRTR = Radiological Response Training Range

[a] Includes the minimum and maximum values from various alternatives of the proposed actions.

5.3.2 Geology and Soils

As described in Section 5.3.1, Table 5–2, cumulative land disturbance at the INL Site could total 48,500 to 48,700 acres, or about 8.5 percent of the total land area at the INL Site of 569,600 acres. The amount of land disturbed under the maximum INL VTR Alternative (including the INL Reactor Fuel Production Options) would be 100 acres or 0.2 percent of the total amount of land disturbed. When land is disturbed, the native soil structure is destroyed. Based on the information presented in Section 5.3.1, the amount of soil disturbed under the maximum INL VTR Alternative, would be a small percentage of the total soil disturbed at the INL Site and would not substantially contribute to cumulative impacts.

As shown in **Table 5–4**, cumulative geologic and soils materials used for the construction projects at the INL Site could total 1,230,000 cubic yards. The amount of geologic and soils materials used under the maximum INL VTR Alternative would be 112,000 cubic yards or about 9 percent of the total amount of geologic and soils materials that would be used by other activities at the INL Site.

In an EA prepared to address the impacts of developing new sources of silt and clay to support INL activities, DOE identified a need for 4,600,000 cubic yards of silt and clay material over a period of 10 years (DOE 2002a:5-215). The 112,000 cubic yards of geologic and soils materials used under the maximum INL VTR Alternative would be about 2.4 percent of the total geologic and soils materials anticipated to be needed at the INL Site as described in the EA.

Table 5–4. Cumulative Geology and Soils Impacts at Idaho National Laboratory

Activity [a]		*Geologic and Soils Materials (cubic yards)*
Past, Present, and Reasonably Foreseeable Future Actions		
Existing Site Activities		NP [b]
GTCC LLW Disposal (DOE 2016a:5-49)		664,000
Sample Preparation Lab (DOE 2019b:1)		480
Multipurpose Haul Road (DOE 2010c:32)		80,600
Power Grid Test Bed (DOE 2019a:3)		163,000
Naval SNF Handling (DOE 2016b:4-28)		209,000
	Subtotal – Baseline Plus Other Actions	**1,117,000**
VTR [c]	INL VTR Alternative	112,000
	INL Reactor Fuel Production Options	little or no use of geologic and soil materials
Subtotal for VTR [d]		**112,000**
Total [e]		**1,230,000**

GTCC = greater-than-Class C; LLW = low-level radioactive waste; NP = not provided; SNF = spent nuclear fuel.

a Activities are from Table 5–1. Only those activities with available estimates of geologic and soil materials use are listed.

b The amount of geologic and soils material used by existing site development is unknown.

c Impact indicator values are from Chapter 4, Section 4.2.1.

d Total is a range that includes the minimum and maximum values from the VTR EIS alternatives. Total may not equal the sum of the contributions due to rounding.

e Total rounded to three significant figures.

5.3.3 Water Resources

As described in Chapter 4, Section 4.3.1.2, no effluent would be discharged directly to natural surface water bodies, and no surface water would be used during implementation of the maximum INL VTR Alternative (including the INL Reactor Fuel Production Options). Therefore, the Proposed Action would not contribute to cumulative impacts on surface water at the INL Site.

As described in Chapter 4, Section 4.3.2.2, no effluent would be discharged directly to groundwater during implementation of the maximum INL VTR Alternative. Therefore, the Proposed Action would not contribute to cumulative impacts on groundwater quality at the INL Site.

Groundwater use during construction of the projects listed in Table 5–1 generally would be for short durations, would involve relatively small quantities of water, and would occur at different times. The staggering of construction activities helps to ensure that the cumulative groundwater use during construction of all present and reasonably foreseeable projects would not substantially add to cumulative impacts on groundwater at the INL Site.

Past and present INL operations use groundwater as the water supply source. The Federal Reserved Water Right for the INL Site allows a maximum water consumption of 11.4 billion gallons per year from the Snake River Plain Aquifer (SRPA). **Table 5–5** lists the cumulative annual groundwater withdrawals expected from operation of the past, present, and reasonably foreseeable future actions at the INL Site. The totals presented in Table 5–5 represent about 872 million gallons per year, or about 7.6 percent of the Federal Reserved Water Right for the INL Site. Compared to the 755 million gallons withdrawn in 2019, the INL VTR Alternative with the Reactor Fuel Production Options represents an estimated 1 percent increase in groundwater use, and a negligible contribution to cumulative impacts on groundwater. However, these withdrawals would contribute to the declining SRPA water table elevation and could eventually impact water availability to other INL Site facilities or to downstream users. As shown in Table 5–5, the groundwater withdrawn to support the maximum INL VTR Alternative (including the INL Reactor Fuel Production Options), would be a very small percentage of annual cumulative groundwater use. Therefore, the groundwater use for this alternative would not substantially contribute to cumulative impacts at the INL Site.

As discussed in Chapter 4, Section 4.3, the anticipated volume of wastewater discharged to the MFC Industrial Waste Pond or active sewage lagoons under the maximum INL VTR Alternative (including the INL Reactor Fuel Production Options) would represent about 12 percent of the permitted limit of 17 million gallons per year. Another 2.4 million gallons per year of sanitary wastewater would be generated during operations, but sanitary wastewater is not regulated under the industrial wastewater reuse permit and would not contribute to the permitted limit of 17 million gallons per year. As the other past, present, and reasonably foreseeable future actions presented in Table 5–5 would be located across the INL Site and would discharge wastewater to different discharge points, there would be little or no cumulative impact of these discharges. As all activities would comply with permit limitations, no adverse cumulative effect from wastewater discharges would be anticipated.

Table 5–5. Cumulative Groundwater Withdrawals During Operation of Past, Present, and Reasonably Foreseeable Actions at Idaho National Laboratory

Activity		*Groundwater Withdrawal (gallons per year)*
Past, Present, and Reasonably Foreseeable Future Actions [a]		
Existing Site Activities [b]		755,000,000
Recapitalization of Infrastructure Supporting Naval SNF Handling (DOE 2016b:5-9)		3,600,000
DOE Idaho Spent Fuel Facilities/Independent SNF Storage Installation (DOE 2016g:5-9)		450,000
Idaho High-Level Waste and Facilities Disposition (DOE 2002a:5-89)		104,000,000
Disposal of GTCC LLW and GTCC-Like Waste (DOE 2016a:5-92, 5 94)		1,400,000
Subtotal – Baseline Plus Other Actions		**865,000,000**
VTR [c]	INL VTR Alternative	4,400,000
	INL Reactor Fuel Production Options	2,400,000
Subtotal for VTR		**6,800,000**
Total [d]		**872,000,000**
INL's Reserved Water Right [b]		11,400,000,000

GTCC = greater-than-Class C; LLW = low-level radioactive waste; SNF = spent nuclear fuel.

[a] Activities are from Table 5–1. Only those activities with available estimates of groundwater use are listed.

[b] Existing groundwater use and INL's Federal Reserved Water Right are from Chapter 3, Section 3.1.3.4.

[c] Impact indicator values are from Chapter 4, Section 4.3.2.2.

[d] Total rounded to three significant figures.

5.3.4 Air Quality

The region surrounding the INL Site is currently in compliance with all State and national ambient air quality standards. The air quality cumulative impacts analysis estimates the potential for emissions from the maximum INL VTR Alternative (including the INL Reactor Fuel Production Options), in combination with emissions from other past, present, and reasonably foreseeable future actions, to exceed an ambient air quality standard. Radiological emissions are discussed in Section 5.3.10.

As described in Chapter 4, Sections 4.4.1.1 and 4.4.4.1 of this VTR EIS, construction activities from the maximum INL VTR Alternative (including the INL Reactor Fuel Production Options) would generate emissions. Emissions would be from the use of fossil fuel-powered equipment and trucks, workers' commuter vehicles, and fugitive dust (PM_{10}/$PM_{2.5}$) due to the operation of equipment on exposed soil. Estimated peak annual construction emissions from these combined activities would remain well below indicator thresholds of significance (see Tables 4–5 and 4–9). The intermittent operation of construction emission sources over an area of 100 acres would result in dispersed concentrations of air pollutants adjacent to construction activities. The transport of construction emissions from MFC to the nearest INL Site boundary (about 3 miles) would produce additional dispersion and would result in inconsequential concentrations of air pollutants beyond the INL Site property boundary. Therefore, in combination with emissions from other past, present, and reasonably foreseeable future actions, the minor increase in offsite air pollutant concentrations produced from construction of the VTR and associated facilities would not result in air pollutant concentrations that would exceed the State and national ambient air quality standards. Emissions from construction activities related to the maximum INL VTR Alternative (including the INL Reactor Fuel Production Options) would not substantially contribute to cumulative air quality impacts.

Emissions from construction trucks transporting materials, equipment, and wastes, and from workers' commuter vehicles, would produce low concentrations of air pollutants along public roadways. These low concentrations are primarily because of the intermittent use of vehicles and equipment and their low emission rates. Because these air pollutant concentrations would be low, offsite on-road construction vehicle activities from the maximum INL VTR Alternative (including the INL Reactor Fuel Production Options) would not substantially contribute to cumulative air quality impacts.

As described in Chapter 4, Sections 4.4.1.2 and 4.4.4.2, operations activities from the maximum INL VTR Alternative (including the INL Reactor Fuel Production Options) would generate emissions. Emissions would be from intermittent use of two diesel-powered backup electrical generators, intermittent use of propane-fired heaters for the VTR sodium heat exchanger system during maintenance activities, diesel-powered trucks that deliver material and transport wastes, and workers' commuter vehicles. Review of the data in Tables 4–6 and 4–10 shows that the combined activities would produce minor amounts of air emissions. Transport of these emissions to the INL Site boundary would produce negligible ambient air pollutant concentrations at offsite locations. Therefore, the minor increase in offsite air pollutant concentrations produced from operations, in combination with emissions from other past, present, and reasonably foreseeable future actions, would result in air pollutant concentrations that would not exceed the State and national ambient air quality standards. Emissions from operations activities related to the maximum INL VTR Alternative (including the INL Reactor Fuel Production Options) would not substantially contribute to cumulative air quality impacts.

5.3.5 Ecological Resources

For the cumulative impacts analysis, the ROI for ecological resources expands to include the proposed project area and nearby areas that could potentially be affected under the INL VTR Alternative (including the INL Reactor Fuel Production Options) when combined with other past, present, and reasonably foreseeable future actions. Table 5–2 is a tabulation of cumulative land disturbance at the INL Site.

Cumulative disturbance to ecological resources could total 48,523 to 48,742 acres, or 8.5 percent of the total 570,000 acres of land area at the INL Site.

Cumulative impacts on ecological resources could occur with the Proposed Action when combined with other past, present, and reasonably foreseeable future actions, including temporary and permanent disturbance, and degradation or loss of animals and habitats from land-clearing activities. The disturbance or displacement of wildlife due to an increase in noise and human activity at the construction site (behavioral avoidance) and the fragmentation of remaining habitats resulting from project developments are also potential cumulative impacts. Also included are the increases in human-wildlife encounters and collisions between wildlife and motor vehicles from wildlife displaced from their habitat by construction activities and possibly made more susceptible to predation and intra-species competition and less able to obtain adequate food and cover.

Vegetation removal activities at the INL Site would increase the amount of habitat loss and could lead to habitat degradation. Direct impacts could include permanent and temporary impacts on wildlife due to an increase in noise and human activity near construction activities and the loss of habitat from land-clearing activities that could result in habitat fragmentation. Construction activities could also result in potential increases in collisions between wildlife and motor vehicles. Indirect impacts would also include an increased potential for the spread of invasive species due to soil disturbance (creating open habitat for invasive species establishment). It is anticipated that impacts on vegetation, wildlife, and special status species from the activities listed in Table 5–2 would be similar to those for the Proposed Action as described in Chapter 4, Section 4.5.

Operational and administrative controls (as described in Section 4.5) will be evaluated and implemented, if warranted, for the Proposed Action and other actions to reduce the potential for adverse effects to wildlife (including migratory birds and special status species) and their habitats. These controls may include daily and seasonal timing of project activities, reduced speed limits, ultrasonic warning whistles, encouraging animals not to use the road, and preemptive awareness programs for construction crews. Administrative controls would include the posting of speed limit signs and creating exclusion areas for sensitive species (such as snake hibernacula and the pygmy rabbit burrow area). Increased vehicle activity within the proposed project area could potentially increase the risk for wildlife strikes by vehicles.

Additionally, construction, land clearing, and vegetation removal activities would be controlled to preclude damage to active bird nests. Following the Migratory Bird Treaty Act permit guidance, performance of migratory bird nesting surveys would occur before any ground disturbance or vegetation removal. Other preventive measures, such as buffer areas or stopping work, would prevent nest abandonment until nestlings have fledged, thus minimizing cumulative impacts.

Vegetation subject to clearing could support foraging, nesting, and other behaviors for mammals, birds (including migratory birds and Birds of Conservation Concern [BCC]), amphibians, and reptiles. Land clearing would cause disturbances in the landscape resulting in new habitat edges, potentially disrupting wildlife ecosystem processes and habitats. The cumulative impacts to sagebrush habitat could be substantial given the extent of habitat affected. The DOE "no net loss of sagebrush habitat" policy (to mitigate loss of sagebrush, monitor sagebrush disturbance, and planting an area equal to that disturbed or removed in areas that are beneficial to greater sage-grouse under the *CCA for Greater Sage-grouse* on the INL Site [DOE-ID & USFWS 2014]), would confer protection of this sensitive ecological resource. To verify compliance with this DOE-ID policy, annual monitoring and summary reporting of sagebrush restoration efforts at the INL Site would continue to be conducted (DOE-ID 2019a). Revegetation of temporary disturbance areas would occur in accordance with annual INL Revegetation Assessment program practices (INL/EXT-19-56726). Invasive species management would continue to be implemented for all projects. Infrastructure and traffic could impose dispersal barriers to most non-flying terrestrial animals.

Cumulative impacts on ecological resources would not be substantial because ground disturbance and land clearing for the Proposed Action and other past, present, and reasonably foreseeable future actions would occur at different locations and times, and appropriate mitigations (such as sagebrush replacement, invasive species management, and the INL Revegetation Assessment program) would be enforced. Revegetation would occur in accordance with annual INL Revegetation Assessment program practices (INL/EXT-19-56726).

5.3.6 Cultural and Paleontological Resources

Damage to the nature, integrity, and spatial context of cultural resources can have a cumulative impact if the initial act is compounded by other similar losses or impacts. The alteration or damage to cultural resources may incrementally impact resources in and around the INL Site.

As described in Section 3.1.6, there are no significant cultural or paleontological resources in the area of potential effect (APE) for proposed VTR construction at the INL Site. Therefore, cumulative impacts on cultural resources within the ROI would be negligible because the proposed new construction is consistent with the historic industrial character of the area and will not diminish the integrity of setting of any historic property within the MFC facility.

5.3.7 Infrastructure

Table 5–6 lists the estimated annual cumulative infrastructure requirements from operations at the INL Site for electricity and water. Projected cumulative site activities would annually require 468,000 to 471,000 megawatt-hours of electricity, which is below the total site-wide capacity of 481,800 megawatt-hours. Cumulative water usage would be about 872 million gallons of water per year, which is well within the site-wide capacity of 11.4 billion gallons per year. Operation of the VTR and associated facilities at the INL Site would use about 6.8 million gallons of water per year, which represents a fraction of cumulative infrastructure use and an even smaller fraction of total site capacity. Electricity use would be about 170,000 megawatt-hours of electricity per year, which represents about one third of current site capacity. When evaluating other site activities, total electric use would be about 10,800 to 13,800 megawatt-hours per year below site capacity. As discussed in Section 4.7.1, several options are under consideration for upgrades to the current electrical system at the INL Site to handle additional loads potentially resulting from VTR operations.

Table 5–6. Annual Cumulative Infrastructure Impacts from Operations at Idaho National Laboratory

Activity		*Electricity Consumption (megawatt-hours per year)*	*Water Usage (gallons per year)*
Past, Present, and Reasonably Foreseeable Future Actions			
Existing Site Activities		186,255 [a]	755,000,000 [a]
Plutonium-238 Production for Radioisotope Power Systems (DOE 2000b:4-317)		negligible	440,000
Disposal of GTCC LLW and GTCC-Like Waste (DOE 2016a:5-92, 5-94)		5,050	1,400,000
Recapitalization of Infrastructure Supporting Naval SNF Handling (DOE 2016b:5-9)		105,000	3,600,000
DOE Idaho Spent Fuel Facility (NRC 2004:2-11)		Not reported	450,000
Idaho HLW and Facilities Disposition (DOE 2002a:5-222))		1,800–5,000 [b]	104,000,000
Subtotal – Baseline Plus Other DOE Actions		**298,000–301,000**	**865,000,000**
VTR	INL VTR Alternative	150,000 [c]	4,400,000 [c]
	INL Reactor Fuel Production Options	20,000 [c]	2,400,000 [c]
Subtotal for VTR		170,000	**6,800,000**

Activity	Electricity Consumption (megawatt-hours per year)	Water Usage (gallons per year)
Total [d]	**468,000–471,000**	**872,000,000**
Total Site-wide Capacity	481,800 [a]	11,400,000,000[a]

GTCC = greater-than-Class C; HLW = high-level radioactive waste; LLW = low-level radioactive waste; SNF = spent nuclear fuel.
[a] From Chapter 3, Section 3.1.7.
[b] Total is a range that includes the minimum and maximum values from various alternatives of Proposed Action.
[c] From Chapter 4, Section 4.7.
[d] Total is rounded to three significant figures.

The Utah Associated Municipal Power Systems (UAMPS) Small Modular Reactors project would have the potential to create additional electrical power capacity to the region. The project would site up to 12 small modular reactors at the INL Site, rated at 50 to 60 megawatts each. Therefore, this project could add up to 600 to 720 megawatts of additional electrical capacity. UAMPS plans to commence site preparation in 2021, with construction commencing in 2023, and commercial operations beginning with one reactor coming online in 2026 and the remainder in 2027 (NuScale 2019).

5.3.8 Noise

The analysis of cumulative noise impacts considers perceptible increases in ambient noise levels and increases of excessive ground-borne vibration to persons or property in the ROI. The ROI for noise extends 0.5 miles from the edge of the construction area. As discussed in Chapter 3, Section 3.1.8.3, the closest noise-sensitive receptor is a dual home and farm about 5.0 miles from the VTR site and about 1.9 miles from U.S. Highway 20, which is expected to be the primary noise source for this location. As a result, the cumulative impacts analysis examines the onsite noise-sensitive receptors to include workers present onsite and within 0.5 miles from the edge of the construction area. Most existing and planned projects at the INL Site listed in Table 5–1 would occur at different locations and at different times and would not contribute to cumulative noise effects in combination with the proposed VTR activities.

Most of the potential impacts from noise are short-term and are related to the construction phase of the project, including noise from construction equipment and vehicles. Examples of construction noise levels are given in Chapter 4, Section 4.8.2.1 and include measurements at 50 feet of 80 decibels (A-weighted) (dBA) from excavators, 85 dBA from tractors and bulldozers, and 89 dBA from graders. Although construction noise could be moderately loud, the temporary and intermittent nature of the construction activities would not result in long-term cumulative impacts. As discussed in Section 4.8.2.1, noise levels fluctuate depending on the type, number, and duration of use of heavy equipment for construction activities. They also differ by the type of activity, distance to noise-sensitive uses, existing topography and vegetation conditions to diminish the sound, and ambient noise levels. Additionally, construction activities are generally limited to daylight hours in conformance with Federal, State, and local codes and ordinances, and manufacturer-prescribed safety procedures and industry practices.

During operation, cumulative impacts include the potential for perceptible increases in ambient noise levels for sensitive receptors (e.g., the INL Site workers). For some projects listed in Table 5–1, operations could cumulatively increase noise due to facility operations, range activities, and additional vehicle trips.

As noted above, the closest sensitive receptor to the VTR site is a dual home and farm that is about 5.0 miles away. Given the large distance, cumulative noise from construction or operation of projects at MFC and others within the INL Site would be indistinguishable from typical background at the closest offsite noise-sensitive receptor. See Section 4.8.2.1 for additional information about potential noise levels at the closest offsite receptor.

5.3.9 Waste Management

The assessment of the waste management cumulative impacts at the INL Site includes the INL VTR Alternative and reactor fuel production options and other reasonably foreseeable actions that result in the generation, treatment as required, and disposal of LLW, MLLW, and transuranic (TRU) waste. **Table 5–7** summarizes the estimated cumulative annual generation rates of these wastes. Additional reasonably foreseeable actions are identified in Section 5.2, Table 5–1. As noted in Table 5–1, some of these activities are ongoing, and the waste generated by these activities are included in the existing site activities' waste generation rates for the INL Site. For some of the activities identified as proposed, there is no waste generation information currently available. For some activities, waste generation was described as "small quantities" or was less than 20 cubic meters. Therefore, these other DOE actions were covered as a group and the annual LLW, MLLW, and TRU waste generation rates are characterized as "small quantities" in Table 5–7 below.

Table 5–7. Cumulative Average Annual Waste Generation at the Idaho National Laboratory Site in Cubic Meters

Activity		***LLW***	***MLLW***	***TRU Waste***
Past, Present, and Reasonably Foreseeable Future Actions				
Existing Site Activities [a]		8,600	4,600	1,100
Other DOE actions		Small Quantities	Small Quantities	Small Quantities
Subtotal – Baseline Plus Other DOE Actions		8,600	4,600	1,100
VTR	INL VTR Alternative [a]	540	38	0.89
	INL Feedstock Preparation/Fuel Fabrication [b]	170[c] /170[d]	2[c, e] /2[d, e]	200[c] /200[d]
Subtotal for VTR		540 - 880	38 - 42	0.89 - 400
Total		9,100 - 9,500	4,600	1,500

LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; TRU = transuranic waste.

[a] Source: Section 4.9.1.2, Table 4-34. INL VTR Alternative wastes are average annual generation rates based on a 60-year operation cycle.

[b] Source: Section 4.9.3.1.1, Table 4-36. Wastes are average annual generation rates based on a 60-year operation cycle.

[c] These quantities are estimates and could be different depending on the process for the feedstock.

[d] These quantities are fuel fabrication with no feedstock preparation.

[e] These quantities are included in the LLW quantities.

Note: All numbers are rounded to two significant figures. Due to rounding, sums and products may not equal those calculated from table entries.

The characteristics of the newly generated wastes are estimated to be similar to the wastes currently generated by existing activities. As described in Chapter 4, Section 4.9.1.2, the waste management infrastructure at the INL Site was developed to support the quantities of waste generated. Therefore, cumulative waste generation would be within site capacities. There are existing offsite DOE and commercial waste management facilities with sufficient capacities for the treatment and disposal needs of the relatively small volumes of LLW and MLLW generated by the Proposed Action. Consequently, substantial cumulative impacts on offsite LLW and MLLW treatment and disposal facilities would not be expected.

The Waste Isolation Pilot Plant (WIPP) facility is the only permanent disposal option for TRU waste generated by atomic energy defense activities as required by the WIPP Land Withdrawal Act (LWA; Pub. L. 102-579). The LWA specifies a total TRU waste disposal volume capacity limit of 6.2 million cubic feet (175,564 cubic meters).

The Annual TRU Waste Inventory Report (ATWIR) serves as a current estimate of the TRU waste inventory for potential disposal at the WIPP facility and documents the TRU waste that may be considered in future Compliance Recertification Applications submitted to the U.S. Environmental Protection Agency (EPA).

The ATWIR estimates are also used for technical analyses, strategic planning and National Environmental Policy Act (NEPA) analyses. The TRU Waste Inventory Profile Reports (Appendices A and B of the ATWIR) reflect the information reported by the TRU waste generator/storage sites. The TRU waste inventory estimates in the ATWIR have inherent uncertainties and therefore the inventory estimates change annually. The TRU waste inventory estimates typically change due to factors, such as: updates or revisions to site treatment plans, waste minimization activities, packaging adjustments, and technical and planning changes. As of the data collection cutoff date for the 2019 ATWIR, approximately 67,400 cubic meters of TRU waste were disposed at the WIPP facility (DOE-CFO 2019).

The maximum total TRU waste estimated to potentially be generated over the life of the alternatives and options evaluated in this EIS is 24,000 cubic meters. The maximum TRU waste volume estimates in this document represent TRU waste volume estimates and not the volume of the overpack disposal container(s). In addition, other proposed actions since publication of the current ATWIR[2] could change the TRU waste inventory for potential disposal at the WIPP facility.[3] These actions will be incorporated, as appropriate, into future ATWIR TRU waste inventory estimates.

TRU waste volume estimates such as those provided in NEPA documents, cannot be used to determine compliance with the WIPP LWA total TRU waste disposal volume capacity limit. The TRU waste estimates in the ATWIR change annually. Determining compliance with the WIPP LWA disposal capacity limit is determined by proven and audited procedures and processes implemented for the WIPP facility by the Carlsbad Field Office. The Carlsbad Field Office monitors and tracks the actual defense-related TRU waste volume emplaced at the WIPP facility to ensure compliance with the WIPP LWA and will take action as appropriate in a timely and appropriate manner to ensure needs of the DOE complex are met.

Any GTCC-like waste (e.g., non-defense TRU waste not eligible for disposal at the WIPP facility) generated from the Proposed Action would be stored at the generator site in accordance with applicable requirements until a disposal capability is available.

5.3.10 Human Health – Normal Operations

Cumulative impacts on public health and safety from radiological emissions could result from activities at the INL Site and potentially from other activities within the INL Site ROI (50 miles from the INL Site boundary). The actions listed in Table 5–1 were reviewed to identify potential worker and public health impact. **Table 5–8** shows information on the potential impacts from the present INL Site operations (from Chapter 3, Section 3.1.10.1 of this VTR EIS), reasonably foreseeable future actions, and the Proposed Action. This table includes those actions identified in Table 5–1 that could contribute to both worker and public (population and maximally exposed individual [MEI]) doses and potential latent cancer fatalities (LCFs). Only those activities that have identified radiological impacts with available estimates of radiation exposure are listed. Some of the actions identified in Table 5–1 would be expected to have radiological impacts, but estimates were not available. At the INL Site, these actions stem from the DOE Naval Nuclear Propulsion Program (NNPP)'s recapitalization of infrastructure supporting fuel examination capabilities, the Department of Defense's construction and demonstration of a Prototype Advanced Mobile Nuclear Reactor, the Oklo Aurora reactor project, and UAMPS Small Modular Reactors (carbon free power project).

[2] The latest ATWIR can be found at: https://wipp.energy.gov/national-tru-program-documents.asp.

[3] Examples include the *Final Supplement Analysis of the 2008 Site-Wide Environmental Impact Statement for the Continued Operation of Los Alamos National Laboratory for Plutonium Operations* (DOE 2020g) and the *Final Environmental Impact Statement for Plutonium Pit Production at the Savannah River Site in South Carolina,* DOE/EIS-0541 (DOE 2020a), https://www.energy.gov/nepa/downloads/doeeis-0541-draft-environmental-impact-statement.

Table 5–8. Annual Cumulative Population Health Effects of Exposure to Radiation from Normal Operations at Idaho National Laboratory

Activity		Workforce		Population within 50 Miles		MEI	
		Dose (person-rem)	***Annual LCF [a]***	***Dose (person-rem)***	***Annual LCF [a]***	***Dose (millirem)***	***Annual LCF Risk [a]***
Past, Present, and Reasonably Foreseeable Future Actions							
Existing Site Activities (baseline) [b]		94	0.06	0.044	5×10^{-6}	0.026	2×10^{-8}
RPS Infrastructure [c]		12	0.005	3.9×10^{-6}	6.8×10^{-8}	2.6×10^{-7}	1.3×10^{-13}
HALEU Fuel Production [d]		NC	NC	NC	NC	1.6	1×10^{-6}
Radiological Response Training Range (North Test Range) [e]		NC	NC	NC	NC	0.048	3×10^{-8}
Radiological Response Training Range (South Test Range) [e]		NC	NC	NC	NC	0.00034	2×10^{-10}
National Security Test Range [e]		NC	NC	NC	NC	0.04	2×10^{-8}
Recapitalization of Infrastructure Supporting Naval SNF Handling [f]		0	0	0.023	1×10^{-5}	0.0006	4×10^{-10}
Idaho Spent Fuel Facility [g]		NC	NC	NC	NC	0.000063	4×10^{-11}
Remote Handled LLW Disposal Facility [h]		0.5	0.0003	(h)	(h)	(h)	(h)
Integrated Waste Treatment Unit (ICP/EXT-05-01116) [e]		NC	NC	NC	NC	0.075	4×10^{-8}
Subtotal – Baseline Plus Other Actions		**110**	**0.06**	**0.067**	$\mathbf{4\times10^{-5}}$	**1.8**	$\mathbf{1\times10^{-6}}$
INL VTR	INL VTR Alternative	42 [i]	0.03	0.044	3×10^{-5}	0.0068	4×10^{-9}
	Feedstock Preparation Option	19 [i]	0.01	0.012	7×10^{-6}	0.0012	7×10^{-10}
	Fuel Fabrication Option	**110**	**0.07**	0.0053	3×10^{-6}	0.0016	1×10^{-9}
Subtotal for VTR		**230**	**220**	**0.1**	$\mathbf{4\times10^{-5}}$	**0.0096**	$\mathbf{6\times10^{-9}}$
Total		**340**	**0.2**	**0.13**	$\mathbf{8\times10^{-5}}$	**1.8**	$\mathbf{1\times10^{-6}}$

HALEU = high-assay low-enriched uranium; LCF = latent cancer fatality; LLW = low-level radioactive waste; MEI = maximally exposed individual; NC = not calculated; NNPP = Naval Nuclear Propulsion Program; RPS = Radioisotope Power System; SNF = spent nuclear fuel; UAMPS = Utah Associated Municipal Power Systems.

[a] LCFs are calculated using a conversion factor of 0.0006 LCFs per rem or person-rem (DOE 2003). The annual LCFs for the analyzed population represent the number of LCFs calculated by multiplying the listed doses by the risk conversion factor; no population LCFs are expected from any individual activity or from all combined activities. The annual MEI LCF risk represents the calculated risk of an LCF to an individual.

[b] From Chapter 3, Section 3.3.10.1 of this EIS. Worker population dose is the average for 2014 to 2018. Population dose is the highest from the last 3 years of operation.

[c] Impacts from the alternative with the highest impacts in the *Final PEIS for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the FFTF* (DOE 2000b:Table 4-169).

[d] Maximum dose calculated for alternatives in the *Environmental Assessment for Use of DOE-Owned High-Assay Low-Enriched Uranium Stored at Idaho National Laboratory* (DOE 2019b:Table 8). The environmental assessment did not calculate a population dose or a collective worker dose (dose to an individual collocated worker was calculated [maximum of 48 millirem per year]).

[e] *Final Environmental Assessment for Expanding Capabilities at the National Security Test Range and the Radiological Response Training Range at Idaho National Laboratory* (DOE 2019h:Table 35). The environmental assessment did not calculate a population dose nor include an assessment of worker dose.

[f] Impacts from *Environmental Impact Statement for the Recapitalization of Infrastructure Supporting Naval Spent Nuclear Fuel Handling* (DOE 2016b: Section 4.10.2, Tables 5.2-3, 5.2-4). Changes in the number of workers are limited to construction workers, who are not expected to receive doses above background levels.

[g] Impacts from the *Environmental Impact Statement for the Proposed Idaho Spent Fuel Facility at the Idaho National Engineering and Environmental Laboratory in Butte county, Idaho* (NRC 2004:Table 4-5) and are identified as less than the quantity shown. The EIS did not calculate a population dose and gave only a maximum individual worker dose.

[h] Worker impacts are from the transportation of wastes. Public impacts from transportation of selected waste to an offsite disposal site (0.48 person-rem and an LCF of 0.003) would not be limited to the ROI. The *Environmental Assessment for the Replacement Capability for Disposal of Remote-Handled Low-Level Radioactive Waste Generated at the Department of*

Activity	Workforce		Population within 50 Miles		MEI	
	Dose (person-rem)	Annual LCF [a]	Dose (person-rem)	Annual LCF [a]	Dose (millirem)	Annual LCF Risk [a]

Energy's Idaho Site (DOE 2011a, 2011f) indicates the impacts from low-level waste storage occur thousands of years from now. The environmental assessment did not include an estimate of an MEI dose or LCF risk.

l Total worker dose for VTR is higher than listed. However, some of the dose would replace worker dose from existing activities and would not result in an increase in cumulative worker dose.

The cumulative offsite population dose would be 0.13 person-rem per year with no expected LCFs (calculated value of 8 x 10^{-5}). Operations of the VTR and associated facilities at the INL Site, including fuel preparation and fabrication, would result in a total population dose of 0.061 person-rem per year with no expected LCFs (calculated value of 4 x 10^{-5}). The total dose and LCFs from the Proposed Action would be 45 percent of the cumulative dose and LCFs. While this is a significant portion of the cumulative impact, the absolute value is low. For that reason, the additional population dose from operations of the VTR and associated facilities would not substantially contribute to human health impacts at the INL Site.

The cumulative MEI dose from activities on the INL Site would be 1.8 millirem per year with an associated LCF risk of 1 x 10^{-6}. This cumulative MEI dose is lower than the DOE limit of 100 millirem per year from all pathways (DOE Order 458.1 [DOE 2011b]), and the EPA individual dose limit of 10 millirem per year from airborne radionuclides (40 CFR Part 61 subpart H [54 FR 51695]). This dose conservatively assumes the same person would be the MEI for all activities at the INL Site. This is unlikely because the activities occur at different locations at the INL Site, each potentially with an MEI located at different offsite locations. Operation of the VTR and associated facilities, including feedstock preparation and fabrication, at the INL Site, would result in a total MEI dose of 0.0096 millirem per year with an associated LCF risk of 6 x 10^{-9}. The total MEI dose and LCFs from the Proposed Action would be 0.05 percent of the cumulative MEI dose and LCFs and therefore, would not substantially contribute to cumulative human health impacts at the INL Site.

The cumulative worker dose would be 220 person-rem per year with no expected LCFs (calculated value of 0.1). Operation of the VTR and associated facilities, including feedstock preparation and fuel fabrication, at the INL Site, would result in a total worker dose of 110 person-rem per year with no expected LCFs (calculated value of 0.07). The total worker dose and LCFs from the Proposed Action would be 51 percent of the cumulative dose and LCFs. The Proposed Action could result in 4 worker LCFs from 60 years of VTR operation. Much of the worker dose estimate is the result of conservatively using 750 millirem per year (the INL administrative dose limit is 700 millirem) as the estimate for some worker doses resulting from fuel fabrication. The flowchart and equipment for this activity are, at best, in the early stages of design. 10 CFR 835 requires DOE "to develop and implement plans and measures to maintain occupational radiation exposures as low as is reasonably achievable" (ALARA). DOE-STD-1098-2017, DOE Standard Radiological Control (DOE 2017f) identifies an effective ALARA process as including implementation of both engineered and administrative controls to control worker dose. All equipment and operations would be designed and implemented following this principle. Therefore, needed worker protection could be incorporated into the final design potentially reducing worker doses.

5.3.11 Traffic

As described in Chapter 4, Section 4.13.1, the impacts on traffic from construction and operation of facilities under the maximum INL VTR Alternative (including the INL Reactor Fuel Fabrication Options) are anticipated to be negligible to minor. Impacts on traffic from this alternative would not substantially contribute to cumulative traffic impacts and are not discussed further.

5.3.12 Socioeconomics

The ROI for cumulative socioeconomic impacts includes the seven Idaho counties near the INL Site: Bannock, Bingham, Bonneville, Butte, Clark, Jefferson, and Madison counties. As shown in **Table 5–9**, cumulative employment at the INL Site from present and reasonably foreseeable future actions could reach a peak of about 7,990 persons. This is about 5.1 percent of the 157,400 people employed in the INL Site ROI in 2018. These values are conservative estimates of short-term future employment at the INL Site. Some of the employment would occur at different times and it may not be appropriate to total these values. The employment totals from existing site activities include existing onsite employment (directly employed and contractor staff) and potential future employees based on activities identified in Table 5–1 and carried over to Table 5–9.

Table 5–9. Cumulative Employment at Idaho National Laboratory

Activity		***Direct Construction Employment (number of personnel in peak year***	***Direct Operations Employment (first year of operation)***
Past, Present, and Reasonably Foreseeable Future Actions [a]			
Existing Site Activities [b]		Not Applicable	6,840
Recapitalization of Infrastructure Supporting Naval SNF Handling (DOE 2016b:4-123–4-128)		360 direct 450 indirect	60 direct 110 indirect
Disposal of GTCC LLW and GTCC-like Waste (DOE 2016a:7-58, 2018d)		62–145	38–51
Expanding Capabilities at the Power Grid Test Bed (DOE 2019a:8, 11)		20	30
Use of DOE-Owned HALEU (DOE 2019b)		No staffing levels given (assume negligible)	
UAMPS Small Modular Reactors (DOE-ID 2016; NuScale 2019; UAMPS 2019:37, 40; Idaho Policy Institute 2019)		2,000 direct 1,360 indirect	360 direct 307 indirect
DOE Idaho Spent Fuel Facility/Independent SNF Storage Installation (NRC 2004:4-16)		250	60
Subtotal – Baseline Plus Other Actions		**2,690–2,780**	**7,390–7,400**
VTR [c]	INL VTR Alternative	1,310 peak, 650 average	218
	INL Fuel Fabrication Option	18 peak, 6 average	70 (230) [e]
	INL Feedstock Preparation Option	18 peak, 6 average	300
Subtotal for VTR		**1,350 peak**	**588 (818)[e]**
Total (Direct labor) [f]		**4,030–4,120**	**7,980–7,990**
ROI Labor Force (2018) [d]		**157,398**	

EIS = environmental impact statement; GTCC = greater-than-Class C; HALEU = High-Assay Low-Enriched Uranium; HLW = high-level radioactive waste; INL = Idaho National Laboratory; LLW = low-level radioactive waste; NNPP = Naval Nuclear Propulsion Program; ROI = region of influence; SNF = spent nuclear fuel; UAMPS = Utah Associated Municipal Power Systems; VTR = Versatile Test Reactor.

[a] Activities are from Table 5–1. Only those activities with available estimates of employment are listed. The following proposed projects in 2019 have no workforce estimates available and were excluded: Sample Test Laboratory, Expanding Capabilities at the Power Grid Test Bed.

[b] Employment from existing site activities is from Chapter 3, Section 3.1.14.

[c] Impacts of the VTR Alternative/Option are from Chapter 4, Section 4.14.1.

[d] ROI Labor Force is from Chapter 3, Section 3.1.14.

[e] Fuel fabrication would employ 70 new workers but an additional 230 workers would be drawn from the existing workforce at the INL Site, which would result in a total of 588 new workers and 818 workers total.

[f] Total rounded to three significant figures.

As identified in Table 5–1, it is assumed that no new workforce would be added to support ongoing projects at the INL Site, based on the NEPA documentation that was completed before 2019. These projects are ongoing and are presumably captured in the current onsite employment totals. These ongoing INL Site projects include:

- Plutonium-238 Production for Radioisotope Power Systems (DOE 2000b, 2013a)
- Treatment and Management of Sodium-Bonded SNF (DOE 2000a)
- Resumption of Transient Testing of Nuclear Fuels and Materials (DOE 2014b)
- Multi-Purpose Haul Road (DOE 2010c, 2010d)
- Idaho HLW and Facilities Disposition (DOE 2002a, 2005d)
- New Remote-Handled LLW Disposal Facility (DOE 2011a, 2011f)

It is assumed that the projects identified in Table 5–1 with NEPA documentation dated on or after 2019 may not yet be complete and operational at this writing. Therefore, these activities could require an additional onsite workforce. This cumulative employment is captured in Table 5–9.

Activities proposed under the maximum INL VTR Alternative (including the INL Reactor Fuel Production Options) could produce direct employment for up to about 1,340 construction workers during the 51-month construction period, nearly 32 percent of the 4,120 cumulative workforce related to construction activities at the INL Site. The 588 operations staff under the maximum INL VTR Alternative (including the INL Reactor Fuel Production Options) would be about 7.4 percent of the 7,990 cumulative workforce related to annual operations at the INL Site. By comparison, about 157,400 people were employed in the INL Site ROI in 2018. In addition to the direct jobs, INL estimates that for every INL Site job, another 1.71 jobs (indirect jobs) are created in other industries (INL 2020b), as described in Chapter 4, Section 4.14.1.

Any migration of workers into the ROI is expected to be small when compared to the projected population of the ROI. Furthermore, any in-migration would be within the historical trends of population growth within the ROI. Due to the low potential for in-migration and changes to the ROI population, impacts on the availability of housing and community services under the Proposed Action are expected to be small. The overall contribution to cumulative socioeconomic impacts (e.g., housing, schools, and community services) from the Proposed Action on the ROI is also expected to be small. The increase in jobs and income levels would be considered a small and beneficial impact on the local and regional economies.

However, it is also important to mention the proposed UAMPS Small Modular Reactors project, which would be located at the INL Site within the socioeconomic impacts ROI. It is a relatively large project with a potentially overlapping construction period with the VTR project. Both adverse and beneficial socioeconomic impacts are anticipated from construction of the UAMPS. The UAMPS project is expected to require large construction and operations workforces – larger than the VTR project (see Table 5–9). One economic impact study estimates the construction workforce for the UAMPS project at 2,000 workers (annually), over a 4-year construction period and a permanent operations workforce of an additional 360 people (Idaho Policy Institute 2019). The combined labor requirements of the two projects, especially during construction, could require a potentially large in-migrating workforce (both projects would require special skill sets), many of whom would bring families. This would result in an increase in the local population. In addition to workers hired directly for project construction or operation, the in-migrating workforce could also include workers required to fill new indirect jobs created by the two projects. This population influx could put additional demands on existing housing supply and local community services (e.g., schools, fire and police, and hospitals). Potential cumulative impacts of both projects would range from small to moderate adverse impacts, at least in the short term, depending on the total number of new employees who move into the area and the existing capacity of local resources and services to accommodate them. Moderate beneficial socioeconomic impacts also would occur due to the increase in income and spending in the local and regional communities and associated tax revenue. Over the longer term, increased tax revenues could be used to offset increased strains on housing and community services by funding enhancements to appropriate services and facilities.

Although project details related to the recently proposed Department of Defense Prototype Advanced Mobile Nuclear Reactor have not yet been identified (including its final location at ORNL or the INL Site) the Notice of Intent implies that it would be constructed and operated within existing facilities and infrastructure and would not have significant labor requirements (85 FR 12273). If this is true, then any adverse socioeconomic impacts from this activity would be expected to be small, and its contribution to potential cumulative impacts at the INL Site would also be small.

5.3.13 Environmental Justice

The analysis in Chapter 4, Section 4.15, indicates no high and adverse human health and environmental impacts on any population within the ROI because of the Combined INL VTR Alternative and the INL Reactor Fuel Production Options. Impacts on minority and low-income populations would be comparable to those on the population as a whole and would be negligible. Because the doses from the Proposed Action at the INL Site would be small and there would be no disproportionate high and adverse impacts on minority and low-income populations, the Proposed Action would not substantially contribute to cumulative environmental justice impacts at the INL Site.

5.4 Oak Ridge National Laboratory

5.4.1 Land Use and Aesthetics

Land Use – Cumulative impacts on land use at ORR are presented in **Table 5–10**. Cumulative actions could occupy 12,250 to 12,450 acres of land, would be generally compatible with existing land use plans and allowable uses, and would not affect offsite land uses. Existing activities at the primary facility areas at ORR currently occupy about 11,600 acres. Many of the other present and reasonably foreseeable future actions identified in Table 5–1 and included in Table 5–10 would occur in industrial or otherwise well-developed areas at ORR (e.g., Y-12, ORNL) and would result in minor or no new land disturbance. One future action, the transfer of property to develop a general aviation airport at ETTP, would result in a net loss of 170 acres of ORR property.

Table 5–10. Cumulative Land Use Impacts at the Oak Ridge Reservation

Activity	*Land Use Commitment (acres)*[a]
Past, Present, and Reasonably Foreseeable Future Actions	
Existing Site Activities	11,600 [b, c]
ORNL Modernization Initiative (DOE 2008b:2-4)	22 [d]
U-233 Material Downblending and Disposition (DOE 2010e:2-3)	2
Environmental Management Disposal Facility (DOE 2017a:7-16)	53–135 [e]
Plutonium-238 Production for Radioisotope Power Systems (DOE 2000b:2-92)	10–66 [e]
NNSA Complex Transformation (DOE 2008a:3-22, 3-41, 3-51)	475
Ongoing and Future Operations at Y-12 (DOE 2016e:39)	75
Y-12 Emergency Operations Center Project (DOE 2015d:4-3)	2
Property Transfer to Develop a General Aviation Airport at ETTP (DOE 2016d:2-1)	-170 [f]
Stable Isotope Production and Research Center (DOE-ORNL 2020b:2)	1
Second Target Station at the Spallation Neutron Source (DOE-ORNL 2020a)	9
Subtotal – Baseline Plus Other DOE Actions	**12,100–12,300**
ORNL VTR Alternative	150 [g]
Total	**12,250–12,450**
Site Capacity	32,867 [c]

ETTP = East Tennessee Technology Park; NNSA = National Nuclear Security Administration; ORNL = Oak Ridge National Laboratory.

[a] Acreages include areas cleared or used for construction staging areas in addition to operational areas.

Activity	Land Use Commitment (acres)[a]

[b] DOE classifies land use on ORR into five categories: Institutional/Research, Industrial, Mixed Industrial, Institutional/Environmental Laboratory, and Mixed Research/Future Initiatives.
[c] From Chapter 3, Section 3.2.1.
[d] New construction is a combination of disturbed, previously disturbed, and undisturbed areas at ORR.
[e] This figure includes the minimum and maximum values from various alternatives of the proposed actions.
[f] DOE currently plans to transfer the property to the Metropolitan Knoxville Airport Authority using the GSA "Public Benefit Conveyance" process.
[g] From Chapter 2, Section 2.5.

Within the boundaries of ORR, the cumulative land use of 12,250 to 12,450 acres would involve about 37 to 38 percent of the 32,867 acres that comprise ORR. Activities evaluated in this EIS for the ORNL VTR Alternative would disturb a maximum of 150 acres, or about 1.2 percent of the 12,250 to 12,450 acres of developed land at ORR and about 0.5 percent of the 32,867 acres of land available at ORR. Therefore, the land used for construction and operation of the VTR and associated facilities at ORNL would not substantially contribute to cumulative land use impacts.

Proposed by the Tennessee Valley Authority, the Clinch River Small Modular Reactors Project has the potential to impact land use in proximity to ORR. Development at the Clinch River Nuclear Site, adjacent to ORR, would result in moderate land use impacts. This is due to the conversion of substantial areas of undeveloped naturally vegetated land to a developed condition and the long-term dedication of a 935-acre tract of federally owned land to an industrial setting that would have otherwise been available for other industrial or urban uses. This change in land use would not destabilize land resources in the region because the changes would take place in an area where energy generation and development projects are common and would not be incompatible with existing land uses. Nor would these changes substantially interfere with anticipated regional growth (NRC 2019:4-9).

Aesthetics – Several of the actions identified in Table 5–1 involve the alteration of existing ground conditions or the construction of new facilities at ORNL with the potential to change the overall visual character of areas within the viewshed (**Table 5–11**). For many of the actions identified in Table 5–11, construction activities would create short-term visual impacts, but would not be out of character for an industrial site and would not be visible from public areas outside ORR. The information in Table 5–11 indicates that because of the geographic separation between the various activities, valley and ridge topography, predominantly forested landscape, location of many of the activities in industrial areas, and the nature of the activities, there would be little cumulative impacts on aesthetics at ORR. Only three of these actions involve the construction of new facilities at ORNL, which once completed, would be consistent with the industrialized character of the area. Because construction of the VTR and associated facilities would disturb only 150 acres and would be geographically and topographically separated from most of the other activities at ORR, the Proposed Action would not substantially contribute to cumulative aesthetics impacts at ORR.

Table 5–11. Reasonably Foreseeable Actions at the Oak Ridge Reservation with Potential to Affect Aesthetics

Activity	Location	Acres	Potential Visual Resources/Aesthetic Impact as Assessed in NEPA Document
ORNL Modernization Initiative (DOE 2008b:4-2)	ORNL – Bethel Valley, Melton Valley	22	Demolition and construction would change the current visual landscape. Architectural consistency would be created within Bethel Valley and Melton Valley, to the extent practicable, to ensure blending of construction with existing structures.
U-233 Material Downblending and Disposition (DOE 2010e:3-22)	ORNL	2	Minor impacts during construction are expected. No impacts on visual resources in modifications incorporated into existing systems are likely.

Activity	Location	Acres	Potential Visual Resources/Aesthetic Impact as Assessed in NEPA Document
Environmental Management Disposal Facility (DOE 2017a:7-32)	Multiple	135	The proposed facility would be visible from Bear Creek Road, western parts of Y-12, Chestnut Ridge, and Pine Ridge. Because Bear Creek Road is not a public thoroughfare and Chestnut Ridge and Pine Ridge are restricted access, there would be no short-term visual impacts from public viewpoints.
Plutonium-238 Production for Radioisotope Power Systems (DOE 2000b:2-91)	ORNL	66	If alternatives involving construction were chosen, a site-specific evaluation of visual resources would be conducted before site selection. This could result in reclassification under BLM guidelines.
NNSA Complex Transformation (DOE 2008a:5-317, 5-318)	Y-12	475	Short-term construction impacts are expected. Y-12 would remain a highly developed area with an industrial appearance, and no change to the VRM classification would be expected.
Ongoing and Future Operations at Y-12 (DOE 2016e:39)	Y-12	75	Y-12 would remain a highly developed area with an industrial appearance, and there would be no change to the VRM Class IV, which is used to describe a highly developed area.
Y-12 Emergency Operations Center Project (DOE 2015d:4-26)	Y-12	2	This one-story structure would not impact Y-12's visual character. Y-12 would remain a highly developed area with an industrial appearance, and no change to the VRM classification would be expected.
Stable Isotope Production and Research Center (DOE-ORNL 2020b:2)	ORNL	1	No visual resources impact analysis. The proposed facility would be located in a highly developed industrial area.
Second Target Station at the Spallation Neutron Source (DOE 1999a:5-47)	ORNL	9	The station is not visible to the public. Startup of the Proposed Action at the Spallation Neutron Source at ORNL would have minimal effects on visual resources.

BLM = Bureau of Land Management; VRM = Visual Resource Management.

[a] Includes the minimum and maximum values from various alternatives of the proposed actions.

5.4.2 Geology and Soils

As described in Section 5.4.1, Table 5–10, cumulative land disturbance at ORR could total 12,250 to 12,450 acres, or about 38 percent of the total land area at ORR of 32,867 acres. The maximum amount of land disturbed under the ORNL VTR Alternative is 150 acres or 1.2 percent of the total amount of land disturbed. When land is disturbed, the native soil structure is destroyed. Based on the information presented in Section 5.4.1, the maximum amount of soil disturbed under the ORNL VTR Alternative would be a small percentage of the total soil disturbed at ORR and would not substantially contribute to cumulative impacts.

As shown in **Table 5–12**, cumulative geologic and soils materials used for construction projects at ORR could total 1,450,000 cubic yards. The maximum amount of geologic and soils materials used under the ORNL VTR Alternative would be 187,000 cubic yards or about 13 percent of the total amount of geologic and soils materials that would be used by these other activities at ORR.

Table 5–12. Cumulative Geology and Soils Impacts at the Oak Ridge Reservation

Activity [a]	*Geologic and Soils Materials (cubic yards)*
Past, Present, and Reasonably Foreseeable Future Actions	
Existing Site Activities	Unknown [b]
Environmental Management Disposal Facility (DOE 2017a:2-12)	839,000
Ongoing and Future Operations at Y-12 (DOE 2011c:3-18)	5,000
Second Target Station at Spallation Neutron Source (DOE-ORNL 2020a:4)	430,000
Subtotal – Baseline Plus Other Actions	**1,274,000**
ORNL VTR Alternative [c]	187,000
Total [d]	**1,460,000**

Activity [a]	Geologic and Soils Materials (cubic yards)

[a] Activities are from Table 5–1. Only those activities with available estimates of geologic and soil materials use are listed.
[b] The amount of geologic and soils material used by existing site development is unknown.
[c] Impact indicator value is from Chapter 4, Section 4.2.2.
[d] Total rounded to three significant figures.

5.4.3 Water Resources

As described in Chapter 4, Section 4.3.2, no effluent would be discharged directly to groundwater, and no groundwater would be withdrawn during operation of the ORNL VTR Alternative, except shallow groundwater withdrawn during dewatering. Excavation activities in the project construction phase could encounter groundwater due to the water table's depth of about 5 to 20 feet below grade in Melton Valley. Dewatering would temporarily discharge uncontaminated groundwater through outfalls to surface water. Because of the short duration and localized extent of this activity, dewatering would not be expected to substantially contribute to cumulative water resources impacts at ORR. Therefore, the Proposed Action would not substantially contribute to cumulative groundwater impacts at ORR.

Construction activities associated with building structures or modifying existing buildings could adversely affect surface waters. Potential impacts could include increased sedimentation from clearing activities, ground disturbance, and increased vehicle and human traffic. Increased vehicle use near surface waters during construction phases of a project could also impact water quality through accidental releases of petroleum, oil, lubricants, or stormwater runoff introducing such contaminants to surface water resources. Long-term and permanent cumulative impacts from construction could include the placement of fill in surface waters or wetlands. Table 5–10 shows the total amount of land disturbed by the other activities at ORR, and Section 5.4.1 summarizes the cumulative land use effects of the ORNL VTR Alternative, which could in turn indirectly affect surface water resources, including those from which drinking water is drawn. The construction phases for the other activities listed in Table 5–1 generally would occur at different times, at different locations, and be of short duration. This would reduce the overall cumulative effect of these construction activities on surface water quality.

This staggering of construction activities helps ensure that cumulative surface water use during construction of all present and reasonably foreseeable projects would not substantially add to cumulative impacts on surface water at ORNL.

As discussed in Chapter 4, Section 4.3.1.3, potable water for ORR is supplied by the Clinch River and treated at the Oak Ridge Water Treatment Plant. **Table 5–13** summarizes the volume of surface water required by existing onsite activities combined with the estimated water requirements of the ORNL VTR Alternative and information from the operation phase of other past, present, and reasonably foreseeable actions across ORR. The cumulative surface water requirements would represent about 36 percent of the Oak Ridge Water Treatment Plant's capacity and about 0.4 percent of the 1 trillion gallons per year (4,400 cubic feet per second) average annual flow of the Clinch River at Melton Hill Dam (DOE 1996c:2-10). Water use under the ORNL VTR Alternative would be less than 0.1 percent of the cumulative surface water use for ORR and would not substantially contribute to cumulative impacts on surface water availability.

As described in Chapter 4, Section 4.3.1.3, no contaminated effluent would be discharged directly to surface water during operation of the ORNL VTR Alternative. Therefore, the Proposed Action would not contribute to cumulative impacts on surface water quality during operations at ORR.

Table 5–13. Cumulative Surface Water Use During Operation of Past, Present, and Reasonably Foreseeable Actions at Oak Ridge Reservation

Activity	*Surface Water Use (gallons per year)*
Past, Present, and Reasonably Foreseeable Future Actions [a]	
Existing Site Activities	3,754,000,000
U-233 Material Downblending and Disposition Project (DOE 2010e:3-3)	1,100,000
NNSA Complex Transformation (DOE 2008a:5-320, 5-334)	404,000,000
Ongoing and Future Operations at Y-12 (DOE 2016e:33, 41)	105,000,000
Subtotal – Baseline Plus Other Actions	**4,264,000,000**
ORNL VTR Alternative [b]	4,400,000
Total [c]	**4,270,000,000**
Capacity of Oak Ridge Water Treatment Plant	11,700,000,000

ORNL = Oak Ridge National Laboratory.
[a] Activities are from Table 5–1. Only those activities with available estimates of surface water use are listed.
[b] Impact indicator value is from Chapter 4, Section 4.3.1.3.
[c] Total rounded to three significant figures.

5.4.4 Air Quality

The region surrounding ORNL currently is in compliance with all State and national ambient air quality standards. The air quality cumulative impacts analysis estimates the potential for emissions from the ORNL VTR Alternative, in combination with emissions from other past, present, and reasonably foreseeable future actions, to exceed an ambient air quality standard. Radiological emissions are discussed in Section 5.4.10.

As described in Chapter 4 Section 4.4.2.1 of this VTR EIS, construction activities from the ORNL VTR Alternative would generate emissions. Emissions would be from the use of fossil fuel-powered equipment and trucks, workers' commuter vehicles, and fugitive dust (particulate matter) due to the operation of equipment on exposed soil. The data in Table 4–7 show that peak annual emissions from construction of the VTR facilities would be well below the annual indicator thresholds. The intermittent operation of construction emission sources over an area of 150 acres would result in dispersed concentrations of air pollutants adjacent to construction activities. The transport of any construction emissions from the VTR site to the nearest ORR boundary (about 0.5 miles) would produce additional dispersion and would result in inconsequential concentrations of air pollutants beyond the ORR property boundary. Therefore, in combination with emissions from other past, present, and reasonably foreseeable future actions, the minor increase in offsite air pollutant concentrations produced from construction of the VTR and associated facilities would not result in air pollutant concentrations that would exceed the State and national ambient air quality standards. Emissions from construction activities related to the ORNL VTR Alternative would not substantially contribute to cumulative air quality impacts.

Emissions from construction trucks transporting materials, equipment, and wastes, and from workers' commuter vehicles, would produce low concentrations of air pollutants along public roadways. These low concentrations are primarily because of the intermittent use of vehicles and equipment and their low emission rates. Because these air pollutant concentrations would be low, offsite on-road construction vehicle activities from the ORNL VTR Alternative would not substantially contribute to cumulative air quality impacts.

As described in Chapter 4, Section 4.4.2.2, operational activities from the ORNL VTR Alternative would generate emissions from intermittent use of diesel-powered backup electrical generators, intermittent use of propane-fired heaters for the VTR sodium heat exchanger system during maintenance activities, diesel-powered trucks that deliver material and transport wastes, and workers' commuter vehicles. The data in Table 4–8 show that operation of the ORNL VTR Alternative would produce minor amounts of air emissions. In addition, the PTE for the generator units based on 500 hours of operation would produce insignificant emissions (less than 5 tons per year for criteria pollutants and less than 1,000 pounds per year for an individual HAP), as defined in Chapter 1200-03-09 of the Tennessee Air Pollution Control Regulations. Transport of these emissions to the ORR boundary would produce negligible ambient air pollutant concentrations at offsite locations. Therefore, the minor increase in offsite air pollutant concentrations produced from operations, in combination with emissions from other past, present, and reasonably foreseeable future actions, would result in air pollutant concentrations that would not exceed the State and national ambient air quality standards. Emissions from operations activities related to the ORNL VTR Alternative would not substantially contribute to cumulative air quality impacts.

5.4.5 Ecological Resources

For the cumulative impacts analysis, the ROI for ecological resources expands to include the proposed project area and nearby areas that could potentially be affected under the ORNL VTR Alternative when combined with other past, present, and reasonably foreseeable future actions. Table 5–10 in Section 5.4.1, is a tabulation of cumulative land disturbance at ORNL. Cumulative impacts to ecological resources at ORNL could total 12,269 to 12,407 acres or about 37 percent of the total land area at ORNL of 33,259 acres.

Cumulative impacts on ecological resources could occur including temporary and permanent disturbance and degradation or loss of habitat from land-clearing activities. The disturbance or displacement of wildlife due to an increase in noise and human activity near construction activities (behavior avoidance), and the fragmentation of remaining habitats resulting from project developments are also potential cumulative impacts. Also included are the increases in human-wildlife encounters and collisions between wildlife and motor vehicles from wildlife displaced from their habitat by construction activities and possibly made more susceptible to predation and intra-species competition and less able to obtain adequate food and cover.

Cumulative activities could increase the amount of overall habitat loss from vegetation removal and could potentially lead to habitat degradation. Direct impacts could include permanent and temporary impacts on wildlife due to an increase in noise and human activity near construction activities and the loss of habitat from land-clearing activities that could result in habitat fragmentation. Construction activities could also result in potential increases in collisions between wildlife and motor vehicles. Indirect impacts would include an increased potential for the spread of invasive species due to soil disturbance (creating open habitat for invasive species establishment). It is anticipated that impacts on vegetation, wildlife, and special status species from the activities listed in Table 5–1 would be similar to those for the Proposed Action as described in Chapter 4, Section 4.5.

Operational and administrative controls (as described in Section 4.5) will be evaluated and implemented, if warranted, for the ORNL VTR Alternative and other actions to reduce the potential for adverse impacts to wildlife (including migratory birds and special status species) and their habitats. Increased vehicle activity during operations could potentially increase the risk for wildlife strikes by vehicles. Operational and administrative controls include daily and seasonal timing of project activities, posting of signs with reduced speed limits, ultrasonic warning whistles, encouraging animals to not use the road or construction area, and preemptive awareness programs for construction crews.

Trees and other vegetation subject to clearing could support foraging, nesting, and other behaviors for mammals, birds (including migratory birds and BCC), amphibians, and reptiles. Land clearing would cause disturbances in the landscape resulting in new habitat edges, potentially disrupting wildlife ecosystem processes and habitats. Any habitat loss could adversely affect individual animals. For less mobile species, such as amphibians and insects, there is the potential for cumulative impacts to affect local populations.

Cumulative land disturbance accounts for about 37 to 38 percent of the land area at ORNL and would be substantial given the extent of habitat affected. Various special and sensitive natural resource areas (i.e., NA, RA, and HA) recognized in the Research Park could be impacted, as well as long-term research opportunities and on-going studies that have occurred within these unique habitats. Species monitoring and management for the area would be administered through the *Wildlife Management Plan for the Oak Ridge Reservation* (ORNL 2020e), and coordinated amongst the ORNL Natural Resources Program, Hemlock Conservation Partnership, and regulatory agencies (e.g., USFWS, USACE, TDEC, and the Tennessee Wildlife Resources Agency [TWRA]), which would confer the continued protection of any sensitive ecological resources. Invasive species management would continue to be implemented through the *Invasive Plant Management Plan for the Oak Ridge Reservation* (ORNL 2017).

Cumulative impacts on ecological resources could be substantial given the total amount of land subject to ground disturbance and land clearing on ORNL. However, the Proposed Action and other past, present, and reasonably foreseeable future actions would occur at different locations and times. Appropriate mitigations (such as wetland mitigation) would be enforced. Land-clearing activities would temporarily and permanently affect vegetation. However, these impacts would generally be evaluated as minor due to the availability of forested-hardwood habitats within the ORNL and intermountain regions of Appalachia. The loss of habitat associated with the Proposed Action would account for less than 1 percent (0.6 percent) of the 24,000 acres of forested-hardwood habitat and less than 1 percent of the 4,100 acres of interior forest available within the ORNL, and thus would represent a small portion of the cumulative impacts on ecological resources at ORNL. However, ongoing assessments of ORNL's ecological resources suggest that in-kind mitigation (i.e., protection or enhancement of ecologically similar resources) could be required due to impacts and may entail greater acreage than available elsewhere on ORNL (ORNL 2020d).

It is anticipated that up to 37 hemlock trees would be disturbed under the Proposed Action. In Tennessee, hemlock trees are voluntarily protected as part of the Hemlock Conservation Partnership (TWRF 2018). Invasive species management would continue to be applied through the Invasive Plant Management Program.

Under the Proposed Action and other actions, species-specific surveys would need to occur to determine an accurate measure of the severity of effects to special status species. DOE would be required to consult with the USFWS Tennessee Ecological Services Field Office under Section 7 Interagency Cooperation regarding potential impacts on federally listed species protected under the ESA. Additionally, DOE would be required to consult with TWRA and TDEC regarding State-listed species of special concern. TWRA conducts wildlife management activities on the ORR through an agreement with DOE. The ORNL Natural Resources Management Program also has ORR wildlife management responsibilities under a DOE assigned task. Mitigation for Federal and State-listed species, aquatic features (including wetlands, seeps, and active springs) and sensitive habitats may also be required. DOE will be required to consult with the USFWS about the potential impacts to migratory birds from the Proposed Action and other actions. In accordance with the USFWS Mitigation Policy, DOE would be required to evaluate ways to avoid or minimize any such impacts (DOE 1999b:6-11, 6-12). Potential impacts to aquatic resources would require wetland delineations (USACE 1987), stream evaluations (TDEC 2019b), and hydrologic determinations of currently unclassified channels and wet weather conveyances (TDEC 2020a). Any potential Exceptional Tennessee Waters will require additional assessment using the Tennessee Rapid Assessment Method, as required by the TDEC. Evaluation of aquatic resources at proposed mitigation sites might also be required to assess adequate mitigation actions (TDEC 2015, 2019b). A Section 404 wetland permit from USACE would be required before any construction work in jurisdictional streams. Compensatory mitigation would be required for any unavoidable impacts resulting from the Proposed Action and other actions.

5.4.6 Cultural and Paleontological Resources

Damage to the nature, integrity, and spatial context of cultural resources can have a cumulative impact if the initial act is compounded by other similar losses or impacts. The alteration or damage to cultural resources may incrementally impact resources in and around ORNL.

As described in Chapter 3, Section 3.2.6, there are no significant cultural resources in the APE for the Proposed Action at ORNL. Therefore, cumulative impacts on cultural resources within the ROI would be negligible because of the lack of important cultural resources within the APE and due to the necessity of following the Section 106 process for all activities.

5.4.7 Infrastructure

Table 5–14 lists the estimated annual cumulative infrastructure requirements from operations at ORR for electricity and water. Projected cumulative site activities would annually require about 1,440,000 to 1,520,000 megawatt-hours of electricity, which is well within the total site-wide capacity of 13,880,000 megawatt-hours. Cumulative water usage would be about 4,270 million gallons of water, which is well within the site-wide capacity of 11,715 million gallons per year. Operation of the VTR and associated facilities at ORNL would use about 180,000 megawatt-hours of electricity and about 4.4 million gallons of water per year, which represents a fraction of cumulative infrastructure use and an even smaller fraction of total site capacity. Therefore, operation of the VTR and associated facilities at ORNL would not substantially contribute to cumulative infrastructure impacts.

While there is adequate capacity for electric needs at ORR, two offsite projects could have an impact on the availability of electricity in the region. Bull Run Fossil Plant, located on Bull Run Creek near Oak Ridge, has a summer net capability of 865 megawatts and generates about 6 billion kilowatt-hours of electricity a year, enough to supply 400,000 homes. After a detailed review that included public input, TVA approved the retirement of the Bull Run Fossil Plant by December 2023 (TVA 2020a).

In December 2019, TVA obtained approval for an early site permit from the U.S. Nuclear Regulatory Commission to potentially construct and operate small modular reactors on the 935-acre Clinch River Nuclear Site, adjacent and southwest of ORR. The facility would be capable of producing up to 800 megawatts. However, there is an extended timetable for facility construction, as TVA will have up to 20 years, with a possibility of an extension, to make a decision to pursue the construction of the reactors (TVA 2019).

Table 5–14. Annual Cumulative Infrastructure Impacts from Operations at the Oak Ridge Reservation

Activity	***Electricity Consumption (megawatt-hours per year)***	***Water Usage (gallons per year)***
Past, Present, and Reasonably Foreseeable Future Actions		
Existing Site Activities	726,000	3,754,000,000
U-233 Material Downblending and Disposition Project (DOE 2010e:3-3)	Not available	1,100,000
NNSA Complex Transformation (DOE 2008a:5-320, 5-334)	268,000	404,000,000
Ongoing and Future Operations at Y-12 (DOE 2016e:33, 41)	270,000–350,000 [a]	105,000,000
Subtotal – Baseline Plus Other DOE Actions	**1,260,000–1,340,000**	**4,264,000,000**
ORNL VTR Alternative	180,000 [b]	4,400,000 [b]
Total [c]	**1,440,000–1,520,000**	**4,270,000,000**
Total Site-wide Capacity	13,880,000	11,700,000,000

NNSA = National Nuclear Security Administration; ORNL = Oak Ridge National Laboratory.

[a] Total is a range that includes the minimum and maximum values from various alternatives of Proposed Action.

[b] From Chapter 4, Section 4.7.2.

[c] Total is rounded to three significant figures.

5.4.8 Noise

The analysis of cumulative noise impacts evaluates perceptible increases in ambient noise levels and increases of excessive ground-borne vibration to persons or property in the ROI. The ROI for noise extends 0.5 miles from the edge of the construction area. As discussed in Chapter 3, Section 3.2.8.3, the closest offsite receptors include residential homes more than 1.25 miles to the east and across the Clinch River in Knox County. As a result, the cumulative impacts analysis considers the onsite noise-sensitive receptors to include ORNL workers present onsite and within 0.5 mile from the edge of the construction area. Most existing and planned projects at ORR listed in Table 5–1 would occur at different locations and at different times and would not contribute to cumulative noise effects in combination with the proposed VTR activities.

Most of the potential impacts from noise would be short-term and aligned with the construction phase of a project, including construction equipment and vehicles. Examples of construction noise levels (given in Chapter 4, Section 4.8.2.1) include measurements at 50 feet of 80 dBA from excavators, 85 dBA from tractors and bulldozers, and 89 dBA from graders. Although construction noise can be moderately loud, the temporary and intermittent nature of the construction activities would not result in long-term cumulative impacts. As discussed in Section 4.8.3.1, noise levels fluctuate depending on the type, number, and duration of use of heavy equipment for construction activities, and differ by the type of activity, distance to noise-sensitive receptors, existing site conditions (topography and vegetation to diminish the sound), and ambient noise levels. Additionally, construction activities are generally limited to daylight hours in conformance with Federal, State, and local codes and ordinances, and manufacturer-prescribed safety procedures and industry practices. Most of the reasonably foreseeable future actions listed in Table 5–1 would not occur at the same location and at the same time as the proposed project. However, if they did overlap, there would be a short-term cumulative impact on onsite receptors (e.g., ORNL workers) due to increased noise during construction activities.

During operation, cumulative impacts include the potential for perceptible increases in ambient noise levels at sensitive receptors (e.g., ORNL workers). For some projects listed in Table 5–1, operations could cumulatively increase noise due to facility operations and additional vehicle trips.

The closest offsite receptors include residential homes more than 1.25 miles to the east and across the Clinch River in Knox County. Given the large distance, cumulative noise from construction or operation of projects at ORNL and other locations within ORR would be indistinguishable from background at the closest offsite noise-sensitive receptors. See Section 4.8.3 for additional information about potential noise levels at the closest offsite receptor.

5.4.9 Waste Management

The assessment of the waste management cumulative impacts at ORR includes the ORNL VTR Alternative and other reasonably foreseeable actions that result in the generation, treatment as required, and disposal of LLW, MLLW, and TRU waste. **Table 5–15** summarizes the estimated cumulative annual generation rates of these wastes. Additional reasonably foreseeable actions are identified in Section 5.2, Table 5–1. As noted in Table 5–1, some of these activities are ongoing and the waste generated by these activities are included in the existing site activities' waste generation rates for ORR. For some of the activities identified as proposed, there is no waste generation information currently available. For some activities, waste generation was described as "small quantities." Therefore, these other DOE actions were covered as a group and the LLW, MLLW, and TRU waste annual generation rates characterized as "small quantities" in Table 5–15 below.

Table 5–15. Cumulative Average Annual Waste Generation Rates at the Oak Ridge Reservation in Cubic Meters

Activity	*LLW*	*MLLW*	*TRU Waste*
Past, Present, and Reasonably Foreseeable Future Actions			
Existing Site Activities [a]	81,000	700	140
Other DOE Actions	Small Quantities	Small Quantities	Small Quantities
Subtotal – Baseline Plus Other DOE Actions	81,000	700	140
ORNL VTR Alternative [a]	540	38	0.89
Subtotal for VTR	540	38	0.89
Total	82,000	740	140

LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; TRU = transuranic waste.

[a] Source: Section 4.9.2.2, Table 4-35. ORNL VTR Alternative wastes are average annual generation rates based on a 60-year operation cycle.

Note: All numbers are rounded to two significant figures. Due to rounding, sums and products may not equal those calculated from table entries.

The characteristics of the newly generated wastes are estimated to be similar to the wastes currently generated by existing activities. As described in Chapter 4, Section 4.9.2.2, the waste management infrastructure at ORR was developed to support the quantities of waste generated. Therefore, cumulative waste generation would be within site capacities. There are existing offsite DOE and commercial waste management facilities with sufficient total capacities for the treatment and disposal needs of the relatively small volumes of LLW and MLLW wastes generated by the Proposed Action. Therefore, substantial cumulative impacts on offsite LLW and MLLW treatment and disposal facilities would not be expected. See Section 5.3.9 for a discussion of the impacts of TRU waste disposal at the WIPP facility.

5.4.10 Human Health – Normal Operations

Cumulative impacts on public health and safety from radiological emissions could result from activities at ORR and potentially from other activities within the ORR ROI (50 miles from the ORR boundary) that could impact worker and public health. The actions identified in Table 5–1 were reviewed to identify those that could have a worker and public health impact. **Table 5–16** shows information on the potential impacts of the present ORR operations (from Chapter 3, Section 3.2.10.1 of this VTR EIS), reasonably foreseeable future actions, and the Proposed Action. This table includes those actions identified in Table 5–1 that could contribute to worker and the public (population and MEI) dose and potential LCFs. Only those activities that have identified radiological impacts with available estimates of radiation exposure are listed. Some of the actions identified in Table 5–1 would be expected to have radiological impacts, but estimates were not available. At ORR, these actions are the Stable Isotope Production and Research Center, the Transformational Challenge Reactor, the Oak Ridge Integrated Facility Disposition Project, and the Construction and Demonstration of a Department of Defense Prototype Advanced Mobile Nuclear Reactor.

The cumulative offsite population dose would be 94 person-rem per year with no expected LCFs (calculated value of 0.06). Operation of the VTR and associated facilities at ORR would result in a total population dose of 0.58 person-rem per year with no expected LCFs (calculated value of 0.0004). The total dose and LCFs from the Proposed Action would be less than 1 percent of the cumulative dose and LCFs and, for that reason, would not substantially contribute to cumulative human health impacts at ORR.

Table 5–16. Annual Cumulative Population Health Effects of Exposure to Radiation from Normal Operations at the Oak Ridge Reservation

Activity	*Workforce*		*Population within 50 Miles*		*MEI*	
	Dose (person-rem	***Annual LCF [a]***	***Dose (person-rem)***	***Annual LCF [a]***	***Dose (millirem)***	***Annual LCF Risk [a]***
Past, Present, and Reasonably Foreseeable Future Actions						
Existing Site Activities (baseline) [b]	72	0.04	12	0.007	2.4	1×10^{-6}
RPS Infrastructure [c]	12	0.005	8.8×10^{-5}	4.6×10^{-8}	1.9×10^{-6}	9.4×10^{-13}
U-233 Downblending and Disposition [d]	NC	NC	NC	NC	0.3	2×10^{-7}
Future Y-12 Operations [e]	NA	NA	-0.5	-0.0004	-0.06	-4×10^{-8}
Second Target Station at the Spallation Neutron Source [f]	0.018	1×10^{-5}	10	0.006	1.1	7×10^{-7}
Subtotal – Baseline Plus Other Actions	**84**	**0.05**	**22**	**0.01**	**3.7**	$\mathbf{2\times10^{-6}}$
ORNL VTR Alternative	44	0.03	0.58	0.0004	0.031	2×10^{-8}
Total for Oak Ridge Reservation	**130**	**0.08**	**222**	**0.01**	**3.8**	$\mathbf{2\times10^{-6}}$
Clinch River Site for Small Modular Reactors [g]	–	–	68	0.04	11	7×10^{-6}
Watts Bar Nuclear Facility [h]	–	–	3.8	0.002	5.8	3×10^{-6}
Total for Region of Influence	**–**	**–**	**94**	**0.06**	**--**	**--**

LCF = latent cancer fatality; MEI = maximally exposed individual; NA = not applicable; NC = not calculated; NNSA = National Nuclear Security Administration; ORNL = Oak Ridge National Laboratory; RPS = Radioisotope Power System; Y-12 = Y-12 National Security Complex; U-233 = uranium-233.

[a] LCFs are calculated using a conversion factor of 0.0006 LCFs per rem or person-rem (DOE 2003). The annual LCFs for the analyzed population represent the number of LCFs calculated by multiplying the listed doses by the risk conversion factor; no population LCFs are expected from any individual activity or from all combined activities. The annual MEI LCF risk represents the calculated risk of an LCF to an individual.

[b] From Chapter 3, Section 3.2.10.1 of this EIS. Worker dose is the average for 2014 to 2017.

[c] Impacts from the alternative with the highest impacts in *Final PEIS for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the* FFTF (DOE 2000b:Table 4-165).

[d] From the *Environmental Assessment for U-233 Material Downblending and Disposition Project at the Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE 2010e:3-28).

[e] The *Final Site-Wide Environmental Impact Statement for the Y-12 National Security Complex* shows a reduction in the MEI and offsite population doses from enactment of any of the action alternatives. The reduction is due to the closure of a uranium facility, reduced quantities of material being processed, and expected safety improvements associated with operation of the new facility. The values listed in this table are the reductions in doses from current operations identified for the capability-sized uranium processing facility. (A supplement analysis for the site-wide EIS examined a new Proposed Action (a combination of facility upgrades and new facilities) that would have similar impacts as the capability-sized uranium processing facility alternative from the Site-Wide EIS (DOE 2016e:Table 4-1). Worker doses from this action are for Y-12 workers and are not applicable to the ORNL workforce.

[f] Impacts are the difference between the 1-megawatt (one target station) and 4-megawatts (two target stations) options identified in the *Final Environmental Impact Statement Construction and Operation of the Spallation Neutron Source* (DOE 1999a:Table 5.2.9.2.1-1; DOE-ORNL 2020a). Worker doses are to uninvolved workers, and no impact was identified for involved workers.

[g] Values are for a site with 4 modular reactors from the *Environmental Impact Statement for an Early Site Permit (ESP) at the Clinch River Nuclear Site* (NRC 2019:Table 5-8, Section 5.9.3.2, pg 5-61). The EIS states that the impacts from radiation exposure to the operations workforce would be small. Additionally, the Clinch River Nuclear Site workforce is separate from that at ORR. Therefore, worker impacts are not presented.

[h] From the Watts Bar, Units 1 and 2, 2018 Annual Radioactive Effluent Release Report ML19120A075 30 April 2019 (Watts Bar 2019:Tables 6A to D, 7A to D, 8A). The Watts Bars' workforce is separate from that at ORR, so worker impacts are not presented here.

The cumulative MEI dose for activities at ORR would be 3.8 millirem per year with an LCF risk of 2 x 10^{-6}. This cumulative MEI dose is lower than the DOE limit of 100 millirem per year from all pathways (DOE Order 458.1 [DOE 2011b]). It is also lower than the EPA individual dose limit of 10 millirem per year from airborne radionuclides (40 CFR Part 61 subpart H [54 FR 51695]). The MEI dose conservatively assumes the same person would be the MEI for all activities at ORR but does not include doses from the Watts Bar Nuclear Facility and Clinch River Site for Small Modular Reactors. It is unlikely the same person would be the MEI for all these activities because the activities occur at different locations, each with an MEI located at different offsite locations. Operation of the VTR and associated facilities at ORR would result in a total MEI dose of 0.031 millirem per year with an LCF risk of 2 x 10^{-8}. The total MEI dose and LCFs from the Proposed Action would be about 1 percent of the cumulative MEI dose and LCFs. Therefore the cumulative MEI dose for VTR activities would not substantially contribute to cumulative human health impacts at ORR.

The cumulative worker dose would be 130 person-rem per year with no expected LCFs (calculated value of 0.08). Operation of the VTR and associated facilities at ORR would result in a total worker dose of 44 person-rem per year with no expected LCFs (calculated value of 0.03). The total worker dose and LCFs from the Proposed Action would be 34 percent of the cumulative dose and LCFs. This could result in 2 worker LCFs from 60 years of VTR operation. 10 CFR 835 requires DOE "to develop and implement plans and measures to maintain occupational radiation exposures as low as is reasonably achievable" (ALARA). DOE-STD-1098-2017, DOE Standard Radiological Control (DOE 2017f) identifies an effective ALARA process as including implementation of both engineered and administrative controls to control worker dose. All equipment and operations would be designed and implemented following this principle. Therefore, needed worker protection could be incorporated into the final design potentially reducing worker doses.

5.4.11 Traffic

As described in Chapter 4, Section 4.13.2, the impacts on traffic from construction and operation of facilities under the ORNL VTR Alternative are anticipated to be negligible to minor. As such, impacts to traffic from this alternative would not substantially contribute to cumulative traffic impacts. Therefore, they are not discussed further.

5.4.12 Socioeconomics

The ROI for cumulative impacts on socioeconomics includes the four-county area near ORNL: Anderson, Knox, Loudon, and Roane counties in Tennessee. As shown in **Table 5–17**, cumulative employment at ORR from past, present, and reasonably foreseeable future actions could reach a peak of about 15,200 persons. This peak is about 4.7 percent of the 320,327 people employed in the ORR ROI, including ORNL, in 2019. These values are conservative estimates of short-term future employment at ORR. Some of the employment would occur at different times and it may not be appropriate to total these values. The employment totals from existing site activities include existing onsite employment (directly employed and contractor staff) and potential future employees based on activities identified in Table 5–1 and carried over to Table 5–17.

Table 5–17. Cumulative Employment at the Oak Ridge Reservation

Activity	*Direct Construction Employment (number of personnel in peak year)*	*Direct Operations Employment (first year of operation)*
Past, Present, and Reasonably Foreseeable Future Actions [a]		
Existing site Activities [b]	Not Applicable	14,300
Environmental Management Disposal Facility (DOE 2017a:7-36, 7-47)	Specific numbers not included but construction workforce would be small, occur in stages, and result in minimal worker influx	Specific numbers not included but operation workforce would be small, occur in stages, and result in minimal worker influx
Transformational Challenge Reactor (DOE-ORNL 2020c)	No staffing estimates available; however, assumed to be minimal given small reactor size, short operating period, and location within existing building	

Activity	Direct Construction Employment (number of personnel in peak year)	Direct Operations Employment (first year of operation)
Construction of a Second Target Station for the Spallation Neutron Source (DOE 1999a:3-14, 3-26)	480 (peak) 166 (full-time annual)	180 (visiting scientists not included)
ORR Subtotal – Baseline Plus Other Actions	**480 (peak)**	**14,500**
ORNL VTR Alternative [c]	1,598	300
ORR Subtotal	**2,078**	**14,800**
Offsite Projects		
Property Transfer for General Aviation Airport at ETTP (DOE 2016d, 2016h)	Not Applicable	5
Bull Run Fossil Plant (Huotari 2019)	Not Provided	-100 to -125
Clinch River Site for Small Modular Reactors (NRC 2019:4-49, 5-30)	3,300 (peak)	500
Total [d]	**5,380**	**15,200**
ROI Labor Force (2018) [e]	**320,327**	

ETTP = East Tennessee Technology Park; ORNL = Oak Ridge National Laboratory; ORR = Oak Ridge Reservation; ROI = region of influence; VTR = Versatile Test Reactor.

[a] Activities are from Table 5–1. Only those activities with available estimates of employment are listed.

[b] Employment from existing site activities is from Chapter 3, Section 3.2.14.

[c] The impacts of the ORNL VTR Alternative are from Chapter 4, Section 4.14.2.

[d] Total rounded to three significant figures.

[e] ROI Labor Force is from Chapter 3, Section 3.2.14.

As identified in Table 5–1, it is assumed that no new workforce would be added to support ongoing projects at ORR, based on the NEPA documentation that was completed before 2019. These projects are ongoing and are presumably captured in the current onsite employment totals. Existing offsite projects or facilities also were reviewed to determine whether any change in existing employment levels was expected in the future. No change was identified for any facility except the Bull Run Fossil Plant and the Clinch River Site for Small Modular Reactor. Ongoing onsite projects that would not be expected to contribute to cumulative socioeconomic impacts at ORNL include:

- Plutonium-238 Production for Radioisotope Power Systems (DOE 2000b, DOE 2013a)
- National Nuclear Security Administration Complex Transformation (DOE 2008a)
- ORNL Modernization Initiative (DOE 2008d)
- Oak Ridge Science and Technology Project (DOE 2008c, 2008e)
- U-233 Material Downblending and Disposition Project (DOE 2010e)
- Oak Ridge Integrated Facility Disposition (DOE 2011c)
- Ongoing and Future Operations at Y-12 (DOE 2011c, 2016e)
- Y-2 Emergency Operations Center Project (DOE 2015b, 2015d)

Ongoing offsite projects that would not be expected to contribute to cumulative socioeconomic impacts at ORNL include:

- Energy*Solutions* Bear Creek Processing Facility (ES 2020)
- Centrus Energy Corporation (Centrus 2020)
- TVA Kingston Fossil Plant (TVA 2020c, 2020d)
- Manufacturing Sciences Corporation (MSC) (MSC 2020)
- TOXCO Inc. Materials Management Center (TOXCO 2020)

Activities proposed under the ORNL VTR Alternative could produce direct employment of up to a peak of 1,590 construction workers during the 51-month construction period, or 30 percent of the 5,380 cumulative workforce (peak) related to construction activities. The 300 operations staff under the ORNL VTR Alternative would be about 2 percent of the 15,200 cumulative workforce related to operations. By comparison, about 320,327 people were employed in the ORR ROI in 2019. In addition to the direct jobs, DOE estimates that for every job within the ORNL, another 1.73 jobs (indirect jobs) are created in other industries (DOE 2018g), as described in Chapter 4, Section 4.14.2.

Any migration of workers into the ROI is expected to be small when compared to the projected population of the ROI. Furthermore, any in-migration would be within the historical trends of population growth within the ROI. Due to the low potential for in-migration and changes to the ROI population, impacts on the availability of housing and community services under the Proposed Action are expected to be small. The overall contribution to cumulative socioeconomic impacts (e.g., housing, schools, and community services) from the Proposed Action on the ROI is expected to be small. The increase in jobs and income levels would be considered a small and beneficial impact on the local and regional economies.

It is also important to mention the proposed Clinch River Small Modular Reactors project, which would be located within the socioeconomic impacts ROI. It is a relatively large project with a potentially overlapping construction period with the VTR project. Both adverse and beneficial socioeconomic impacts are anticipated from construction of the Clinch River Small Modular Reactors. The Clinch River Small Modular Reactors are expected to require a large construction and operations workforce. The workforce, in fact, would be larger than that of the VTR project (see Table 5–17). The Early Site Permit EIS for the Clinch River Small Modular Reactors (NRC 2019) estimates the construction workforce at 3,300 workers (peak) over a 72-month construction period and a permanent operations workforce of 500 (NRC 2019). It further estimates that 1,365 construction workers would migrate into the ROI with their families, resulting in a population increase of 3,453. Of these workers, 250 operations workers would migrate into the ROI with their families, resulting in a population increase of 633 (NRC 2019). The combined labor requirements of the two projects, especially during construction, could require a potentially large in-migrating workforce (both projects would require special skill sets), many of whom would bring families. In addition to workers hired directly for project construction or operation, the in-migrating workforce could also include workers required to fill new indirect jobs created by the two projects. This population influx could put additional demands on existing housing supply and local community services (e.g., schools, fire and police, hospitals). Potential cumulative impacts of both projects could be small to moderate and adverse, at least in the short term, depending on the total number of new employees that move into the area and the existing capacity of local resources and services to accommodate them. Moderate beneficial socioeconomic impacts also would occur due to the increase in income and spending in the local and regional communities and associated tax revenue. Over the longer term, increased tax revenues also could be used to offset increased strains on housing and community services by funding enhancements to appropriate services and facilities. Another positive outcome would be that the additional jobs created by the 2 nuclear projects would help reduce the local adverse socioeconomic effects from the planned closing of the Bull Run Fossil Plant and loss of 100 to 125 workers in 2023.

Although project details related to the recently proposed Department of Defense Prototype Advanced Mobile Nuclear Reactor have not yet been identified, including its final location (ORNL or the INL Site), the Notice of Intent implies that it would be constructed and operated within existing facilities and infrastructure and not have significant labor requirements (85 FR 12274). If this is true, then any adverse socioeconomic impacts from this activity would be expected to be small, and its contribution to potential cumulative impacts at ORNL would be small.

5.4.13 Environmental Justice

Similar to the INL Site, the analysis in Chapter 4, Section 4.15, indicates no high and adverse human health and environmental impacts on any population within the ROI because of the ORNL VTR Alternative. Impacts on minority and low-income populations would be comparable to those on the population as a whole and would be negligible. Similarly, there would be no high and adverse impacts for a subsistence exposure scenario. Because the doses from the Proposed Action at ORNL would be small and there would be no disproportionate high and adverse impacts on minority and low-income populations, the Proposed Action would not substantially contribute to cumulative environmental justice impacts at ORNL.

5.5 Savannah River Site

As described in Appendix B, Section B.5.4.2, modification and operation of K Area facilities[4] for Reactor Fuel Production for the VTR would occur largely within existing buildings with no new land disturbance. Therefore, as described in Chapter 4, impacts on land use and aesthetics, geology and soils, ecological resources, cultural and paleontological resources, and noise, would be minimal and would not contribute to cumulative impacts. Therefore, these resource areas are not discussed further.

5.5.1 Water Resources

As described in Appendix B, Section B.5.4.2, modification and operation of K Area facilities for Reactor Fuel Production for the VTR would occur within existing buildings with no new land disturbance and no effluent discharged directly to surface water or groundwater. Therefore, as described in Chapter 4, Section 4.3.3.2, impacts on surface water and groundwater quality would be minimal and would not contribute to cumulative impacts.

As described in Chapter 4, Section 4.3.3.2, no surface water would be used during modification and operation of the SRS Reactor Fuel Production Options. Therefore, the Proposed Action would not contribute to cumulative impacts from surface water use at SRS.

Groundwater use during construction of the projects listed in Table 5–1 generally would be for short durations, would be for relatively small quantities of water, and would occur at different times. This staggering of construction activities helps ensure that cumulative groundwater use during construction of all present and reasonably foreseeable projects would not substantially add to cumulative impacts on groundwater at SRS.

Table 5–18 includes the cumulative annual groundwater withdrawals expected from operation of the past, present, and reasonably foreseeable future actions at the SRS. The totals presented in Table 5–18 represent a potential maximum of about 623 million gallons per year, or about 21 percent of the total site-wide capacity. Compared to the baseline of 320 million gallons, the projects listed in Table 5–5 represent an increase of about 10 percent in the portion of the total site-wide capacity used, or a minor cumulative impact on groundwater.

[4] As described in Chapter 2, Section 2.6.3, similar impacts would be expected if Reactor Fuel Production activities were to be constructed and operated in L Area.

Table 5–18. Cumulative Groundwater Withdrawals During Operation of Past, Present, and Reasonably Foreseeable Actions at Savannah River Site

Activity	*Water Usage (gallons per year)*
Past, Present, and Reasonably Foreseeable Future Actions [a]	
Existing Site Activities	320,000,000 [a]
NNSA Complex Transformation (DOE 2008a:5-245, 5-261, 6-12)	80,500,000
Disposal of GTCC LLW and GTCC-Like Waste (DOE 2016a:5-92, 5-94)	1,400,000
Surplus Plutonium Disposition (DOE 2015a:2-42, 4-129)	25,000,000–57,000,000 [b]
Acceptance and Disposition of SNF from Germany (DOE 2017d:4-73, 4-90)	37,000,000–89,000,000 [b]
H-Canyon Processing of SNF (DOE 2000c:2-50, 5-11)	55,700,000
Plutonium Pit Production (DOE 2020a:5-7)	12,100,000–13,300,000 [b]
HLW Salt Processing Facility (DOE 2001:5-14)	3,200,000
Subtotal – Baseline Plus Other DOE Actions	**534,900,000–620,100,000**
SRS Reactor Fuel Production Options	2,900,000 [c]
Total [d]	**538,000,000–623,000,000**
Site-wide Capacity	2,950,000,000 [a]

GTCC = greater-than-Class C; HLW = high-level radioactive waste; LLW = low-level radioactive waste; NNSA = National Nuclear Security Administration; SNF = spent nuclear fuel.

[a] From Chapter 3, Section 3.3.7.

[b] Total is a range that includes the minimum and maximum values from various alternatives of Proposed Action.

[c] From Chapter 4, Section 4.7.4.2 and Appendix B, Table B-44 (SRS Fuel Fabrication Operational Resource Requirements).

[d] Total rounded to three significant figures.

5.5.2 Air Quality

The region surrounding SRS is currently in compliance with all State and national ambient air quality standards. The air quality cumulative impacts analysis estimates the potential for emissions from the proposed SRS Reactor Fuel Production Options, in combination with emissions from other past, present, and reasonably foreseeable future actions, to exceed an ambient air quality standard. Radiological emissions are discussed in Section 5.5.4.

As described in Chapter 4, Section 4.4.3.2 of this VTR EIS, construction activities from the SRS Reactor Fuel Production Options would generate emissions. Emissions would be from the use of fossil fuel-powered equipment, trucks, and workers' commuter vehicles. Estimated peak annual construction activities would result in minimal emissions that would be well below annual indicator thresholds of significance (see Table 4–11). The intermittent operation of construction emission sources would result in dispersed concentrations of air pollutants adjacent to construction activities. The movement of any construction emissions from the K-reactor building to the nearest SRS boundary (about 5.5 miles) would produce additional dispersion and would result in minor concentrations of air pollutants beyond the SRS property boundary. Therefore, the slight increase in offsite air pollutant concentrations produced from construction of the fuel fabrication facility, in combination with emissions from other past, present, and reasonably foreseeable future actions, would result in air pollutant concentrations that would not exceed the State and national ambient air quality standards. Emissions from construction activities related to the SRS Reactor Fuel Production Options would not substantially contribute to cumulative air quality impacts.

As described in Chapter 4, Section 4.4.3.2 of this VTR EIS, operational activities from the SRS Reactor Fuel Production Options would generate emissions. These emissions would be from intermittent use of a diesel-powered backup electrical generator, diesel-powered trucks that deliver materials and haul off wastes, and workers' commuter vehicles. Review of the data in Table 4–12 shows that proposed operations would produce minor amounts of air emissions. Transport of these emissions to the SRS boundary would produce negligible ambient air pollutant concentrations at offsite locations. Therefore, the minor increase in offsite air pollutant concentrations produced from operations, in combination with emissions from other past, present, and reasonably foreseeable future actions, would result in air pollutant concentrations that would not exceed the State and national ambient air quality standards. Emissions from operations activities related to the SRS Reactor Fuel Production Options would not substantially contribute to cumulative air quality impacts.

5.5.3 Infrastructure

Table 5–19 shows the estimated annual cumulative infrastructure requirements from operations at SRS for electricity and water. Projected cumulative site activities would annually require about 858,000 to 1,010,000 megawatt-hours of electricity, which is well within the total site-wide capacity of 4,400,000 megawatt-hours. Cumulative water usage would range from about 538 million to 623 million gallons of water, which is well within the site-wide capacity of 2,950 million gallons per year. Operation of the reactor fuel production capability at SRS would use about 20,000 megawatt-hours of electricity and 2.9 million gallons of water per year, which represents a fraction of the cumulative infrastructure use and an even smaller fraction of total site capacity. Therefore, operation of the reactor fuel production capability at SRS would not substantially contribute to cumulative infrastructure impacts.

While there is adequate capacity for electric needs at SRS, construction of Unit 3 (expected to be online in November 2021) and Unit 4 (expected to be online in November 2022) of the Vogtle Electric Generating Plant, located about 6.5 miles from K Area, would generate 6,800 megawatts of additional capacity to the area. Once complete, the 2 new Westinghouse AP1000 reactors will produce enough energy to power 500,000 homes and businesses (Georgia Power 2018).

Table 5–19. Annual Cumulative Infrastructure Impacts from Operations at Savannah River Site

Activity	*Electricity Consumption (megawatt-hours per year)*	*Water Usage (gallons per year)*
Past, Present, and Reasonably Foreseeable Future Actions		
Existing Site Activities	310,000 [a]	320,000,000 [a]
NNSA Complex Transformation (DOE 2008a:5-245, 5-261, 6-12)	268,000	80,500,000
Disposal of GTCC LLW and GTCC-Like Waste (DOE 2016a:5-92, 5-94)	5,050	1,400,000
Surplus Plutonium Disposition (DOE 2015a:2-42, 4-129)	170,000–310,000 [b]	25,000,000–57,000,000 [b]
Acceptance and Disposition of SNF from Germany (DOE 2017d:4-73, 4-90)	15,000–27,000 [b]	37,000,000–89,000,000 [b]
H-Canyon Processing of SNF (DOE 2000c:2-50, 5-11)	15,800	55,700,000
Plutonium Pit Production (DOE 2020a:5-7)	30,000	12,100,000–13,300,000 [b]
HLW Salt Processing Facility (DOE 2001:5-14)	24,000	3,200,000
Subtotal – Baseline Plus Other DOE Actions	**838,000–990,000**	**534,900,000–620,100,000**
SRS Reactor Fuel Production Options	20,000 [c]	2,900,000 [c]
Total [d]	**858,000–1,010,000**	**538,000,000–623,000,000**
Total Site-wide Capacity	**4,400,000 [a]**	**2,950,000,000 [a]**

GTCC = greater-than-Class C; HLW = high-level radioactive waste; LLW = low-level radioactive waste; NNSA = National Nuclear Security Administration; SNF = spent nuclear fuel.

[a] From Chapter 3, Section 3.3.7.

[b] Total is a range that includes the minimum and maximum values from various alternatives of Proposed Action.

[c] From Chapter 4, Section 4.7.3.2 and Appendix B, Table B-44 (SRS Fuel Fabrication Operational Resource Requirements).

[d] Total rounded to three significant figures.

5.5.4 Waste Management

The assessment of the waste management cumulative impacts at SRS includes the reactor fuel production options and other reasonably foreseeable actions that result in the generation, treatment as required, and disposal of LLW, MLLW, and TRU waste. **Table 5–20** summarizes of the estimated cumulative annual generation rates of these wastes. Additional reasonably foreseeable actions are identified in Section 5.2, Table 5–1. As noted in Table 5–1, some of these activities are ongoing and the waste generated by these activities are included in the existing site activities' waste generation rates for SRS. For some of the activities identified as proposed, there is no waste generation information currently available. For those that had information available, they are included in Table 5–20 below.

The characteristics of the newly generated wastes are estimated to be similar to the wastes currently generated by existing activities. As described in Chapter 4, Section 4.9.3.2, the waste management infrastructure at SRS was developed to support the quantities of waste generated. Therefore, cumulative waste generation would be within site capacities. There are existing offsite DOE and commercial waste management facilities with sufficient total capacities for the treatment and disposal needs of the relatively small volumes of LLW and MLLW wastes generated by the Proposed Action. Therefore, substantial cumulative impacts on offsite LLW and MLLW treatment and disposal facilities would not be expected. See Section 5.3.9 for a discussion of the impacts of TRU waste disposal on the WIPP facility.

Table 5–20. Cumulative Average Annual Waste Generation Rates at Savannah River Site in Cubic Meters

Activity	*LLW*	*MLLW*	*TRU Waste*
Past, Present, and Reasonably Foreseeable Future Actions			
Existing Site Activities [a]	5,300	55	11
Other DOE Actions Evaluated in the Surplus Plutonium Disposition SEIS [b]	1,800	97	200
Surplus Plutonium Disposition [b]	1,070	30	170 – 710
SRS Pit Production [c]	1,700 – 2,200	7.6 – 11	460 – 670
Subtotal – Baseline Plus Other DOE Actions	9,900 – 10,400	190	840 – 1,600
SRS Feedstock Preparation/Fuel Fabrication [a]	170 [d] /170 [e]	2 [d, g] /2 [e, f]	200 [d]/200 [e]
Subtotal – Feedstock Preparation and Fuel Fabrication	170 – 340	2 – 4	200 – 400
Total	10,100 – 10,800	190	1,040 – 2,000

LLW = low-level radioactive waste; MLLW = mixed low-level radioactive waste; TRU = transuranic waste.

[a] Source: Section 4.9.3.2.1, Table 4-37. SRS Reactor Fuel Production Option wastes are average annual generation rates based on a 60-year operation cycle.

[b] Source: SPD SEIS (DOE 2015a: Table 4-43 alternatives with the greatest potential impacts).

[c] Source: Final SRS Pit Production EIS (DOE 2020a).

[d] These quantities are estimates and could be different depending on the process for the feedstock.

[e] These quantities are fuel fabrication with no feedstock preparation.

[f] These quantities are included in the LLW quantities.

Note: All numbers are rounded to two significant figures. Due to rounding, sums and products may not equal those calculated from table entries.

5.5.5 Human Health – Normal Operations

Cumulative impacts on public health and safety from radiological emissions could result from activities at SRS and potentially from other activities within the SRS ROI (50-mile radius from the SRS boundary) that could impact worker and public health. The activities identified in Table 5–1 were reviewed to identify those that could have a worker and public health impact. **Table 5–21** gives information on the potential impacts from the present SRS operations (from Chapter 3, Section 3.3.10.1 of this VTR EIS), reasonably foreseeable future actions, and the Proposed Action. This table includes those actions identified in Table 5–1 that could contribute to worker and the public (population and MEI) dose and potential LCFs.

Only those activities that have identified radiological impacts with available estimates of radiation exposure are listed. Some of the actions identified in Table 5–1 would be expected to have radiological impacts, but estimates were not available. At SRS, this activity is the Tritium Finishing Facility.

Table 5–21. Annual Cumulative Population Health Effects of Exposure to Radiation From Normal Operations at Savannah River Site

Activity	*Workforce*		*Population within 50 Miles*		*MEI*	
	Dose (person-rem)	*Annual LCF* [a]	*Dose (person-rem)*	*Annual LCF* [a]	*Dose (millirem)*	*Annual LCF Risk* [a]
Past, Present, and Reasonably Foreseeable Future Actions						
Existing Site activities (baseline) [b]	75	0.04	6.0	0.004	0.27	2×10^{-7}
Surplus Plutonium Disposition [c]	620	0.4	1.0	0.0006	0.01	6×10^{-9}
HLW Salt Processing [d]	6.5	0.004	18	0.01	0.31	2×10^{-7}
Acceptance and Disposition of SNF from Germany [e]	41	0.02	2.3 to 7.8	0.001 to 0.005	0.029 to 0.12	2×10^{-8} to 7×10^{-8}
Mark-18A Target Processing [f]	–	0.002	–	2.2×10^{-5}	0.11	7×10^{-8}
Pit Production [g]	178 to 200	0.11 to 0.12	3.3×10^{-5} to 5.2×10^{-5}	1.9×10^{-8} to 3.1×10^{-8}	5.0×10^{-7} to 8.0×10^{-7}	3×10^{-13} to 4.8×10^{-13}
Subtotal – Baseline Plus Other Actions	**920 to 940**	**0.5**	**27 to 33**	**0.02**	**0.82**	$\mathbf{5\times10^{-7}}$
SRS VTR – Feedstock Preparation Option	51	0.03	0.0.42	2×10^{-5}	0.0015	1×10^{-9}
SRS VTR – Fuel Fabrication Option	51	0.03	0.020	1×10^{-5}	0.00071	4×10^{-10}
Subtotal for VTR	**102**	**0.06**	**0.062**	$\mathbf{4\times10^{-5}}$	**0.0022**	$\mathbf{1\times10^{-9}}$
Total for Savannah River Site	**1,020 to 1,040**	**0.6**	**27 to 33**	**0.02**	**0.73 to 0.82**	$\mathbf{4\times10^{-7}}$ **to** $\mathbf{5\times10^{-7}}$
Plant Vogtle [h]	–	–	1.8	0.001	2.4	1×10^{-6}
Total for Region of Influence	–	–	**29 to 35**	**0.02**	--	--

HLW = high-level radioactive waste; LCF = latent cancer fatality; MEI = maximally exposed individual; NA = not available; NRC = U.S. Nuclear Regulatory Commission; SNF = spent nuclear fuel; WIPP = Waste Isolation Pilot Plant.

[a] LCFs are calculated using a conversion factor of 0.0006 LCFs per rem or person-rem (DOE 2003). The annual LCFs for the analyzed population represent the number of LCFs calculated by multiplying the listed doses by the risk conversion factor. No population LCFs are expected from any individual activity or from all combined activities. The annual MEI LCF risk represents the calculated risk of an LCF to an individual.

[b] From Chapter 3, Section 3.3.10.1 of this EIS. Worker dose is the average for 2014 to 2018.

[c] Impacts from the Preferred Alternative (the WIPP Alternative) for the disposal of non-pit plutonium from SPD Supplemental EIS (DOE 2015a:Chapter 4, Tables 4-38, 4-39). A preferred option for the pit plutonium has not been identified. The WIPP Alternative public impacts are the largest among all of the alternatives evaluated; immobilization to Defense Waste Processing Facility impacts are largest for workers.

[d] Interim waste salt processing is being performed, pending startup of the facility. Impacts are those associated with operation of the new facility (DOE 2001:Table 4-12).

[e] A disposition process at SRS has not been selected. Values represent the range of impacts identified in the *Final Environmental Assessment for the Acceptance and Disposition of Spent Nuclear Fuel Containing U.S.-Origin Highly Enriched Uranium from the Federal Republic of Germany* (DOE 2017d:Tables 4-31, 4-32).

[f] The *Supplement Analysis of the Mark-18A Target Material Recovery Program at the Savannah River Site* identifies a total MEI dose of 0.109 from fission products added to a caustic waste stream. The Supplement Analysis does not identify a population dose or a worker dose, but states operational impacts would be within current site impacts (DOE 2016f:pg 18).

[g] Range of impacts identified for action alternatives in the *Final Environmental Impact Statement for Plutonium Pit Production at the Savannah River Site in South Carolin*a (DOE 2020a [DOE/EIS-0541]:Tables 5-5 and 5-6).

[h] Impacts identified in the *Final EIS for Plutonium Pit Production* (DOE 2020a:Table 5-5). The Vogtle workforce is separate from that at SRS, and thus, worker impacts are not presented.

The cumulative offsite population dose would be up to 35 person-rem per year with no expected LCFs (calculated value of 0.02). Operation of the VTR feedstock preparation and fuel fabrication facilities at SRS would result in a total population dose of 0.062 person-rem per year with no expected LCFs (calculated value of 4 x 10^{-5}). The total dose and LCFs from the Proposed Action would be about 0.2 percent of the cumulative dose and LCFs and so would not substantially contribute to cumulative human health impacts at SRS.

The cumulative MEI dose from SRS activities would be up to 0.82 millirem per year with an associated LCF risk of 5×10^{-7}. This cumulative MEI dose is lower than the DOE limit of 100 millirem per year from all pathways (DOE Order 458.1 [DOE 2011b]), and the EPA individual dose limit of 10 millirem per year from airborne radionuclides (40 CFR Part 61, Subpart H). This dose conservatively assumes the same person would be the MEI for all activities at SRS, but does not include activities not on SRS (Vogtle Plant). It is unlikely that the same person would be the MEI for SRS and Vogtle activities because the activities would occur at different locations, each with an MEI located at different offsite locations. Operation of the VTR fuel preparation and fabrication facilities at SRS would result in a total MEI dose of 0.0022 millirem per year with an associated LCF risk of 1 x 10^{-9}. The total MEI dose and LCFs from the Proposed Action would be about 0.03 percent of the cumulative MEI dose and LCFs and therefore, would not substantially contribute to cumulative human health impacts at SRS.

The cumulative worker dose would be up to about 1,000 person-rem per year with 1 expected LCF (calculated value of 0.6). Operation of the VTR fuel preparation and fuel fabrication capabilities at SRS would result in a total worker dose of 102 person-rem per year with no expected LCFs (calculated value of 0.06). The total worker dose and LCFs from the Proposed Action would be 10 percent of the cumulative dose and LCFs. Cumulative worker dose, consequently, would not substantially contribute to cumulative human health impacts at SRS. This could result in 4 worker LCFs from 60 years of VTR operation. 10 CFR 835 requires DOE "to develop and implement plans and measures to maintain occupational radiation exposures as low as is reasonably achievable" (ALARA). DOE-STD-1098-2017, DOE Standard Radiological Control (DOE 2017f) identifies an effective ALARA process as including implementation of both engineered and administrative controls to control worker dose. All equipment and operations would be designed and implemented following this principle. Therefore, needed worker protection could be incorporated into the final design potentially reducing worker doses.

5.5.6 Traffic

As described in Chapter 4, Section 4.13.3, the impacts on traffic from construction and operation of facilities under the SRS reactor fuel options are anticipated to be negligible to minor. As such, impacts to traffic from this alternative would not substantially contribute to cumulative traffic impacts. Therefore, they are not discussed further.

5.5.7 Socioeconomics

The ROI for cumulative impacts on socioeconomics includes the four-county area near SRS: Aiken and Barnwell counties, South Carolina; and Columbia and Richmond counties, Georgia. As shown in **Table 5–22**, cumulative employment at SRS from past, present, and reasonably foreseeable future actions could reach a peak of about 15,600 persons. This peak is about 6.4 percent of the 243,863 people employed in the SRS ROI in 2019. These values are conservatively high estimates of short-term future employment at SRS. Some of the employment would occur at different times and it may not be appropriate to total these values. The employment totals from existing site activities include existing onsite employment (directly employed and contractor staff) and potential future employees based on proposed projects identified in Table 5–1 and carried over to Table 5–22.

Table 5–22. Total Cumulative Employment at Savannah River Site

Activity	*Direct Construction Employment (number of personnel in peak year)*	*Direct Operations Employment (first year of operation)*
Past, Present, and Reasonably Foreseeable Future Actions [a]		
Existing Site Activities	Not Applicable	11,100 [b]
Disposal of GTCC LLW and GTCC-Like Waste (DOE 2016a:9-69, 2018d)	62-145	38-51
Surplus Plutonium Disposition Program (DOE 2015a:4-39, 4-40; SRNS 2020)	741	1,680
SNF from Germany Containing U.S.-Origin Highly Enriched Uranium (DOE 2017d:4-54, 4-55; 2017e)	201	150
Tritium Finishing Facility (NNSA 2020)	Not Provided	Not Provided
Pit Production (DOE 2020a:4-38)	1,800 peak	1,830-2,015
SRS Subtotal – Baseline Plus Other Actions	**2,890**	**15,000**
SRS Fuel Fabrication Option [c]	**120**	**300**
SRS Feedstock Preparation Option	**120**	**300**
Subtotal for VTR	**240**	**600**
SRS Total	**3,130**	**15,600**
Offsite Projects		
Vogtle Generating Plant (NRC 2008; Bloomberg 2019; Georgia Power 2018; Southern Nuclear 2020)	4,300	812
Total [d]	**7,430**	**16,400**
ROI Labor Force (2018)[e]	**243,863**	

GTCC = greater-than-Class C; LLW = low-level radioactive waste; ROI = region of influence; SNF = spent nuclear fuel; SRS = Savannah River Site; VTR = Versatile Test Reactor.

[a] Activities are from Table 5–1. Only those activities with available estimates of employment are listed. The proposed Commercial Disposal of Defense Waste Processing Facility Recycle Wastewater Project did not include workforce estimates (DOE 2020e).

[b] Employment from existing site activities is from Chapter 3, Section 3.3.14.

[c] The impacts of the SRS VTR Alternative are from Chapter 4, Section 4.14.3.

[d] Total rounded to three significant figures.

[e] ROI Labor Force is from Chapter 3, Section 3.3.14.

It is assumed that no new workforce would be added to support ongoing projects at SRS identified in Table 5–1, at least those where the NEPA documentation was completed on or before 2019. These projects are ongoing and are presumably captured in the current onsite employment totals. Existing offsite projects or facilities also were reviewed to determine whether any change in existing employment was expected in the future. No change was identified for any identified offsite facility. The ongoing onsite SRS projects, which would not be expected to contribute to cumulative socioeconomic impacts at SRS, include:

- National Nuclear Security Administration Complex Transformation (DOE 2008a)
- SRS HLW Salt Processing Facility (DOE 2001)
- H-Canyon Processing of Target Residue Material (DOE 2015e, SRNS 2020)
- H-Canyon Processing of SNF (DOE 2000c, 2013b; SRNS 2020)
- Mark-18A Target Material Recovery Program (DOE 2016f)
- Use of SRS Lands for Military Training (DOE 2011g, 2011h, 2012b)

The ongoing nearby offsite projects, which would not be expected to contribute to cumulative socioeconomic impacts at SRS, include:

- American Zinc Recycling LLC (AZR 2020a, 2020b)
- Energy*Solutions* LLW Disposal Facility (DOE 2015a; SRNS 2020)

Activities proposed under the SRS Reactor Fuel Production Options could produce direct employment of up to a peak of 240 construction workers during the 3-year construction period, or 3.2 percent of the 7,430 cumulative workforce (peak) related to construction activities. The operations staff would number 600 and represent about 3.7 percent of the 16,400 cumulative workforce related to operations. By comparison, about 243,863 people were employed in the SRS ROI in 2019. In addition, DOE estimates that for every direct job, another 2.5 indirect jobs are created in other industries, based on a 2011 Economic Impact Study (Noah et al. 2011) and as described in Chapter 4, Section 4.14.3.

Given the locally available labor supply, very few, if any, construction and operations workers would be expected to in-migrate to the ROI to support reactor fuel production activities. Due to the relatively small workforce and low potential for any in-migration, impacts on the availability of housing and community services under the Proposed Action are expected to be small. The overall contribution to cumulative socioeconomic resource impacts from the Proposed Action on the ROI (e.g., housing, schools, and community services) is expected to be small during construction and negligible during operation. The overall increase in employment and income levels within the ROI would be evaluated as a beneficial impact on the local and regional economies.

While the employment requirements of the Proposed Action at SRS are very small, the total estimated operations workforce from all other actions (including the existing workforce at SRS) represents about 6.4 percent of the available workforce in the SRS ROI in 2018. The increased employment could affect conditions in the ROI. In particular, the larger-scale proposed projects include the processing of non-pit plutonium, the production of plutonium pits at SRS, and the ongoing expansion of the Vogtle Nuclear Generating Plant in nearby Burke County, Georgia. DOE anticipates that the majority of the construction workforce for the plutonium pits would be local and require only a small in-migrating workforce (DOE 2020a). Operations of all these other proposed projects would overlap with reactor fuel activities at SRS under the proposed VTR project. Even though the new Units 3 and 4 at the Vogtle plant are located outside the ROI in Burke County, they could affect conditions in Richmond and Columbia counties in Georgia, which are within the SRS ROI.

Both adverse and beneficial socioeconomic impacts are anticipated from these projects. The potential adverse impacts on the local community services are expected to be minimal, given the small number of in-migrating workers (and their families) projected for the SRS ROI from the various projects compared to the existing population and labor force in the SRS ROI. Moderate beneficial socioeconomic impacts would occur due to the increase in income and spending in the local and regional communities and associated tax revenue. In addition, in the event a larger-than-expected in-migrating workforce originating from the various projects entered the ROI and affected existing community services, the effects would be short-term. Over the longer term, the increased income and tax revenues generated by the projects could be used to offset any increased strains on local housing or community services by funding enhancements to appropriate supplies and markets.

5.5.8 Environmental Justice

Similar to the INL Site, the analysis in Chapter 4, Section 4.15, indicates no high and adverse human health and environmental impacts on any population within the ROI because of the SRS Reactor Fuel Production Options. Impacts on minority and low-income populations would be comparable to those on the general population as a whole and would be negligible. Because the doses from the Proposed Action at SRS would be small and there would be no disproportionate high and adverse impacts on minority and low-income populations, the Proposed Action would not substantially contribute to cumulative environmental justice impacts at SRS.

5.6 Transportation

The assessment of cumulative transportation impacts for past, present, and reasonably foreseeable future actions concentrates on offsite transportation throughout the nation[5] that would result in potential radiation exposure to the transportation workers and the general population. Cumulative radiological impacts from transportation are estimated using the dose to the workers and the general population, because dose can be directly related to LCFs using a cancer risk coefficient.

The comprehensive transportation cumulative impacts analysis that is presented in the Yucca Mountain EIS (DOE 2002e, 2008d), and updated in the *Surplus Plutonium Disposition (SPD) Supplemental EIS* (DOE 2015a) Section 4.5.3.7, is incorporated in, and forms the basis for, this VTR EIS analysis. The analysis included historical shipments, reasonably foreseeable future actions, and general radioactive materials transportation that was not related to any particular action. The timeframe of the SPD Supplemental EIS transportation impacts analysis began in 1943 and extended to 2073. The timeframe for this VTR EIS analysis is for 63 years beyond the 2028 start of VTR operation, which extends the cumulative impact period beyond 2090.

Table 5–23 shows estimated cumulative impacts on transportation workers and the general population based on the cumulative impacts estimated in the SPD Supplemental EIS (DOE 2015a) and additional past, present, and reasonably foreseeable future actions, including transportation activities analyzed in this VTR EIS. When combined with past, present, and reasonably foreseeable future nation-wide transportation, the cumulative transportation worker dose was estimated to be about 430,000 person-rem (about 258 LCFs). The cumulative general population dose was estimated to be about 441,000 person-rem (about 265 LCFs). For the INL VTR and the ORNL VTR Alternatives evaluated in this EIS, doses to transportation workers and the general population would be less than 2,120 and 2,025 person-rem, respectively. Therefore, worker and population doses from the Proposed Action would be less than 0.5 percent of the cumulative worker and population doses and would not substantially contribute to cumulative transportation impacts.

The total number of LCFs (among the workers and the general population) estimated to result from radioactive material transportation over the period between 1943 and 2090 is about 525, or an average of about 4 LCFs per year. Over this same period (148 years), about 88 million people are projected to die from cancer, based on National Center for Health Statistics data. The annual number of cancer deaths in the United States in 2017 was about 599,000 (CDC 2019), with about 3 percent fluctuation in the number of cancer fatalities from 1 year to the next, over the previous 10 years (2008 through 2017), and a mean of 584,000 cancer fatalities per year. The transportation-related LCFs would be 0.0006 percent of the total annual number of LCFs. As a result, this number is indistinguishable from the natural fluctuation in the total annual death rate from cancer.

[5] An assessment of potential cumulative impacts of DOE shipments of radioactive material across the global commons is presented in Appendix F, Section F.7. This includes incident-free marine transport of up to 34 metric tons of plutonium from Europe to the United States. The cumulative transportation worker dose was estimated to be about 134 to 135 person-rem with no LCFs expected (calculated value of 0.08). There would be no dose to the general public.

Table 5–23. Cumulative Transportation-Related Radiological Doses and Latent Cancer Fatalities

Category	Worker Dose (person-rem)	General Population Dose (person-rem)
Historical [a]	49	25
Past, Present, and Reasonably Foreseeable Future Actions (DOE) [a, b]	29,600	36,700
Additional Reasonably Foreseeable Future Actions (DOE)		
Permanent Disposal or Interim Storage of Spent Nuclear Fuel [c]	5,600–5,900	1,100–1,200
Disposal of Greater-Than-Class C LLW [d]	180	68
Disposition of Depleted Uranium Oxide Conversion Product [l]	145–276	217–723
SRS Pit Production [m]	581–901	334–455
Surplus Plutonium Disposition [n]	230–650	150–580
WIPP Transuranic Waste Disposal Supplemental Analysis [e]	492	383
Production of Tritium in a Commercial Light Water Reactor [f]	25–60	2.7–12
Liquid Highly Enriched Uranium Shipments from Canada [g]	17	10
Santa Susana Field Laboratory Remediation [h]	3.0	0.89
Acceptance and Disposition of Spent Nuclear Fuel from the Federal Republic of Germany [i]	0.12–10.9	0.54–4.7
Sister Rod Shipments [j]	0.27	0.75
Total Past, Present, and Reasonably Foreseeable Future Actions (DOE)	**36,900–38,100**	**38,900–40,100**
Past, Present, and Reasonably Foreseeable Future Actions (non-DOE) [a]	5,380	61,300
General Radioactive Materials Transportation [a]	384,000	338,000
Transportation Impacts in this VTR EIS [k]		
INL VTR Alternative	624–1,920	699–1,780
ORNL VTR Alternative	832–2,120	945–2,020
Total [o]	**427,000–430,000**	**439,000–441,000**
Total LCFs [p]	256–258	263–265

LCF = latent cancer fatalities; LLW = low-level radioactive waste; WIPP = Waste Isolation Pilot Plant.

[a] DOE 2015a:Table 4-48, p. 4-136 and 4-137. Historical shipments are shipments that occurred in the past.

[b] DOE 2015a:Table 4-48, p. 4-136 and 4-137. Excludes transportation doses from the greater-than-Class C LLW EIS (DOE/EIS-0375) and DUF6 conversion at Paducah and Portsmouth EISs (DOE/EIS-0359 and DOE/EIS-0360).

[c] DOE 2008d:Table 8-14, p. 8-44. For the purposes of the transportation cumulative impacts analysis, DOE evaluated the Yucca Mountain, Nevada, repository site as a surrogate destination for an interim storage facility or a permanent repository.

[d] DOE 2016a:Table 4.3.9-1, p. 4-68 and 4-69, DOE 2018d:3-20.

[e] DOE 2009:Table 2, p. 5.

[f] DOE 2016b:Table F-12, p. F-17. Calculated from LCFs.

[g] DOE 2013b:A-11. Calculated from LCFs.

[h] DOE 2018f:Table H-9, p. H-31.

[i] DOE 2017d:Table 4-28, p. 4-68.

[j] DOE 2015f:Table 3-1, p. 24. Calculated from LCFs.

[k] From Section E.8 (Table E-6) of Appendix E or Section 4.12 and adjusted for the 63 years of operations in this VTR EIS. Range includes INL and SRS Reactor Fuel Production Options.

[l] DOE 2020b:Table 4-51, p 4-93. The highest impacts for rail and truck shipments.

[m] DOE 2020a:Table 5-7, for 50 to 80 pits per year with 50 years of operation.

[n] DOE 2015a:Table E-20 in Appendix E. Impacts are conservative because a decision on disposition of the 34 metric tons of surplus plutonium has not been made. The impacts of transportation of surplus pit plutonium from the Pantex Plant to LANL or SRS for disassembly and conversion are a fraction of the total impacts presented here.

[o] Total values are rounded to three significant figures. (Note: the lower end of the range totals includes the lowest value from the VTR alternatives; the upper end of the range includes the highest value.) Total rounded to three significant figures.

[p] Total LCFs are calculated assuming 0.0006 latent cancer fatalities per person-rem of exposure (DOE 2003).

5.7 Global Commons

5.7.1 Ozone Depletion

Construction and operation activities would use materials and equipment that would comply with applicable ozone-depleting substances (ODSs) laws and regulations. DOE works to reduce its use of ODSs complex-wide, based on Federal directives and DOE Order 436.1, Departmental Sustainability (DOE 2011e). The VTR Alternative is not expected to use substantial quantities of ODSs as regulated under 40 CFR Part 82, "Protection of Stratospheric Ozone." Emissions of ODSs would be very small and would represent a negligible contribution to the destruction of the Earth's protective ozone layer.

5.7.2 Climate Change

Greenhouse gases (GHGs) are gases that trap heat in the atmosphere by absorbing infrared radiation. The accumulation of GHGs in the atmosphere regulates the Earth's temperature. GHG emissions occur from natural processes and human activities. The most common GHGs emitted from natural processes and human activities include carbon dioxide, methane, and nitrous oxide. The main source of GHGs from human activities is the combustion of fossil fuels, such as natural gas, crude oil (including gasoline, diesel fuel, and heating oil), and coal (USGCRP 2018).

Atmospheric levels of GHGs and their resulting effects on climate change are due to innumerable sources of GHGs across the globe. The direct environmental effect of GHG emissions is a general increase in global temperatures, which indirectly causes numerous environmental and social effects. Therefore, the ROI for potential GHG impacts is global. These cumulative global impacts would be manifested as impacts on resources and ecosystems in the United States, including Idaho, Tennessee, and South Carolina.

Predictions of long-term environmental impacts due to increased atmospheric GHGs include sea-level rise, changing weather patterns (e.g., increases in severity of storms and droughts), changes in local and regional ecosystems (e.g., potential loss of species), and a substantial reduction in winter snowpack (IPCC 2014; USGCRP 2018). The Northwest region that encompasses Idaho is at risk from an increase in flooding, drought, and heat waves; compromises to water supplies and hydropower; and an increase in wild fires. The region risks damage to aquatic and terrestrial ecosystems, an increase in the incidence of infectious diseases and other human health problems, and stresses to agricultural productivity (USGCRP 2018). The Southeast region that encompasses both ORR and SRS would experience an increase in extreme rainfall events, which would increase flood risks in low-lying regions, and an increase in heat and vector-borne diseases in urban areas. The Southeast is also at risk from more frequent extreme heat episodes and changing seasonal climates, which would increase exposure-linked health impacts and economic vulnerabilities in the agricultural, timber, and manufacturing sectors (USGCRP 2018).

Table 5–24 shows estimates of GHG emissions that would occur from construction and operation of the VTR and associated facilities at the INL Site, ORNL, and SRS. Emissions from construction and operations would occur over a period of up to 65 years and would imperceptibly add to U.S. and global GHG emissions, which were estimated to be 6.7 billion metric tons and 36.6 billion metric tons of CO_2e in 2018, respectively (EPA 2019e; Global Carbon Project 2019). Therefore, GHGs emitted from the proposed actions at the INL Site, ORR, and SRS would be a negligible percentage of U.S. and global GHG emissions and would not substantially contribute to future climate change.

Table 5–24. Greenhouse Gas Emissions from Construction and Operation of the Versatile Test Reactor and Associated Facilities at Idaho National Laboratory, Oak Ridge National Laboratory, and Savannah River Site

Activity	Alternatives/Options (metric tons of CO_2e)		
	INL VTR Alternative, Including the Maximum Reactor Fuel Production Option	ORNL VTR Alternative	SRS Reactor Fuel Production Options
Construction – Total Emissions over 5 Years	18,039	23,055	696
Operations – Annual Emissions/Total Emissions over 60 Years	769 / 46,862	1,222 / 74,009	980 / 58,782
Total Emissions over 65 Years [a]	65,000	97,000	59,000

CO_2e = carbon dioxide equivalent.
[a] Rounded to two significant figures.
Source: Air Quality/GHG Calculation Package version 1.

Chapter 6
Resource Commitments

6.0 RESOURCE COMMITMENTS

This section describes: any unavoidable adverse environmental impacts that could result from implementation of the alternatives; the irreversible and irretrievable commitments of resources; and the relationship between short-term uses of the environment and long-term productivity. Unavoidable adverse environmental impacts are impacts that would occur after implementation of any mitigation measures. Resources that would be irreversibly and irretrievably committed are those that cannot be recovered or recycled and those that are consumed or reduced to unrecoverable forms. The relationship between short-term uses of the environment and long-term productivity addresses issues associated with the condition and maintenance of existing environmental resources used to support the proposed action and the function of these resources after their use.

6.1 Unavoidable Adverse Environmental Impacts

Implementing any of the alternatives considered in this *Versatile Test Reactor Environmental Impact Statement* (VTR EIS) would result in varying degrees of unavoidable adverse environmental impacts. As described in Chapter 4, and summarized in Chapter 2, Section 2.9, these impacts are expected to be minor overall and would arise from incremental impacts attributed to the construction and operations of the VTR and associated facilities at the candidate sites.

6.1.1 Construction

As described in Chapter 4, construction of a VTR and associated facilities at any site would result in land disturbance, air emissions and noise, damage to the soil profile, stormwater runoff and soil erosion, damage to wildlife habitat, consumption of utilities and material resources including labor, generation of waste, and increased vehicle traffic that would be unavoidable, even with the application of best management practices. Activities performed to modify or upgrade existing facilities to support VTR operation (such as modification of existing post-irradiation examination, reactor fuel, and spent nuclear fuel (SNF) conditioning facilities at Idaho National Laboratory [INL]) would also result in some unavoidable adverse impacts that would generally be similar to but less than those noted above for construction of new facilities. Also, activities that would modify contaminated facilities or equipment, would result in worker radiation exposure and would generate radioactive wastes. Although some of the impacts would be unavoidable, construction activities are expected to have minor impacts overall and would be temporary in nature (i.e., lasting less than 5 years).

6.1.2 Operations

As described in Chapter 2, Sections 2.4 and 2.5, the completed VTR complex would occupy up to 25 acres at the Materials and Fuels Complex (MFC) at the INL Site or 50 acres at the Oak Ridge National Laboratory (ORNL), and is assumed to operate for 60 years. As described in Chapter 4, operation of a VTR and associated facilities at any site would result in committing land to that use for the operations period, generation of air emissions and noise, generation of stormwater, radiation exposure to workers and the public, consumption of utilities and material resources including labor, generation of waste, and increased vehicle traffic that would be unavoidable, even with the application of best management practices.

Operation of new or modified facilities at any of the candidate sites would produce minimal unavoidable adverse impacts on air quality and climate change. Emissions would be associated with facility emissions, testing of emergency generators, employee vehicle trips, delivery vehicle trips, and truck trips for transporting waste to offsite management facilities.

VTR and associated facility operations would result in unavoidable radiation and chemical exposure to workers and the general public. Workers would be exposed to radiation and chemicals associated with material handling, reactor fuel fabrication, reactor operation, and SNF and waste management. The public would be exposed to minor radioactive emissions during facility operations and small amounts of direct radiation during radioactive material and waste transportation. Independent of the characteristics of the cargo, there would be unavoidable risks of accident fatalities among members of the public resulting from the physical forces imposed by traffic accidents. The risks from facility operation to the general population, maximally exposed offsite individual, and workers are discussed in Chapter 4, Section 4.10. The risks from transportation of radioactive materials and wastes to the general population, maximally exposed offsite individual, and transportation crew are discussed in Section 4.12.

Also unavoidable would be the generation of radioactive, hazardous, mixed, and solid waste associated with normal facility operations. Any waste generated during operations would be collected, packaged, and eventually removed for recycling or disposal in accordance with applicable U.S. Environmental Protection Agency and/or State regulations. Recycling of solid waste is preferable because it would avoid the impacts of disposal. Sanitary wastewater would also be generated and disposed of through onsite wastewater treatment systems.

Under the No Action Alternative, operation of existing reactors and associated facilities would also result in similar unavoidable adverse impacts.

Future decontamination and decommissioning of reactors and associated facilities (see Chapter 4, Section 4.16) would result in unavoidable adverse impacts in terms of air emissions, worker radiation exposure, consumption of fuel and labor, and waste generation.

6.2 Irreversible and Irretrievable Commitment of Resources

Table 6–1 presents the commitment of resources related to construction activities under the Action Alternatives at INL, ORNL and Savannah River Site (SRS). Implementation of any of the alternatives, would entail the commitment of land, energy (e.g., electricity, fossil fuels) and water, labor, and materials and resources (e.g., steel, concrete, crushed stone, soil). In general, the commitments of energy, many materials, and labor, would be irreversible and, once committed, these resources would be unavailable for other purposes.

Table 6–2 presents the commitment of resources related to facility operations, over the projected periods of operation, of the reactor fuel capability, VTR, post-irradiation examination facilities, SNF conditioning capability, and spent fuel pad at INL, ORNL, and SRS as applicable.

6.2.1 Land

Operation of the VTR and associated facilities would require the commitment of land to the prescribed use over the 60-year operating period considered in this VTR EIS. Thus, land would be committed during the operational period, but not necessarily irreversible over the long term. Over the long term, the land that would be occupied by either existing or proposed facilities could ultimately be returned to another use if the buildings, roads, and other structures were removed. Alternatively, at the end of their VTR-related mission, facilities could be converted for other beneficial uses. In addition, the disposal of waste would entail the irreversible commitment of land.

Table 6–1. Commitment of Construction/Modification Resources under the Action Alternatives and Options

	INL			*ORNL*	*SRS*
	VTR Alternative	***Reactor Fuel Production Options***	***Total***	***VTR Alternative***	***Reactor Fuel Production Options***
Land Use					
Disturbed land (acres)	100	NA	100	150	Minimal
Energy and Water					
Electricity (megawatt-hours)	4,300	Minimal	4,300	5,600	Minimal
Diesel fuel, gasoline (gallons)	2,700,000	300	2,700,000	3,800,000	24,000
Water (gallons)	128,000,000	460,000	129,000,000	167,000,000	18,000,000
Labor					
Full-time equivalent (person-year)	2,700	36	2,800	3,700	720
Materials and Resources					
Acetylene, Oxygen, Nitrogen, CO_2, Argon (cubic feet)	4,600,000	Minimal	4,600,000	6,000,000	130,000
Asphalt (cubic yards)	1,400	NA	1,400	3,300	NA
Backfill and Landscaping (cubic yards)	200,000	NA	200,000	300,000	7,200
Cable and Wire (linear feet)	1,200,000	–	1,200,000	1,600,000	170,000
Cable Tray (linear feet)	18,000	–	18,000	23,000	4,900
Concrete and Cement (tons)	110,000	–	110,000	150,000	1,600
Conduit (linear feet)	270,000	–	270,000	410,000	150,000
Crushed stone, gravel, sand, rip rap (tons)	68,000	–	68,000	110,000	4,600
Ductwork (pounds)	–	–	–	–	100,000
Formwork (square feet)	–	–	–	–	72,000
Fencing (linear feet)	NA	NA	NA	10,000	NA
Helium (cubic feet)	–	Minimal	Minimal	–	2,300
Lumber (tons)	250	NA	250	330	NA
Paints, Coatings, and Sealants (square feet)	–	–	–	–	250,000
Piping (linear feet)	32,000	–	32,000	41,000	28,000
Road base geotextile (square feet)	NA	NA	NA	380,000	NA
Steel (tons)	8,600	–	8,600	11,000	1,200

– = use of material was not identified as significant; INL = Idaho National Laboratory; NA = not applicable; ORNL = Oak Ridge National Laboratory; SRS = Savannah River Site; VTR = Versatile test Reactor.

Notes:

- VTR includes supporting facilities (i.e., post-irradiation examination facilities, spent fuel conditioning capability, and spent fuel pad).
- Assumes 51-month construction period for VTR, 2 years for Reactor Fuel Capability at INL, and 3 years for Reactor Fuel Capability at SRS.
- Only chemicals used in quantities of over 1,000 pounds are shown in the table. Other chemicals and gases would be used in smaller quantities.
- Values rounded to 2 significant figures.

Sources: Appendix B.

Table 6–2. Commitment of Operations Resources under the Action Alternatives and Options

	INL			*ORNL*	*SRS*
	VTR Alternative	***Reactor Fuel Production Options***	***Total***	***VTR Alternative***	***Reactor Fuel Production Options***
Land Use					
Occupied land (acres)	25	NA	25	50	Minimal
Energy and Water					
Electricity (megawatt-hours)	9,000,000	1,200,000	10,000,000	12,000,000	1,200,000
Diesel fuel (gallons)	550,000	210,000	760,000	710,000	630,000
Propane (cubic feet)	5,600,000	1,000,000	6,600,000	5,600,000	2,000,000
Water (gallons)	260,000,000	140,000,000	400,000,000	260,000,000	170,000,000
Labor					
Full-time equivalent (person-years)	18,000	36,000	54,000	18,000	36,000
Materials and Resources					
Acetone (pounds)	1,000,000	NA	1,000,000	1,000,000	NA
Adhesive (pounds)	420,000	NA	420,000	420,000	NA
Alcohol (pounds)	2,600,000	110,000	2,700,000	2,600,000	–
Aluminum nitrate nanohydrate (pounds)	NA	40,000	40,000	NA	40,000
Ammonium hydrozide (pounds)	420,000	NA	420,000	420,000	NA
Antifreeze (pounds)	100,000	NA	100,000	100,000	NA
Argon/carbon dioxide/ hydrogen/methane/methanol/ oxygen (cubic feet)	270,000	2,000,000,000	2,000,000,000	270,000	3,400,000,000
Acsorbic acid (pounds)	NA	13,000	13,000	NA	13,000
Compressed helium (cubic feet)	90,000	95,000,000	95,000,000	90,000	160,000,000
Compressed neon (gallons)	360,000	NA	360,000	360,000	NA
Coolant (pounds)	84,000	NA	84,000	84,000	NA
Decon (pounds)	840,000	NA	840,000	840,000	NA
Gasoline (gallons)	790,000	NA	790,000	790,000	NA
Graphite (pounds)	NA	66,000	66,000	NA	66,000
Groundskeeping (pounds)	110,000	NA	110,000	110,000	NA
Polymer resin (pounds)	NA	5,300	5,300	NA	5,300
Hydroxylamine nitrate (pounds)	NA	17,000	17,000	NA	17,000
Liquid argon (cubic feet)	3,700,000	NA	3,700,000	3,700,000	NA
Liquid nitrogen (cubic feet)	200,000	NA	200,000	200,000	NA
Metal cleaner (pounds)	120,000	NA	120,000	120,000	NA
Oils and lubricants (pounds)	6,200,000	NA	6,200,000	6,200,000	NA
Oxalic acid (pounds)	NA	190,000	190,000	NA	190,000
P-10 argon/10% methane gas (cubic feet)	190,000	NA	190,000	190,000	NA
Paints, coatings, and sealants (pounds)	1,100,000	NA	1,100,000	1,100,000	NA
Plutonium (metric tons)	NA	34	34	NA	34
Potassium fluoride (pounds)	NA	79,000	79,000	NA	79,000
Quartz (pounds)	NA	400,000	400,000	NA	400,000
Refrigerants (pounds)	850,000	NA	850,000	850,000	NA
Sodium hydroxide solutions (pounds)	470,000	5,700	470,000	470,000	5,700

	INL			ORNL	SRS
	VTR Alternative	Reactor Fuel Production Options	Total	VTR Alternative	Reactor Fuel Production Options
Sodium hypochlorite (pounds)	72,000	NA	72,000	72,000	NA
Sulfuric, nitric, hydrochloric, and boric acids (pounds)	40,000,000	18,000,000	57,000,000	40,000,000	18,000,000
Uranium (metric tons)	NA	120	120	NA	120
Yttria (pounds)	NA	1,200	1,200	NA	1,200
Zirconia mold wash (pounds)	NA	12,000	12,000	NA	12,000
Zirconium (metric tons)	NA	17	17	NA	17

– = use of material was not identified as significant; INL = Idaho National Laboratory; NA = not applicable; ORNL = Oak Ridge National Laboratory; SRS = Savannah River Site; VTR = Versatile Test Reactor.

Notes:

- VTR includes supporting facilities (i.e., post-irradiation examination facility, spent fuel conditioning capability, and spent fuel pad).
- Assumes 60 year operations period.
- Only chemicals used in quantities of over 1,000 pounds are shown in the table. Other chemicals and gases would be used in smaller quantities.
- Values rounded to 2 significant figures.

Sources: Appendix B.

6.2.2 Energy and Water

Energy expended to support construction and operation of the VTR and associated facilities would be in the form of electricity to operate equipment and fossil fuels to operate equipment (including heating equipment) and vehicles. Consumption of electricity (from certain sources) and fossil fuels would be an irretrievable commitment of nonrenewable resources. Some of the water consumed for construction and operation (e.g., water used in concrete) would constitute an irreversible commitment and would not be available for other uses. Some water, such as that discharged from wastewater treatment facilities, would return to the natural hydrologic cycle and would not be irreversibly and irretrievably committed.

6.2.3 Materials and Resources

The irreversible and irretrievable commitment of materials, equipment, and other resources comprises those used in the construction and modification of facilities, and those used during operations. This includes materials that cannot be recovered or recycled, materials that are contaminated and cannot be effectively decontaminated, and materials consumed or reduced to unrecoverable forms of waste. Principal construction materials would include concrete (a product of cement, sand, and gravel), crushed stone, and steel, although other materials such as wood, gases, and other metals would also be used. For practical purposes, materials including concrete incorporated into the framework of existing or new facilities would be unrecoverable and irretrievably lost. Some materials such as uncontaminated steel and other metals may be recycled when the facility is eventually decontaminated, decommissioned, and demolished. Materials such as uranium, plutonium, and zirconium used in the reactor fuel during operations would be disposed of as SNF and therefore would be irreversibly and irretrievably committed. Employee labor during construction and operations would also be irreversibly and irretrievably committed.

6.3 Relationship Between Short-Term Uses of the Environment and Long-Term Productivity

Each of the action alternatives would entail similar relationships between short-term uses of the environment and long-term productivity. However, there would be differences in the relative magnitude of the short-term uses based on differences in location, including use of existing versus new facilities, utility and transportation infrastructure availability, and labor availability and utilization. Regardless, upon completion of the useful life of the VTR and associated facilities at any of the candidate locations, land and facilities could be returned to other uses, including long-term productive uses.

Air emissions associated with the VTR and associated facilities would introduce small amounts of radiological and nonradiological constituents to the air. As described in Chapter 4, over the assumed 60-year operating period, these emissions would result in additional environmental loading and exposure to human receptors, but would not impact compliance with air quality or radiation exposure standards. Because of the very small quantities of constituents released and the short half-life of many of the constituents, there would be no substantial residual environmental effects on long-term productivity.

At the INL Site, losses of wildlife and sagebrush habitat during construction are possible. At ORNL, losses of wildlife and forested and aquatic habitat during construction are possible. Land clearing and construction activities would disperse wildlife and temporarily eliminate habitat. These short-term disturbances of wildlife and habitat could cause long-term reductions in the biological productivity of an area. Although some wildlife and habitat destruction would be inevitable during construction, these losses would be minimized by timing land disturbance to avoid nesting and mating seasons, by compensation of certain lost habitats (e.g., sagebrush and/or wetlands, and by restoration of temporarily disturbed habitat where possible. Groundwater at the INL Site and SRS, or surface water at ORNL, would be used to meet process and sanitary water needs over the construction and operations periods. After use and treatment, most of this water would be released through outfalls into evaporation basins or surface water streams. The withdrawal, use, treatment, and discharge of water is not likely to affect the long-term productivity of this resource.

The disposal of waste would require energy and labor, and space at disposal facilities. The land occupied for waste disposal would require a long-term commitment and a reduction of the long-term productivity of the land.

After the operational life of the VTR and associated facilities, DOE could decontaminate and decommission the facilities in accordance with applicable regulatory requirements and then repurpose the facilities for other productive uses. Alternatively, DOE could demolish the facilities and then restore the areas occupied by the facilities for other productive uses. Demolition activities could have short-term impacts similar to those normally associated with construction activities. Appropriate environmental regulatory reviews, including National Environmental Policy Act reviews, would be conducted before initiation of decontamination, decommissioning, and demolition actions.

Under the No Action Alternative, environmental resources have already been, and continue to be, committed to operation of existing reactors and supporting facilities. Similar to the Action Alternatives, upon completion of their useful life, land and facilities used under the No Action Alternative could be returned to other uses, including long-term productive uses.

Chapter 7
Laws, Regulations, and Other Requirements

7.0 LAWS, REGULATIONS, AND OTHER REQUIREMENTS

This chapter presents the environmental, safety, and health laws, regulations, orders, and permits that could apply to activities associated with the proposed alternatives evaluated in this *Versatile Test Reactor Environmental Impact Statement* (VTR EIS). These requirements and standards originate from a number of sources. Federal and State statutes define broad environmental and safety programs and provide authorization to agencies to carry out the mandated programs. More-specific requirements are established through regulations, at both the Federal and State levels. Federal agencies, such as the U.S. Department of Energy (DOE), receive additional direction in complying with executive policy through Executive Orders. In addition, DOE has established regulations and management directives (DOE Orders) that are applicable to DOE activities, facilities, and contractors. Regulations often include requirements for permits and consultations, which provide an in-depth, facility-specific review of the activities proposed.

Section 7.1 of this chapter summarizes the Federal, DOE, and State environmental, safety, and health requirements. Section 7.2 summarizes the existing facility permits and potential new permits or approvals for construction and operation of facilities at the candidate sites. Section 7.3 discusses required and potential consultations with Federal and State agencies and federally recognized American Indian tribal governments.

7.1 Applicable Federal and State Laws and Regulations

The proposed activities at the Idaho National Laboratory (INL), Oak Ridge Reservation (ORR), and Savannah River Site (SRS) would be regulated by numerous Federal and State legal requirements addressing environmental compliance. For some activities, DOE has sole authority to take action, such as under the Atomic Energy Act of 1954. The VTR would be authorized by DOE, just like previous test reactors (e.g., the Advanced Test Reactor, High Flux Isotope Reactor, and Transient Reactor Test Facility). The VTR would not be licensed by the U.S. Nuclear Regulatory Commission.

The U.S. Department of Transportation regulates commercial transportation of hazardous and radioactive materials. The U.S. Environmental Protection Agency (EPA) would regulate many aspects of the proposed activities. In many cases, EPA has delegated all or part of its environmental protection authorities to the States but retains oversight authority. In this delegated role, the Idaho Department of Environmental Quality (IDEQ), Tennessee Department of Environment and Conservation (TDEC), and South Carolina Department of Health and Environmental Control (SCDHEC) regulate most air emissions; discharges to surface water and groundwater; drinking water quality; and hazardous and nonhazardous waste treatment, storage, and disposal. Under DOE Order 436.1, Departmental Sustainability, it is DOE’s policy to carry out its mission in a sustainable manner by maximizing energy and water efficiency; minimizing chemical toxicity and harmful environmental releases; promoting renewable and other clean energy development; and conserving natural resources while sustaining assigned mission activities.

The major Federal laws, regulations, Executive Orders (Presidential directives that apply only to Federal agencies), and DOE Orders; State laws and regulations; and other requirements that could apply to the alternatives analyzed in this VTR EIS are identified in **Table 7–1**.

Table 6–1. Applicable Laws, Regulations, Orders, and Other Requirements

Law, Regulation, Order, or Other Requirement	*Description*
General Environmental	
National Environmental Policy Act of 1969, as amended (NEPA), 42 U.S. Code (U.S.C.) § 4321 et seq.	Establishes a national policy for environmental protection and directs all Federal agencies to use a systematic, interdisciplinary approach to incorporating environmental values into decision-making (Idaho, Tennessee, and South Carolina do not have State NEPA regulations).
Council on Environmental Quality, *Regulations for Implementing NEPA,* 40 Code of Federal Regulations (CFR) Parts 1500–1508	Defines actions that Federal agencies must take to comply with NEPA, such as the development of environmental impact statements.
DOE National Environmental Policy Act Implementing Procedures, 10 CFR Part 1021	Establishes DOE's program implementing the procedural provisions of NEPA.
Executive Order 11514, *Protection and Enhancement of Environmental Quality* (03/05/70), as amended by Executive Order 11991 (05/24/77)	Requires Federal agencies to direct their policies, plans, and programs so as to meet national environmental goals established by NEPA.
Executive Order 12088, *Federal Compliance with Pollution Control Standards* (10/13/78)	Directs Federal agencies to comply with applicable administrative and procedural pollution control standards established by, but not limited to, the Clean Air Act (CAA), Noise Control Act, Clean Water Act (CWA), Safe Drinking Water Act, Toxic Substances Control Act, and Resource Conservation and Recovery Act (RCRA).
Executive Order 13834, *Efficient Federal Operations* (05/17/18)	Focuses on meeting statutory requirements to improve efficiency, optimize performance, eliminate unnecessary use of resources, and protect the environment.
DOE Order 231.1B, *Environment, Safety, and Health Reporting* (Change 1, 11/28/12)	Ensures timely collection, reporting, analysis, and dissemination of information on environment, safety, and health issues as required by law or regulations or as needed by DOE.
DOE Order 436.1, *Departmental Sustainability* (05/02/11)	Defines requirements and responsibilities for managing sustainability within DOE.
DOE Policy 450.4A, *Integrated Safety Management Policy* (Change 1, 01/18/18)	Sets forth the framework for identifying, implementing, and complying with environmental safety and health requirements so that work is performed in the DOE complex in a manner that ensures adequate protection of workers, the public, and the environment.
DOE Policy 451.1, *National Environmental Policy Act Compliance Program* (12/21/17)	Establishes DOE's expectations for implementing NEPA; the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500-1508); and the DOE NEPA Implementing Procedures (10 CFR Part 1021).
Water Resources	
Federal Water Pollution Control Act (Clean Water Act [CWA]), 33 U.S.C. 1251 et seq.	Establishes a national program to restore and maintain the chemical, physical, and biological integrity of navigable waters by prohibiting the discharge of toxic pollutants in significant amounts; requires Federal agencies to comply with Federal, State, and local water quality requirements; Section 404 of the CWA regulates development activities in jurisdictional surface waters and wetlands, and delegates EPA and the U.S. Army Corps of Engineers (USACE) to share Section 404 enforcement authority regarding the discharge of dredged or fill material into waters of the United States; allows EPA to delegate primary enforcement authority for National Pollutant Discharge Elimination System (NPDES) permits (Section 402) to Idaho, Tennessee, and South Carolina (see NPDES discussion below).

Law, Regulation, Order, or Other Requirement	***Description***
National Pollutant Discharge Elimination System, 40 CFR Part 122	Creates a permit program for point-source discharges of pollutants to waters of the United States; establishes permitted effluent limits to ensure that water quality standards are met; delegates authority for administration of the NPDES Program to the States of Tennessee and South Carolina. (On June 5, 2018, the EPA Administrator approved the application by the State of Idaho to administer and enforce the Idaho Pollutant Discharge Elimination System [IPDES] program. Idaho administration of the NPDES program is expected to be fully implemented by 2021 [EPA 2019c].)
Navigation and Navigable Waters, 33 CFR Parts 320-332	Provides for U.S. Army Corps of Engineers regulation of activities that may modify any navigable waters of the U.S. including the discharge of dredged or fill materials.
Department of the Army, USACE, and EPA Final Rule: *Repeal of the 2015 Clean Water Rule: Definition of "Waters of the United States"* (12/23/19) 33 CFR Part 328, 40 CFR Part 110, 40 CFR Part 112, 40 CFR Part 116, 40 CFR Part 117, 40 CFR Part 122, 40 CFR Part 230, 40 CFR Part 232, 40 CFR Part 300, 40 CFR Part 302, 40 CFR Part 401	Amends portions of the CFR to restore the regulatory text that existed prior to the 2015 Rule regarding the definition of "*Waters of the United States*". With this final rule, the regulations defining the scope of Federal CWA jurisdiction will be those portions of the CFR as they existed before the amendments promulgated in the 2015 Rule.
Safe Drinking Water Act of 1974, as amended, 42 U.S.C. 300f et seq.	Establishes a national program to ensure the quality of drinking water in public water systems; allows EPA to delegate primary enforcement authority to Idaho, Tennessee, and South Carolina.
National Primary Drinking Water Regulations, 40 CFR Part 141	Creates standards for maximum contaminant levels for pollutants in drinking water; used as groundwater protection standards.
Procedures for Decision-making (Permitting), 40 CFR Part 124	Contains EPA procedures for issuing, modifying, revoking and reissuing, or terminating all RCRA, Prevention of Significant Deterioration (PSD), and NPDES permits.
Executive Order 11988, *Floodplain Management* (05/24/77)	Directs Federal agencies to consider the effects of flood hazards and avoid impacts on floodplains, if practicable. Also requires Federal agencies to evaluate the potential effects of any actions to minimize impacts on the floodplain's natural and beneficial values. Applicable to any new structures built in areas that include floodplains.
Executive Order 11990, *Protection of Wetlands* (05/24/77)	Directs Federal agencies to avoid construction in wetlands and to mitigate impacts of any use of wetlands. Applicable to any new structures built in areas that impact wetlands.
DOE Compliance with Floodplain and Wetlands Environmental Review Requirements, 10 CFR Part 1022	Establishes policy and procedures for implementing responsibilities for protection of floodplains and wetlands.
Idaho Water Pollution Control Act of 1983, Idaho Code (IC) 39-3600 et seq. Idaho Wastewater Rules, Idaho Administrative Procedures Act (IDAPA), 58.01.16 Idaho Recycled Water Rules, IDAPA 58.01.17	Establishes a program to enhance and preserve the quality and value of water resources. Creates procedures and requirements for the planning, design, and operation of wastewater facilities and the discharge of wastewaters and human activities which may adversely affect public health and water quality in the waters of the State.
Idaho Groundwater Quality Rules, IDAPA 58.01.11	Establishes minimum requirements for protection of groundwater quality through standards and an aquifer categorization process; serves as basis for administration of programs which address groundwater quality but do not in and of themselves create a permit program.

Law, Regulation, Order, or Other Requirement	***Description***
Idaho Rules for Public Drinking Water Systems, IDAPA 58.01.08	Controls and regulates the design, construction, operation, maintenance, and quality control of public drinking water systems to provide a degree of assurance that such systems are protected from contamination and maintained free from contaminants that may injure the health of the consumer.
Tennessee Water Quality Control Act, Tennessee Code Annotated (TCA) 69-1-117, TCA 69-3-101 et seq., 70-324-70 Tennessee Division of Water Pollution Control, Tennessee Rules 0400-40-01 et seq.	Governs impairment or obstruction of navigability of watercourses; establishes the authority to issue new or modify existing NPDES permits required for a water discharge source and mandates protection of water quality; requires permit prior to alteration of a wetland.
Tennessee National Pollutant Discharge Elimination System, TCA 69-3-108 NPDES General Permits, TDWPC, Rule 0400-40-10	Implements an EPA-authorized State program that administers both Federal and State requirements for point and nonpoint source discharges to surface water.
Tennessee Safe Drinking Water Act of 1983, TCA 68-221-701 Public Water Systems, Tennessee Rules 0400-45-01	Adopts Federal standards for drinking water.
Tennessee Aquatic Resource Alteration, Tennessee Rules, 0400-40-07 et seq.	Creates an Aquatic Resource Alteration Permit that “authorizes the alteration of properties of waters of the state that result from activities other than discharges of wastewater through a pipe, ditch, or other conveyance”; establishes a permit process for activities that are likely to impair or obstruct navigability.
Tennessee Department of Environment and Conservation, General Water Quality Criteria, Chapter 0400-40-03, Rule 0400-40-03-.06(4)a	Provides requirements for a wetland to be considered Exceptional Tennessee Waters (ETW). ETWs are aquatic resources with features that merit special attention or consideration and are significant at the national, State, or regional level. An ETW designation is expected for aquatic features within the proposed project area. The ETW designation is determined via the Tennessee Rapid Assessment Method (TRAM), used to protect existing uses of all surface waters.
South Carolina Pollution Control Act, SC Code § 48-1-10 et seq. Water Pollution Control Permits, SC Regulation 61-9 Water Classifications and Standards, SC Regulation 61-68 Water Quality Certification, SC Regulation 61-101	Establishes a wide-ranging water protection program, including some provisions not addressed by the CWA (for example, permit requirements for construction of wastewater treatment plants). Provides an opportunity for the State to review and certify a Federal permit or license for an activity that results in discharges to navigable waters.
South Carolina Safe Drinking Water Act, SC Code § 44-55-10 et seq. State Primary Drinking Water Regulations, SC Regulation 61-58	Creates a State program regulating public water systems. Adopts Federal standards for drinking water and controls and regulates the design, construction, operation, maintenance, and quality control of public drinking water systems.
South Carolina Groundwater Use and Reporting Act, SC Code § 49-5-10 et seq. Groundwater Use and Reporting, SC Regulation 61-113	Establishes State standards to maintain, conserve, and protect groundwater in the State. Mandates that any person withdrawing groundwater in excess of 3 million gallons during any 1 month from a single or multiple wells under common ownership and within 1 mile of an existing or proposed well or intake must register with, annually report to, and be permitted by the SCDHEC.
South Carolina Surface Water Withdrawal, Permitting Use, and Reporting Act of 2010, SC Code § 49-4-10 et seq. Surface Water Withdrawal, Permitting Use, and Reporting, SC Regulation 61-119	Mandates that any person withdrawing surface water in excess of 3 million gallons during any 1 month must register with, annually report to, and be permitted by the SCDHEC.

Law, Regulation, Order, or Other Requirement	***Description***
South Carolina Erosion and Sediment Reduction Act, SC Code § 48-18-70 Standards for Stormwater Management and Sediment Reduction, SC Regulations, 72-405 et seq.	Establishes a comprehensive program and processes for managing stormwater and sediment to reduce potential flooding and to prevent water quantity and quality problems and meet the requirements of Section 402 of the CWA and the NPDES Stormwater Program.
Air Quality	
Clean Air Act of 1970, as amended, 42 U.S.C. 7401 et seq.	Requires Federal agencies to comply with air quality regulations; includes four major programs: the National Ambient Air Quality Standards (NAAQS); State implementation plans; new source performance standards; and National Emission Standards for Hazardous Air Pollutants (NESHAP). Allows EPA to delegate authority for most CAA provisions to Idaho, Tennessee, and South Carolina, who would issue or modify permits, as needed, for stationary sources associated with the proposed activities.
Ambient Air Quality Standards/State Implementation Plans, 40 CFR Parts 51 and 58	Establishes the National Ambient Air Quality Standards (NAAQS), which are divided into primary and secondary categories for carbon monoxide, lead, nitrogen dioxide, ozone, sulfur dioxide, and particulate matter. (Proposed activities would add to site emissions, whose combined ambient concentrations are then compared to the standards.)
Prevention of Significant Deterioration, 40 CFR 51.166	Establishes processes for maintaining air quality in areas already in compliance with the NAAQS (attainment areas); requires comprehensive preconstruction review and the application of best-available control technology for major stationary sources.
New Source Performance Standards, 40 CFR Part 60	Creates industry- and process-specific standards that apply to any new, modified, or reconstructed sources of air pollution.
National Emission Standards for Hazardous Air Pollutants and for Source Categories, 40 CFR Parts 61 and 63	Defines hazardous air pollutants (HAPs) (such as radionuclides, mercury, and asbestos) and maximum achievable control technologies by industry or process. (Proposed activities would add to site HAPs emissions, whose combined ambient concentrations are then compared to the standards).
National Emission Standards for Emissions of Radionuclides other than Radon from Department of Energy Facilities, 40 CFR Part 61, Subpart H	Establishes requirements for monitoring radionuclide emissions from facility operations and analyzing and reporting radionuclide doses; limits, in Subpart H, the radionuclide dose to a member of the public to 10 millirem per year.
State Operating Permit Programs, 40 CFR Part 70	Defines minimum permit requirements, including air pollution control, reporting, monitoring, and compliance certification requirements; includes permitting program known as Title V for major sources of air pollution.
Idaho Environmental Protection and Health Act, IC, Title 39, Health and Safety, Chapter 1, Department of Health and Welfare, Sections 39-105 Rules for the Control of Air Pollution in Idaho, IDAPA 58.01.01	Provides for development of regulations for the control and permitting of air emission sources. Provides rules and permitting programs to control air pollutant emissions in Idaho.
Tennessee Air Quality Act, TCA 53-3408 et seq. Tennessee Air Pollution Control Regulations, Tennessee Rules 1200-3-1-.01 et seq.	Requires permits to operate an air containment source; sets fugitive dust requirements. Implements provisions of the Tennessee Air Quality Act; identifies measures and programs to control and permit sources of air pollution and hazardous air contaminants in Tennessee. Sources that emit criteria pollutants and HAPs are regulated under permits to construct and operate.
South Carolina Pollution Control Act (1972), SC Code §48-1-10 et seq. South Carolina Air Pollution Control Regulations and Standards, SC Regulation 61-62	Defines regulatory authority for air quality permitting and regulation pertaining to activities at SRS that are permitted by the State. Regulates sources that emit criteria pollutants and HAPs under construction and operational permits.

Law, Regulation, Order, or Other Requirement	***Description***
Biological Resources	
Migratory Bird Treaty Act of 1918, 16 U.S.C. 703 et seq. Migratory Bird Hunting, 50 CFR Part 20 Migratory Bird Permits, 50 CFR Part 21	Implements several international treaties related to the protection of migratory birds and makes it illegal to take, capture, or kill any migratory bird, or to take any part, nest, or egg of any such birds; applies to purposeful actions, not to actions that result from otherwise lawful activities (incidental take).
Fish and Wildlife Coordination Act of 1934, 16 U.S.C. 661 et seq. Taking, Possession, Transportation, Sale, Purchase, Barter, Exportation, and Importation of Wildlife and Plants, 50 CFR Parts 10-24 Management of Fisheries Conservation Areas, 50 CFR Parts 70-71 Interagency Cooperation – Endangered Species Act of 1973, as amended, 50 CFR Part 402	Provides the basic authority for the involvement of the USFWS and state agencies to evaluate impacts of proposed projects that may result in the construction, modification, or control of a natural streams or bodies of water in excess of 10 acres in surface area.
Anadromous Fish Conservation Act of 1965, 16 U.S.C. 757 et seq. Anadromous Fish, 50 CFR 223.203 Anadromous Fisheries Conservation, Development, and Enhancement, 50 CFR Part 401	Authorizes the Secretary of the Interior to enter into agreements with States and other non-Federal entities to protect and enhance resources of anadromous fish (fish that return to rivers from the sea to spawn).
Endangered Species Act of 1973, 16 U.S.C. 1531 et seq. Taking, Possession, Transportation, Sale, Purchase, Barter, Exportation, and Importation of Wildlife and Plants, 50 CFR Parts 10-24 Interagency Cooperation – Endangered Species Act of 1973, as amended, 50 CFR Part 402	Requires Federal agencies to assess whether actions could adversely affect threatened or endangered species or their habitat.
Bald and Golden Eagle Protection Act of 1973, as amended, 16 U.S.C. 668-668d Eagle Permits, 50 CFR Part 22	Imposes criminal and civil penalties for the possession or taking of bald or golden eagles.
North American Wetlands Conservation Act of 1989, 16 U.S.C. 4401–4414	Requires the head of each Federal agency responsible for Federal lands and waters to cooperate with the Director of the USFWS to restore, protect, and enhance the wetland ecosystems and other habitats for migratory birds, fish, and wildlife within the lands and waters of the agency.
Federal Noxious Weed Act, 7 U.S.C. 28142 Noxious Weed Regulations, 7 CFR Part 360	Requires each Federal land-managing agency to establish integrated management systems to control or contain undesirable plant species targeted under cooperative agreements with State agencies.
Sikes Act of 1960, 16 USC 670a–670o Resource Management and Public Activities on Federal Lands, 43 CFR 24.4 Criteria for Designating Critical Habitat, 50 CFR 424.12	Calls for cooperation with State fish and game agencies in planning and managing wildlife habitat on Federal lands; is particularly relevant to wildlife management on the ORR, as it specifically mentions what are now lands controlled by DOE; states that the "Secretary of the Interior shall develop, with the prior written approval of the Atomic Energy Commission (AEC) [now a part of DOE], a comprehensive plan for conservation and rehabilitation programs to be implemented on public land under the jurisdiction of the Chairman" of the AEC (now the Secretary of Energy).

Law, Regulation, Order, or Other Requirement	***Description***
Executive Order 11990, *Protection of Wetlands* (05/24/77)	Establishes wetland protection as the official policy of all Federal agencies; directs each agency to provide leadership and "to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands;" applies to federally undertaken, financed, or assisted construction and improvements in, or with significant impacts on, wetlands.
Executive Order 13112, *Invasive Species* (2/3/99)	Directs each Federal agency whose actions may affect the status of invasive species to take action to prevent the introduction of invasive species and promote restoration of native species and natural habitat. Establishes the National Invasive Species Council (NISC) to safeguard interests of the U.S. by preventing, eradicating, and controlling invasive species, as well as restoring ecosystems and other assets impacted by invasive species. NISC prepares and maintains a National Invasive Species Management Plan.
Executive Order 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds* (01/10/01)	Requires each Federal agency whose actions have or are likely to have a measurable negative effect on migratory birds to enter into a Memorandum of Understanding with USFWS defining protective measures.
Idaho, Various Acts Regarding Fish and Game, IC, Title 36, Fish and Game, Chapter 9 – Protection of Fish, Chapter 11 – Protection of Animals and Birds, and Chapter 24 – Species Conservation	Establishes protection of wildlife from certain methods of take; establishes species management plan requirements.
Idaho Endangered Species Act, IC, Title 67, State Government and State Affairs, Chapter 8, Executive and Administrative Officers, Section 67-818 Rules for Classification and Protection of Wildlife, IDAPA 13.01.06-09	Establishes State responsibility and coordination of policy and programs related to threatened and endangered species. Establishes authority for the Idaho Fish and Game Commission to adopt rules concerning the taking of wildlife species and classification of wildlife species.
Tennessee Nongame and Endangered or Threatened Wildlife Species Conservation Act of 1974, TCA 70-8-105 Rules and Regulations for in Need of Management, Threatened, and Endangered Species, Tennessee Rules 1660-01-32	Requires consultation with responsible agency. Provides list of protected species and rules governing those species.
Tennessee Rare Plant Protection and Conservation Act of 1985, TCA 70-8-301 et seq. Rare Plant Protection and Conservation Regulations, Tennessee Rules 0400-06-02.01-07	Requires consultation with responsible agency. Provides list of protected species and rules governing those species.
South Carolina Nongame and Endangered Species Conservation Act, SC Code 50-15-10-90 Article 5, Non-Game and Endangered Species, SC Regulation 123-150 et seq.	Provides protection for State-designated endangered and threatened species in need of management; specifies the statute that it is unlawful to take indigenous species (including sea turtles, birds, fish, reptiles, amphibians, and mammals) in the State that are listed as endangered by the State.
Cultural and Paleontological Resources	
American Antiquities Act of 1906, 16 U.S.C. 431 et seq. Preservation of American Antiquities, 43 CFR Part 3	Protects prehistoric American Indian ruins and artifacts on Federal lands; authorizes the President to designate historic areas as national monuments.
Historic Sites Act of 1935, 16 U.S.C. 461 National Historic Landmarks Program, 36 CFR Part 65	Provides for the preservation of historic American sites, buildings, objects, and antiquities of national significance, and serves other purposes.

Law, Regulation, Order, or Other Requirement	***Description***
National Historic Preservation Act of 1966, 16 U.S.C. 470 et seq. National Register of Historic Places, 36 CFR Part 60 et seq. Curation of Federally Owned and Administered Archeological Collections, 36 CFR Part 79 Protection of Historic Properties, 36 CFR Part 800	Sets forth the procedural requirements for listing properties on the National Register of Historic Places; identifies the process for evaluating the eligibility of properties for inclusion in the National Register of Historic Places; requires consultation with the State Historic Preservation Officer prior to any action that could affect historic resources (this consultation is being accomplished for the proposed activities, as needed).
Archaeological and Historic Preservation Act of 1974, as amended, 16 U.S.C. 469 et seq.	Requires the preservation of historical and archeological data (including relics and specimens) that might otherwise be irreparably lost or destroyed as the result of Federal construction projects.
American Indian Religious Freedom Act of 1978, 42 U.S.C. 1996	Protects and preserves, for American Indians, their inherent right of freedom to believe, express, and exercise their traditional religions, including access to sites.
Archaeological Resources Protection Act of 1979, 16 U.S.C. 470aa-mm Protection of Archaeological Resources, 43 CFR Part 7	Protects archaeological resources and sites on Federal and American Indian lands and establishes the uniform definitions, standards, and procedures to be followed by all Federal land managers in providing protection for archaeological resources located on public lands and American Indian lands of the United States, including collections of prehistoric and historic material remains, and associated records, recovered under the authority of the American Antiquities Act (16 U.S.C. 431-433), the Reservoir Salvage Act (16 U.S.C. 469–469c), Section 110 of the National Historic Preservation Act (16 U.S.C. 470h-2), or the Archaeological Resources Protection Act (16 U.S.C. 470aa-mm); could apply if such resources were to be disturbed by activities associated with the proposed facilities.
Native American Graves Protection and Repatriation Act of 1990, 25 U.S.C. 3001 et seq. Native American Graves Protection and Repatriation Regulations, 43 CFR Part 10	Protects American Indian burial remains and funerary objects found on Federal or tribal land; could apply if such resources were to be disturbed by activities associated with the proposed facilities.
Executive Order 11593, *Protection and Enhancement of the Cultural Environment* (05/13/71)	Requires preservation of historic and archaeological information prior to construction activities, such as those associated with the proposed facilities.
Executive Order 13007, *Indian Sacred Sites* (05/24/96) MOU Interagency Coordination and Collaboration for the Protection of Indian Sacred Sites (2016)	Requires Federal agencies to accommodate, to the extent practicable, access to American Indian sacred sites and avoid adverse impacts on such sites.
Executive Order 13175, *Consultation and Coordination with Indian Tribal Governments* (11/06/00)	Requires consultation and coordination with American Indian Tribes prior to taking actions that affect federally recognized tribal governments.
Executive Order 13195, *Trails for America in the 21st Century* (01/18/01)	Requires Federal agencies —to the extent permitted by law and where practicable, and in cooperation with Tribes, States, local governments, and interested citizen groups— to protect, connect, promote, and assist trails of all types throughout the United States.
Executive Order 13287, *Preserve America* (03/03/03)	Promotes the protection of Federal historic properties and cooperation among governmental and private entities in preserving cultural heritage.
DOE Order 144.1, *Department of Energy American Indian Tribal Government Interactions and Policy* (Change 1, 11/06/09)	Establishes a policy committing DOE to consultation with American Indian tribal governments to solicit input on DOE issues.

Law, Regulation, Order, or Other Requirement	***Description***
DOE Policy 141.1, *Department of Energy Management of Cultural Resources* (1/28/11)	Ensures that DOE programs and field elements integrate cultural resources management into their mission and activities.
Idaho Historic Preservation Act, IC, Title 67, Chapter 46, Preservation of Historic Sites State Protocol Agreement between the Idaho State Director, BLM, and the Idaho SHPO that Implements the NHPA	Requires consultation with responsible local governing body for historic preservation.
Idaho Protection of Graves, IC, Title 27, Chapter 5	Defines permitted activities and establishes guidelines for the legal removal of human remains from Idaho gravesites by qualified archaeologists or law enforcement personnel.
Tennessee, Desecration of Venerated Objects, TCA 39-17-311	Forbids a person to offend or intentionally desecrate venerated objects, including a place of worship or burial.
Tennessee, Excavation of Areas Containing Native American Indian Human Remains, TCA 11-6-116 Native American Indian Cemetery Removal and Reburial, TN Rule 0400-9-1	Requires notification prior to excavation in areas containing human remains of Native American Indians.
South Carolina Institute of Archaeology and Anthropology, SC Code 60-13-210 Institute of Archaeology and Anthropology, SC Regulations 9-100.1 — 9-100.450	Establishes and recommends methods and standards for archaeological and anthropological research on behalf of the State.
Infrastructure	
Solid Waste Disposal Act of 1965, as amended by the Resource Conservation and Recovery Act (RCRA) of 1976 and the Energy Policy Act of 2005, 42 U.S.C. 6991 et seq. Technical Standards for and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST), 40 CFR Parts 280-282	Regulates construction of underground storage tanks, including for radioactive materials.
Idaho Underground Storage Tank Act, IC Title 39, Chapter 88, Health and Safety Idaho Rules Regulating Underground Storage Tank Systems, IDAPA 58.01.07	Creates standards and procedures for the regulation of underground storage tank systems.
Tennessee Petroleum Underground Storage Tank Act, TCA 68-53-101 et seq. Tennessee Underground Storage Tank Program Regulations, Tennessee Rules, 1200-1-15	Establishes a requirement for a permit prior to construction or modification of an underground storage tank.
State Underground Petroleum Environmental Response Bank Act, SC Code 44-2 South Carolina, Underground Storage Tank Control Regulations, SC Regulations R.61-92	Addresses underground storage tank installation and operation permits.
Noise	
Noise Control Act of 1972, 42 U.S.C. 4901 et seq. as amended by the Quiet Communities Act of 1978	Protects the health and safety of the public from excessive noise levels; requires Federal agencies to comply with Federal, State, and local noise abatement requirements.

Law, Regulation, Order, or Other Requirement	***Description***
Waste Management	
Low-Level Radioactive Waste Policy Act of 1980, 42 U.S.C. 2021 et seq. Criteria and Procedures for Emergency Access to Non-Federal and Regional Low-Level Waste Disposal Facilities, 10 CFR Part 62	Specifies that the Federal Government is responsible for the disposal of certain low-level radioactive waste, including low-level radioactive waste owned or generated by the DOE; and specifies States are responsible for the disposal of commercially generated low-level radioactive waste; pertains to waste that could be generated by the proposed activities.
Nuclear Waste Policy Act of 1982, 42 U.S.C. 10101 et seq. Disposal of High-Level Radioactive Wastes in Geologic Repositories, 10 CFR Part 60 Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste, 10 CFR Part 72	Establishes national program for the disposal of high-level radioactive waste and used nuclear fuel.
Byproduct Material, 10 CFR Part 962	Defines byproduct material as identified in the Atomic Energy Act, and clarifies that the hazardous portion of mixed radioactive waste is subject to RCRA.
Waste Isolation Pilot Plant Land Withdrawal Act, as amended, Public Law 102-579 DOE National Security and Military Applications of Nuclear Energy Authorization Act of 1980, Public Law 96-164, 93 Stat. 1259	Withdraws land from the public domain for the purposes of creating and operating a geologic repository in New Mexico designated as the national disposal site for defense transuranic waste. The Land Withdrawal Act also defines the characteristics and amount of waste that will be disposed of at the facility. Includes information related to the authorization basis of the WIPP facility for the disposal of contact-handled and remote-handled transuranic waste.
Solid Waste Disposal Act of 1965 as amended by the Resource Conservation and Recovery Act (RCRA) of 1976 and the Hazardous and Solid Waste Amendments of 1984, 42 U.S.C. 6901 et seq. RCRA Regulations for Non-hazardous Waste, 40 CFR Parts 239-259 RCRA Regulations for Hazardous Waste, 40 CFR Parts 260-273	Establishes comprehensive management system for hazardous wastes, addressing generation, transportation, storage, treatment, and disposal; allows, per Section 3006 of RCRA (42 U.S.C. 6926), States to establish and administer permit programs with EPA approval; allows EPA to delegate primary enforcement authority to Idaho, Tennessee, and South Carolina.
Federal Facility Compliance Act of 1992, 42 U.S.C. 6961 et seq.	Waives sovereign immunity for Federal facilities under RCRA; requires DOE to conduct an inventory and develop a treatment plan for mixed wastes.
Toxic Substances Control Act of 1976, 15 U.S.C. 2601 et seq. Toxic Substances Control Act, 40 CFR Parts 700-799	Gives EPA the authority to screen and regulate new and existing chemicals to protect the public from the risks of exposure to chemicals; establishes specific provisions to address polychlorinated biphenyls, asbestos, radon, and lead-based paint.
Pollution Prevention Act of 1990, 42 U.S.C. 13101 et seq. Comprehensive Procurement Guidelines for Products Containing Recovered Materials, 40 CFR Part 247	Establishes requirement to prevent pollution by emphasizing source reduction and recycling. EPA is charged with developing measures for source reduction and evaluating regulations to promote source reduction.
DOE Order 435.1, *Radioactive Waste Management* (Change 1, 08/28/01)	Ensures that all DOE radioactive waste is managed in a manner that is protective of worker and public health and safety and the environment.
Idaho Hazardous Waste Management Act, IC Title 39, Chapter 44 Idaho Rules and Standards for Hazardous Waste, IDAPA 58.01.05	Requires proper controls for the management of solid and hazardous waste. Establishes requirements applicable to all hazardous waste management facilities in Idaho.

Law, Regulation, Order, or Other Requirement	***Description***
Idaho Solid Waste Facilities Act, IC Title 39, Chapter 74 Idaho Solid Waste Management Rules, IDAPA 58.01.06	Establishes requirements applicable to all solid waste and solid waste management facilities in Idaho.
Tennessee Hazardous Waste Management Act, TCA 68-212 Hazardous Waste Management, Tennessee Rules 0400-12-01	Establishes requirements for a permit to construct, modify, or operate a hazardous waste treatment, storage, or disposal facility.
Tennessee Solid Waste Management Act of 1991, TCA 68-211-101 et seq. Tennessee Solid Waste Processing and Disposal Regulations, Tennessee Rules, 1200-1-7	Establishes requirements for a permit to construct or to operate a solid waste processing or disposal facility.
South Carolina Hazardous Waste Management Act, SC Code 44-56-10-840 South Carolina Hazardous Waste Management Regulations, SC Regulations R.61-79	Regulates the generation, transportation, treatment, storage, and disposal of hazardous waste in South Carolina. Establishes requirements for a permit to construct, modify, or operate a hazardous waste treatment, storage, or disposal facility.
South Carolina Solid Waste Management Act, SC Code 44-96 South Carolina Solid Waste Management: Solid Waste Landfills and Structural Fill, SC Regulations R.61-107.19	Establishes standards to treat, store, or dispose of solid waste. Establishes requirements for a permit to construct or to operate a solid waste processing or disposal facility.
Nuclear Materials Management	
Atomic Energy Act of 1954, as amended, 42 U.S.C. 2011 et seq.	Provides fundamental jurisdictional authority to DOE and NRC over governmental and commercial use, respectively, of nuclear materials; authorizes DOE to establish standards to protect health or minimize dangers to life or property for activities under DOE jurisdiction; allows DOE to issue a series of orders to establish a system of standards and requirements that ensure safe operation of DOE facilities.
Procedural Rules for DOE Nuclear Facilities, 10 CFR Part 820	Governs the conduct of persons involved in DOE nuclear activities and, in particular, to achieve compliance with DOE nuclear safety requirements.
Nuclear Safety Management, 10 CFR Part 830	Governs the conduct of DOE contractors, DOE personnel, and other persons conducting activities (including providing items and services) that affect, or may affect, the safety of DOE nuclear facilities.
DOE Order 410.2, *Management of Nuclear Materials* (Change 1, 04/10/14)	Establishes requirements and procedures for the lifecycle management of nuclear materials within DOE.
DOE Order 425.1D, *Verification of Readiness to Start Up or Restart Nuclear Facilities* (Change 2, 10/04/19)	Establishes requirements for DOE for verifying readiness for startup of new nuclear facilities and for the restart of existing nuclear facilities that have been shut down.
DOE Order 426.2, *Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities* (Change 1, 07/29/13)	Establishes selection, qualification, and training requirements for management and operating contractor personnel involved in the operation, maintenance, and technical support of DOE reactors and nonreactor nuclear facilities.
DOE Order 433.1B, *Maintenance Management Program for DOE Nuclear Facilities* (Change 1, 03/12/13)	Establishes a safety management program required by 10 CFR Part 830 for maintenance and the reliable performance of structures, systems, and components that are part of the safety basis at Hazard Category 1, 2, and 3 DOE nuclear facilities.

Law, Regulation, Order, or Other Requirement	Description
DOE Policy 470.1B, *Safeguards and Security Program* (2/10/16)	Ensures that DOE efficiently and effectively meets all its obligations to protect special nuclear material, other nuclear materials, classified matter, sensitive information, government property, and the safety and security of employees, contractors, and the general public.
DOE Order 470.4B, *Safeguards and Security Program* (Change 2, 01/17/17)	Identifies roles and responsibilities for the DOE Safeguards and Security Program.
South Carolina Atomic Energy and Radiation Control Act, SC Code 13-7 et seq. Radioactive Materials, SC Regulations R.61-63	Addresses license to receive, use, possess, transfer, or dispose of radioactive material.
Human Health	
Occupational Safety and Health Act of 1970, 29 U.S.C. 651 et seq. Occupational Safety and Health Standards, 29 CFR Part 1910, 29 CFR Part 1926	Ensures worker and workplace safety, including a workplace free from recognized hazards, such as exposure to toxic chemicals, excessive noise levels, and mechanical dangers. Establishes standards to protect workers from hazards encountered in the workplace (Part 1910) and construction site (Part 1926).
Worker Safety and Health Program, 10 CFR Part 851	Creates DOE's health and safety program to control and monitor hazardous materials to ensure that workers are not being exposed to health hazards, such as toxic chemicals, excessive noise, and ergonomic stressors.
Occupational Radiation Protection, 10 CFR Part 835	Establishes radiation protection standards, limits, and program requirements for protecting workers from ionizing radiation resulting from DOE activities.
Chemical Accident Prevention Provisions, 40 CFR Part 68	Provides the list of regulated substances and thresholds, and the requirements for owners or operators of stationary sources concerning the prevention of accidental releases, and the State accidental release prevention programs approved under CAA Section 112(r).
Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level, and Transuranic Radioactive Wastes, 40 CFR Part 191	Applies to radiation doses received by members of the public as a result of the management (except for transportation) and storage of spent nuclear fuel, transuranic, or high-level radioactive wastes.
DOE Order 420.1C, *Facility Safety* (Change 3 11/14/19)	Establishes facility and programmatic safety requirements for DOE facilities, including nuclear and explosives safety design criteria, fire protection, criticality safety, natural phenomena hazards mitigation, and the System Engineer Program.
DOE Policy 420.1, *Department of Energy Nuclear Safety Policy* (02/08/11)	Documents DOE's nuclear safety policy.
DOE Order 430.1C, *Real Property Asset Management* (Change 1, 10/04/19)	Establishes a corporate, holistic, and performance-based approach to real property life-cycle asset management that links real property asset planning, programming, budgeting, and evaluation to program mission projections and performance outcomes. To accomplish the objective, this Order identifies requirements and establishes reporting mechanisms and responsibilities for real property asset management.
DOE Order 440.1B, *Worker Protection Program for DOE (including the National Nuclear Security Administration) Federal Employees* (05/17/07; Change 2, 03/14/13)	Describes the DOE program to protect workers and reduce accidents and losses; adopts occupational safety and health standards.
DOE Order 458.1, *Radiation Protection of the Public and the Environment* (02/11/11; Change 3, 01/15/13)	Establishes requirements to protect the public and the environment against undue risk from radiation associated with radiological activities conducted under the control of DOE, pursuant to the Atomic Energy Act of 1954, as amended.

Law, Regulation, Order, or Other Requirement	***Description***
Transportation	
Hazardous Materials Transportation Act of 1975, 49 U.S.C. 5101 et seq. Transportation, Subchapter C, Hazardous Materials Regulations, 49 CFR Parts 171–180	Provides the U.S. Department of Transportation (DOT) with authority to protect against the risks associated with transportation of hazardous materials, including radioactive materials, in commerce. Establishes DOT requirements for classification, packaging, hazard communication, incident reporting, handling, and transportation of hazardous materials.
DOE Order 460.1D, *Hazardous Materials Packaging and Transportation Safety* (12/20/16)	Describes DOE safety requirements for the proper packaging and transportation of offsite shipments and onsite transfers of radioactive and other hazardous materials.
DOE Order 460.2A, *Departmental Materials Transportation and Packaging Management* (12/22/04)	Describes DOE requirements and responsibilities for materials transportation and packaging management to ensure the safe, secure, and efficient packaging and transportation of materials, both hazardous and nonhazardous.
DOE Order 461.1C, *Packaging and Transportation for Offsite Shipment of Materials of National Security Interest* (Change 1, 10/04/19)	Affirms that the packaging and transportation of all offsite shipments of materials of national security interest for DOE must be conducted in accordance with DOT and NRC regulations that would be applicable to comparable commercial shipments, except where an alternative course of action is identified in the Order.
DOE Order 461.2, *Onsite Packaging and Transfer of Materials of National Security Interest* (11/01/10)	Establishes safety requirements and responsibilities for onsite packaging and transfers of materials of national security interest to ensure safe use of Transportation Safeguards System (TSS), non-TSS Government- and contractor-owned and/or leased resources.
Idaho Transportation of Hazardous Waste, IC Title 18, Chapter 39 Hazardous Materials/Hazardous Waste Transportation Enforcement, IC Title 49, Chapter 22	Regulates transportation of hazardous materials/hazardous waste on Idaho highways.
Tennessee Requirements Applicable to Transfer Facilities and Permit Requirements and Standards Applicable to Transporters of Hazardous Waste, Tennessee Rules, 0400-12-01-.04	Establishes standards which apply to persons transporting hazardous waste within Tennessee.
South Carolina Hazardous Waste Management Act, Promulgation of Rules and Regulations, SC Code 44-56-30 Transportation of Radioactive Waste into or within South Carolina, SC Regulations R.61-83	Establishes the DOT regulations for the transportation, containerization, and labelling of hazardous wastes. Establishes requirements and permits for shippers, carriers and disposal facility operators for all aspects of packaging and transporting of radioactive waste material.
Environmental Justice	
Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (2/11/94), as amended by Executive Order 12948 (1/30/95)	Requires each Federal agency to identify and address disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations.
Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks* (4/21/97), as amended by Executive Order 13296 (4/18/03)	Requires each Federal agency to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children and to ensure that its policies, programs, activities, and standards address disproportionate environmental health or safety risks to children.
Emergency Management	
Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. 9601 et seq.	Provides broad Federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment.

Law, Regulation, Order, or Other Requirement	***Description***
Emergency Planning and Community Right-to-Know Act of 1986, 42 U.S.C. 11001 et seq.	Requires that Federal, State, and local emergency planning authorities be provided information regarding the presence and storage of hazardous substances and their planned and unplanned environmental releases, including provisions and plans for responding to emergency situations involving hazardous materials.
Price-Anderson Act and Amendments, 42 U.S.C. 2210 Financial Protection Requirements and Indemnity Agreements, 10 CFR Part 140	Establishes a system of financial protection for persons who may be liable for and persons who may be injured by a nuclear incident.
Oil Pollution Prevention, 40 CFR Part 112	Outlines the requirements for both the prevention of and the response to oil spills; includes requirements for Spill Prevention, Control, and Countermeasure Plans, and for Facility Response Plans.
Designation, Reportable Quantities, and Notification, 40 CFR 302	Requires facilities to notify Federal authorities of spills or releases of certain hazardous substances designated under CERCLA and CWA; specifies the quantities of hazardous substance spills/releases that must be reported to authorities and delineate the notification procedures for a release that equals or exceeds the reportable quantities.
Emergency Planning and Notification, 40 CFR Part 355	Describes emergency planning provisions for facilities in possession of an extremely hazardous substance in a quantity exceeding a specified threshold quantity; could apply to substances to be used in the proposed facilities.
Hazardous Chemical Reporting: Community Right-To-Know, 40 CFR Part 370	Establishes reporting requirements for providing the public with important information on the hazardous chemical inventories in their communities.
Toxic Chemical Release Reporting: Community Right-To-Know, 40 CFR Part 372	Establishes reporting requirements for providing the public with important information on the release of toxic chemicals in their communities.
Radiological Emergency Planning and Preparedness, 44 CFR Part 351	Requires emergency plans for DOE nuclear facilities; defines additional DOE responsibilities for assisting the Federal Emergency Management Agency.
Executive Order 12580, *Superfund Implementation* (1/23/87)	Delegates responsibility to a Federal agency for hazardous substance response activities when the release is from, or the sole source of the release is located in, any facility or vessel under the control of that agency.
Executive Order 12656, *Assignment of Emergency Preparedness Responsibilities* (11/18/88)	Ensures that DOE has sufficient capabilities to meet defense and civilian needs during a national emergency; establishes DOE as the lead agency responsible for energy-related emergency preparedness and for assuring the security of DOE nuclear materials and facilities.
Executive Order 12856, *Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements* (8/3/93)	Requires all Federal facilities to comply with the provisions of EPCRA; requires reports to be submitted pursuant to EPCRA, Sections 302–303 (Planning Notification), 304 (Extremely Hazardous Substances Release Notification), 311–312 (Material Safety Data Sheet/Chemical Inventory), and 313 (Toxic Chemical Release Inventory Reporting).
DOE Order 151.1D, Comprehensive Emergency Management System (10/4/19)	Establishes policy; assigns roles and responsibilities; provides the framework for developing, coordinating, controlling, and directing DOE's emergency management system (i.e., emergency planning, preparedness, response, recovery, and readiness assurance).
DOE Order 153.1, Departmental Radiological Emergency Response Assets (06/27/07)	Establishes requirements and responsibilities for the DOE national radiological emergency response assets and capabilities and Nuclear Emergency Support Team assets.

Law, Regulation, Order, or Other Requirement	Description
Standards and Procedures for Application of Risk Based Corrective Action at Petroleum Release Sites, IDAPA 58.01.24	Establishes standards and procedures to determine whether and what risk-based corrective action measures should be applied to petroleum release sites.
South Carolina Regulations as to Removal of Discharges of Pollutants, SC Code 48-43-550 State of South Carolina Contingency Plan For Spills and Releases of Oil & Hazardous Substances	Regulations relating to the cleanup and removal of discharges of pollutants into the waters or onto the coasts of the State.

CFR = *Code of Federal Regulations*; CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act; DOT = Department of Transportation; EPCRA= Emergency Planning and Community Right-to-Know Act; EPA = U.S. Environmental Protection Agency; IC = Idaho Code; IDAPA = Idaho Administrative Procedures Act; NAAQS = National Ambient Air Quality Standards; NEPA = National Environmental Policy Act; NESHAP = National Emission Standards for Hazardous Air Pollutants; RCRA = Resource Conservation and Recovery Act; SCDHEC = South Carolina Department of Health and Environmental Control; TCA = Tennessee Code Annotated; TDEC = Tennessee Department of Environment and Conservation; U.S.C. = *United States Code*; USFWS = U.S. Fish and Wildlife Service; WIPP = Waste Isolation Pilot Plant.
Source: Information is primarily from DOE 1999a, 2008a, 2011c, 2015a, 2016a.

7.2 Applicable Permits

Implementation of any of the action alternatives proposed in this VTR EIS would require compliance with existing environmental permits and/or modifications to those permits, and could require acquisition of new permits. This section identifies existing relevant environmental permits for DOE's activities, as well as potential new permits or permit modifications necessary to implement the proposed alternatives at each potential location. **Table 7–2** summarizes the relevant environmental permits for air, water, and hazardous waste for each of the candidate locations. Sections 7.2.1 through 7.2.3 provide more details on the permits potentially required for INL, Oak Ridge National Laboratory (ORNL), and SRS, respectively.

All of the candidate locations currently have existing air permits, stormwater discharge permits, industrial wastewater discharge permits, and hazardous waste permits. Communication and coordination with applicable regulatory agencies, including discussion of site-specific and facility-specific permitting requirements (application for new permits or modification to existing permits), would be required at the selected site.

7.2.1 Idaho National Laboratory

INL holds environmental permits, including those for air quality, water quality, and hazardous waste. The *Idaho National Laboratory Site Environmental Report Calendar Year 2018* describes existing permits for INL in more detail (INL 2019c:2.1–2.18). In general, IDEQ is an EPA-authorized State agency. However, regulation of radionuclide air emissions at DOE facilities, as prescribed in Title 40 of the CFR, Part 61, Subpart H, has not been delegated to Idaho and is administered by EPA.

Air – Under EPA regulations, the State of Idaho has been delegated authority under CAA to maintain the National Ambient Air Quality Standards (40 CFR Part 52, Subpart N), to issue Prevention of Significant Deterioration (PSD) permits (40 CFR 52.683), to enforce performance standards for new stationary sources, and to issue permits to construct and operate. Construction or modifications of facilities that are regulated under the IDEQ, Rules for the Control of Air Pollution in Idaho (IDAPA 58.01.01), are subject to a preconstruction review and permitting under the program (IDEQ 2019). To date, the State of Idaho does not have authority delegated from EPA to administer the National Emission Standards for Hazardous Air Pollutants (NESHAP) Subpart H Program (radionuclide emissions); that authority remains with EPA (40 CFR 61.90–61.97) (EPA 2019b).

Table 6–1. Summary of Relevant Environmental Permits

Permit	*INL – MFC (Idaho)*	*ORR – ORNL (Tennessee)*	*SRS – K Area (South Carolina)*
Air			
Nonradioactive Emissions			
Existing Permit	Yes – State Issued	Yes – State Issued	Yes – State Issued
New Permit Application	Yes – submitted through the construction air permit process	Yes – submitted through the construction air permit process	Yes – submitted through the construction air permit process
Permit Modification	Yes	Yes	Yes
Radioactive Emissions			
Existing Permit	Yes – EPA Issued	Yes – State Issued	Yes – State Issued
New Permit Application	No	No	No
Permit Modification	Yes	Yes	Yes
Water			
CWA Section 404 – State Aquatic Resources Alteration			
Existing Permit	NA – no alteration of surface water bodies or wetlands	No	NA – no alteration of surface water bodies or wetlands
New Permit Application		Yes – USACE/State Issued	
Permit Modification		NA	
CWA Section 402 – General Construction Stormwater			
Existing Permit	Yes – EPA Issued	Yes – State Issued	Yes – State Issued
New Permit Application	No	No	No
Permit Modification	Yes	Yes	No
CWA Section 402 – National Pollutant Discharge Elimination System			
Existing Permit	No [a]	Yes – State Issued	Yes – State Issued
New Permit Application	No	No	No
Permit Modification	No	Yes	Yes
Wastewater Reuse			
Existing Permit	Yes – State Issued	NA – No wastewater reuse or land application	NA – No wastewater reuse or land application
New Permit Application	No		
Permit Modification	Yes		
Hazardous Waste [b]			
Existing Permit	Yes – State Issued	Yes – State Issued	Yes – State Issued
New Permit Application	No	No	No
Permit Modification	Yes	Yes	Yes [c]

USACE = U.S. Army Corps of Engineers; CWA = Clean Water Act; EPA = U.S. Environmental Protection Agency; INL = Idaho National Laboratory; MFC = Materials and Fuels Complex; NA = not applicable; ORNL = Oak Ridge National Laboratory; ORR = Oak Ridge Reservation; SRS = Savannah River Site; TSD = treatment, storage, and disposal.

[a] On June 5, 2018, the EPA Administrator approved the application by the State of Idaho to administer and enforce the Idaho Pollutant Discharge Elimination System (IPDES) program. Idaho administration of the NPDES program is expected to be fully implemented by 2021 (EPA 2019c). However, there are no navigable waters near MFC.

[b] Hazardous waste permits are also applicable to the hazardous components of mixed radioactive wastes.

[c] Hazardous and mixed waste generation at the reactor fuel facility may trigger the need to modify the existing SRS hazardous waste permit if a hazardous or mixed waste storage pad was needed in K Area, otherwise waste would be managed under the conditions of a large quantity generator.

The Idaho Air Quality Program is primarily administered through the permitting process. Potential sources of air pollutants are evaluated against regulatory criteria to determine if the source is specifically exempt from permitting requirements or if the source's emissions are significant or insignificant. If emissions are determined to be significant, several actions may occur: (1) permitting determinations may be made to demonstrate that the project or process is either below emission thresholds or listed as exempted source categories in State of Idaho regulations allowing self-exemption or (2) an application for a permit to construct may be submitted. If emissions are deemed major under PSD regulations, then a PSD analysis must be completed. If not deemed significant per PSD regulations, an application for only a permit to construct without the additional PSD modeling and analyses is needed (DOE 2011d).

The operation of INL includes sources that emit criteria and hazardous air pollutants and require a permit to construct (PTC), as outlined in IDAPA 58.01.01.200–228. These sources currently operate under a PTC (PTC #P-2015.0023) with a facility emissions cap. This PTC limits facility-wide emissions to below levels that would require a Title V operating permit and rescinds the previous Title V permit that regulated emission sources at the INL Site (IDEQ 2018:3).

Water – On June 5, 2018, EPA approved the application by the State of Idaho to administer and enforce the Idaho Pollutant Discharge Elimination System (IPDES) program. Transitioning regulatory authority from EPA to Idaho is being phased in over a number of years with Idaho administration of the IPDES program expected to be fully implemented by 2021 (EPA 2019c).

INL complies with two Clean Water Act (CWA) permits through the implementation of procedures, policies, and best management practices. These permits are (1) NPDES general permit for stormwater discharges from construction activities, and (2) discharges from Idaho Falls facilities to the city of Idaho Falls–owned treatment works. The latter permit is not discussed further in this VTR EIS because the Proposed Action does not involve changes in DOE activities in Idaho Falls. INL obtains coverage under the general permit for individual construction projects. Construction of new facilities or modifications to existing facilities would require the development of written stormwater discharge plans. The permit would then need to be modified to include the additional facilities. Only construction projects that are determined to have a reasonable potential to discharge pollutants to regulated surface water are required to have a stormwater pollution prevention plan (SWPPP) (DOE 2011d). Because wastewater would not be discharged to natural surface water bodies at the INL Site, an NPDES/IPDES discharge permit would not be required.

To protect human health and prevent pollution of surface- and groundwaters, the State of Idaho requires a wastewater reuse permit for the land application of wastewater. The IDEQ issues the reuse permits in accordance with IDAPA 58.01.17 "Recycled Water Rules," IDAPA 58.01.16 "Wastewater Rules," and IDAPA 58.01.11 "Ground Water Quality Rule." All wastewater reuse permits incorporate water quality standards for groundwater protection. INL has a wastewater reuse permit to land apply wastewater at the Material and Fuels Complex (MFC) Industrial Waste Ditch and Industrial Waste Pond (INL 2019c:2.10). It is possible the MFC wastewater reuse permit would need to be modified to accommodate discharges from the new VTR facilities.

Hazardous/Mixed Waste – The State of Idaho is authorized by EPA to administer its own Resource Conservation and Recovery Act (RCRA) program and is responsible for reviewing applications and issuing permits under the IDEQ, Rules and Standards for Hazardous Waste (IDAPA 58.01.05). The IDEQ has issued a RCRA permit for INL (DOE 2011d).

When IDEQ receives any information (e.g., information received during facility inspection or in a permit submission), IDEQ may determine if there exists one or more of the causes for modification or revocation and reissuance, or both. If cause exists, IDEQ may modify or revoke and reissue the permit accordingly and may request an updated application, if necessary (DOE 2011d). Hazardous and mixed waste generation at VTR and associated facilities may trigger the need to modify the existing INL hazardous waste permit if the waste would be stored for more than 90 days.

Other Agreements – The DOE and the U.S. Fish and Wildlife Service (USFWS) established the *Candidate Conservation Agreement for Greater Sage-grouse on INL* (CCA) (DOE-ID & USFWS 2014). DOE and USFWS continue to collaborate on sage-grouse protection at the INL Site. In compliance with the CCA, pre- and post-construction surveys are performed to establish the amounts of sagebrush restoration and other native revegetation efforts needed to rehabilitate disturbed areas.

DOE's *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Environmental Impact Statemen*t (DOE 1995) (hereafter referred to as the Programmatic SNF EIS) analyzed alternatives for the management of existing and reasonably foreseeable inventories of DOE's spent nuclear fuel (SNF). The June 1, 1995, Record of Decision (ROD) for the Programmatic SNF EIS (60 FR 28680) stated in part that DOE would consolidate nonaluminum-clad SNF at the Idaho National Engineering and Environmental Laboratory (now INL), and would consolidate the management of its aluminum-clad SNF at SRS.

The Federal Facility Agreement/Consent Order (FFA/CO) and Site Treatment Plan was signed by the State of Idaho on November 1, 1995, and is updated annually (INL 2019c:2.4, 2.7, 2.9). The FFA/CO required preparation of a site treatment plan for the treatment of mixed waste stored or generated at the INL Site. The INL Site Treatment Plan would likely be updated to reflect construction and operation of the VTR and associated facilities.

On October 16, 1995, DOE, the U.S. Navy, and the State of Idaho entered into an agreement (also known as the Idaho Settlement Agreement [ISA]) that guides management of SNF and radioactive waste at the INL Site. The ISA limits shipments of DOE and Naval SNF into the State and sets milestones for shipments of SNF and radioactive waste out of the State (INL 2019c:2.7). In a 2019 *Supplemental Agreement Concerning Conditional Waiver of Sections D.2.e and K.1 of 1995 Settlement Agreement* between DOE and the State of Idaho (DOE-ID & Idaho 2019), Idaho allowed receipt of a specific quantity of commercial power SNF at the INL Site and established terms and conditions under which DOE could resume and plan for additional shipments of commercial SNF pursuant to a 2011 Memorandum of Agreement.

On February 4, 2020, the *Agreement Concerning Handling of Spent Nuclear Fuel Generated by the Advanced Test Reactor* was signed between DOE-Idaho and the State of Idaho (DOE-ID & Idaho 2020). The agreement allows Advanced Test Reactor (ATR) SNF to be stored for 6 years in the ATR Operating Canal for thermal cooling.

SNF generated by the operation of VTR would be managed in accordance with applicable laws and agreements.

7.2.2 Oak Ridge National Laboratory

ORNL holds environmental permits, including those for air quality, water quality, and hazardous waste. The *Oak Ridge Reservation Annual Site Environmental Report 2018* contains a more detailed description of existing permits for ORNL (ORO 2019:5-17, 5-18).

Air – Airborne discharges from DOE facilities, both radioactive and nonradioactive, are subject to regulation by EPA and TDEC. The most recent sitewide Title V Major Source Operating Permit (571359) was issued in October 2018. The Title V Major Source Operating Permit (569768) for the Central Exhaust Stack (Building 3039) was renewed in September 2015. In addition, Isotek has a Title V Major Source Operating Permit (568276) for the Radiochemical Development Facility (Building 3019 Complex) (ORO 2019:5-20, 5-28).

Permits to construct and operate new nonradiological air emissions sources would be required. These new sources would potentially include the vents for any building heating systems, laboratory hood vents (nonradioactive use), and a concrete batch plant. These permits would include operating conditions and emissions limitations for air pollutants. Permits for construction of new radioactive emission sources and modification of the existing NESHAP permit for radionuclide emissions would be required for the proposed VTR and associated facilities. As described in 40 CFR 61.96, if the effective dose equivalent caused by all emissions from facility operations is projected to be greater than one percent of the 10 millirem per year NESHAP standard, an application for approval to construct under 40 CFR 61.07 would have to be filed (DOE 1999a:6-4).

Water – Section 404 of the CWA requires the issuance of a Section 404 permit for discharge of dredge or fill material into the waters of the United States. This includes the filling of wetland areas by construction projects. The authority to implement these requirements and issue the permits has been given to the U.S. Army Corps of Engineers (USACE). In addition, in Tennessee, TDEC requires an Aquatic Resource Alteration Permit to alter the waters of the State. When a Federal construction project would result in the filling of a wetland area, the issuance of a Section 404 permit is usually contingent upon approval of a wetlands mitigation plan by USACE (DOE 1999a:6-6, 6-7). A USACE Section 404 permit and a TDEC Aquatic Resource Alteration Permit would likely be required for construction of the VTR and associated facilities at ORR.

EPA has delegated authority for implementation and enforcement of the NPDES program to the State of Tennessee. A Tennessee NPDES construction general permit covering stormwater discharges from construction activities would be required for construction of the proposed facilities at ORR (ORO 2019:5-69). An NPDES general permit for point-source stormwater discharges associated with industrial activity would be required for operation of the proposed facilities. The ORNL SWPPP would be revised to include the new stormwater sources (DOE 1999a:6-6).

The NPDES permit (TN0002941) issued to DOE for ORNL, includes requirements for discharging wastewaters from the two ORNL onsite wastewater treatment facilities and from more than 150 outfalls, and for the development and implementation of a Water Quality Protection Plan. The two wastewater treatment systems provide appropriate treatment of various research and development (R&D), operational, and domestic wastewaters generated by ORNL staff and activities (ORO 2019:5-20, 5-51, 5-54). ORNL submitted an application for NPDES permit renewal in 2018 and received the permit on June 1, 2019 (TDEC 2020a). Construction and operation of the VTR and associated facilities would likely require modification of the existing NPDES permit.

Hazardous/Mixed Waste – TDEC has been delegated authority by EPA to implement the Hazardous Waste Program; EPA retains an oversight role. In 2018, DOE and its contractors at ORNL were jointly regulated as a “large quantity generator of hazardous waste” because, collectively, they generated more than 1,000 kilograms of hazardous waste in at least one calendar month during 2018. ORNL holds three permits for treatment and storage of hazardous waste (TNHW-134, TNHW-145, and TNHW-178) (ORO 2019:5-21–5-23; TDEC 2019a).

A TDEC permit is required for facilities that store hazardous waste on site for more than 90 days, treat it, or dispose of it. The construction and operation of the VTR and associated facilities would generate small quantities of hazardous waste and mixed waste. Hazardous and mixed waste generated at VTR and associated facilities may trigger the need to modify the existing ORNL hazardous waste permit, if it would be stored for more than 90 days.

Other Agreements – An interagency agreement under Section 120(c) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), known as the ORR Federal Facility Agreement (FFA), was effective in 1992 among EPA, TDEC, and DOE. The agreement establishes the procedural framework and schedule for developing, implementing, and monitoring remedial actions on ORR (and ORNL) in accordance with CERCLA. The agreement lists all of the sites/areas that will be investigated, and possibly undergo remediation, under CERCLA (DOE 2008a:10-34). The Site Treatment Plan, prepared in accordance with the ORR FFA, would likely be updated to reflect construction and operation of the VTR and associated facilities.

On September 26, 1995, TDEC issued a Commissioner's Order, requiring compliance with the Site Treatment Plan for Mixed Wastes (TDEC 1995). The latest version of the *Site Treatment Plan for Mixed Wastes on the U.S. Department of Energy Oak Ridge Reservation* (DOE-OR 2018) provides overall schedules for achieving compliance with RCRA storage and treatment requirements for mixed waste at ORR. DOE provides TDEC with annual updates to the information in the Site Treatment Plan. If ORNL were selected as the location for the VTR and associated facilities, DOE would include any mixed transuranic (TRU) waste and mixed low-level radioactive waste associated with operation of the proposed facilities in a future update to the Site Treatment Plan.

7.2.3 Savannah River Site

SRS holds environmental permits, including those for air quality, water quality, and hazardous waste. The *Savannah River Site Environmental Report for 2018* contains a more detailed description of existing permits for SRS (SRNS 2019a:3-8–3-22).

Air – EPA has delegated regulatory authority for all types of air emissions to SCDHEC. Air emissions from SRS facilities, including both radioactive and nonradioactive air pollutant emissions, are regulated under the SRS air quality operating permit, issued under Title V of the Clean Air Act (CAA) (42 U.S.C. § 7401 et seq.) and administered by SCDHEC. Under the CAA, SRS is considered a "major source" of nonradiological air emissions and, therefore, falls under the CAA Part 70 Operating Permit Program. The current sitewide CAA Air Quality Permit (TV-0080-0041) expired on March 31, 2008. SRS submitted a complete renewal application of the current permit prior to the expiration date. SCDHEC granted an application shield, effective on September 21, 2007, allowing SRS to continue operating under the expired permit (SRNS 2019a:3-11, 3-12). Changes resulting from reactor fuel activities could necessitate a construction permit and modifications to the Title V permit. The Ameresco Federal Solutions, Inc. ("Ameresco") Biomass Facilities have a separate CAA Air Quality Permit (SRNS 2019a:3-11, 3-12).

Water – Permits under CWA Section 404 are required when work would be conducted in waters of the United States or in a wetland area. Installation of a reactor fuel capability in an existing building in K Area is not expected to require Section 404 permitting.

Wastewater discharges at SRS are regulated by four permits under the NPDES Program, CWA (33 U.S.C. § 1251 et seq.) program administered by SCDHEC under authority delegated by EPA:

- General Permit for Stormwater Discharges from Construction Activities (SCR100000)
- General Permit for Storm Water Discharges Associated with Industrial Activities (Except Construction) (SCR000000)
- Permit for Discharge to Surface Waters – D-Area (SC0047431)
- Permit for Discharge to Surface Waters – Other Areas (SC0000175)

SCDHEC has issued a General Permit for Stormwater Discharges from Construction Activities that are "Associated with Industrial Activity" (Permit No. SCR100000). Installation of the reactor fuel capability in K Area, could involve activities outside existing buildings (e.g., laydown areas, construction trailers, parking). Stormwater from these areas, would be managed under the SRS general construction stormwater permit. An approved plan would be needed that includes erosion control and pollution prevention measures to be implemented for construction activities.

SCDHEC has issued a General Permit for Storm Water Discharges Associated with Industrial Activities (Permit No. SCR000000), authorizing stormwater discharges to the waters of the State of South Carolina in accordance with effluent limitations, monitoring requirements, and conditions set forth in the permit. This permit requires preparation and submittal of a SWPPP for all new and existing point source discharges associated with industrial activity. Accordingly, DOE has developed a SWPPP for stormwater discharges at SRS. The SRS SWPPP might need to be revised to include pollution prevention measures to be implemented for reactor fuel capability operations (DOE 2002b:7-11).

The NPDES permit includes 28 industrial wastewater outfalls across SRS (SRNS 2019a:3-14, 3-15). When SCDHEC receives a request for an NPDES permit modification, it may modify and reissue the permit accordingly and may request an updated application, if necessary. When a permit is modified, only the conditions subject to modification are reopened (DOE 2011d:5-28). Operation of the reactor fuel capability in K Area could require modification of the existing NPDES permit.

In 2018, SRS held seven other Clean Water Act related permits (SRNS 2019a:3-14):

- Land Application Permit (ND0072125)
- General Permit for Utility Water Discharges (SCG250000)
- General Permit for Discharges from Application of Pesticides (SCG160000)
- General Permit for Vehicle Wash Water Discharges (SCG750000)
- General Wastewater Construction Permit (SCG580000)
- General Construction Permit for Water Supply Distribution Systems (151218)
- General Permit for Land Disturbing Activities at SRS

As described Chapter 2 and Appendix B, installation and operation of the reactor fuel capability in K Area would not result in the land application of wastewater. Therefore, modifications to the Land Application Permit (ND0072125) would not be required. In addition, installation and operation of the reactor fuel capability in K Area is not likely to result in substantial changes to: utility water discharges; discharges from application of pesticides; vehicle wash water discharges; wastewater systems; water supply distribution systems; and land-disturbing activities. Therefore, it is unlikely that substantial modifications to these six General Permits would be needed.

In addition to the environmental permits discussed above, groundwater withdrawal at SRS is regulated by a permit issued under the South Carolina Groundwater Use and Reporting Act of 2000. SRS exceeds the permitting and reporting threshold of 3 million gallons of withdrawal from wells under common ownership. If the feedstock preparation option, the fuel fabrication option, or both are established at SRS, the water needs of the VTR project would be evaluated relative to the permit conditions and a revision to the permit pursued if needed.

Hazardous/Mixed Waste – The EPA authorizes SCDHEC to regulate hazardous waste and the hazardous components of mixed waste. SRS holds a RCRA hazardous waste permit issued by SCDHEC (SRNS 2019a:3-9). SRS's hazardous waste permit is for the storage and treatment of hazardous waste, mixed low-level radioactive waste, and mixed TRU waste in E-Area. The remainder of SRS manages hazardous and mixed waste as a large quantity generator.

Other Agreements – The 1993 FFA for SRS, a tri-party agreement between DOE, EPA, and SCDHEC, integrates CERCLA and RCRA requirements to achieve a comprehensive remediation strategy and to coordinate administrative and public participation requirements. SRS conducts remediation and closure activities identified in the FFA in accordance with applicable Federal and State regulations. SRS has 515 waste units subject to the FFA, including RCRA/CERCLA units, site evaluation areas, and facilities covered by the SRS RCRA permit. At the end of fiscal year 2018, SRS had completed the surface and groundwater cleanup of 408 of these units and was in the process of remediating an additional 10 units (SRNS 2019a:3-3).

On September 20, 1995, SCDHEC approved the Site Treatment Plan for SRS. SCDHEC issued a consent order, signed by DOE, requiring compliance with the plan on September 29, 1995. The Site Treatment Plan provides overall schedules for achieving compliance with RCRA storage and treatment requirements for mixed waste at SRS. DOE provides SCDHEC with annual updates to the information in the SRS Site Treatment Plan. If SRS were selected as the location for reactor fuel production, DOE would include any mixed TRU or low-level radioactive waste associated with operation of the proposed facility that cannot meet the 1-year storage limitation in a future update to the SRS Site Treatment Plan.

In keeping with U.S. nonproliferation policies and a prior agreement with the Russian Federation[1] to reduce the availability of material that is readily usable in nuclear weapons, DOE, including the semiautonomous National Nuclear Security Administration (NNSA), is engaged in a program to disposition U.S. surplus weapons-usable plutonium (referred to in this EIS as “surplus plutonium”). Surplus plutonium includes pit[2] and non-pit[3] plutonium that is no longer needed for U.S. national security or programmatic purposes. In the 2000 ROD (65 FR 1608) and 2003 amended ROD (68 FR 20134) for the Surplus Plutonium Disposition Environmental Impact Statement (SPD EIS) (DOE/EIS-0283), DOE decided to convert 34 metric tons of surplus plutonium into mixed oxide (MOX) fuel at a MOX Fuel Fabrication Facility (MFFF) that was to be constructed and operated at SRS (DOE 2015a:1-1, 1-9).

Because of the high cost of the MFFF, NNSA began to assess alternative strategies for plutonium disposition. In April 2014, NNSA identified an alternative strategy that it believed could significantly reduce the life-cycle cost of surplus plutonium disposition. Under this strategy, referred to as dilute and dispose, NNSA would convert surplus metal plutonium to plutonium oxide, which could then be diluted by mixing it with inert material to inhibit plutonium recovery and prevent its future use in weapons, and packaged as TRU waste for permanent disposal at the Waste Isolation Pilot Plant (WIPP) facility.[4] In May 2018, DOE notified Congress of its decision to cancel MFFF construction, and in October 2018, DOE issued a notice of termination of the contract for the MFFF, leaving the dilute and dispose strategy as its preferred disposition strategy (GAO 2019:4, 5).

In a 2016 ROD (81 CFR 19588) for the *Surplus Plutonium Disposition Supplemental Environmental Impact Statement* (DOE/EIS-0283-S2) (DOE 2015a), NNSA decided to disposition 6 metric tons of non-pit plutonium by preparing the plutonium material as TRU waste for disposal at the WIPP facility. Non-pit plutonium containers are to be opened in an existing glovebox or newly constructed glovebox capability in HB Line or K-Area at SRS. Plutonium metal is to be converted to oxide. Plutonium oxide then will be

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[1] On September 1, 2000, the Agreement Between the Government of the United States and the Government of the Russian Federation Concerning the Management and Disposition of Plutonium Designated as No Longer Required for Defense Purposes and Related Cooperation (referred to as “the PMDA”) (USA and Russia 2000) was signed. The PMDA (and its 2010 Protocol) calls for each country to dispose of no less than 34 metric tons of plutonium in forms unusable for nuclear weapons. The Russian Federation unilaterally suspended implementation of the PMDA in October 2016 (IPFM 2016). However, the United States remains committed to the safe and secure disposition of 34 metric tons of surplus plutonium, so it can never again be used for nuclear weapons (DOS 2020).

[2] The plutonium was made by the United States in nuclear reactors for use in nuclear weapons. A pit is the central core of a primary assembly in a nuclear weapon and is typically composed of plutonium metal (mostly plutonium-239), enriched uranium, or both, and other materials. Most surplus pits are currently stored at the Pantex Plant near Amarillo, Texas.

[3] Non-pit plutonium may exist in metal or oxide form, and may be combined with other materials that were used in the process of manufacturing plutonium for use in nuclear weapons or related R&D activities. Most surplus non-pit plutonium is currently stored at SRS.

[4] The end state (after both dilution and emplacement at the WIPP facility) of the dilute and dispose process would introduce sufficient chemical and physical barriers to practical recovery of the material to meet non-proliferation objectives (i.e., deterring future recovery), thus meeting the intent of the PMDA to prevent plutonium recovery and reuse.

repackaged into suitable containers, blended with inert material, and packaged as TRU waste for disposal at the WIPP facility. In a 2020 amended ROD (85 FR 53350), NNSA announced its decision to amend the 2003 decision (68 FR 20134) and use the dilute and dispose method to disposition up to an additional 7.1 metric tons of non-pit plutonium as TRU waste at the WIPP facility. Conversion of metal to oxide may occur at SRS or LANL. In this amended ROD, NNSA decided to perform the repackaging, blending, and packaging for disposal in an existing single glovebox plus newly installed gloveboxes in K Area.

SRS stores substantial quantities of surplus plutonium pending disposition. The Bob Stump National Defense Authorization Act for fiscal year 2003[5] required DOE to prepare a plan to produce MOX reactor fuel[6] at an average rate of at least 1 metric ton per year. As subsequently amended, the law provides that if DOE did not meet this 1 metric ton production objective by January 1, 2014, it was required to remove 1 metric ton of defense plutonium from South Carolina by January 1, 2016. In December 2017, the court ordered DOE to remove 1 metric ton of plutonium from South Carolina by 2020. In response, DOE moved 1 metric ton of plutonium from SRS to other DOE facilities by August 2019. DOE is required by statue to remove additional amounts of defense plutonium or defense plutonium material (50 U.S.C. § 2566) (GAO 2019:19, 20). The statute also provides for economic and impact assistance payments under certain circumstances if sufficient progress is not made on material removal. The State of South Carolina brought suit to collect on those payments. On August 31, 2020, DOE and the State of South Carolina signed a settlement agreement with respect to the State's lawsuit and the ongoing removal of 9.5 metric tons of plutonium from the State. The settlement agreement provides an upfront payment of $600 million to the State of South Carolina and allows DOE more time (through 2036) to safely remove the plutonium from the State without the threat of lawsuits (DOE 2020f).

7.3 Consultations

Consultations with other Federal, State, and local agencies and federally recognized American Indian tribal governments are usually conducted prior to the disturbance of any land and are usually related to biotic, cultural, or American Indian resources. Certain laws, such as the Endangered Species Act (ESA), Fish and Wildlife Coordination Act, Migratory Bird Treaty Act (MBTA), and National Historic Preservation Act (NHPA), require consultation and coordination by DOE with other governmental entities, including other Federal agencies, State and local agencies, and federally recognized American Indian governments. In addition, the DOE American Indian and Alaska Native Government Policy requires DOE to consult with any American Indian or Alaska Native Tribal Government with regard to any property to which the Tribe attaches religious or cultural importance that might be affected by a DOE action.

Biotic resource consultations generally pertain to the potential for activities to disturb sensitive species, migratory birds, or their habitats. Cultural resource consultations relate to the potential for disruption of important historic resources or archaeological sites. American Indian consultations are concerned with the potential for impacts on any rights and interests, including the disturbance of ancestral American Indian sites and sacred sites, traditional and religious practices of American Indians, and natural resources of importance to American Indians.

DOE consults with the U.S. Fish and Wildlife Service (USFWS) and appropriate State regulators, as required by Section 7(a)(2) of the ESA, the Bald and Golden Eagle Protection Act, the MBTA, and State laws; and appropriate State Historic Preservation Offices, as required by Section 106 of NHPA. This section identifies the consultations needed to implement the proposed alternatives at each potential location. **Table 7–3** lists those organizations consulted for this EIS.

[5] Pub. L. No. 107- 314, § 3182, 116 Stat. 2458, 2747 (2002) (codified as amended at 50 U.S.C. § 2566).
[6] Reactor fuel containing plutonium-239 as the primary fissile material.

Table 6–2. Consultations for this VTR EIS

Site/Subject	Addressee (Date of Letter)
Idaho National Laboratory	
Ecological Resources Consultations	None anticipated; no species or habitat protected under Federal law would be disturbed. Existing agreements and controls provide protection of State and locally sensitive species.
Cultural Resources Consultations	DOE-ID will send a complete cultural resource report to the Idaho State Historic Preservation Officer reporting the results of the 2019/2020 cultural survey conducted on the VTR project site.
American Indian Consultations	Consultation with the Shoshone-Bannock Heritage Tribal Office was initiated when planning the cultural survey for the project. The Heritage Tribal Office has been informed regarding survey results and the determination of project effect. A copy of the report will be submitted to the Heritage Tribal Office.
Oak Ridge National Laboratory	
Ecological Resources Consultations	If the ORNL VTR Alternative were selected, DOE would consult with the USFWS Tennessee Ecological Services Field Office under Section 7 Interagency Cooperation regarding potential impacts to federally listed species protected under the ESA. Additionally, DOE would consult with the TWRA and/or TDEC regarding State-listed species of special concern. For aquatic resources, additional consultations required could include wetland delineations (USACE 1987), stream evaluations (TDEC 2019c), and hydrologic determinations of currently unclassified channels and wet weather conveyances (TDEC 2020b). Any potential ETW will require additional assessment using the Tennessee Rapid Assessment Method, as required by the TDEC.
Cultural Resources Consultations	If the ORNL VTR Alternative were selected, DOE would consult with Tennessee SHPO prior to any land-disturbing activities.
American Indian Consultations	If the ORNL VTR Alternative were selected, DOE would consult with the Eastern Band of the Cherokee Indians and the Cherokee Nation of Oklahoma prior to any land-disturbing activities.
Savannah River Site	
Ecological Resources Consultations	None anticipated [a]
Cultural Resources Consultations	None anticipated [a]
American Indian Consultations	None anticipated [a]

DOE-ID = DOE Idaho Operations Office; ESA = Endangered Species Act; ETW = Exceptional Tennessee Waters; SHPO = State Historical Preservation Officer; TDEC = Tennessee Department of Environment and Conservation; TWRA = Tennessee Wildlife Resources Agency; USFWS = U.S. Fish and Wildlife Service.

[a] Consultations are not expected to be needed at SRS because construction/modification would be internal to buildings in K Area and no new land disturbance is expected.

7.3.1 Idaho National Laboratory

Ecological Resources Consultations – Federally listed species are protected under the ESA (16 USC 1532 et seq.) as administered by USFWS. Land-clearing activities resulting in temporary and permanent impacts within the proposed action area at the INL Site are not anticipated to affect federally threatened and endangered (T&E) species. No federally listed T&E species or designated critical habitats were identified within or near the proposed action area (Section 3.1.5). Additionally, no federally listed species have been historically documented within the INL Site. Therefore, no consultation under ESA Section 7(a)(2) is required. However, if new information reveals activities that may affect T&E species, consultation with the USFWS Idaho Field Office would be initiated.

State-listed species are protected under the *Idaho State Wildlife Action Plan*, per Title 36 of the Idaho Code. There are seven Idaho Fish and Game (IDFG) State-listed species known to occur on or in the immediate vicinity of the INL Site (Section 3.1.5). These species include the greater sage-grouse (*Centrocercus urophasianus*) – an IDFG Species of Greatest Conservation Need (SGCN) Tier 1, pygmy rabbit

(*Brachylagus idahoensis*) – SGCN Tier 2, hoary bat (*Lasiurus cinereus*) – SGCN Tier 2, silver-haired bat (*Lasionycteris noctivagans*) – SGCN Tier 2, Townsend's big-eared bat (*Corynorhinus townsendii*) – SGCN Tier 3, western small-footed myotis (*Myotis ciliolabrum*) – SGCN Tier 3, and little brown myotis (*M. lucifugus*) – SGCN Tier 3. Land-clearing activities are not expected to impact State-listed bat species, as no loss of hibernacula would occur (Section 4.5.1). The proposed action would result in the direct loss of vegetation and associated indirect impacts to pygmy rabbit habitat could occur. However, this action would not cause loss of local populations from direct mortality or diminished survivorship as the documented pygmy rabbit burrow system does not occur within the permanent impact area. The burrow system is located within the temporary disturbance area and would be avoided during construction. Therefore, no State-level consultations with IDFG are required.

The DOE and the USFWS established the CCA (DOE-ID & USFWS 2014). There are no greater sage-grouse lek locations within the proposed action area (Section 3.1.5). The closest documented lek site is categorized as inactive and is located about 1.7 miles northwest. The closest active lek is located about 2.7 miles east of the proposed project area. Although the sage-grouse does not warrant protection under the ESA, DOE and USFWS continue to collaborate on sage-grouse protection at the INL Site. The proposed project area is not within the established sage-grouse conservation area but is subject to DOE's 'no net loss of sagebrush habitat' policy on the INL Site. In compliance with the CCA (DOE-ID & USFWS 2014) the project must complete pre- and post-construction surveys to establish the amounts of sagebrush restoration and other native revegetation efforts needed to rehabilitate disturbed areas as determined by DOE's Environmental Surveillance, Education, and Research (ESER) contractor. To comply with DOE policy, the proposed action requires monitoring sagebrush disturbance and planting amounts equal to that disturbed in areas beneficial to sage-grouse.

The MBTA (16 U.S.C. 703-712) prohibits taking any migratory bird, or any part, nest, or egg of any such bird, without authorization from the USFWS. DOE-ID has a Special Purpose Permit for limited nest relocation and destruction and the associated take of migratory birds if absolutely necessary for mission-critical activities. The permit would be applied in very limited and extreme situations where no other recourse is practicable (INL 2019c:2.14, 2.15). In accordance with the USFWS Mitigation Policy, DOE would be required to evaluate ways to avoid or minimize any such impacts during construction and operation of the proposed facilities. This may include implementing restrictions during land-clearing activities for MBTA-protected species. Surface- and vegetation-disturbing activities should avoid nesting season for the various groups of birds or be preceded by surveys to confirm the absence of nesting birds. Construction/land-clearing activities, including vegetation removal, would be controlled to preclude damage to active nests of passerines. Work during the migratory bird nesting season for passerines (April 1 through October 1) would require a migratory bird nesting survey 72 hours prior to vegetation disturbance in an area. If surveys discover active nests, measures would be implemented, such as buffer areas or halting work, to prevent nest abandonment until after the migratory bird nesting season or until young have fledged.

No bald or golden eagles protected under the Bald and Golden Eagles Protection Act (16 USC 668-668c) are known to nest in or near the proposed project area (Section 3.1.5). Therefore, no consultation with USFWS is required. If bald or golden eagles, their nests, or their eggs appear near the proposed action area prior to the initiation of construction-related activities, DOE would be required to obtain a permit from the USFWS if disturbance or relocation was determined to be necessary.

Cultural Resources Consultations – Prior to any new facility construction or existing facility modifications, DOE would consult with the Idaho State Historic Preservation Officer, Tribes, and interested parties in compliance with Section 106 of the NHPA and its implementing regulations (36 CFR Part 800) and follow requirements as appropriate or as specified in the *INL Cultural Resource Management Plan* (INL 2016f) and the *Programmatic Agreement Between the Department of Energy Idaho Operations Office the Idaho*

State Historic Preservation Office and the Advisory Council on Historic Preservation Concerning the Management of Historical Cultural Resources on the Idaho National Engineering and Environmental Laboratory (DOE-ID, ID SHPO, and ACHP 2004).

American Indian Consultations – The Shoshone and Bannock Tribes have a government-to-government relationship with DOE-ID that is strengthened and maintained through an Agreement-in-Principle between the Tribes and the DOE-ID (DOE-ID 2017). The Agreement-in-Principle defines working relationships between the Shoshone and Bannock Tribes and DOE-ID and fosters a mutual understanding and commitment to addressing a variety of tribal concerns regarding protection of health, safety, and environment, including cultural resources of importance to the Tribes. DOE initiated consultation with the Shoshone-Bannock Heritage Tribal Office during the planning for the 2019 and 2020 cultural resource survey of the project area. DOE information the Shoshone-Bannock Heritage Tribal Office of the results of the survey and will provide the Office with a copy of the report. Additional consultation with the Shoshone and Bannock Tribes would be conducted in accordance with the Agreement-in-Principle.

7.3.2 Oak Ridge National Laboratory

Ecological Resources Consultations – DOE would be required to consult with the USFWS, Tennessee Ecological Services Field Office regarding potential impacts to federally listed T&E species protected under the ESA as a result of the proposed action. Land-clearing activities, including tree removal, and changes to hydroperiods may affect special status species and their habitats (such as caves, karst, and other subterranean habitat), therefore consultation under ESA Section 7(a)(2) is required. Past surveys have identified multiple Federal and State-listed species and special habitats (Section 3.2.5). More surveys will be required and will need to be conducted at specific times of the year for the various sensitive plant and wildlife species (see Chapter 3, Tables 3–22 and 3–23) to determine the level of impact. Many of these could require consultation with the USFWS, USACE, TDEC, and/or the Tennessee Wildlife Resource Agency prior to fieldwork. Mitigation for Federal and State-listed species, aquatic features, and sensitive habitats may also be required. Some species, such as federally listed bats (e.g., Indiana bat [*Myotis sodalis*], northern long-eared bat [*M. septentrionalis*], gray bat [*M. grisescens*], little brown bat [*M. lucifugus*], small-footed bat [*M. leibii*], tricolored bat [*Perimyotis subflavus*]), amphibians (e.g., four-toed salamander [*Hemidactylium scutatum*]), and migratory birds (including the wood thrush [*Hylocichla mustelina*], a bird of conservation concern and management concern of which a breeding pair has been seen in the project area) may require that tree removal and other activities be avoided during certain times of the year. DOE would be required to consult with the USFWS about the potential impacts from the proposed action on bats, amphibians, and migratory birds. In accordance with the USFWS Mitigation Policy, DOE would be required to evaluate ways to avoid or minimize any such impacts during land-clearing activities.

No bald or golden eagles are known to nest within the proposed action area (Section 3.2.5). The nearest recorded active bald eagle nest is approximately 2 miles northeast of the site. Therefore, no consultation with USFWS is required. If bald or golden eagles, their nests, or their eggs appear near (within 1 mile) the proposed action area prior to the initiation of construction-related activities, DOE would be required to obtain a permit if disturbance or relocation was determined to be necessary.

In accordance with DOE Compliance with Floodplain and Wetlands Environmental Review Requirements (10 CFR Part 1022), DOE would be required to consult with the USFWS and USACE about the potential impacts from the proposed action on streams, springs, and wetland areas within the proposed action area. Minimally, this would include Section 404 coordination with the USACE regarding wetland delineations (USACE 1987), coordination with the TDEC regarding stream evaluations, Exceptional Tennessee Waterways, and hydrologic determinations of currently unclassified channels and wet weather conveyances (TDEC 2020b).

Cultural Resources Consultations – Prior to any land disturbance and facility construction, DOE would consult with the Tennessee State Historic Preservation Officer, Tribes, and interested parties in compliance with Section 106 of the NHPA and its implementing regulations (36 CFR Part 800). Site activities would be performed in accordance with the requirements specified in the *Cultural Resource Management Plan* (DOE-OR 2001) and the "Programmatic Agreement Among the Department of Energy Oak Ridge Operations, Tennessee State Historic Preservation Office, and the Advisory Council on Historic Preservation Concerning the Management of Historical Cultural Properties at Oak Ridge National Laboratory, Oak Ridge, Tennessee" (DOE-OR 2005).

American Indian Consultations – Prior to any ground-disturbing activities, DOE would consult with the Eastern Band of the Cherokee Indians and the Cherokee Nation of Oklahoma in accordance with Section 106 of the NHPA and its implementing regulations (36 CFR Part 800) and Executive Order 13175.

7.3.3 Savannah River Site

Ecological Resources Consultations – Constructing/modifying and operating facilities in support of the option for reactor fuel fabrication in K Area are not expected to have any impact on federally listed T&E species. No federally listed species are known to occur in or near the K Area (Section 3.3.5), construction/modification would be internal to buildings in K Area, and no new land disturbance is expected. If new information reveals activities that may affect T&E species, consultation with the USFWS and South Carolina Ecological Services Office would be initiated.

No bald or golden eagles are known to nest in or near K Area (Section 3.3.5). Therefore, no consultation with USFWS is required. If bald or golden eagles, their nests, or their eggs appear near K Area prior to the initiation of construction-related activities, DOE would be required to obtain a permit if disturbance or relocation was determined to be necessary.

Construction and operation of the proposed reactor fuel capability in an existing building in K Area is not expected to impact migratory birds (Section 4.5.3.2), but if necessary, DOE would consult with the USFWS about potential impacts on migratory birds. In accordance with the USFWS Mitigation Policy, DOE would be required to evaluate ways to avoid or minimize any such impacts during construction and operation of the proposed facilities.

Cultural Resources Consultations – Similarly, constructing and operating the reactor fuel production capability in an existing building in K Area are not expected to affect archaeological resources because there would be no new land disturbance and K-Reactor is not an NRHP-eligible Historic Cold War property (Section 4.6.3.2). Therefore, DOE would not need to consult with the South Carolina State Historic Preservation Office, Tribes, and interested parties to comply with Section 106 of the NHPA and its implementing regulations (36 CFR Part 800). Activities would be conducted in accordance with survey requirements, as appropriate or as specified in the Archaeological Resource Monitoring Plan (SRARP 2016), Programmatic Memorandum of Agreement (SRARP 2016:Appendix C), and the Programmatic Agreement and Cold War Historic District CRMP (DOE, SC SHPO, and ACHP 2020).

American Indian Consultations – Consultations with Native American groups are not expected to be needed at SRS because construction/modification would be internal to buildings in K Area and no new land disturbance is expected. Inadvertent discoveries of American Indian resources would be handled in accordance with the requirements of 43 CFR Part 10, "Native American Graves Protection and Repatriation Regulations," regarding American Indian human remains, funerary objects, objects of cultural patrimony, and sacred objects.

Chapter 8
References

8.0 REFERENCES

AHD (American Hospital Directory), 2020, Individual Hospital Statistics by State (accessed September 2020 at https://www.ahd.com/state_statistics.html).

Aiken County Planning Commission, 2013, Aiken County Land Management Regulations (accessed January 15, 2020 at www.aikencountysc.gov/Reference/LMO/LMR2013-06-01.pdf), June 1.

Anderson County, 2015, Zoning Resolution of Anderson County, Tennessee, Section 045-107: Noise, Amended July 20, 2015 (accessed on January 27, 2020 at www.anderson-county.com/wp-content/uploads/2015/05/Revised-Anderson-County-Zoning-Resolution.pdf).

Anderson, S. R., M. J. Liszewski, and D. J. Ackerman, 1996, *Thickness of Surficial Sediment at and near the Idaho National Engineering Laboratory, Idaho*, DOE/ID-22128, U.S. Geological Survey Open-File Report 96-330, Idaho Falls, ID, June.

ARC (Augusta-Richmond County Planning Commission), 2008, *Augusta-Richmond County Comprehensive Plan*, Augusta, Georgia, October 6.

ATSDR (Agency for Toxic Substances and Disease Registry), 2007, *Public Health Assessment for Evaluation of Off-Site Groundwater and Surface Water Contamination at the Savannah River Site (USDOE)*, EPA Facility ID: SC1890008989, Atlanta, Georgia, December 17.

AZR (American Zinc Recycling Corp), 2020a, Facilities, Pittsburgh, Pennsylvania.

AZR (American Zinc Recycling Corp), 2020b, Barnwell South Carolina Facility.

BEA (Bureau of Economic Analysis), 2019a, Local Area Personal Income, Per Capita Personal Income by County and State 2018 (available at https://www.bea.gov/system/files/2019-11/lapi1119.pdf).

BEA (Bureau of Economic Analysis), 2019b, Local Area Personal Income 2010, Initially published April 25, 2012 (accessed 2019 at https://apps.bea.gov/regional/histdata/releases/0412lapi/index.cfm).

BJWSA (Beaufort-Jasper Water and Sewer Authority), 2019, Water Quality Report (accessed January 16, 2020 at www.bjwsa.org/wp-content/uploads/2019/07/2019-CCR-for-website.pdf), Okatie, South Carolina.

BLM (Bureau of Land Management), 1986, *Visual Resource Contrast Rating*, Manual 8431, VRM Class Objectives, Washington, DC, January 17.

Bloomberg, 2019, Georgia Power's new Vogtle units approximately 79% complete (available at www.bloomberg.com/press-releases/2019-08-30/georgia-power-s-new-vogtle-units-approximately-79-complete), Atlanta, Georgia, August 30.

BLS (Bureau of Labor Statistics), 2018a, Injuries, Illnesses, and Fatalities (accessed February 28, 2020 at www.bls.gov/iif/oshsum.htm#17Quartile).

BLS (Bureau of Labor Statistics), 2018b, Census of Fatal Occupational Injuries (CFOI) - Current and Revised Data, File BLS2018 cfoi_rates_2018hb (accessed February 2020 at www.bls.gov/iif/oshcfoi1.htm#rates).

BLS (Bureau of Labor Statistics), 2020a, Local Area Unemployment Statistics, County Data, Labor Force Data by County, 2010 and 2018, Annual Averages (accessed August 2020 at https://www.bls.gov/lau/#cntyaa).

BLS (Bureau of Labor Statistics), 2020b, BLS State Unemployment (Annual) News Release (Archived data) for 2018, Economic News Release dated February 28, 2019 (accessed August 2020 at www.bls.gov/news.release/archives/srgune_02282019.pdf or www.bls.gov/bls/news-release/home.htm #SRGUNE).

BLS (Bureau of Labor Statistics), 2020c, BLS State Unemployment (Annual) News Release (Archived data) for 2010, Release data of February 25, 2011 (accessed August 2020 at www.bls.gov/news.release/archives/srgune_02252011.pdf).

BLS (Bureau of Labor Statistics), 2020d, Occupational Employment Statistics, May 2019 Occupational Employment and Wage Estimates (accessed March 2020 at https://www.bls.gov/oes/current/oes_id.htm#47-0000), Idaho.

BMPC (Bechtel Marine Propulsion Corporation), 2011, Naval Reactors Facility Environmental Summary Report.

Boise State University, 2010, Department of Economics, Research Details Positive Economic Impacts from Idaho National Laboratory Operations (accessed 2019 at www.boisestate.edu/cobe-economics/2010/12/09/research-details-positive-economic-impacts-from-idaho-national-laboratory-operations/), December 9.

Bolt, Beranek, and Newman, 1971, Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances, Prepared for the U.S. Environmental Protection Agency, Office of Noise Abatement and Control, Washington, DC, December 31.

BRC (Breeder Reactor Corporation), 1985, *Final Report, The Clinch River Breeder Reactor Plant Project,* Oak Ridge, Tennessee, January.

Bumgardner, J., 2019, VTR Program Manager, Idaho National Laboratory, Versatile Test Reactor Overview Presentation, Idaho Falls, Idaho, May 13.

California Air Resources Board, 2018, Speciation Profiles Used in ARB Modeling (available at https://ww3.arb.ca.gov/ei/speciate/speciate.htm).

CDC (Centers for Disease Control and Prevention), 2019, *Deaths: Final Death for 2017*, National Vital Statistics Reports, Vol. 68, No. 9, U.S. Department Of Health And Human Services, Centers for Disease Control and Prevention, National Center for Health Statistic, National Vital Statistics System (available at *www.cdc.gov/nchs/products/index.htm*), June 24.

Census (U.S. Census Bureau), 2010a, QuickFacts, Population, Housing Units, Area, and Density: 2010 – Bingham County, Idaho (accessed September 18, 2018 at www.census.gov/quickfacts/fact/table/binghamcountyidaho/POP060210#POP060210).

Census (U.S. Census Bureau), 2010b, QuickFacts, Population per Square Mile, 2010 – Aiken County, South Carolina (accessed January 15, 2020 at www.census.gov/quickfacts/fact/table/aikencountysouthcarolina/POP060210).

Census (U.S. Census Bureau), 2010c, QuickFacts, Population per Square Mile, 2010 – Burke County, Georgia (accessed January 15, 2020 at www.census.gov/quickfacts/fact/table/burkecountygeorgia/POP060210).

Census (U.S. Census Bureau), 2010d, QuickFacts, Barnwell County, South Carolina (accessed June 2, 2020 at https://www.census.gov/quickfacts/fact/table/barnwellcountysouthcarolina/PST040219).

Census (U.S. Census Bureau), 2011, Population Distribution and Change: 2000 to 2010, 2010 Census Briefs (available at https://www.census.gov/prod/cen2010/briefs/c2010br-01.pdf), March.

Census (U.S. Census Bureau), 2016, How the Census Bureau Measures Poverty, Last Revised May 12, 2016 (accessed August 2020 at www.census.gov/topics/income-poverty/poverty/about.html).

Census (U.S. Census Bureau), 2017a, "Table B03002: Hispanic or Latino Origin By Race 2013-2017 American Community Survey 5-year Estimates," Online Database (accessed on January 22, 2020 at https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml).

Census (U.S. Census Bureau), 2017b, "Table C17002: Ratio of Income to Poverty Level in the Past 12 Months 2013-2017 American Community Survey 5-year Estimates," Online Database (accessed on March 25, 2020 at https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml).

Census (U.S. Census Bureau), 2017c, ACS 5-Year Data Profile 2017, 2013-2017, Housing Characteristics (accessed September 2020 at www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/2017/.Census (U.S. Census Bureau), 2018, ACS Demographic and Housing Estimates 2018 (accessed August 2020 at https://data.census.gov/cedsci/?q=tennessee).

Census (U.S. Census Bureau), 2018, ACS Demographic and Housing Estimates 2018 (accessed August 2020 at https://data.census.gov/cedsci/?q=tennessee).

Census (U.S. Census Bureau), 2019a, Population Estimates July 1, 2018, QuickFacts (accessed 2019), Washington, DC.

Census (U.S. Census Bureau), 2019b, TIGER/Lines Geodatabase for Roads in Anderson and Roane Counties in Tennessee (accessed April 27, 2020 at www.census.gov/geographies/mapping-files/time-series/geo/tiger-geodatabase-file.html).

Census (U.S. Census Bureau), 2020a, Population: Census April 1, 2010, QuickFacts (accessed March 2020 at www.census.gov/quickfacts/fact/table/US/PST045219), Washington DC.

Census (U.S. Census Bureau), 2020b, Total population 2000: DEC Summary File 1, Table ID P001 (accessed March 2020 at https://data.census.gov/cedsci/?q=population%20in%202000%20by%20county).

Census (U.S. Census Bureau), 2020c, American Community Survey, Population by Age, 2018 1-Year ACS Supplemental Estimates, Supplemental Tables, Table K200104 (accessed September 2020 at www.census.gov/acs/www/data/data-tables-and-tools/supplemental-tables/).

Census (U.S. Census Bureau), 2020d, ACS 5-Year Data Profile 2018, 2014-2018, Demographic Characteristics (Population by Sex and Age) (accessed September 2020 at www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/2018/).

Centrus (Centrus Energy Corporation), 2020, Oak Ridge, Tennessee Enrichment Technology Development Engineering and Advanced Manufacturing Facility (accessed February 10, 2020 at www.centrusenergy.com/ contact/location-page-tennessee/).

CEQ (Council on Environmental Quality), 1997, *Environmental Justice Guidance Under the National Environmental Policy Act*, Executive Office of the President, Washington, DC, December 10.

City of Hardeeville, 2009, *City of Hardeeville Comprehensive Plan 2009 Update*, Draft, South Carolina, September 4.

City of Oak Ridge, 2019, *City of Oak Ridge, Tennessee, Proposed Budget Fiscal Year 2019* (accessed August 2020 at www.oakridgetn.gov/images/uploads/Documents/Departments/Finance%20 Department/Budget/2019/Proposed%20FY2019%20Budget.pdf).

Countess Environmental, 2006, WRAP Fugitive Dust Handbook, Prepared for the Western Governors' Association, Table 3-7 for water application every 2.1 hours.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe, 1979, *Classification of Wetlands and Deepwater Habitats of the United States*, FWS/OBS-79/31, U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC, December.

Crawford, D., 2019, VTR Fuel Cycle Manager/MFC Chief Scientist, Idaho National Laboratory, VTR Fuel Cycle Update, Idaho Falls, Idaho, June 6. **OUO**

Crocker, B., 2017, U.T. Network, Editor, "Oak Ridge National Laboratory could face massive layoffs under Trump budget request," *knoxnews.com* (accessed October 16, 2019 at www.knoxnews.com/story/news/2017/06/29/senate-house-push-back-trump-budget-request-which-would-trigger-mass-ornl-layoffs/440984001/), June 29.

CROET (Community Reuse Organization of East Tennessee), 2007, *The Global Nuclear Energy Partnership, Site Characterization Report for the Oak Ridge Reservation Melton Valley Site*, prepared for U.S. Department of Energy, Oak Ridge, Tennessee, May.

De Grey, L. and P. Link, 2020, Snake River Plain Aquifer, Digital Atlas of Idaho (accessed May 7, 2020 at http://geology.isu.edu/Digital_Geology_Idaho/Module15/mod15.htm).

Denham M. E., 1999, *SRS Geology/Hydrogeology Environmental Information Document*, WSRC-TR-95-O046, Aiken, South Carolina, June.

DNFSB (Defense Nuclear Facilities Safety Board), 2020, Memorandum to C. J. Roscetti, Technical Director from T. L. Hunt, Cognizant Engineer, Re: March 2020 Earthquake, April 3.

DOC (U.S. Department of Commerce), 2008, *Local Employment Dynamics, On the Map Version 2*, Bureau of the Census, Center for Economic Studies (assessed July 17, 2008 at http://lehdmap2.did.census.gov/themap/), July 17.

DOE (U.S. Department of Energy), 1982, *Final Environmental Impact Statement, Liquid Metal Fast Breeder Reactor Program (Supplement to ERDA 1535, December 1975)*, DOE/EIS-0085-FS, Washington, DC, May.

DOE (U.S. Department of Energy), 1994, *Final Supplemental Environmental Impact Statement, Defense Waste Processing Facility, Savannah River Site, Aiken, South Carolina*, DOE/EIS-0082-S, Savannah River Operations Office, Aiken, South Carolina, November.

DOE (U.S. Department of Energy), 1995, *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement*, DOE/EIS-0203-F, Idaho Operations Office, Idaho Falls, Idaho, April.

DOE (U.S. Department of Energy), 1996a, *Environmental Assessment for the Management of Spent Nuclear Fuel on the Oak Ridge Reservation Oak Ridge, Tennessee,* DOE/EA-1117, February.

DOE (U.S. Department of Energy), 1996b, *Finding of No Significant Impact Management of Spent Nuclear Fuel on the Oak Ridge Reservation Oak Ridge, Tennessee,* DOE/EA-1117, February.

DOE (U.S. Department of Energy), 1996c, *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement*, DOE/EIS-0229, Office of Fissile Materials Disposition, Washington, DC, December.

DOE (U.S. Department of Energy), 1997a, *Final Waste Management Programmatic Environmental Impact Statement for Managing, Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*, DOE/EIS-0200, Vol. 1, Office of Environmental Management, Washington, DC, May.

DOE (U.S. Department of Energy), 1997b, *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement*, DOE/EIS-0026-S-2, Carlsbad, New Mexico, September.

DOE (U.S. Department of Energy), 1997c, *Final Environmental Assessment for Lease of Land and Facilities within the East Tennessee Technology Park, Oak Ridge, Tennessee*, DOE/EA-1175, Oak Ridge, Tennessee, November.

DOE (U.S. Department of Energy), 1999a, *Final Environmental Impact Statement Construction and Operation of the Spallation Neutron Source*, DOE/EIS-0247, Office of Science, Germantown, Maryland, April.

DOE (U.S. Department of Energy), 1999b, *Surplus Plutonium Disposition Final Environmental Impact Statement*, DOE/EIS-0283, Office of Fissile Materials Disposition, Washington, DC, November.

DOE (U.S. Department of Energy), 1999c, DOE Standard Radiological Control, DOE-STD-1098-99 (Change Notice No. 1, March 2005), Washington, DC, July.

DOE (U.S. Department of Energy), 2000a, *Final Environmental Impact Statement for the Treatment and Management of Sodium-Bonded Spent Nuclear Fuel,* DOE/EIS-0306, Washington, DC, July.

DOE (U.S. Department of Energy), 2000b, *Final Programmatic Environmental Impact Statement for Accomplishing Expanded Civilian Nuclear Energy Research and Development and Isotope Production Missions in the United States, Including the Role of the Fast Flux Test Facility*, DOE/EIS-0310, Office of Nuclear Energy, Science and Technology, December.

DOE (U.S. Department of Energy), 2000c, *Savannah River Site, Spent Nuclear Fuel Management Final Environmental Impact Statement*, DOE/EIS-0279, Aiken, South Carolina.

DOE (U.S. Department of Energy), 2001, *Savannah River Site Salt Processing Alternatives Final Supplemental Environmental Impact Statement*, DOE/EIS-0082-S2, Savannah River Operations Office, Aiken, South Carolina, June.

DOE (U.S. Department of Energy), 2002a, *Idaho High-Level Waste and Facilities Disposition Final Environmental Impact Statement*, DOE/EIS-0287, Idaho Operations Office, Idaho Falls, Idaho, September.

DOE (U.S. Department of Energy), 2002b, *Savannah River Site High-Level Waste Tank Closure Final Environmental Impact Statement*, DOE/EIS-0303, Aiken, South Carolina, May.

DOE (U.S. Department of Energy), 2002c, *Final Environmental Impact Statement for the Proposed Relocation of Technical Area 18 Capabilities and Materials at the Los Alamos National Laboratory*, DOE/EIS-0319, National Nuclear Security Administration, Washington, DC, August.

DOE (U.S. Department of Energy), 2002d, *Savannah River Site High-Level Waste Tank Closure Final Environmental Impact Statement*, DOE/EIS-0303, Savannah River Operations Office, Aiken, South Carolina, May.

DOE (U.S. Department of Energy), 2002e, *Final Environmental Impact Statement for a Geological Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250, Office of Civilian Radioactive Waste Management, Yucca Mountain Site Characterization Office, North Las Vegas, Nevada, February.

DOE (U.S. Department of Energy), 2003, *Estimating Radiation Risk from Total Effective Dose Equivalent (TEDE), ISCORS Technical Report No. 1,* DOE/EH-412/0015/0802, Rev. 1, Office of Environmental Policy and Guidance, January.

DOE (U.S. Department of Energy), 2005a, *Savannah River Site's Cold War Built Environment Cultural Resources Management Plan*, Savannah River Operations Office, Aiken, South Carolina, January 26.

DOE (U.S. Department of Energy), 2005b, *Draft Environmental Impact Statement for the Proposed Consolidation of Nuclear Operations Related to Production of Radioisotope Power Systems*, DOE/EIS-0373D, Washington, DC, June.

DOE (U.S. Department of Energy), 2005c, *Environmental Assessment for the Safeguards and Security Upgrades for Storage of Plutonium Materials at the Savannah River Site*, DOE/EA-1538, Savannah River Operations Office, Aiken, South Carolina, December.

DOE (U.S. Department of Energy), 2005d, *Supplement Analysis for the Idaho High-Level Waste and Facilities Disposition Final Environmental Impact Statement*, DOE/EIS-0287-SA-01, Idaho Operations Office, June.

DOE (U.S. Department of Energy), 2005e, *Savannah River Site End State Vision*, Office of Environmental Management, Aiken, South Carolina, July 26.

DOE (U.S. Department of Energy), 2007, *Environmental Assessment for the National Pollutant Discharge Elimination System Stormwater Compliance Alternative at the Savannah River Site*, DOE/EA-1563, Savannah River Operations Office, Aiken, South Carolina, June.

DOE (U.S. Department of Energy), 2008a, *Final Complex Transformation Supplemental Programmatic Environmental Impact Statement*, DOE/EIS-0236-S4, National Nuclear Security Administration, Washington, DC, October.

DOE (U.S. Department of Energy), 2008b, *Environmental Assessment for the Oak Ridge National Laboratory Modernization Initiative Oak Ridge, Tennessee*, DOE/EA-1618, Oak Ridge Office, Oak Ridge, Tennessee, July.

DOE (U. S. Department of Energy), 2008c, *Environmental Assessment for the Oak Ridge Science and Technology Project at the Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/EA-1575, Oak Ridge Office, February.

DOE (U.S. Department of Energy), 2008d, *Final Supplemental Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250F-S1, Office of Civilian Radioactive Waste Management, Las Vegas, Nevada, June.

DOE (U. S. Department of Energy), 2008e, Finding of No Significant Impact Oak Ridge Science and Technology Project at the Oak Ridge National Laboratory, Oak Ridge, Tennessee, Oak Ridge Office, February 20.

DOE (U.S. Department of Energy), 2009, *Supplement Analysis for Waste Isolation Pilot Plant Site-Wide Operations*, Table 2, DOE/EIS-0026-SA-7, Carlsbad, New Mexico, May.

DOE (U.S. Department of Energy), 2010a, Idaho National Laboratory (INL) Site Greenhouse Gas (GHG) Monitoring Plan – 40 C.F.R. § 98, Idaho Operations Office, Idaho Falls, Idaho.

DOE (U.S. Department of Energy), 2010b, Federal Energy Management Program (FEMP) Exterior Lighting Guide for Federal Agencies 2010, August.

DOE (U.S. Department of Energy), 2010c, *Environmental Assessment for the Multipurpose Haul Road Within the Idaho National Laboratory Site*, DOE/EA-1772, Idaho Operations Office, Idaho Falls, Idaho, August.

DOE (U.S. Department of Energy), 2010d, Finding of No Significant Impact for the Multipurpose Haul Road Within the Idaho National Laboratory Site, EM-FMDP-I0-068, Idaho Operations Office, August 4.

DOE (U.S. Department of Energy), 2010e, *Final Environmental Assessment for U-233 Material Downblending and Disposition Project at the Oak Ridge National Laboratory Oak Ridge, Tennessee*, DOE/EA-1651, Oak Ridge Office, January.

DOE (U.S. Department of Energy), 2011a, *Environmental Assessment for the Replacement Capability for Disposal of Remote-Handled Low-Level Waste Generated at the Department of Energy's Idaho Site*, DOE/EA-1793, Idaho Operations Office, Idaho Falls, Idaho, December.

DOE (U.S. Department of Energy), 2011b, DOE Order 458.1, *Radiation Protection of the Public and the Environment*, Office of Health, Safety and Security, Washington, DC, February 2.

DOE (U.S. Department of Energy), 2011c, *Final Site-Wide Environmental Impact Statement for the Y-12 National Security Complex*, DOE/EIS-0387, National Nuclear Security Administration, Y-12 Site Office, Oak Ridge, Tennessee, February.

DOE (U.S. Department of Energy), 2011d, *Final Long-Term Management and Storage of Elemental Mercury Environmental Impact Statement*, DOE/EIS-0423, Office of Environmental Management, Washington, DC, January.

DOE (U.S. Department of Energy), 2011e, Departmental Sustainability, DOE Order 436.1, (available at https://www.directives.doe.gov/directives-documents/400-series/0436.1-BOrder), May 2.

DOE (U.S. Department of Energy), 2011f, *Finding of No Significant Impact for the Environmental Assessment for the Replacement Capability for the Disposal of Remote-Handled Low-Level Radioactive Waste Generated at the Department of Energy's Idaho Site, Idaho Operations Office, Idaho Falls, Idaho*, December.

DOE (U.S. Department of Energy), 2011g, *Environmental Assessment for the Proposed use of Savannah River Site Lands for Military Training*, DOE/EA-1606, Savannah River Operations Office, December.

DOE (U.S. Department of Energy), 2011h, Finding of No Significant Impact for the Proposed Use of Savannah River Site Lands for Military Training, December 15.

DOE (U.S. Department of Energy), 2012a, *Final Tank Closure and Waste Management Environmental Impact Statement for the Hanford Site, Richland, Washington*, DOE/EIS-0391, Office of River Protection, Richland, Washington, November.

DOE (U.S. Department of Energy), 2012b, Revised Finding of No Significant Impact for the Proposed Use of Savannah River Site Lands for Military Training, July 26.

DOE (U.S. Department of Energy), 2013a, Supplemental Analysis for the Nuclear Infrastructure Programmatic Environmental Impact Statement for Plutonium-238 Production for Radioisotope Power Systems, DOE/EIS-0310-SA-02, Washington, DC, September.

DOE (U.S. Department of Energy), 2013b, *Supplement Analysis, Savannah River Site Spent Nuclear Fuel Management,* DOE/EIS-0279-SA-01, DOE/EIS-0218-SA-06, Aiken, South Carolina, March.

DOE (U.S. Department of Energy), 2013c, Final Site-Wide Environmental Impact Statement for the Continued Operation of the Department of Energy/National Nuclear Security Administration Nevada National Security Site and Off-Site Locations in the State of Nevada, DOE/EIS-0426, Nevada Site Office, February.

DOE (U.S. Department of Energy), 2014a, *U.S. Department of Energy Strategic Plan 2014-2018*, DOE/CF-0067, Washington, DC, March.

DOE (U.S. Department of Energy), 2014b, Finding of No Significant Impact and *Environmental Assessment for the Resumption of Transient Testing of Nuclear Fuels and Materials*, DOE/EA-1954, Idaho Operations Office, February.

DOE (U.S. Department of Energy), 2015a, *Final Surplus Plutonium Disposition Supplemental Environmental Impact Statement*, DOE/EIS-0283-S2, Office of Environmental Management and National Nuclear Security Administration, Washington, DC, April.

DOE (U.S. Department of Energy), 2015b, *Environmental Assessment of the Emergency Operations Center Project*, DOE/EA-2014, National Nuclear Security Administration Production Office, September.

DOE (U.S. Department of Energy), 2015c, *Tritium And Enriched Uranium Management Plan Through 2060*, Report to Congress, Washington, DC, October.

DOE (U.S. Department of Energy), 2015d, *Finding of No Significant Impact for the Emergency Operations Center Project*, Y-12 National Security Complex, Oak Ridge, Tennessee, DOE/EA-2014, National Nuclear Security Administration, October 26.

DOE (U.S. Department of Energy), 2015e, *Supplement Analysis for the Foreign Research Reactor Spent Nuclear Fuel Acceptance Program, Highly Enriched Uranium Target Residue Material Transportation*, DOE/EIS-0218-SA-07, Washington, DC, November 30.

DOE (U.S. Department of Energy), 2015f, *Supplement Analysis Proposed Shipment of Commercial Spent Nuclear Fuel to DOE National Laboratories for Research and Development Purposes*, Table 3-1, DOE/EIS-0203-SA-07, DOE/EIS-0250F-S-1-SA-02, Office of Nuclear Energy, December.

DOE (U.S. Department of Energy), 2015g, *DOE 2014 Occupational Radiation Exposure*, Office of Environment, Health, Safety and Security, Oak Ridge, Tennessee.

DOE (U.S. Department of Energy), 2016a, *Final Environmental Impact Statement for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste*, DOE/EIS-0375, Washington, DC, January.

DOE (U.S. Department of Energy), 2016b, *Final Environmental Impact Statement for the Recapitalization of Infrastructure Supporting Naval Spent Nuclear Fuel Handling*, DOE/EIS-0453-F, Naval Nuclear Propulsion Program, Washington, DC, October.

DOE (U.S. Department of Energy), 2016c, *Environmental Management Program Management Plan Savannah River Site*, September.

DOE (U.S. Department of Energy), 2016d, *Final Environmental Assessment Property Transfer to Develop a General Aviation Airport at the East Tennessee Technology Park Heritage Center, Oak Ridge, Tennessee*, DOE/EA-2000, Oak Ridge Office of Environmental Management, Oak Ridge, Tennessee, February.

DOE (U.S. Department of Energy), 2016e, *Supplement Analysis for the Site-Wide Environmental Impact Statement for the Y-12 National Security Complex*, DOE/EIS-0387-SA-01, National Nuclear Security Administration, Production Office, Y-12, April.

DOE (U.S. Department of Energy), 2016f, *Supplement Analysis of the Mark-18A Target Material Recovery Program at the Savannah River Site*, DOE/EIS-0220-SA-02 and DOE/EIS-0279-SA-06, Savannah River Operations Office, Aiken, South Carolina, November.

DOE (U.S. Department of Energy), 2016g, DOE ID Spent Fuel Facilities/Independent SNF Storage Installation.

DOE (U.S. Department of Energy), 2016h, Finding of No Significant Impact, Property Transfer to Develop a General Aviation Airport at the East Tennessee Technology Park Heritage Center, Oak Ridge, Tennessee, DOE/EA-2000, Oak Ridge Office of Environmental Management, Oak Ridge, Tennessee, February.

DOE (U.S. Department of Energy), 2016i, DOE Order 151.1D, Comprehensive Emergency Management System, Chg. 1, 10-4-2019, Washington, DC, August 11.

DOE (U.S. Department of Energy), 2016j, *DOE 2015 Occupational Radiation Exposure*, Office of Environment, Health, Safety and Security, Oak Ridge, Tennessee, October.

DOE (U.S. Department of Energy), 2016k, *Final Environmental Impact Statement for the Recapitalization of Infrastructure Supporting Naval Spent Nuclear Fuel Handling*, DOE/EIS-0453-F, Washington, DC, October.

DOE (U.S. Department of Energy), 2017a, Environmental Management Disposal Facility.

DOE (U.S. Department of Energy), 2017b, *Report from the Department of Energy Voluntary Protection Program Onsite Review October 10-19, 2017,* Office of Environment, Health, Safety and Security, Washington, DC.

DOE (U.S. Department of Energy), 2017c, *Remedial Investigation/Feasibility Study for Comprehensive Environmental Response, Compensation, and Liability Act, Oak Ridge Reservation Waste Disposal, Oak Ridge, Tennessee*, DOE/OR/01-2535&D5, Office of Environmental Management, Oak Ridge, Tennessee, February 8.

DOE (U.S. Department of Energy), 2017d, *Final Environmental Assessment for the Acceptance and Disposition of Spent Nuclear Fuel Containing U.S.-Origin Highly Enriched Uranium from the Federal Republic of Germany*, DOE/EA-1977, Aiken, South Carolina, December.

DOE (U.S. Department of Energy), 2017e, *Finding of No Significant Impact for the Final Environmental Assessment for the Acceptance and Disposition of Spent Nuclear Fuel Containing U.S.-Origin Highly Enriched Uranium from the Federal Republic of Germany*, DOE/EA-1977, Aiken, South Carolina, December 20.

DOE (U.S. Department of Energy), 2017f, DOE Standard Radiological Control Technical Standard, DOE-STD-1098-2017, Change Notice 1, Washington, DC, January 2017.

DOE (U.S. Department of Energy), 2017g, *DOE 2016 Occupational Radiation Exposure*, Office of Environment, Health, Safety and Security, Oak Ridge, Tennessee, November.

DOE (U.S. Department of Energy), 2018a, *Mission Need Statement for the Versatile Test Reactor (VTR) Project, A Major Acquisition Project,* Office of Nuclear Technology Research and Development, Office of Nuclear Energy, December.

DOE (U.S. Department of Energy), 2018b, *DOE 2017 Occupational Radiation Exposure*, Office of Environment, Health, Safety and Security, Oak Ridge Tennessee.

DOE (U.S. Department of Energy), 2018c, DOE Standard, Hazard Categorization of DOE Nuclear Facilities, DOE-STD-1027-2018, Washington, DC, November.

DOE (U.S. Department of Energy), 2018d, *Environmental Assessment for the Disposal of Greater-Than-Class C (GTCC) Low-Level Radioactive Waste and GTCC-Like Waste at Waste Control Specialists, Andrews County, Texas*, DOE/EA-2082, Washington, DC, October.

DOE (U.S. Department of Energy), 2018e, *Proposed Plan for the Disposal of Oak Ridge Reservation Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Waste*, DOE/OR/01-2695&D2/R1, Environmental Management Program, September.

DOE (U.S. Department of Energy), 2018f, *Final Environmental Impact Statement for Remediation of Area IV and the Northern Buffer Zone of the Santa Susana Field Laboratory*, DOE/EIS-0402, November.

DOE (U.S. Department of Energy), 2018g, *U.S. Department of Energy FY2017 Economic Impact in Tennessee* (available at https://eteconline.org/wp-content/uploads/2018/05/DOE-EIS-FY17-Report.pdf), East Tennessee Economic Council.

DOE (U.S. Department of Energy), 2018h, *Office of Enterprise Assessments, Assessment of the Emergency Management Exercise Program at the Idaho Site*, Washington, DC, January.

DOE (Department of Energy), 2018i, *Assessment of the Savannah River Site Emergency Management Exercise Program*, Office of Enterprise Assessments, October.

DOE (U.S. Department of Energy), 2019a, *Injury and Illness Dashboard* (accessed September 11, 2019 and October 17, 2019 at https://data.doe.gov/MS/asp/Main.aspx).

DOE (U.S. Department of Energy), 2019b, *Finding of No Significant Impact and Environmental Assessment for Use of DOE-Owned High-Assay Low-Enriched Uranium Stored at Idaho National Laboratory*, DOE/EA-2087, Idaho Operations Office, Idaho Falls, Idaho, January.

DOE (U.S. Department of Energy), 2019c, *Finding of No Significant Impact and Final Environmental Assessment for Expanding Capabilities at the Power Grid Test Bed at Idaho National Laboratory*, DOE/EA-2097, Idaho Operations Office, July.

DOE (U.S. Department of Energy), 2019d, *Analysis of Alternatives, Versatile Test Reactor Project*, Office of Nuclear Energy, November 15.

DOE (U.S. Department of Energy), 2019e, *Final Supplement Analysis of the Complex Transformation Supplemental Programmatic Environmental Impact Statement*, DOE/EIS-0236-S4-SA-02, Aiken, South Carolina, December.

DOE (U.S. Department of Energy), 2019f, *Natural Resources Management Plan for the Savannah River Site* (available at www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5208304.pdf), prepared by U.S. Department of Agriculture, Forest Service-Savannah River, New Ellenton, South Carolina, November.

DOE (U.S. Department of Energy), 2019g, *Occupational Radiation Exposure Report for Calendar Year 2018*, Office of Environment, Health, Safety and Security, Oak Ridge, Tennessee.

DOE (U.S. Department of Energy), 2019h, *Finding of No Significant Impact and Final Environmental Assessment for Expanding Capabilities at the National Security Test Range and the Radiological Response Training Range at Idaho National Laboratory*, DOE/EA-2063, Idaho Operations Office, Idaho Falls, Idaho, November.

DOE (U.S. Department of Energy), 2020a, *Final Environmental Impact Statement for Plutonium Pit Production at the Savannah River Site in South Carolina*, DOE/EIS-0541, National Nuclear Security Administration, Savannah River Site, September.

DOE (U.S. Department of Energy), 2020b, *Final Supplemental Environmental Impact Statement for Disposition of Depleted Uranium Oxide Conversion Product Generated from DOE's Inventory of Depleted Uranium Hexafluoride*, DOE/EIS-0359-S1 and DOE/EIS-0360-S1, Office of Environmental Management, Washington, DC, April.

DOE (U.S. Department of Energy), 2020c, Personal communication (email) with B. Dingman, Re: Number of workers at the Idaho Site, April 30.

DOE (U.S. Department of Energy), 2020d, *Supplement Analysis for Disposition of Additional Non-Pit Surplus Plutonium*, DOE/EIS-0283-SA-4, National Nuclear Security Administration, August.

DOE (U.S. Department of Energy), 2020e, *Final Environmental Assessment for the Commercial Disposal of Defense Waste Processing Facility Recycle Wastewater from the Savannah River Site*, DOE/EA-2115, August.

DOE (U.S. Department of Energy), 2020f, "Secretary Brouillette and South Carolina Officials Announce Historic Agreement between the Trump Administration and the State of South Carolina," *Energy News*, August 31.

DOE (U.S. Department of Energy), 2020g, *Final Supplement Analysis of the 2008 Site-Wide Environmental Impact Statement for the Continued Operation of Los Alamos National Laboratory for Plutonium Operations*, DOE/EIS-0380-SA-06, National Nuclear Security Administration, August.

DOE (U.S. Department of Energy), 2020h, Personal communication (email) from J. L. Eddins, DOE-Office of Nuclear Energy, to J. Lovejoy, DOE-Idaho, Re: HALEU Availability for Draft EIS, July 6.

DOE, SC SHPO, and ACHP (U.S. Department of Energy, South Carolina State Historic Preservation Office, and the Advisory Council on Historic Preservation), 2020, Programmatic Agreement (PA) Between the U.S. Department of Energy (DOE), the South Carolina State Historic Preservation Office (SHPO), and the Advisory Council on Historic Preservation (ACHP) regarding the Management of Historic Properties on the Savannah River Site (SRS), Aiken, Barnwell, and Allendale Counties, South Carolina, Aiken, South Carolina.

DOE/Navy/ID (U.S. Department of Energy, U.S. Navy, and the State of Idaho), 1995, Idaho Settlement Agreement, October 16.

DOE-CFO (U.S. Department of Energy, Carlsbad Field Office), 2018, Permit Modification Request for the Waste Isolation Pilot Plant Hazardous Waste Facility Permit, Number NM4890139088-TSDF, January.

DOE-CFO (U.S. Department of Energy, Carlsbad Field Office), 2019, *Annual Transuranic Waste Inventory Report –2019*, DOE/TRU-19-3425, Rev. 0, Carlsbad, New Mexico, December.

DOE-ID & Idaho (U.S. Department of Energy and State of Idaho), 2019, Supplemental Agreement Concerning Conditional Waiver of Sections D.2.e and K.1 of 1995 Settlement Agreement, November 6.

DOE-ID & Idaho (State of Idaho, through the Governor of the State of Idaho and the Idaho Attorney General, and the U.S. Department of Energy), 2020, Agreement Concerning Handling of Spent Nuclear Fuel Generated by the Advanced Test Reactor, February 4.

DOE-ID & USFWS (U.S. Department of Energy, Idaho Operations Office and U.S. Fish and Wildlife Service, Idaho State Office), 2014, *Candidate Conservation Agreement for Greater Sage-grouse (Centrocercus urophasianus) on the Idaho National Laboratory Site in Southeast Idaho*, DOE/ID-11514, prepared by: Gonzales-Stoller Surveillance, LLC, and Wildlife Conservation Society Under the Environmental Surveillance, Education, and Research Program, September.

DOE-ID (U.S. Department of Energy, Idaho Operations Office), 1998, Final Record of Decision for Argonne National Laboratory-West, W7500-000-ES-04, Operable Unit 9-04, Idaho Falls, Idaho, September 25.

DOE-ID (U.S. Department of Energy, Idaho Operations Office), 2014, Technical Basis for Environmental Monitoring and Surveillance at the Idaho National Laboratory Site, DOE/ID-11485, February.

DOE-ID (U.S. Department of Energy, Idaho Operations Office), 2016, NEPA CX Determination, Small Modular Reactor (SMR) Site Inspection Visit, INL-16-015, March 14.

DOE-ID (U.S. Department of Energy, Idaho Operations Office), 2017, Agreement-in-Principle Between the Shoshone-Bannock Tribes and the U.S. Department of Energy, September 25.

DOE-ID (U.S. Department of Energy, Idaho Operations Office), 2018, Idaho National Laboratory Site Bat Protection Plan, DOE/ID-12002, Rev 0, Idaho Falls, Idaho, September.

DOE-ID (U.S. Department of Energy, Idaho Operations Office), 2019a, *Fiscal Year 2019 Revegetation Assessment*, INL/EXT-19-56726, Idaho Falls, Idaho, November.

DOE-ID (U.S. Department of Energy, Idaho Operations Office), 2019b, DOE-ID NEPA CX Determination, *Idaho National Laboratory Gravel Source and Borrow Pit Operations (Overarching)*, INL-19-155, December 11.

DOE-ID (U.S. Department of Energy, Idaho Operations Office), 2019c, NEPA CX Determination, Sample Preparation Laboratory, Rev 2, INL-16-060 R2, Idaho National Laboratory, November 21.

DOE-ID, ID SHPO, and ACHP (U.S. Department of Energy Idaho Operations Office, Idaho State Historic Preservation Office, and the Advisory Council on Historic Preservation), 2004, Programmatic Agreement Concerning the Management of Historical Cultural Resources on the Idaho National Engineering and Environmental Laboratory, September 15.

DOE-OR (U.S. Department of Energy, Oak Ridge Operations Office), 2001, *Cultural Resource Management Plan*, Department of Energy Oak Ridge Operations Office, Anderson and Roane Counties, Tennessee, DOE/ORO-2085, Oak Ridge, Tennessee, July.

DOE-OR (U.S. Department of Energy, Oak Ridge Operations Office), 2005, Programmatic Agreement Among the Department of Energy Oak Ridge Operations, Tennessee State Historic Preservation Office, and the Advisory Council on Historic Preservation Concerning the Management of Historical Cultural Properties at Oak Ridge National Laboratory, Oak Ridge, Tennessee, February 23.

DOE-OR (U.S. Department of Energy, Oak Ridge Operations Office), 2018, *Site Treatment Plan for Mixed Wastes on the U.S. Department of Energy Oak Ridge Reservation*, TDEC-VER.23.0, DOE-ORNL (U.S. Department of Energy, Oak Ridge National Laboratory Site Office), 2020a, Memorandum for J. O. Moore, Manager, ORNL Site Office from P. R. Siebach, NEPA Compliance Officer, Re: National Environmental Policy Act (NEPA) Determination for the Preparation of a Supplement Analysis for the Construction of the Second Target at the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory, January 29.

DOE-ORNL (U.S. Department of Energy, Oak Ridge National Laboratory Site Office), 2020b, Memorandum for J. Moore, Manager, ORNL Site Office, from P. Siebach, NEPA Compliance Officer, Re: National Environmental Policy Act (NEPA) Environmental Assessment Determination for the Stable Isotope Production and Research Center (SIPRC) at Oak Ridge National Laboratory, January 30.

DOE-ORNL (U.S. Department of Energy, Oak Ridge National Laboratory Site Office), 2020c, Memorandum for J. Moore, Manager, ORNL Site Office, from P. Siebach, NEPA Compliance Officer, Re: National Environmental Policy Act (NEPA) Environmental Assessment Determination for the Transformational Challenge Reactor (TCR) at Oak Ridge National Laboratory, February 12.

DOS (U.S. Department of State), 2020, Adherence to and Compliance with Arms Control, Nonproliferation, and Disarmament Agreements and Commitments, Washington, DC, June.

DOT (U.S. Department of Transportation), 2012, *High-Speed Ground Transportation Noise and Vibration Impact Assessment*, Office of Railroad Policy and Development, Federal Railroad Administration, DOT/FRA/ORD-12/15, September.

DOT (U.S. Department of Transportation), 2018, *Transit Noise and Vibration Impact Assessment Manual*, FTA Report No. 0123, Federal Transit Administration, September.

DOT (U.S. Department of Transportation), 2019, *Traffic Safety Facts 2017*, DOT HS 812 806, National Highway Traffic Safety Administration, Washington, DC, September.

EPA (U.S. Environmental Protection Agency), 1974, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare within Adequate Margin of Safety, Office of Noise Abatement and Control, Washington, DC, March.

EPA (U.S. Environmental Protection Agency), 1978, Protective Noise Levels, Condensed Version of EPA Levels Document, EPA 550/9-79-100, Office of Noise Abatement and Control, Washington, DC, November.

EPA (U.S. Environmental Protection Agency), 2008, *Compilation of Air Pollutant Emission Factors, AP-42, Vol. I,* Section 1.5, Liquefied Petroleum Gas Combustion (available at www3.epa.gov/ttn/chief/ap42/ch01/final/c01s05.pdf).

EPA (U.S. Environmental Protection Agency), 2011, *Sole Source Aquifers in the Southeast*, Atlanta, Georgia, February 9.

EPA (U.S. Environmental Protection Agency), 2016, NAAQS Table (available at www.epa.gov/ criteria-air-pollutants/naaqs-table).

EPA (U.S Environmental Protection Agency), 2018a, Latest Version of Motor Vehicle Emission Simulator (MOVES) - MOVES2014b: Latest Version of Motor Vehicle Emission Simulator (available at www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves).

EPA (U.S Environmental Protection Agency), 2018b, Exhaust and Crankcase Emission Factors for Nonroad Compression-Ignition Engines in MOVES2014b, VOC, CO, NOx, and PM factors from Table 2-1 and PM10/PM2.5 ratios from page 34 (available at www.epa.gov/moves/nonroad-technical-reports).

EPA (U.S. Environmental Protection Agency), 2019a, Interactive map of SSAs (Sole Source Aquifers) (accessed September 12, 2019 at https://epa.maps.arcgis.com/apps/webappviewer/index.html?id=9ebb047ba3ec41ada1877155fe31356b).

EPA (U.S. Environmental Protection Agency), 2019b, Letter K. Viswanathan to J. Tippets, Approval of the Idaho Department of Environmental Quality's Request for Updated Delegation of Authority for National Emissions Standards for Hazardous Air Pollutants, October 30.

EPA (U.S. Environmental Protection Agency), 2019c, Idaho NPDES Program Authorization, accessed on January 15, 2020 at https://www.epa.gov/npdes-permits/idaho-npdes-program-authorization#schedule, December 6.

EPA (U.S. Environmental Protection Agency), 2019d, 2018 Greenhouse Gas Emissions from Large Facilities – Savannah River Nuclear Solutions LLC, Savannah River Site, GHGRP Id: 1007270 - FRS Id: 110039497416 (available at https://ghgdata.epa.gov/ghgp/service/facilityDetail/2018?id=1007270&ds=E&et=&popup=true).

EPA (U.S. Environmental Protection Agency), 2019e, Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018, EPA Document 430-P-20-001 (available at https://www.epa.gov/ghgemissions/draft-inventory-us-greenhouse-gas-emissions-and-sinks-1990-2018).

ERDA (U.S. Energy Research and Development Administration), 1975, *Final Environmental Statement, Liquid Metal Fast Breeder Reactor Program*, ERDA-1535, Washington, DC.

ERDA (U.S. Energy Research and Development Administration), 1976, *Light Water Breeder Reactor Program, Final Environmental Statement*, ERDA-1541, Washington, DC, June 1.

ES (Energy*Solutions*), 2020, Bear Creek Processing Facility (accessed February 10, 2020 at https://www.energysolutions.com/waste-processing/bear-creek-processing-facility/).

ESER (Environmental Surveillance, Education and Research Program), 2007, Sensitive Animal Species Inventory on the INL Sagebrush Steppe Ecosystem Reserve, Stoller-ESER-108, November 27.

ESER (Environmental Surveillance, Education, and Research Program), 2019a, *Vegetation Community Classification and Mapping of the INL Site 2019*, VFS-ID-ESER-Land-064, June.

ESER (Environmental Surveillance, Education, and Research Program), 2019b, *Idaho National Laboratory Site Environmental Report Calendar Year 2018*, DOE/ID-12082(18), Idaho Falls, Idaho, September.

ESER (Environmental Surveillance, Education, and Research Program), 2019c, 2018 Breeding Bird Surveys on the Idaho National Laboratory Site, VFS-ID-ESER-WILD-030, July 9.

ESER (Environmental Surveillance, Education, and Research Program), 2019d, *Implementing the Candidate Conservation Agreement for the Greater Sage-Grouse on the Idaho National Laboratory Site: 2019 Full Report*, VFS-ID-ESER-CCA-074, Idaho Falls, Idaho, January 2020.

FBI (Federal Bureau of Investigation), 2020a, 2016 Crime in the United States, Table 28, Full Time Law Enforcement Employees by State, by Metropolitan and Nonmetropolitan Counties, 2016 (accessed September 2020 at https://ucr.fbi.gov/crime-in-the-u.s/2016/crime-in-the-u.s.-2016/tables/table-28/table-28.xls/).

FBI (Federal Bureau of Investigation), 2020b, 2016 Crime in the United States, Table 26, Full Time Law Enforcement Employees by State, by City, 2016 (accessed September 2020 at https://ucr.fbi.gov/crime-in-the-u.s/2016/crime-in-the-u.s.-2016/tables/table-26/table-26.xls/view).

FHWA (Federal Highway Administration), 2006, Roadway Construction Noise Model User's Guide, Final Report, FHWA-HEP-05-054. January.

Fire Department, 2020, Fire Department Information, Fire Department Directory by state (and county) (accessed August 2020 at https://www.firedepartment.net/).

Gallant, E., J. Richardson, C. Connor, P. Wetmore, and L. Connor, 2018, "A new approach to probabilistic lava flow hazard assessments, applied to the Idaho National Laboratory, eastern Snake River Plain, Idaho, USA, *GEOLOGY*, Vol. 46, p. 895–898 (available at https://doi.org/10.1130/G45123.1).

GAO (U.S. Government Accountability Office), 2019, *Surplus Plutonium Disposition, NNSA's Long-Term Plutonium Oxide Production Plans Are Uncertain*, GAO-20-166, Report to the Committee on Armed Services, U.S. Senate, Washington, DC, October.

GDOT (Georgia Department of Transportation), 2020, I-20 @ Savannah River Bridge Replacements (available at http://www.dot.ga.gov/BS/Projects/SpecialProjects/I20SavannahRiver).

Georgia Power, 2018, "Plant Vogtle 3 and 4" *Plant Vogle* (accessed November 26, 2018, at www.georgiapower.com/company/plant-vogtle.html), Atlanta, Georgia.

Georgia Governor's Office, 2020, Office of Planning and Budget, Population Projections Data, County Residential Population Data, 2018-2063 (accessed September 2020 at https://opb.georgia.gov/census-data/population-projections).

Global Carbon Project, 2019, Global Carbon Budget 2019, Version 1.0 (available at https://www.icos-cp.eu/global-carbon-budget-2019).

Hackett, W. R., and R. P. Smith, 1992, Quaternary Volcanism, *Tectonics and Sedimentation in the Idaho National Engineering Laboratory Area*, Field Guide to Geologic Excursions in Utah and Adjacent areas of Nevada, Idaho and Wyoming, Utah.

Hackett, W. R., R. P. Smith, and S. Khericha, 2002, "Volcanic Hazards of the Idaho National Engineering and Environmental Laboratory, Southeast Idaho," Tectonic and Magmatic Evolution of the Snake River Plain Volcanic Province, Idaho Geological Survey Bulletin 30, p. 461-482.

HUD (U.S. Department of Housing and Urban Development), 1985, HUD Noise Guidebook, HUD-953-CPD (available at www.hudexchange.info/resource/313/hud-noise-guidebook/), Washington, DC, March.

Huotari, J., 2019, TVA Board Unanimously Approves Closing Bull Run Fossil Plant, Oak Ridge Today (available at https://oakridgetoday.com/2019/02/14/tva-board-unanimously-approves-closing-bull-run-fossil-plant/), January 14.

ICRP (International Commission on Radiological Protection), 1991, "1990 Recommendations of the International Commission on Radiological Protection," ICRP Publication 60, Annals of the ICRP, Pergamon Press, Elmsford, New York.

IDA (International Dark-Sky Association), 2019, International Dark Sky Parks - Craters Of The Moon National Monument (accessed September 14, 2019 at https://www.darksky.org/our-work/conservation/idsp/parks/).

Idaho Conservation League, 2019, Declining Groundwater Quality in the Eastern Snake Plain Aquifer, Causes, Trends, and Public Health Effects (accessed May 7, 2020 at https://www.idahoconservation.org/wp-content/uploads/2019/07/ICL_GroundWaterReport-07082019-FINAL-Web-1.pdf), July.

Idaho Department of Labor, 2020, Population Projections, State Projections 2019 through 2029 (available at https://lmi.idaho.gov/population-projections), September 8.

Idaho Medical Association, 2019, Idaho Hospitals (accessed 2019 at www.idmed.org/idaho/Idaho_Public/Resources/Idaho_Hospitals/Idaho_Public/Resources/Idaho_Hospitals.aspx?hkey=b89bea50-4345-4624-be76-7b8cd25e9135).

Idaho Policy Institute (Boise State University, McClure Center for Public Policy Research, and University of Idaho), 2019, *Economic Impact Report*, Construction and Operation of a Small Modular Reactor Electric Power Generation Facility at the Idaho National laboratory Site, Butte County, Idaho (available at https://easternidaho.org/wp-content/uploads/2019/02/SMR-Economic-Impact-Report-FINAL.pdf), January 29.

IDEQ (Idaho Department of Environmental Quality), 2018, Air Quality Permit to Construct, Permit Number P-2015.0023.

IDEQ (Idaho Department of Environmental Quality), 2019, Rules for the Control of Air Pollution in Idaho (available at www.deq.idaho.gov/air-quality/planning/).

IDFG (Idaho Department of Fish and Game), 2017, Idaho State Wildlife Action Plan 2015 (accessed September 12, 2019 at https://idfg.idaho.gov/sites/default/files/state-wildlife-action-plan.pdf).

IIFA (Idaho Wetland Functional Assessment Committee), 1999, Idaho Interim functional Assessment for Riverine Wetlands on the Floodplains of Low-to Moderate Gradient, 2nd or 3rd Order Streams on Fine Textured Substrates, May.

INEEL (Idaho National Engineering and Environmental Laboratory), 2005, *Updated Final Safety Analysis Report for the Advanced Test Reactor*, SAR-153, Rev. 16, April 7.

INL (Idaho National Laboratory), 2001, Ecological Support Reports (accessed September 11, 2019 at http://idahoeser.com/BBS/BBS2017ES.htm), Environmental Surveillance, Education, and Research Program, Idaho Falls, Idaho.

INL (Idaho National Laboratory), 2006, Development Of Rock And Soil Design Basis Earthquake (DBE) Parameters For The Materials And Fuels Complex (MFC), INL/EXT-05-00925, Idaho Falls, Idaho, March.

INL (Idaho National Laboratory), 2010a, INL Seismic Monitoring Program (accessed March 17, 2011 at https://inlportal.inl.gov/portal/server.pt/community/inl_seismic_monitoiring_program), Idaho Operations Office, Idaho Falls, Idaho.

INL (Idaho National Laboratory), 2010b, Idaho National Laboratory Materials and Fuels Complex Natural Phenomena Hazards Flood Assessment, INL/EXT-10-20572, Idaho Falls, Idaho, December.

INL (Idaho National Laboratory), 2010c, *Idaho National Laboratory Site Environmental Report Calendar Year 2009*, DOE/ID-12082(09), Environmental Surveillance, Education and Research Program, Idaho Operations Office, Idaho Falls, Idaho.

INL (Idaho National Laboratory), 2011a, *Idaho National Laboratory Site Environmental Report Calendar Year 2010*, DOE/ID-12082(10), Environmental Surveillance, Education, and Research Program, Idaho Operations Office, Idaho Falls, Idaho, September.

INL (Idaho National Laboratory), 2011b, *INL Wildland Fire Management Plan*, PLN-14401.

INL (Idaho National Laboratory), 2013, *INL Sitewide Noxious Weed Management Plan*, PLN-611.

INL (Idaho National Laboratory), 2014, *Idaho National Laboratory Site Environmental Report Calendar Year 2013*, DOE/ID-12082(13), Environmental Surveillance, Education, and Research Program, Idaho Operations Office, Idaho Falls, Idaho, September.

INL (Idaho National Laboratory), 2015a, *Idaho National Laboratory Site Environmental Report Calendar Year 2014*, DOE/ID-12082(14), Environmental Surveillance, Education, and Research Program, Idaho Operations Office, Idaho Falls, Idaho, September.

INL (Idaho National Laboratory), 2015b, *INL Site Conditions and Properties*, INL/EXT-15-36721, Rev. 0, U.S. Department of Energy, Idaho Operations Office, Idaho, September.

INL (Idaho National Laboratory), 2015c, *Idaho National Laboratory Comprehensive Land Use and Environmental Stewardship Report*, INL/EXT-05-00726, Rev 2, Infrastructure Optimization, Integration, and Planning, Idaho Falls, Idaho, July.

INL (Idaho National Laboratory), 2016a, SSHAC Level 1 Probabalistic Seismic Hazard Analysis for the Idaho National Laboratory; INL SSHAC Level 1 Team, INL/EST-15-036682, Rev. 1, March.

INL (Idaho National Laboratory), 2016b, *Idaho National Laboratory Site Envoironmental Report Calendar Year 2015*, DOE/ID-12082(14), Environmental Surveillance, Education, and Research Program, Idaho Operations Office, Idaho Falls, Idaho, September.

INL (Idaho National Laboratory), 2016c, Experimental Fuels Facility factsheet, Idaho Falls, Idaho.

INL (Idaho National Laboratory), 2016d, *Idaho National Laboratory Emergency Readiness Assurance Plan–Fiscal Year 2016*, INL/EXT-16-39810, Rev. 1, Idaho Falls, Idaho, September.

INL (Idaho National Laboratory), 2016e, Historical Data Analysis Supporting the Data Quality Objectives for the INL Site Environmental Soil Monitoring Program, INL/INT-15-37431, February.

INL (Idaho National Laboratory), 2016f, *Idaho National Laboratory Cultural Resource Management Plan*, DOE/ID-10997, Rev. 6, Idaho Operations Office, Idaho Falls, Idaho, February.

INL (Idaho National Laboratory), 2017a, *2016 Annual Industrial Wastewater Reuse Report for the Idaho National Laboratory Site's Materials and Fuels Complex Industrial Waste Ditch and Industrial Waste Pond*, INL/EXT-17-40841, Idaho Falls, Idaho, February.

INL (Idaho National Laboratory), 2017b, *Idaho National Laboratory Site Environmental Report Calendar Year 2016*, DOE/ID-12082(16), Environmental Surveillance, Education, and Research Program, Idaho Operations Office, Idaho Falls, Idaho, September.

INL (Idaho National Laboratory), 2017c, Technical Evaluation: Utility Study for the Versatile Reactor (VTR) at MFC, December.

INL (Idaho National Laboratory), 2017d, Advanced Demonstration and Test Reactor Options Study, INL/EXT-16-37867, Rev. 3, Idaho Falls, Idaho, January.

INL (Idaho National Laboratory), 2017e, INL Emergency Plan/Resource Conservation and Recovery Act Contingency Plan, PLN-114, Rev. 91, July 26.

INL (Idaho National Laboratory), 2018a, *Idaho National Laboratory Site Environmental Report Calendar Year 2017*, DOE/ID-12082(17), Environmental Surveillance, Education, and Research Program, Idaho Operations Office, Idaho Falls, Idaho, September.

INL (Idaho National Laboratory), 2018b, *2017 Idaho National Laboratory Water Use Report and Comprehensive Well Inventory*, Rev. 26, INL/EXT-18-45157, Idaho Falls, Idaho, June.

INL (Idaho National Laboratory), 2018c, *Idaho National Laboratory Site Bat Protection Plan*, DOE/ID--12002, Rev. 0, (accessed September 12, 2019 at http://idahoeser.com/PDF/BatProtectionPlan2018.pdf), September.

INL (Idaho National Laboratory), 2018d, *Idaho National Laboratory FY2017 Economic Summary*, Research and Development, INL/MIS-17-43835 (available at https://public.inl.gov/public/pdfs/17-50340-R3_Report_FINAL_PRINT.pdf).

INL (Idaho National Laboratory), 2019a, *Idaho National Laboratory Annual Report for Permit to Construct P-2015.0023 for Calendar Year 2018*, INL/EXT-19-52683, Rev. 0, Idaho Falls, Idaho, March.

INL (Idaho National Laboratory), 2019b, *Idaho National Laboratory Environmental Surveillance, Research and Education Program* (available at http://idahoeser.com/Publications_number.htm).

INL (Idaho National Laboratory), 2019c, *Idaho National Laboratory Site Environmental Report Calendar Year 2018*, DOE/ID-12082(18), Environmental Surveillance, Education, and Research Program, Idaho Operations Office, Idaho Falls, Idaho, September.

INL (Idaho National Laboratory), 2019d, *FY 2018 Idaho National Laboratory Economic Summary*, Research and Development, INL/MIS-18-52220 (accessed 2019 at https://inl.gov/inl-initiatives/economic-and-workforce-development/).

INL (Idaho National Laboratory), 2019e, VTR Fuel Facility Plan, INL/LTD-19-54001, Idaho Falls, Idaho, May. **OUO**

INL (Idaho National Laboratory), 2019f, Annual Emergency Exercise Demonstrates Vast First Response Capacity in Region, Idaho Falls, Idaho, June 26.

INL (Idaho National Laboratory), 2019g, Conceptual Design Report for the Versatile Test Reactor (VTR), INL/LTD-19-56681, Rev. 0, Idaho Falls, Idaho, November. **OUO, Export Controlled Information**

INL (Idaho National Laboratory), 2019h, Technical Evaluation: Utility Study for the Versatile Reactor (VTR) at MFC, December.

INL (Idaho National Laboratory), 2020a, Personal communication (email), L. Nelson to D. Outlaw, March 6.

INL (Idaho National Laboratory), 2020b, INL and Idaho Regional Impact, FY2019 (accessed May 2020 at https://inl.gov/inl-initiatives/economic-and-workforce-development/).

INL (Idaho National Laboratory), 2020c, *INL Seismic Monitoring Report: January 1, 2018 – December 31, 2018*, INL/EXT-19-56524, Idaho Falls, Idaho, January.

INL (Idaho National Laboratory), 2020d, VTR Fuel Polishing, TEV No.: 4077, Rev. 0, Idaho Falls, Idaho, August 4.

INL (Idaho National Laboratory), 2020e, *Comprehensive Land Use and Environmental Stewardship Report Update*, INL/EXT-20-57515, Idaho Falls, Idaho.

INL (Idaho National Laboratory), 2020f, VTR Hazards and Impacts Information in Support of National Environmental Policy Act Data Needs, INL/EXT-19-55588, October.

INL (Idaho National Laboratory), 2020g, Technical Evaluation Versatile Test Reactor (VTR) Waste and Material Data for Environmental Impact Statement (EIS), TEM-10300-1, Rev. 9, TEV-3976, Rev. 1, November 12.

INL (Idaho National Laboratory), n.d., Zero Power Physics Reactor Facility factsheet, Idaho Falls, Idaho.

IPCC (Intergovernmental Panel on Climate Change), 2014, *Climate Change 2014: Synthesis Report, Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (available at http://www.ipcc.ch/activities/activities.shtml), Geneva, Switzerland.

IPFM (International Panel on Fissile Materials), 2016, "Decree by the President of the Russian Federation on the Suspension of the Plutonium Management and Disposition Agreement," President of the Russian Federation V. Putin, Moscow, Russia, October.

ITD (Idaho Transportation Department), 2020, Roadway Data Section, Annual Average Daily Travel Application, AADT 1999 – Present (accessed at https://iplan.maps.arcgis.com/apps/webappviewer/index.html?id=e8b58a3466e74f249cca6aad30e83ba2).

Jackson, S. M., and J. Boatwright, 1985, "The Borah Peak, Idaho Earthquake of October 28, 1983—Strong Ground Motion," *Earthquake Spectra*, Vol. 2, No. 1, pp. 51–68.

Jones and Stokes, 2004, Transportation- and Construction-Induced Vibration Guidance Manual, J&S 02-039, Sacramento, California, June.

Keeling, C. D., 1960, "The Concentration and Isotopic Abundances of Carbon Dioxide in the Atmosphere," *Tellus*, Vol. 12, pp. 200-203.

Knox County, 2019, Knox County, Tennessee Code of Ordinances, Supplement 16, Updated March 11, 2019, Section 10-92 Amendments (accessed March 2, 2020 at https://library.municode.com/tn/knox_county/codes/code_of_ordinances).

Kuntz, M. A., B. Skipp, M. A. Lanphere, W. E. Scott, K. L. Pierce, G. B. Dalrymple, D. E. Champion, G. F. Embree, W. R. Page, L. A. Morgan, R. P. Smith, W. R. Hackett, and D. W. Rodgers, 1994, *Geologic Map of the Idaho National Engineering Laboratory and Adjoining Areas, Eastern Idaho,* U.S. Geological Survey Miscellaneous Investigations Map 1-2330, 1:100,000 scale.

Lamancusa, J., 2009, "Noise Control – Outdoor Sound Propagation," Pennsylvania State University, Department of Mechanical and Nuclear Engineering (accessed May 25, 2018 at www.mne.psu.edu/lamancusa/me458/10_osp.pdf), July 20.

Lee, S. D, 2020, Environmental and Cultural Resources Services, Idaho National Laboratory, Memo to J. Roglans-Ribas, Deputy Project Manager, Versatile Text Reactor, Re: Completion of Versatile Test Reactor Project Site Cultural Field Surveys, July 2020, Idaho Falls, Idaho, August 31.

Leidos, 2020, *Information for Construction of the Versatile Test Reactor at the Oak Ridge National Laboratory*, VTR-RPT-01, Rev. 0, November.

Liu, D. and Lipták, B., 1997, "Noise Measurements," *Environmental Engineers' Handbook*, Second Edition, Lewis Publishers.

LSCOG (Lower Savannah Council of Governments), 2006, *Rural Long-Range Transportation Plan 2015-2040*, March 28.

LSCOG (Lower Savannah Council of Governments), 2017, *Rural Long-Range Transportation Plan 2015-2040*, Aiken, South Carolina, March 2006 with amendments to July 2017.

Mastin, L. G., A. R. Van Eaton, and J. B. Lowenstern, 2014, "Modeling ash fall distribution from a Yellowstone supereruption," *Geochemistry, Geophysics, Geosystems*, Vol. 15, 3459–3475 (doi:10.1002/2014GC005469), August 27.

Mattson, E. D., et al., 2004, "Interpreting INEEL Vadose Zone Water Movement on the Basis of Large-Scale Field Tests and Long-Term Vadose Zone Monitoring Results," Vadose Zone Journal, 3:35–46.

Mitchell, J. C., et al., 1980, *Geothermal Investigations in Idaho — Potential for Direct Heat Application of Geothermal Resources*, Idaho Department of Water Resources Water Information Bulletin Number 30, Part 9.

MSC (Manufacturing Sciences Corporation), 2020, MSC - Manufacturing Sciences Corporation (accessed February 10, 2020 at http://mfgsci.com/).

NA (City of North Augusta), 2005, 2005 Comprehensive Plan, North Augusta, South Carolina, December 19.

National Hurricane Center, 2019, Tropical Cyclone Climatology – 1900-2010 U.S. Hurricane Strikes – Southeast (available at https://www.nhc.noaa.gov/climo/).

National Weather Service, 2019a, NOWData – NOAA Online Weather Data – Aiken Area – Monthly summarized data – Snowfall (available at https://w2.weather.gov/climate/xmacis.php?wfo=cae), Forecast Office, Columbia, South Carolina.

National Weather Service, 2019b, Severe Weather Database Files (1950-2017), File1950-2018_all_tornadoes.csv (available at https://www.spc.noaa.gov/wcm/#data), Storm Prediction Center.

NatureServe, 2019, *Brachylagus idahoensis* Pygmy Rabbit, NatureServe Explorer: An online encyclopedia of life [web application], Version 7.1 (accessed September 12, 2019 at http://explorer.natureserve.org/servlet/NatureServe?searchSpeciesUid=ELEMENT_GLOBAL.2.102656), Arlington, Virginia.

NatureServe, 2020, NatureServe Explorer: An online encyclopedia of life [web application], Version 7.1 (accessed on January 23, 2020 at http://explorer.natureserve.org/), Arlington, Virginia.

NCEI (National Centers for Environmental Information), 2019a, Data Tools: 1981-2010 Normals – South Carolina – BARNWELL 5 ENE (available at https://www.ncdc.noaa.gov/cdo-web/datatools/normals).

NCEI (National Centers for Environmental Information), 2019b, Storm Events Database - Search Results for Aiken County, South Carolina - Event Types: Thunderstorm Wind (available at https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=45%2CSOUTH+CAROLINA).

NCES (National Center for Education Statistics), 2020, CCD public school data for 2018-2019 and 2019-2020 school year (accessed September 2020 at http://nces.ed.gov/ccd/districtsearch), U.S. Department of Education, Washington, DC.

NCI (National Cancer Institute), 2018, *State Cancer Profiles NIH National Cancer Institute*. (accessed September 10, 2019 at https://statecancerprofiles.cancer.gov/data-topics/incidence.html).

NEAC (Nuclear Energy Advisory Committee), 2017, *Assessment of Missions and Requirements for a New U.S. Test Reactor,* February.

Nelson, L., 2020, Idaho National Laboratory, Personal communication (email) to D. Outlaw, Leidos, Re: Updated Energy Use Information, September 30.

NNSA (National Nuclear Security Administration), 2020, Tritium facility at Savannah River Site reaches key milestone, March 2.

NOAA (National Oceanic and Atmospheric Administration), 2018, Climatography of the Idaho National Laboratory, 4th Edition, NOAA Technical Memorandum OAR ARL-278, Air Resources Laboratory, Idaho Falls, Idaho, June.

NOAA (National Oceanic and Atmospheric Administration), 2019, Trends in Atmospheric Carbon Dioxide - Annual Mean Growth Rate of CO2 at Mauna Loa, Hawaii, Earth System Research Laboratory, Global Monitoring Division (available at https://www.esrl.noaa.gov/gmd/ccgg/trends/gr.html).

Noah, J. C., H. S. Grewal, K. Edington, S. Porca, S. Medcalfe, M. C. Millies, 2011, *The Economic Impact of the Savannah River Site on Five Adjacent Counties in South Carolina and Georgia* (availale at www.garivers.org/images/Economic_Benefits/ 2011_Noah.pdf), May.

NPS (National Park Service), 2019, Interactive Map of NPS Wild and Scenic Rivers (accessed January 16, 2020 at https://www.nps.gov/orgs/1912/plan-your-visit.htm).

NRC (U.S. Nuclear Regulatory Commission), 1977, *Environmental Statement Related to Construction and Operation of Clinch River Breeder Reactor Plant*, NUREG-0139, Docket No. 50-537, Office of Nuclear Reactor Regulation, Washington, DC, February.

NRC (U.S. Nuclear Regulatory Commission), 1982, *Supplement to Final Environmental Statement Related to Construction and Operation of Clinch River Breeder Reactor Plant*, NUREG-0139-Suppl. 1-Vol. 2, Washington, DC, October 1.

NRC (U.S. Nuclear Regulatory Commission), 1994, *Preapplication Safety Evaluation Report for the Power Reactor Innovative Small Module (PRISM) Liquid-Metal Reactor*, NUREG-1368, Washington, DC, February.

NRC (U.S. Nuclear Regulatory Commission), 1996, *Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors*, NUREG 1537 Part 1, Washington, DC, March 6.

NRC (U.S. Nuclear Regulatory Commission), 2004, *Environmental Impact Statement for the Proposed Idaho Spent Fuel Facility at the Idaho National Engineering and Environmental Laboratory in Butte County, Idaho*, NUREG-1773, Washington, DC, January.

NRC (U.S. Nuclear Regulatory Commission), 2005a, *Environmental Impact Statement on the Construction and Operation of a Proposed Mixed Oxide Fuel Fabrication Facility at the Savannah River Site, South Carolina*, NUREG-1767, Office of Nuclear Material Safety and Safeguards, Washington, DC, January.

NRC (U.S. Nuclear Regulatory Commission), 2005b, *Final Safety Evaluation Report on the Construction Authorization Request for the Mixed Oxide Fuel Fabrication Facility at the Savannah River Site, South Carolina*, NUREG-1821, Washington, DC, March.

NRC (U.S. Nuclear Regulatory Commission), 2008, Final EIS for Early Site Permit at the Vogtle Electric Generating Plant Site, NUREG 1872 (available at www.nrc.gov/reading-rm/doc-collections/nuregs/staff/ sr1872/), August.

NRC (U.S. Nuclear Regulatory Commission), 2011, *Environmental Impact Statement for the Proposed Eagle Rock Enrichment Facility in Bonneville County, Idaho*, NUREG-1945, Vol. 1, Washington, DC, February.

NRC (U.S. Nuclear Regulatory Commission), 2019, *Environmental Impact Statement for an Early Site Permit (ESP) at the Clinch River Nuclear Site*, NUREG-2226, Office of New Reactors, Washington, DC, April.

NRC (U.S. Nuclear Regulatory Commission), 2020a, *Environmental Impact Statement for the Holtec International's License Application for a Consolidated Interim Storage Facility for Spent Nuclear Fuel and High Level Waste*, Draft Report for Comment, NUREG-2237, Office of Nuclear Material Safety and Safeguards, Washington, DC, March.

NRC (U.S. Nuclear Regulatory Commission), 2020b, *Draft Environmental Impact Statement for Interim Storage Partners LLC's License Application for a Consolidated Interim Storage Facility for Spent Nuclear Fuel in Andrews County, Texas*, NUREG-2239, Office of Nuclear Material Safety and Safeguards, May.

NRC (U.S. Nuclear Regulatory Commission), 2020c, Oklo Power LLC – Acceptance of the Application for a Combined License Application for the AURORA at Idaho National Laboratory, letter from J. Mazza, U.S. Nuclear Regulatory Commission, to Dr. J. DeWitte, Oklo, Inc., June 5.

NRCS (National Resources Conservation Service), 2018, Soil Map – Savannah River Plant Area (K-Area), Web Soil Survey, Washington, DC, October.

NuScale, 2019, "UAMPS at Vanguard of NuScale's Relentless March Towards Commercialization" *NuScale Power* (accessed November 11, 2019 at www.nuscalepower.com/newsletter/nucleus-fall-2018/uamps-update), NuCleus Fall 2018 Newsletter, Portland, Oregon.

NWL (National Wildlife Federation), 2019, Sagebrush Steppe (accessed September 11, 2019 at https://www.nwf.org/Educational-Resources/Wildlife-Guide/Threats-to-Wildlife/Climate-Change/Habitats/Sagebrush-Steppe).

OkloPower, 2020, Aurora Environmental Report Combined License Stage, Rev. 0, Sunnyvale, California.

Olson, G. L., D. J. Jeppesen, and R. D. Lee, 1995, The Status of Soil Mapping for the Idaho National Engineering Laboratory, INEEL/EXT-95-00960, Lockheed Idaho Technologies Company, Idaho Falls, Idaho.

OREM (Oak Ridge Office of Environmental Management), 2018, Environmental Management Disposal Facility Factsheet, U.S. Department of Energy, Office of Environmental Management, September.

OREM (Oak Ridge Office of Environmental Management), 2019, *Program Plan FY 2014 to 2024* (accessed August 2020 at www.energy.gov/sites/prod/files/2019/09/f66/ OREM_10yr_Fall2019_0.pdf).

ORNL (Oak Ridge National Laboratory), 1992, *Phase I Environmental Report for the Advanced Neutron Source at Oak Ridge National Laboratory*, ORNL/TM-12069, Oak Ridge, Tennessee, February.

ORNL (Oak Ridge National Laboratory), 2002, Oak Ridge National Laboratory Land and Facilities Plan, ORNL/TM-2002/1, Oak Ridge, Tennessee, August.

ORNL (Oak Ridge National Laboratory), 2005, High Flux Isotope Reactor Updated Safety Analysis Report, ORNL/HFIR/USAR/2344/Rev. 5, Research Reactors Division, Oak Ridge, Tennessee, May 13.

ORNL (Oak Ridge National Laboratory), 2006, *Oak Ridge Reservation Physical Characteristics and Natural Resources*, ORNL/TM-2006/110, Oak Ridge, Tennessee, October.

ORNL (Oak Ridge National Laboratory), 2008, *NPDES Water Quality Protection Plan*, Volume II Monitoring and Investigations, October.

ORNL (Oak Ridge National Laboratory, 2009, Natural Areas Analysis and Evaluation: Oak Ridge Reservation, ORNL/TM-2009/201, Oak Ridge, Tennessee, November.

ORNL (Oak Ridge National Laboratory), 2015, *Forest Management Plan for the DOE Oak Ridge Reservation: An Interdisciplinary Approach for Managing a Heritage Resource*, ORNL/TM-2015/98, Oak Ridge, Tennessee, September.

ORNL (Oak Ridge National Laboratory), 2017, *Invasive Plant Management Plan for the Oak Ridge Reservation*, ORNL/TM-2004/98/R2 (available at https://nerp.ornl.gov/wp-content/uploads/2018/11/InvasivePlantMgmtPlan_2017.pdf), Oak Ridge, Tennessee, August.

ORNL (Oak Ridge National Laboratory), 2018a, Invasive Species (accessed on January 22, 2020 at https://nerp.ornl.gov/invasive-species/).

ORNL (Oak Ridge National Laboratory), 2018b, *Oak Ridge National Laboratory FY 2019 Site Sustainability Plan with FY 2018 Performance Data*, Sustainability Performance Office, December.

ORNL (Oak Ridge National Laboratory), 2019, Workforce Demographics (available at www.ornl.gov/diversity/workforce-demographics).

ORNL (Oak Ridge National Laboratory), 2020a, Oak Ridge National Environmental Research Park (accessed on January 23, 2020 at https://nerp.ornl.gov/).

ORNL (Oak Ridge National Laboratory), 2020b, U.S. Department of Energy, Available Data (accessed on January 23, 2020 at https://nerp.ornl.gov/available-data/).

ORNL (Oak Ridge National Laboratory), 2020c, *Oak Ridge National Laboratory Response to Versatile Test Reactor Environmental Impact Statement Data Request*, ORNL/SPR-2020-1645, Oak Ridge, Tennessee.

ORNL (Oak Ridge National Laboratory), 2020d, Sensitive Resources Assessment and Forest Analysis for the Proposed Versatile Test Reactor, ORNL/TM-2020/1703, Oak Ridge, Tennessee, September.

ORNL (Oak Ridge National Laboratory), 2020e, *Wildlife Management Plan for the Oak Ridge Reservation*, ORNL/TM-2012/387/R1, Oak Ridge, Tennessee, July.

ORO (U.S. Department of Energy – Oak Ridge Operations Office), 2004, *Oak Ridge Reservation Annual Site Environmental Report for 2003*, DOE/ORO/2185, Oak Ridge, Tennessee, September.

ORO (U.S. Department of Energy – Oak Ridge Operations Office), 2015, *Oak Ridge Reservation Annual Site Environmental Report for 2014*, DOE/ORO/2502, Oak Ridge, Tennessee, September.

ORO (U.S. Department of Energy – Oak Ridge Operations Office), 2016, *Oak Ridge Reservation Annual Site Environmental Report for 2015*, DOE/ORO/2509, Oak Ridge, Tennessee, September.

ORO (U.S. Department of Energy – Oak Ridge Operations Office), 2017a, *Department of Energy Air Emissions Annual Report - Oak Ridge Reservation, Oak Ridge, Tennessee - 40 Code of Federal Regulations (CFR) 61, Subpart H - Calendar Year 2016*, June 30.

ORO (U.S. Department of Energy – Oak Ridge Operations Office), 2017b, *Oak Ridge Reservation Annual Site Environmental Report for 2016*, DOE/ORO/251, Oak Ridge, Tennessee, September.

ORO (U.S. Department of Energy – Oak Ridge Operations Office), 2018, *Oak Ridge Reservation Annual Site Environmental Report 2017*, DOE/ORO-2511, Oak Ridge, Tennessee, September.

ORO (U.S. Department of Energy – Oak Ridge Operations Office), 2019, *Oak Ridge Reservation Annual Site Environmental Report 2018*, DOE/ORO-2512, Oak Ridge, Tennessee, September.

Papacostas, C. S., and P. D. Prevedouros, 2001, Transportation Engineering and Planning, 3rd ed., pp. 148-149, Upper Saddle River, New Jersey: Pearson Education.

Pasamehmetoglu, K., 2019, Versatile Test Reactor Executive Director, Idaho National Laboratory, Versatile Test Reactor Overview Presentation, Advanced Reactors Summit VI, San Diego, California, January 29-31.

Payne, S., 2006, *Modeling of the Sedimentary Interbedded Basalt Stratigraphy for the Idaho National Laboratory Probabilistic Seismic Hazard Analysis*, INL/EXT-05-01047, Idaho National Laboratory, Idaho Falls, Idaho, April.

Payne, S. J. and B. M. Bockholt, 2017, “Seismicity In and Around the Eastern Snake River Plain, Idaho,” Pacific Northwest National Association of Geoscience Teachers (NAGT) Symposium, abstract, June 22-24.

Peterson, S., 2018, *WebTRAGIS: Transportation Routing Analysis Geographic Information System User’s Manual*, ORNL/TM-2018/856, Oak Ridge National Laboratory, Oak Ridge, Tennessee, May.

PNNL (Pacific Northwest National Laboratory), 2018, *Data Qualification Report: 2016-2018 Socioeconomic Data for Use in DSP SEIS Analyses*, SPD-DQR-001, Rev 0, Richland, Washington, December. OUO

Rhodes, O. E., Jr., 2018, Director SREL, Presentation to the Savannah River Site Citizens Advisory Board, “The SRS as a National Environmental Research Park - What Does It Mean?,” November 27.

Richmond County Sheriff’s Office, 2020, Staffing numbers (accessed August 2020 at www.richmondcountysheriffsoffice.com/the-sheriffs-office.cfm).

Rodgers, D. W., H. T. Ore, R. T. Bobo, N. McQuarrie, and N. Zentner, 2002, “Extension and Subsidence of the Eastern Snake River Plain, Idaho,” *Tectonic and Magmatic Evolution of the Snake River Plain Volcanic Province*, Idaho Geological Survey Bulletin 30, pp. 121–155.

Rogers, V. A., 1990, U.S. Department of Agriculture, Soil Conservation Service, *Soil Survey of Savannah River Plant Area, Parts of Aiken, Barnwell, and Allendale Counties, South Carolina*, June.

Rood, A. S. and A. J. Sondrup, 2014, *Development and Demonstration of a Methodology to Quantitatively Assess the INL Site Ambient Air Monitoring Network*, INL/EXT-14-33194, December.

Saricks, C. L., and M. M. Tompkins, 1999, *State-Level Accident Rates of Surface Freight Transportation: A Reexamination,* ANL/ESD/TM-150, Argonne National Laboratory, Energy Systems Division, Center for Transportation Research, Argonne, Illinois, April.

SCARC (South Carolina Association of Regional Councils), 2019, About Us (accessed on January 15, 2020, https://www.lscog.org/about-us).

SCDHEC (South Carolina Department of Health and Environmental Control), 2003, *National Pollutant Discharge Elimination System Permit for Discharge to Surface Waters*, Permit Number SC0000175, Industrial, Agricultural, and Storm Water Permitting Division, Bureau of Water, December 1.

SCDHEC (South Carolina Department of Health and Environmental Control), 2005, *South Carolina – Savannah River Basin Facilities Water Use Report 2004*, TR-010-05, Bureau of Water, Columbia, South Carolina, August.

SCDHEC (South Carolina Department of Health and Environmental Control), 2011, *South Carolina Water Use Report, 2010 Annual Summary*, 6J30-11, Bureau of Water, Columbia, South Carolina, July.

SCDHEC (South Carolina Department of Health and Environmental Control), 2019, *South Carolina Water Use Report 2018 Summary*, Technical Document Number 0528-19 (accessed May 14, 2020 at https://www.dhec.sc.gov/sites/default/files/media/document/South%20Carolina%20Water%20Use%20Report%202018%20Summary%20%281%29.pdf).

SCDNR (South Carolina Department of Natural Resources), 2016, Crackerneck Wildlife Management Area and Ecological Reserve (accessed on January 14, 2020, https://www2.dnr.sc.gov/ManagedLands/ManagedLand/ManagedLand/69).

SCDNR (South Carolina Department of Natural Resources), 2019, Bald Eagle Nest Locations (accessed on January 13, 2020 at http://dnr.sc.gov/wildlife/baldeagle/locations.html).

SCDOT (South Carolina Department of Transportation), 2019, "GIS Mapping, Shape Files" (accessed January 14, 2020, at http://info2.scdot.org/sites/GIS/SitePages/GISFiles.aspx?MapType=Shape), Columbia, South Carolina.

Scripps (Scripps Institution of Oceanography), 2019, Scripps CO2 Program (available at http://scrippsco2.ucsd.edu/).

Sehlke, G., and P. Wichlacz, 2010, *Idaho National Laboratory Materials and Fuels Complex Natural Phenomena Hazards Flood Assessment*, IN/EXT-10-20572 (accessed July 10, 2020 at https://inldigitallibrary.inl.gov/sites/sti/sti/4731814.pdf), December 2010.

South Carolina Legislature, 2019, South Carolina Code of Regulations – Chapter 61 Department of Health and Environmental Control (available at https://www.scstatehouse.gov/coderegs/Chapter61.php).

Southern Nuclear, 2020, Plant Vogtle (available at www.southerncompany.com/our-companies/southern-nuclear/plant-vogtle.html), data on current workforce levels at Units 1 and 2.

South Carolina Revenue and Fiscal Affairs Office, 2020, Population Projections 2000-2035 – Revised November 2019 (accessed September 2020 at http://www.sccommunityprofiles.org/census/projections_2010.html).

Spaling, H., 1994, "Cumulative Effects Assessment: Concepts and Principles," *Impact Assessment* 12:3, 231-251, DOI:10.1080/07349165.1994.9725865.

SRARP (Savannah River Archaeological Research Program), 2016, *Archaeological Resource Management Plan of the Savannah River Archaeological Research Program*, Savannah River Archaeological Research Program, University of South Carolina, December.

SRARP (Savannah River Archaeological Research Program), 2017, *Annual Review of Cultural Resource Investigations by the Savannah River Archaeological Research Program*, Fiscal Year 2017, Savannah River Archaeological Research Program, University of South Carolina, October.

SREL (Savannah River Ecology Laboratory), 2018a, The Smooth Purple Coneflower on the SRS Factsheet, University of Georgia.

SREL (Savannah River Ecology Laboratory), 2018b, Wood Stork Research Factsheet, University of Georgia.

SREL (Savannah River Ecology Laboratory), 2018c, Carolina Bays Fact Sheet, University of Georgia.

SREL (Savannah River Ecology Laboratory), 2019, DOE Research Set-Aside Program (accessed on January 14, 2020, https://archive-srel.uga.edu/set-asides/set-asides.html).

SRNL (Savannah River National Laboratory), 2020, *Conceptual Assessment of VTR Add-on Processing Capability*, SRNL-TR-2020-00171, Rev. 2, Aiken, South Carolina, July 22.

SRNS (Savannah River Nuclear Solutions, LLC), 2009, *Savannah River Site Environmental Report for 2008*, SRNS-STI-2009-00190, Aiken, South Carolina.

SRNS (Savannah River Nuclear Solutions, LLC), 2010, *Savannah River Site Comprehensive Plan/Ten Year Plan, FY 2011-2020*, SRNS-RP-2010-00251, Aiken, South Carolina, May. OUO.

SRNS (Savannah River Nuclear Solutions, LLC), 2011, *Savannah River Site Environmental Report for 2010*, SRNS-STI-2011-00059, Aiken, South Carolina.

SRNS (Savannah River Nuclear Solutions, LLC), 2012a, *SRS Infrastructure Power Quantity Cost Distribution Report D7257000*, FY 2010.

SRNS (Savannah River Nuclear Solutions, LLC), 2012b, *Surplus Plutonium Disposition Supplemental Environmental Impact Statement* Data Call Response, Aiken, South Carolina.

SRNS (Savannah River Nuclear Solutions, LLC), 2014, *Savannah River Site Land Use Plan*, SRNS-RP-2014-00537, Aiken, South Carolina, November.

SRNS (Savannah River Nuclear Solutions, LLC), 2015a, *Savannah River Site Ten Year Site Plan FY 2016 – 2025*, SRNS-RP-2015-00001, Aiken, South Carolina, June.

SRNS (Savannah River Nuclear Solutions, LLC), 2015b, *Savannah River Site Environmental Report 2014*, SRNS-RP-2015-00008, Aiken, South Carolina.

SRNS (Savannah River Nuclear Solutions, LLC), 2016, *Savannah River Site Environmental Report 2015*, SRNS-RP-2016-00089, Aiken, South Carolina.

SRNS (Savannah River Nuclear Solutions, LLC), 2017, *Savannah River Site Environmental Report 2016*, SRNS-RP-2017-00174, Aiken, South Carolina.

SRNS (Savannah River Nuclear Solutions, LLC), 2018a, *Savannah River Site Environmental Report 2017,* SRNS-RP=2018-00470, Aiken, South Carolina.

SRNS (Savannah River Nuclear Solutions, LLC), 2018b, 2017 Savannah River Site Total Air Pollutant Emissions by Source [Data], Aiken, South Carolina.

SRNS (Savannah River Nuclear Solutions, LLC), 2019a, *Savannah River Site Environmental Report 2018*, SRNS-RP-2019-00022, Aiken, South Carolina.

SRNS (Savannah River Nuclear Solutions, LLC), 2019b, *Savannah River Site – Radionuclide Air Emissions Report – 2018*, pages 5, 6, 8, A1, and Appendix B, Report number SRNS-IM-2019-00001.

SRNS (Savannah River Nuclear Solutions), 2019c, *Infrastructure Alignment Study*, SRNS-RP-2019-00123, July.

SRNS (Savannah River Nuclear Solutions), 2020, *Savannah River Site Data Call Response for the Versatile Test Reactor Fuel Fabrication Facility*, SRNS-RP-2020-00286, Rev. 2, Aiken, South Carolina, July 22.

SRS (Savannah River Site), 2005, Savannah River Site End State Vision, Office of Environmental Management, Aiken, South Carolina, July 26.

TDEC (Tennessee Department of Environment and Conservation), 1995, Oak Ridge Reservation Compliance Order, September 26, 1995, Commissioner's Order requiring compliance with the Site Treatment Plan for Mixed Wastes, Tennessee Department of the Environment and Conservation.

TDEC (Tennessee Department of Environment and Conservation), 2006, Rules of Tennessee Department of Environment and Conservation Bureau of Environment - Division of Air Pollution Control – Chapter 1200-3-3 - Ambient Air Quality Standards.

TDEC (Tennessee Department of Environment and Conservation), 2015, *Tennessee Rapid Assessment Method (TRAM) 2015*, Division of Water Resources Natural Resources Unit, Nashville, Tennessee.

TDEC (Tennessee Department of Environment and Conservation), 2019a, Final Permit, Oak Ridge National Laboratory, Oak Ridge, Tennessee, TNHW-178, Letter from D. Mokha, Division of Solid Waste Management, TSD Section, Hazardous Waste Program, to J. 0. Moore, ORNL Site Office, and J. Powell, Oak Ridge National Laboratory, August 15.

TDEC (Tennessee Department of Environment and Conservation), 2019b, Draft 2020 List of Impaired and Threatened Waters (accessed January 30, 2020 at https://www.tn.gov/content/dam/tn/environment/water/water-public-notices/ppo_water_2019-11-15-dwr-2020-list-impaired-waters-draft.xlsx), November 15.

TDEC (Tennessee Department of Environment and Conservation), 2019c, *Stream Mitigation Guidelines*. (accessed September 15, 2020 at https://www.tn.gov/content/dam/tn/environment/water/policy-and-guidance/dwr-nr-g-01-stream-mitigation-guidelines-052019.pdf.

TDEC (Tennessee Department of Environment and Conservation), 2020a, Permit Number TN0002941, Tennessee Division of Water Resources (accessed on January 17, 2020 at http://environment-online.state.tn.us:8080/pls/enf_reports/f?p=9034:34051:0::NO:34051:P34051_PERMIT_NUMBER:TN0002941).

TDEC (Tennessee Department of Environment and Conservation), 2020b, *Guidance for Making Hydrologic Determinations Version 1.5* (available at www.tn.gov/content/dam/tn/environment/water/policy-and-guidance/dwr-nr-g-03-hydrologic-determinations%E2%80%9304012020.pdf), Division of Water Pollution Control, Nashville, Tennessee.

TDOT (Tennessee Department of Transportation), 2019, Annual Average Daily Traffic (AADT), (available at www.arcgis.com/apps/webappviewer/index.html?id=075987cdae37474b88fa400d65681354, www.tn.gov/tdot/long-range-planning-home/longrange-annual-average-daily-traffic-aadt.html).

TEI (TEI Engineers & Planners), 2004, *Columbia County 2025 Long Range Transportation Plan Existing Conditions* (available at www.columbiacountyga.gov/Index.aspx?page=2978), June.

Tennessee Hospital Association, 2020, Tennessee Hospitals Inform (by county) (available at http://www.tnhospitalsinform.com/tn-hospitals.aspx).

Tennessee Secretary of State, 2019, Effective Rules and Regulations of the State of Tennessee (available at https://sos.tn.gov/effective-rules).

Tennessee State Data Center, 2020, 2018 to 2070 Projections, Released October 22, 2019 (accessed March 2020 at https://tnsdc.utk.edu/estimates-and-projections/boyd-center-population-projections/).

TOXCO (TOXCO Inc.), 2020, Materials Management Center (accessed February 10, 2020 at www.toxcommc.com/index.html).

Tuberville, T. D., K. A. Buhlmann, H. E. Balbach, S. H. Bennett, J. P. Nestor, J. W. Gibbons, and R. R. Sharitz, 2007, *Habitat Selection by the Gopher Tortoise (Gopherus polyphemus)*, ERDC/CERL TR-07-01, U.S. Army Corps of Engineers/Construction Engineering Research Laboratory, Champaign, Illinois, March.

TVA (Tennessee Valley Authority), 2019, *NRC Approves Clinch River Nuclear Site for Potential Small Modular Reactors* (accessed February 10, 2020 at www.tva.gov/Newsroom/News-Features/NRC-Approves-Clinch-River-Nuclear-Site-for-Potential-Small-Modular-Reactors), December 17.

TVA (Tennessee Valley Authority), 2020a, *Bull Run Fossil Plant* (accessed February 10, 2020 at www.tva.gov/Energy/Our-Power-System/Coal/Bull-Run-Fossil-Plant/).

TVA (Tennessee Valley Authority), 2020b, *Bull Run Fossil Plant Emissions* (accessed February 10, 2020 at www.tva.gov/Environment/Environmental-Stewardship/Air-Quality/Bull-Run-Fossil-Plant-Emissions).

TVA (Tennessee Valley Authority), 2020c, *Kingston Fossil Plant* (accessed February 10, 2020 at https://www.tva.gov/Energy/Our-Power-System/Coal/Kingston-Fossil-Plant).

TVA (Tennessee Valley Authority), 2020d, *Kingston Fossil Plant Emissions* (accessed February 10, 2020 at www.tva.gov/Environment/Environmental-Stewardship/Air-Quality/Kingston-Fossil-Plant-Emissions).

TVA (Tennessee Valley Authority), 2020e, Melton Hill (accessed January 30, 2020 at https://www.tva.gov/Energy/Our-Power-System/Hydroelectric/Melton-Hill-Reservoir).

TWRA (Tennessee Wildlife Resources Agency), 2016, Proclamation 1660-01-32, Endangered and Threatened Species (accessed on January 23, 2020 at https://www.tn.gov/content/dam/tn/twra/documents/1660-01-32%20threatened-endangered-species-rule.pdf).

TWRF (Tennessee Wildlife Resources Foundation), 2018, Tennessee Hemlock Conservation Partnership (accessed on February 26, 2020 at https://www.twrf.net/tennessee-hemlock-conservation-partnership).

UAMPS (Utah Associated Municipal Power Systems), 2019, *Small Modular Reactors for Baseload Supply* (accessed November 11, 2019 at https://www.uamps.com/nu-scale-modular-reactor), Salt Lake City, Utah.

USA and Russia (United States of America and Russian Federation), 2000, Agreement Between the Government of the United States and the Government of the Russian Federation Concerning the Management and Disposition of Plutonium Designated as No Longer Required for Defense Purposes and Related Cooperation, September 1.

USACE (U.S. Army Corps of Engineers), 1987, *Wetlands Delineation Manual*, Technical Report Y-87-1, Vicksburg, Mississippi, January.

USDA (U.S. Department of Agriculture), 2019a, 2019 Census of Agriculture, Idaho County Profiles (Bingham, Bonneville, Butte, Clark, and Jefferson), National Agricultural Statistics Service (accessed on January 15, 2020 at www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_County_Level/Idaho/), April.

USDA (U.S. Department of Agriculture), 2019b, 2017 Census of Agriculture, South Carolina County Profiles (Aiken, Allendale, and Barnwell), National Agricultural Statistics Service (accessed on January 15, 2020, https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/South_Carolina/index.php), April.

USDA (U.S. Department of Agriculture), 2019c, Savannah River (accessed on January 8, 2020 at https://www.fs.usda.gov/savannahriver).

USDA (U.S. Department of Agriculture), 2020, Natural Resources Conservation Service. Idaho State-listed Noxious Weeds. Introduced, Invasive, and Noxious Plants. Accessed June 2020: https://plants.usda.gov/java/noxious?rptType=State&statefips=16

USFS (US. Forest Service), 2020, First Order Fire Effects Model (FOFEM), Rocky Mountain Research Station (available at www.fs.usda.gov/rmrs/tools/first-order-fire-effects-model-fofem).

USFWS (U.S. Fish and Wildlife Service), 2008, *Birds of Conservation Concern 2008*, Division of Migratory Bird Management, Arlington, Virginia, December.

USFWS (U.S. Fish and Wildlife Service), 2019a, Information for Planning and Consultation (IPaC) Resource List (accessed August 8, 2019 and January 13, 2020 at file:///C:/Users/bresnans/Desktop/VTR_DOE%20EIS/Referrences/prelim%20IPaC_%20Explore%20Location.pdf.

USFWS (U.S. Fish and Wildlife Service), 2019b, National Wetlands Inventory, Wetlands Mapper, Data last modified May 5, 2019 (accessed September 12, 2019 at https://www.fws.gov/wetlands/data/Mapper.html).

USFWS (U.S. Fish and Wildlife Service), 2019c, National Wetlands Inventory, Wetlands Mapper (accessed on January 27, 2020 at www.fws.gov/wetlands/data/Mapper.html).

USFWS (United States Fish and Wildlife Service), 2020a, *Official Species List - Anderson & Roane, TN,* Tennessee Fish and Wildlife Office, Consultation Code: 01EIFW00-2020-SLI-0446, January 23.

USFWS (U.S. Fish and Wildlife Service), 2020b, Information for Planning and Consultation (IPaC) Resource List (accessed August 8, 2019 and January 13, 2020 at https://ecos.fws.gov/ipac/).

USGCRP (U.S. Global Change Research Program), 2017, *Climate Science Special Report: Fourth National Climate Assessment*, Vol. I (accessed at https://science2017.globalchange.gov/), page 217, Washington, DC.

USGCRP (U.S. Global Change Research Program), 2018, *Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment*, Vol. II (accessed at https://nca2018.globalchange.gov/), Washington, DC.

USGS (U.S. Geological Survey), 2014a, *Earthquake Hazards Program, Lower 48 Maps and Data, Two-Percent Probability of Exceedance in 50 Years Map of Peak Ground Acceleration* (accessed September 13, 2019 at https://earthquake.usgs.gov/hazards/hazmaps/conterminous/index.php#2014).

USGS (U.S. Geological Survey), 2014b, haz/USpga250_2014 (MapServer), map overlay for Google Earth of peak ground acceleration with a two-percent probability of exceedance in 50 years (accessed September 13, 2019 at http://earthquake.usgs.gov/arcgis/rest/services/haz/USpga250_2014/MapServer).

USGS (U.S. Geological Survey), 2017, U.S Geological Survey Geohydrologic Studies and Monitoring at the Idaho National Laboratory, Southeastern Idaho, Fact Sheet 2017-3070, September.

USGS (U.S. Geological Survey), 2019a, Earthquake Search Results, 100-mile-diameter search centered on the SRS K-Area (Latitude 33.211779; Longitude -81.664528) (accessed on October 24, 2019 at http://earthquake.usgs.gov/earthquakes/search/).

USGS (U.S. Geological Survey), 2019b, Earthquake Search Results, 100-mile-diameter search centered on the ORNL-MVS (Latitude 35.9246; Longitude -84.290985) (accessed on October 2, 2019 at http://earthquake.usgs.gov/earthquakes/search/ ().

USGS (U.S. Geological Survey), 2019c, Earthquake Search Results, 100-mile-diameter search centered on the INL–MFC (Latitude 43.594433; Longitude -112.656458) (accessed October 2, 2019 at http://earthquake.usgs.gov/earthquakes/search/).

USGS (U.S. Geological Survey), 2020, Sparta Earthquake, Earthquake Hazards Program, August 9.

Veolia, 2019, *Proposed Versatile Test Reactor Project Site Ecological Field Surveys*, VSF-ID-BEA-VTR-034, Idaho Falls, Idaho, October 30.

VNSFS, 2020, *Ecological Field Surveys: Vegetation and Wildlife*, Supplemental Report, Proposed Versatile Test Reactor Project Site, Idaho Falls, Idaho, May.

Watts Bar, 2019, Watts Bar, Units 1 and 2, 2018 Annual Radioactive Effluent Release Report ML19120A07530, April.

Wayment, J., N. Stokes, J. Gundersen, J. Norman, I. Archibald, and K. Barnes, 2019, *INL Power Transmission System Capacity Study*, Idaho National Laboratory, prepared for the U.S. Department of Energy Office of Nuclear Energy, Rev. 0, August.

Weaver, K., 2019, VTR Experiment Vehicles presentation, Predecisional Draft, VTR EIS Kick-Off Meeting, May 13-15, Idaho Falls, Idaho.

Weiner, R. F., D. Hinojosa, T. J. Heames, C. O. Farmum, and E. A. Kalinina, 2013, RADTRAN 6/RadCat 6 User Guide, SAND2013-8095, Sandia National Laboratories, Albuquerque, New Mexico, September.

Weiner, R. F., K. S. Neuhauser, T. J. Heames, B. M. O'Donnell, and M. L. Dennis, 2014, RADTRAN 6 Technical Manual, SAND2014-0780, Sandia National Laboratories, Albuquerque, New Mexico, January.

WSRC (Washington Savannah River Company), 2000, *Flood Hazard Recurrence Frequencies for A-, K-, and L-Areas, and Revised Frequencies for C-, F-, E-, S-, H-, Y-, and Z-Areas*, WSRC-TR-2000-00206, Aiken, South Carolina.

WSRC (Washington Savannah River Company), 2006a, *Savannah River Site Environmental Report for 2005*, WSRC-TR-2006-00007, Aiken, South Carolina.

WSRC (Washington Savannah River Company), 2006b, *SRS Ecology Environmental Information Document*, WSRC-TR-2005-00201, Aiken, South Carolina, July.

WSRC (Washington Savannah River Company), 2007, *Savannah River Site Environmental Report for 2006*, WSRC-TR-2007-00008, Aiken, South Carolina.

WSRC (Washington Savannah River Company LLC), 2008, *Savannah River Site Environmental Report for 2007*, WSRC-STI-2008-00057, Aiken, South Carolina.

Yuan, Y. C., S. Y. Chen, B. M. Biwer, and D. J. LePoire, 1995, *RISKIND—A Computer Program for Calculating Radiological Consequences and Health Risks from Transportation of Spent Nuclear Fuel*, ANL/EAD-1, Argonne National Laboratory, Argonne, Illinois, November.

Chapter 9
Glossary

9.0 GLOSSARY

***adsorb* —** To gather an atom, ion, or molecule from a gas, liquid, or dissolved solid on a surface in a condensed layer.

***air pollutant* —** Generally, an airborne substance that could, in high enough concentrations, harm living things or cause damage to materials. From a regulatory perspective, an air pollutant is a substance for which emissions or atmospheric concentrations are regulated, or for which maximum guideline levels have been established because of potential harmful effects on human health and welfare.

***air quality* —** The cleanliness of the air as measured by the levels of pollutants relative to standards or guideline levels established to protect human health and welfare. Air quality is often expressed in terms of the pollutant for which concentrations are the highest percentage of a standard (e.g., air quality may be unacceptable if the level of a single pollutant exceeds its standard, even if levels of other pollutants are well below their respective standards).

***alluvium* —** Clay, silt, sand, gravel, or similar material that has been eroded from rocks transported from the rocks location of origin by gravity, wind, or water and deposited by running water.

***alpha particle* —** Alpha particles consist of two protons and two neutrons. They can travel only a few centimeters in air and can be stopped easily by a sheet of paper or by the skin's surface. (See *neutron*.)

***ambient air quality standards* —** Regulations prescribing the levels of airborne pollutants that may not be exceeded during a specified time within a defined area.

***aquifer* —** A body of rock that is sufficiently porous and permeable (i.e., contains spaces between the rock and soil particles that permit water to move through) to store, transmit, and yield significant quantities of groundwater to wells and springs.

***archaeological resources* —** Resources that occur in places where people altered the ground surface or left artifacts or other physical remains (e.g., arrowheads, glass bottles, pottery). Archaeological resources can be classified as either sites or isolates. Isolates generally cover a small area and often contain only one or two artifacts, while sites are usually larger in size, contain more artifacts, and sometimes contain features or structures. Archaeological resources can date to either the pre-contact, ethnographic, or post-contact eras.

***architectural resources* —** Standing buildings, facilities, wells, canals, bridges, and other such structures.

***area of potential effects (APE)* —** 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.

***attainment area* —** An area that the U.S. Environmental Protection Agency has designated as meeting (i.e., being in attainment of) the National Ambient Air Quality Standards for sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, and particulate matter.

***average daily traffic* —** The average number of vehicles passing a specific point in both directions in a 24-hour period, normally measured throughout a year.

***bedrock* —** Solid rock underlying loose deposits, such as soil or alluvium.

***beta particle* —** Beta particles are smaller and lighter than alpha particles and have the mass of a single electron. A high-energy beta particle can travel a few meters in air. Beta particles can pass through a sheet of paper but may be stopped by a thin sheet of aluminum or glass. (See *alpha particle*.)

***cancer fatality* —** A death resulting from cancer; also referred to as cancer mortality.

cancer incidence — The occurrence of a cancer; also referred to as cancer morbidity.

collective dose — The sum of the individual doses received in a given period of time by a specified population from exposure to a specified source of radiation. In this environmental impact statement, collective dose is expressed in units of person-rem.

concentration — The quantity of a substance in a unit quantity (e.g., milligrams per liter or micrograms per kilogram).

conglomerate — Rock composed of rounded pebbles that are cemented together with another mineral substance. Clay, silt, and sand can also be present.

Council on Environmental Quality regulations — Regulations found in Title 10, Code of Federal Regulations, Parts 1500–1508, that direct Federal agencies in complying with the procedures of and achieving the goals of the National Environmental Policy Act.

core — The central portion of a nuclear reactor. The VTR core contains driver fuel assemblies, test assemblies, control assemblies, safety assemblies, reflector assemblies, shield assemblies, and support structures. The active core (consisting of the driver fuel assemblies, test assemblies, control assemblies, and safety assemblies) is where nuclear fission occurs.

criteria pollutants — An air pollutant that is regulated by the National Ambient Air Quality Standards. The U.S. Environmental Protection Agency must describe the characteristics and potential health and welfare effects that form the basis for setting, or revising, the standard for each regulated pollutant. Criteria pollutants include sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, and two size classes of particulate matter (less than 10 micrometers [0.0004 inches] in diameter and less than 2.5 micrometers [0.0001 inches] in diameter). New pollutants may be added to or removed from the list of criteria pollutants as more information becomes available.

cultural landscapes — Geographic areas where cultural and natural resources and wildlife have been associated with historic events, activities, or people, or which serve as an example of cultural or aesthetic value. The four types of cultural landscapes are historic sites (e.g., battlefields, properties of famous historical figures); historic designed landscapes (e.g., parks, estates, gardens); historic vernacular landscapes (e.g., industrial parks, agricultural landscapes, villages); and ethnographic landscapes (contemporary settlements, religious sites, massive geological structures). This latter category includes traditional cultural landscapes.

cultural resources — A pre-contact or historic district, site, building, structure, or object considered to be important to a culture, subculture, or community for scientific, traditional, religious, or other reasons. Cultural resources are usually divided into three major categories: pre-contact and historic archaeological resources, architectural resources, and traditional cultural resources.

cumulative impacts — Impacts on the environment that result when the incremental impact of a proposed action is added to the impacts from other past, present, and reasonably foreseeable future actions, regardless of which agency (Federal or non–Federal) or person undertakes the other actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time (Title 40, *Code of Federal Regulations,* Section 1508.7).

curie — The basis unit used to describe the intensity of radioactivity in a sample of material; it is equal to 37 billion disintegrations per second. One trillionth of a curie is a picocurie. (See *radioactivity*.)

decibel — A unit used to measure the intensity of a sound or the power level of an electrical signal by comparing it with a given level on a logarithmic scale (in general use, a degree of loudness).

decibels A-weighted (dBA) — A-weighted decibels are an expression of the relative loudness of sounds in air as perceived by the human ear. In the A-weighted system, the decibel values of sounds at low frequencies are reduced; no correction is made for audio frequency when unweighted decibels are used. The correction is made using dBAs because the human ear is less sensitive to low audio frequencies, especially those below 1000 Hertz, than high audio frequencies.

decommissioning — Removing facilities such as processing plants, waste tanks, and burial grounds from service and reducing or stabilizing radioactive contamination. Includes the following concepts: decontamination, dismantling, and return of an area to its original condition without restrictions on use or occupancy; partial decontamination; isolation of remaining residues; and continued surveillance and restrictions on use or occupancy.

decontamination — The actions taken to reduce or remove substances that pose a substantial present or potential hazard to human health or the environment, such as radioactive or chemical contamination from facilities, equipment, or soils by washing, heating, chemical or electrochemical action, mechanical cleaning, or other techniques.

depleted uranium — A byproduct of the uranium enrichment process and refers to uranium in which the percentage of uranium 235 is less than occurs naturally (0.7 percent).

dip — The angle at which a stratum or other planar feature is inclined from the horizontal. The strike of a structure is perpendicular to the direction of the dip.

disposal — As used in this environmental impact statement, the term is used for emplacing waste in a manner that ensures its isolation from the biosphere, with no intent of retrieval; as such, deliberate action would be required to gain access after emplacement.

disposal facility — A natural and/or man-made structure in which waste is disposed. (See *disposal*.)

dose (radiation) — As used in this environmental impact statement, it means total effective dose, a term referring to the amount of energy absorbed by a tissue or organ adjusted by a radiation weighting factor, a tissue weighting factor, and other factors that allows radiation of different types received through different modes of exposure to be compared on a common basis.

driver fuel (assembly) — The fuel required to run a reactor. Driver fuel is distinguished from other assemblies in the reactor. Reflector assemblies made of non-fuel material (e.g., HT-9 stainless steel) surround the driver fuel assemblies and function to reduce neutron leakage (i.e., they scatter back [or reflect] many neutrons into the core that would otherwise escape). Around the outside of the reflector assemblies are shield assemblies made of non-fuel material (e.g., HT-9 stainless steel) and containing neutron-absorbing boron carbide to reduce neutron damage to the reactor structural components.

emission — A material discharged into the atmosphere from a source operation or activity.

enriched uranium — Uranium in which the concentration of the isotope uranium-235, usually expressed as a percentage, exceeds the concentration occurring in natural uranium (0.7 percent). Low-enriched uranium (LEU), highly enriched uranium (HEU) and high assay, low-enriched uranium (HALEU) are all enriched forms of uranium.

environmental assessment — A concise public document prepared pursuant to the National Environmental Policy Act that provides sufficient evidence and analysis for determining whether a Federal agency should issue a Finding of No Significant Impact or prepare an environmental impact statement.

environmental impact statement (EIS) — A detailed written statement required by Section 102(2)(C) of the National Environmental Policy Act (NEPA) for a proposed major Federal action significantly affecting the quality of the human environment. A U.S. Department of Energy (DOE) EIS is prepared in accordance with applicable requirements of the Council on Environmental Quality NEPA regulations in Title 40, *Code of Federal Regulations*, Parts 1500-1508 (40 CFR Parts 1500–1508) and the DOE NEPA regulations in 10 CFR Part 1021. The statement includes, among other information, discussions of the environmental impacts of the proposed action and all reasonable alternatives; adverse environmental effects that cannot be avoided should the proposal be implemented; the relationship between short-term uses of the human environment and enhancement of long-term productivity; and any irreversible and irretrievable commitments of resources.

environmental justice — 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. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic groups, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of Federal, state, local, and tribal programs and policies. Executive Order 12898 directs Federal agencies to make achieving environmental justice part of their missions by identifying and addressing disproportionately high and adverse effects of agency programs, policies, and activities on minority and low-income populations.

ephemeral — A stream or drainage feature that flows only briefly and in response to precipitation in the immediate vicinity. The channel of the ephemeral feature is above the water table.

ethnographic — Refers to time periods during which specific cultures existed and related information can be systematically studied and recorded. Formal study of Native American culture in the United States is considered to have begun in the late 1800s.

exposure — Being exposed to a radioactive or chemical material.

fast neutrons — Highly energetic neutrons (ranging from 0.1 million to 10 million electron volts [MeV] and travelling at speeds of thousands to tens of thousands kilometers per second) emitted during fission. The fast-neutron spectrum refers to the range of energies associated with fast neutrons.

fast reactor — A class of advanced nuclear reactors in which the fission chain reaction is sustained by fast neutrons. Traditional reactors contain moderators that slow down neutrons (i.e., make them thermal neutrons) after they are emitted from the nucleus of an atom.

fault — Linear geologic structures along which movement of rocks has taken place. Movement, or displacement, along the fault can be a few feet or hundreds of feet.

fault zone — A fault that is expressed as a zone of many smaller faults. A fault zone may be hundreds of feet wide.

Finding of No Significant Impact (FONSI) — A public document issued by a Federal agency that briefly presents the reasons why an action for which the agency has prepared an environmental assessment has no potential to have a significant effect on the human environment and, thus, does not require preparation of an environmental impact statement. (See *environmental assessment* and *environmental impact statement*.)

fuel assembly — A hexagonal array of fuel pins, top and bottom reflectors (shields), surrounded by an assembly duct with assorted mechanical components. A VTR driver fuel assembly comprises 217 fuel pins. Sometimes called a subassembly.

***fuel pin* —** A single rod of fuel. The pin consists of a cladding tube with top and bottom end plugs, contained fuel slugs that are sodium-bonded to the cladding, and an inert gas plenum above the fuel.

***fuel slug* —** A cylindrical rod of alloyed fuel to be inserted into the fuel pin.

***flux* —** See neutron flux.

***gamma radiation* —** Gamma rays (and x-rays), unlike alpha or beta particles, are waves of pure energy. Gamma radiation is very penetrating and can travel several hundred feet in air. Gamma radiation requires a thick wall of concrete, lead, or steel to stop it. (See *alpha particle* and *beta particle*.)

***global warming potential (GWP)* —** The ability of a gas or aerosol to trap heat in the atmosphere. The GWP rating system is standardized to carbon dioxide, which has a value of one. For example, methane has a GWP of 28, which means that it has a global warming effect 28 times greater than carbon dioxide on an equal-mass basis.

***glovebox* —** A sealed enclosure with gloves that allows an operator to manipulate materials and perform other tasks while keeping the enclosed material contained. Normally constructed of stainless steel with large acrylic/lead glass windows. In some cases, remote manipulators may be installed in place of gloves. The gloves, glass and siding material of the glovebox are designed to protect workers from radiation contamination and exposure.

***greater-than-class C (low-level radioactive) waste* —** A type of low-level radioactive waste with concentrations of radionuclides that exceed the limits established in 10 CFR 61.55 for Class C low-level radioactive waste.

***greenhouse gases* —** Gases that trap heat in the atmosphere by absorbing infrared radiation.

***groundwater* —** Water below the ground surface in a zone of saturation.

***half-life (radiological)* —** The time in which one-half of the atoms of a particular radionuclide disintegrate into another nuclear form. Half-lives for specific radionuclides vary from millionths of a second to billions of years.

***hazardous air pollutants* —** Air pollutants that are not covered by the National Ambient Air Quality Standards, but may present a threat of adverse human health or environmental effects. Those specifically listed in Title 40, *Code of Federal Regulations*, Section 61.01 are asbestos, benzene, beryllium, coke oven emissions, inorganic arsenic, mercury, radionuclides, and vinyl chloride. More broadly, hazardous air pollutants are any of the 189 pollutants listed in or pursuant to Section 112(b) of the Clean Air Act. Very generally, hazardous air pollutants are any air pollutants that may realistically be expected to pose a threat to human health or welfare. (See *toxic air contaminants*.)

***hazardous waste* —** Waste that is defined as hazardous waste under the Resource Conservation and Recovery Act (Title 42, *United States Code*, Section 6901 et seq.) or state statute or regulation. State regulations may define a larger spectrum of materials as hazardous waste than Federal regulations.

***high assay, low-enriched uranium (HALEU)* —** Uranium in which the concentration of the isotope uranium-235 has been increased to over 5 percent, but less than 20 percent.

***historic properties* —** Any pre-contact or post-contact districts, sites, buildings, structures, or objects included in, or eligible for inclusion in, the *National Register of Historic Places* (Title 36, *Code of Federal Regulations*, Sections 800.16(l)(1) and (2)).

***hot cell* —** A shielded structure that requires the use of remote manipulators for handling hazardous or radioactive materials.

inert atmosphere — An atmosphere required in some gloveboxes and hot cells that replaces the ambient air. An inert atmosphere (e.g., of argon or nitrogen) is used in gloveboxes or hot cells where necessary to prevent test specimen degradation or unacceptable (e.g., pyrophoric) reactions that could occur in an air atmosphere.

ingot — An oblong block of metal (e.g., plutonium, uranium, zirconium, an alloy).

involved worker — A worker directly or indirectly involved with VTR operations at either the INL MFC or ORNL or reactor fuel production at either INF MFC or SRS who may receive an occupational radiation exposure from direct radiation (i.e., neutron, x-ray, beta, or gamma) or from radionuclides released to the environment.

isotope — Any of two or more variations of an element in which the nuclei have the same number of protons (i.e., the same atomic number) but different numbers of neutrons so that their atomic masses differ. Isotopes of a single element possess almost identical chemical properties, but often different physical and nuclear properties (e.g., carbon-12 and -13 are stable, but carbon-14 is radioactive).

latent cancer fatality — Deaths from cancer resulting from and occurring sometime after exposure to ionizing radiation or other carcinogens.

level of service — A qualitative measurement of operational conditions affecting the traffic on a roadway based on factors such as speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience, and safety.

low enriched uranium (LEU) — Uranium in which the concentration of the isotope uranium-235 has been increased above what occurs in nature (0.7 percent), but is below 20 percent.

low-level radioactive waste — Radioactive waste not classified as high-level radioactive waste, transuranic waste, spent nuclear fuel, or the tailings or wastes produced by the extraction or concentration of uranium or thorium from ore processed primarily for its source material. Test specimens of fissionable material that are irradiated for research and development only, not for the production of power or plutonium, may be classified as low-level radioactive waste, provided the transuranic concentrations are less than 100 nanocuries per gram of waste (DOE Order 435.1).

maximally exposed individual — A hypothetical individual worker or member of the public whose location and habits result in the highest total radiological or chemical exposure (and thus dose) from a particular source for all exposure pathways (inhalation, ingestion, external exposure).

maximum contaminant level (MCL) — Standards that are set by the United States Environmental Protection Agency for drinking water quality. An MCL is the legal threshold limit on the amount of a substance that is allowed in public water systems under the Safe Drinking Water Act.

metric tons of heavy metal (MTHM) — A commonly used measure of the mass of nuclear fuel. Heavy metal refers to elements with an atomic number greater than 89 (e.g., thorium, uranium, and plutonium) in the fuel. The masses of other constituents of the fuel, such as cladding, alloy materials, and structural materials (and fission products in spent nuclear fuel), are not included in this measure. A metric ton is 1,000 kilograms, which is equal to about 2,200 pounds.

millirem — One-thousandth of a roentgen equivalent man (rem) (see r*oentgen equivalent man*).

mitigation — Includes: (1) avoiding an impact altogether by not taking a certain action or parts of an action; (2) minimizing impacts by limiting the degree or magnitude of an action and its implementation; (3) rectifying an impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating the impact over time by preservation and maintenance operations during the life of an action; or (5) compensating for an impact by replacing or providing substitute resources or environments.

mixed low-level radioactive waste — Low-level radioactive waste that also contains hazardous components regulated under the Resource Conservation and Recovery Act (RCRA) (Title 42, *United States Code*, Section 6901 et seq.) or state statute or regulation. State regulations may define a larger spectrum of materials as hazardous waste than Federal RCRA regulations.

National Pollutant Discharge Elimination System (NPDES) — A provision of the Clean Water Act that prohibits discharge of pollutants into waters of the United States unless a special permit is issued by the U.S. Environmental Protection Agency, a state, or, where delegated, a tribal government. An NPDES permit typically includes effluent limitations based on applicable technology and water quality standards, as well as monitoring and reporting requirements, and may include other provisions such as special studies or compliance schedules.

neutron — A subatomic particle with a mass similar to that of a proton and with no electric charge. Because it has no electric charge it can travel longer distances than alpha and beta particles without interacting with matter. A neutron is most effectively stopped by materials with high hydrogen content, such as water or plastic. (See *alpha particle* and *beta particle*.)

neutron flux — A measure of the intensity of neutron radiation, determined by the rate of flow of neutrons. It is the product of neutron density times velocity, usually expressed in terms of neutrons per square centimeter per second.

nonattainment area — An area that the U.S. Environmental Protection Agency has designated as not meeting (i.e., not being in attainment of) one or more of the National Ambient Air Quality Standards for sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, lead, and particulate matter. An area may be in attainment for some pollutants, but not for others.

nonhazardous waste — Discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations or from community activities. This category does not include source, special nuclear, or byproduct material as defined by the Atomic Energy Act (Title 42, *United States Code*, Section 2011 et seq.)

noninvolved worker — A site worker outside of the facility who would not be subject to direct radiation exposure but could be incidentally exposed to radiological emissions from the VTR or reactor fuel production facility***.***

Notice of Intent (NOI) — A notice published in the *Federal Register* that an environmental impact statement (EIS) will be prepared and considered. The NOI is intended to briefly describe the proposed action and possible alternatives; describe the agency's proposed scoping process, including whether, when, and where any scoping meeting(s) will be held; and state the name and address of a person within the agency who can answer questions about the proposed action and the EIS.

off-link — A term used in radioactive transportation analyses to describe populations living within 0.50 miles of a shipment route.

***offsite* (adjective) —** Denotes a location, facility, or activity occurring outside of the boundary of a U.S. Department of Energy complex site.

on-link — A term used in radioactive transportation analyses to describe pedestrians and car occupants sharing the shipment route.

***onsite* (adjective) —** Denotes a location or activity occurring within the boundary of a U.S. Department of Energy complex site.

particulate matter (PM) — Any finely divided solid or liquid material, other than uncombined (i.e., pure) water. A subscript denotes the upper limit of the diameter of particles included. Thus, PM_{10} includes only those particles equal to or less than 10 micrometers (0.0004 inches) in diameter; $PM_{2.5}$ includes only those particles equal to or less than 2.5 micrometers (0.0001 inches) in diameter.

permeability — A measure of a rock's ability to transmit fluid (in this case water); also, the rate at which the fluid can move a given distance over a given interval of time.

person-rem — A unit of collective radiation dose applied to a population or group of individuals. It is calculated as the sum of the estimated doses, in rem, received by each individual of the specified population. For example, if 1,000 people each received a dose of 0.001 rem (1 millirem), the collective dose would be 1 person-rem (1,000 persons × 0.001 rem) (see *roentgen equivalent man* and *millirem*).

polishing — The term used for removing undesirable components from plutonium. For example, americium-241 builds up from the decay of plutonium-241, so polishing may be needed for the plutonium to meet the specifications for a particular use.

population dose — see collective dose

radiation (ionizing) — Particles (alpha, beta, neutrons, and other subatomic particles) or photons (i.e., gamma, x-rays) emitted from the nucleus of unstable atoms as a result of radioactive decay. Such radiation is capable of displacing electrons from atoms or molecules in the target material (such as biological tissues), thereby producing ions.

radioactive decay — The spontaneous transformation of one radionuclide into a different nuclide or into a different energy state of the same radionuclide. The process results in a decrease, with time, of the number of the radioactive atoms in a sample. Decay generally involves the emission from the nucleus of alpha particles, beta particles, or gamma rays. (See *half-life*.)

radioactive waste — Solid, liquid, or gaseous material that contains radionuclides regulated under the Atomic Energy Act of 1954, as amended, that is of negligible economic value considering the costs of recovery.

radioactivity —

> Defined as a process: The spontaneous transformation of unstable atomic nuclei, usually accompanied by the emission of ionizing radiation.
>
> Defined as a property: The property of unstable nuclei in certain atoms to spontaneously emit ionizing radiation during nuclear transformations.

radioisotope or radionuclide — An unstable isotope that undergoes spontaneous transformation, emitting radiation. (See *isotope*.)

Record of Decision (ROD) — A concise public document that records a Federal agency's decision(s) concerning a proposed action for which the agency has prepared an environmental impact statement. The ROD is prepared in accordance with the requirements of the Council on Environmental Quality National Environmental Policy Act regulations (Title 40, *Code of Federal Regulations*, Section 1505.2). A ROD identifies the alternatives considered in reaching the decision, the environmentally preferable alternative(s), factors balanced by the agency in making the decision, whether all practicable means to avoid or minimize environmental harm have been adopted, and if not, why they were not. (See *environmental impact statement*.)

reflector assemblies — See driver fuel.

region of influence — A site-specific geographic area in which the principal direct and indirect effects of actions are likely to occur and are expected to be of consequence for local jurisdictions.

rem — See r*oentgen equivalent man.*

remediation — The process, or a phase in the process, of rendering land or water containing radioactive or hazardous constituents, or both, environmentally safe, whether through removal, processing, entombment, or other methods.

risk — The probability of a detrimental effect from exposure to a hazard. To describe impacts, risk is often expressed quantitatively as the probability of an adverse event occurring, multiplied by the consequence of that event (i.e., the product of these two factors). However, a separate presentation of probability and consequence to describe impacts is often informative.

roentgen — A unit of exposure to ionizing radiation equal to the amount of gamma or x-rays that produces one electrostatic unit charge in a cubic centimeter of air. (See *gamma radiation.*)

roentgen equivalent man (rem) — A unit of radiation dose used to measure the biological effects of different types of radiation on humans. The dose in rem is estimated by a formula that accounts for the type of radiation, the total absorbed dose, and the tissues involved. One thousandth of a rem is a millirem. (See *absorbed dose and millirem*.)

sacred sites — Well-known areas that are associated with the cultural practices or beliefs of a living community.

sandstone — Rock composed of sand-sized particles that also contains finer-grained particles that form the “matrix” or the material in which the sand grains are embedded.

scope — In a document prepared pursuant to the National Environmental Policy Act, the range of actions, alternatives, and impacts to be considered.

scoping — An early and open process for determining the scope of issues and alternatives to be addressed in an environmental impact statement (EIS) (or other National Environmental Policy Act [NEPA] document) and for identifying the significant issues related to a proposed action. The scoping period begins after publication in the *Federal Register* of a Notice of Intent to prepare an EIS (or other NEPA document). The public scoping process is that portion of the process where the public is invited to participate. The U.S. Department of Energy (DOE) also conducts an early internal scoping process for environmental assessments or EISs (and supplemental environmental impact statements [SEISs]). For EISs and SEISs, this internal scoping process precedes the public scoping process. DOE’s scoping procedures are found in Title 10, *Code of Federal Regulations*, Section 1021.311.

shale — Rock composed predominately of clay-sized particles.

shield assemblies — See driver fuel.

siltstone — Rock composed predominately of silt-sized particles.

soils — All unconsolidated materials above bedrock. Also, natural earthy materials on the Earth’s surface, in places modified or even made by human activity, that contain living matter and support or are capable of supporting plants out of doors.

Test assembly — A hexagonal assembly within the active region of the core that holds a test specimen. Test assemblies may be normal test assemblies (contains non-instrumented or passively instrumented test specimens), extended length test assemblies (include an instrument stalk that allows the test specimen to be monitor while in the reactor core), or rabbit test assemblies (part of a rabbit facility and contains specimens that can be inserted and removed from the core during reactor operations).

thermal neutrons — Neutrons that are less energetic than fast neutrons (generally, less than 1 electron volt and travelling at speeds of less than 5 kilometers per second), having been slowed by collisions with other materials such as water. The thermal neutron spectrum refers to the range of energies associated with thermal neutrons.

traditional cultural properties — Areas that are associated with the cultural practices or beliefs of a living community that link the community to its past, are "important in maintaining the continuing cultural identity of the community," and are potentially eligible for listing or are listed on the *National Register of Historic Places*. Traditional cultural properties may also be associated with other traditional life ways, such as agriculture. Traditional cultural properties can include archaeological resources, locations of pre-contact or post-contact events, sacred areas, traditional hunting and gathering areas, or landscapes.

tritium — A beta-particle-emitting radioactive isotope of hydrogen whose nucleus contains one proton and two neutrons. Because it is chemically identical to natural hydrogen, tritium can easily be taken into the body by any ingestion pathway. (See *neutron*.)

TRU (transuranic) waste — waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for — (a) high-level radioactive waste; (b) waste that the Secretary [of Energy] has determined, with the concurrence of the Administrator (of the Environmental Protection Agency], does not need the degree of isolation required by the disposal regulations; or (c) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with part 61 of title 10, Code of Federal Regulations.

vadose zone — The unsaturated soil above the water table. The vadose zone may contain residual water, but it is not completely saturated. Air and gases in the vadose zone are under atmospheric pressure.

viewshed — The extent of the area that may be viewed from a particular location. Viewsheds are generally bounded by topographic features such as hills or mountains.

volatile organic compounds — Organic chemicals that have a high vapor pressure at ordinary room temperature. Their high vapor pressure results from a low boiling point, which causes large numbers of molecules to evaporate or sublimate from the liquid or solid form of the compound and enter the surrounding air.

water table — The surface of an aquifer or perched zone formed by the upper limit of the zone of saturation; along this surface, the pressure is the same as atmospheric pressure.

wetland — An area that is inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Chapter 10
List of Preparers

10.0 LIST OF PREPARERS

The U.S. Department of Energy prepared this document, *Versatile Test Reactor Environmental Impact Statement.* This chapter identifies the organizations and individuals who contributed to the overall effort of producing it.

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Experience/Technical Specialty:
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M.S., Nuclear Physics, North Carolina State University
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Experience/Technical Specialty:
Thirty years. Source emission quantifications, dispersion modeling, health risk assessments, greenhouse gas and climate change analyses, mitigation evaluations, determination of project compliance with air pollution standards and regulations, including NEPA, CEQA, General Conformity Regulations, and regional air pollution agencies.

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Ten years. Administrative record management and reference management for multiple NEPA documents, geology and earth resources, soil resources.

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EIS RESPONSIBILITIES: ENVIRONMENTAL JUSTICE LEAD

Education: M.S., Environmental Planning and Management, Johns Hopkins University
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EIS RESPONSIBILITIES: LAWS AND REGULATIONS

Education: M.Arch., Architecture, University of New Mexico
B.A., Ethics/Archaeology, University of Cape Town

Experience/Technical Specialty:
Twenty-eight years. Environmental planning, project management, analysis of land use, recreation, visual, and other social resources, as well as project description development for complex investigations under NEPA; Certified Leader in Energy and Environmental Design Accredited Professional with specialty in Building Design and Construction (LEED AP BD+C).

ERNEST HARR, LEIDOS

EIS RESPONSIBILITIES: WASTE MANAGEMENT LEAD; CHAPTER 4 MANAGER; MITIGATION MEASURES

Education: B.S., Zoology, University of Maryland

Experience/Technical Specialty:
Forty years. NEPA analysis; radiological analyses – normal operation, accidents and intentionally destructive acts; human health and safety – worker and public; radioactive and mixed waste management; transportation – radiological and nonradiological; remediation; decontamination and decommissioning; and regulatory and compliance analyses.

JOSEPH JIMENEZ, LEIDOS

EIS RESPONSIBILITIES: CULTURAL RESOURCES LEAD

Education: M.A., Anthropology, Idaho State University
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Register of Professional Archaeologists (RPA #15644)

Experience/Technical Specialty:
Thirty-four years. Cultural resource project management, NEPA analysis, *National Register of Historic Places* evaluations, Historic American Building Survey documentation review, Integrated Cultural Resource Management Plans, documentation for compliance with Section 110 of the National Historic Preservation Act; documentation and support for consultation in compliance with Section 106 of the National Historic Preservation Act; and various aspects of field and laboratory archaeology, including performing project management and coordination, data collection, research, reporting, and writing.

GEOFF KAISER, LEIDOS

EIS RESPONSIBILITIES: INTENTIONAL DESTRUCTIVE ACTS

Education: PhD, Physics, Cavendish Laboratory, Cambridge, UK
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Experience/Technical Specialty:
Forty-six years. Risk assessment and risk management; development and use of models for the dispersion and consequences of releases of radioactive materials and toxic and explosive chemicals to the atmosphere.

ROY KARIMI, LEIDOS

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M.S., Nuclear Engineering, Massachusetts Institute of Technology
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Experience/Technical Specialty:
Forty years. Nuclear power plant safety, risk and reliability analysis, design analysis, criticality analysis, accident analysis, consequence analysis, spent fuel dry storage safety analysis, transportation risk analysis, and probabilistic risk assessment.

MARK KIDDER, LEIDOS

EIS RESPONSIBILITIES: CONSTRUCTION DATA DEVELOPMENT

Education: B.S., Civil Engineering, South Dakota State University

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Twenty years. Engineering and Construction Estimating, Civil and Environmental Design, Environmental Restoration, Construction Management.

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B.S., Conservation, Kent State University

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EIS RESPONSIBILITIES: SHAREPOINT SITE AND ADMINISTRATIVE RECORD SUPPORT

Education: B.S., Geology-Biology

Experience/Technical Specialty:
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MATTHEW MILLIGAN, LEIDOS

EIS RESPONSIBILITIES: COMMITMENT OF RESOURCES; GIS

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B.S., Meteorology, North Carolina State University

Experience/Technical Specialty:
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SARAH RAUCH, LEIDOS

EIS RESPONSIBILITIES: ECOLOGICAL RESOURCES LEAD

Education: B.S., Plant Biology Environmental Science and Ecology, Arizona State University

Experience/Technical Specialty:
Fourteen years. Environmental permitting, regulatory compliance and assessment, National Environmental Policy Act (NEPA) reviews, natural resources fieldwork, and research.

VICKIE MCQUAY REDDICK, LEIDOS

EIS RESPONSIBILITIES: TECHNICAL EDITOR

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Additional Graduate Studies, University College Cork, Ireland

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CHRIS RUA, POTOMAC-HUDSON ENGINEERING, INC.

EIS RESPONSIBILITIES: TRAFFIC LEAD

Education: M.S., Environmental Management, University of Maryland-University College
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Experience/Technical Specialty:
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EIS RESPONSIBILITIES: TECHNICAL EDITOR/WRITER

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Twenty-eight years. Technical Writing and editing, document management, NEPA project management and analysis.

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Education: Executive M.B.A., Loyola University
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Experience/Technical Specialty:
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Education: M.S., Nuclear Science and Engineering, Idaho State University
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Experience/Technical Specialty:
Forty-two years. Safety and risk analysis, radiological and hazardous material consequence analysis, nuclear safety, regulatory compliance, health and safety assessment.

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EIS RESPONSIBILITIES: ECOLOGICAL RESOURCES

Education: Ph.D., Lincoln University Centre for Research Excellence and Ecology Division, PhD Program in Ecology
M.S., Frostburg State University Applied Ecology and Conservation Biology Master's Program
B.S., Biology (Ecology emphasis), University of California Irvine

Experience/Technical Specialty:
Eighteen years. Habitat Conservation Plans, Integrated Natural Resource Management Plans, Environmental Impact Statements and Reviews, Biological and Environmental Assessments, Species and Climatic Modeling as well as many other documents addressing sensitive species protection, mitigation, habitat restoration, monitoring and recovery throughout in the U.S. and internationally. Section 7 documentation and consultation support with particular focus on assessment and management of sensitive environments, streams, wetlands, species and habitat modeling, natural resources permitting and project management for the military, state and private sector.

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Experience/Technical Specialty:
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Sixteen years. NEPA analysis, land use, utilities, Geographic Information Systems (GIS) and mapping, and graphics.

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Education: M.En. Environmental Science, Miami University of Ohio
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Experience/Technical Specialty:

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Education: M.S., Environmental Engineering, Johns Hopkins University
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Experience/Technical Specialty:

Nineteen years. NEPA analysis, environmental studies, regulatory analysis, and program management.

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Twenty-seven years. NEPA analysis, environmental remediation, engineering studies, and regulatory compliance.