DOE/EA-2025

Draft Environmental Assessment

Pacific Northwest National Laboratory Richland Campus Future Development

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Pacific Northwest Site Office
Richland, Washington 99352

U.S. DEPARTMENT OF ENERGY | Office of Science

SUMMARY

To meet the long-term federal agency mission need to enable discovery and advance science, the U.S. Department of Energy (DOE) needs to provide laboratory space and associated infrastructure for research and development capabilities at the Pacific Northwest National Laboratory (PNNL) Campus located in Richland, Washington. This environmental assessment (EA) provides information and analysis of proposed DOE activities associated with the next 20 years of buildout of the PNNL Richland Campus. Information contained in this EA will be used by the DOE Office of Science to determine if the Proposed Action represents a major federal action that would significantly affect the quality of the human environment.

Proposed Action. Under the Proposed Action evaluated in this EA, the proposed facilities and infrastructure envisioned in the current PNNL Richland Campus Master Plan would be constructed and operated on the 269 ha (664 ac) PNNL Richland Campus. DOE would construct and operate multiple buildings on the campus, including research laboratories, office space, support buildings, and associated infrastructure. The Proposed Action includes potential decontamination and demolition of buildings that DOE determines no longer support mission needs. Portions of the campus could be leased or transferred to other entities for development compatible with the PNNL Richland Campus Master Plan.

Affected Environment. The PNNL Richland Campus is located next to the Columbia River at the northern end of the City of Richland in Benton County. The DOE Hanford Site and a mix of light industrial, agricultural, business, school, and residential areas are located in the vicinity of the campus. The campus consists of research and development facilities, roads and infrastructure, landscaping, irrigated pasture, and undeveloped native shrub-steppe habitat. Based on 2013 U.S. Census American Community Survey population data, the population residing within 80 km (50 mi) of the site was about 480,000, and the region contained some concentrations of minority and low-income populations. About 24 ha (59 ac) of existing soils on the PNNL Richland Campus are classified as "prime farmland if irrigated," and about 10 ha (24 ac) are classified as "farmland of statewide importance." No scarce geological resources, surface waterbodies, floodplains, or wetlands are within the boundaries of the PNNL Richland Campus. Biological resources on the campus consist of a mix of desert-adapted shrubs and grasses as well as a variety of mammals and birds that inhabit those environments. During recent biological surveys, no federal or state threatened or endangered species, species proposed for listing, or critical habitats were observed. Cultural and historic resources have been identified within some portions of the campus, and appropriate measures for their management have been established. No soil contamination that would require remedial action has been identified on the campus. Groundwater in the campus area is routinely monitored for contaminants originating from waste sites located off-campus.

Environmental Impacts of the Proposed Action. Table S.1 summarizes potential impacts associated with the 20-year buildout of the PNNL Richland Campus.

Table S.1. Potential Environmental Impacts Associated With the 20-Year Buildout of the PNNL Richland Campus

Resource Area	Impact Summary
Land Use	The activities within the PNNL Richland Campus would be consistent with adjacent land uses planned by the City of Richland and Benton County.
Air Quality	Emissions from construction activities would be intermittent and occur over months, and as a result would not be expected to cause any air-quality standards to be exceeded. The future buildout of the PNNL Richland Campus would result in minimal increases in PNNL staffing levels. Consequently, there may be a minimal increase in vehicle or other emissions from the Proposed Action.

Table S.1. (contd)

Resource Area	Impact Summary
Soils and Geological Resources	About 24 ha (59 ac) of soils classified as "prime farmland if irrigated" and about 10 ha (24 ac) of soils classified as "farmland of statewide importance" could be affected by construction. No surface soils would be mined for offsite uses and no offsite materials would be required.
Water Resources	Future development is anticipated to replace existing structures, with minimal increase in PNNL staffing levels and minimal change to the PNNL water use for non-irrigation purposes. Irrigation water requirements are expected to be somewhat reduced from current levels by increasing the proportion of the campus using xeriscaping or rock landscaping. Excavations for new facilities are not expected to extend into the groundwater.
Cultural and Historical Resources	A memorandum of agreement would be drafted in consultation with the Washington State Historic Preservation Officer, the Advisory Council on Historic Preservation, and consulting parties to address protective requirements and associated mitigation options to resolve potential adverse effects to National Register of Historic Places-eligible properties from the Proposed Action. The National Register of Historic Places-eligible traditional cultural property *Shu Wipa* would be directly and indirectly impacted by construction activities occurring outside of the preservation designated area and the area to the north and would require mitigation. Construction and operations-related activities occurring outside of the preservation area and the area to the north would impact the Yakama Nation traditional cultural property.
Biological Resources	Development in the project area would remove native shrub-steppe habitats. Wildlife present west of George Washington Way could suffer direct mortality, disturbance, and displacement. A mitigation action plan would be implemented to mitigate for habitat loss and potential impacts to wildlife, including migratory birds.
Wetlands and Floodplains	There are no wetlands or floodplains in the project area.
Socioeconomics	Based on construction workforce estimates, construction activities would likely have little effect on the existing community. The proposed facilities would house existing research staff and a minimal number of new research staff. Consequently, no impacts on socioeconomics or community infrastructure would be expected from operations.
Environmental Justice	The Proposed Action would not result in disproportionately high and adverse effects on minority or low-income populations.
Transportation and Traffic	Potential increases in traffic during peak construction represent an approximately 23 to 31 percent increase over current average daily traffic on Horn Rapids Road. During non-peak construction periods, the increase over current average daily traffic on Horn Rapids Road would be about 12 to 15 percent.
Human Health and Safety	The radiological impact to construction workers would be negligible and would be similar to that of members of the public in the vicinity of the PNNL Richland Campus. There would be no appreciable difference in operational impacts on human radiological health and safety.
Visual Resources	Development would be consistent with the visual resource goals of the City of Richland Comprehensive Land Use Plan.
Noise and Vibration	Construction activities would generate noise typical of using heavy equipment and transport of materials. The commercial limit of 65 dBA would apply to facilities on campus.
Utilities and Infrastructure	Some additional water, electrical, communication and other infrastructure may have to be constructed to support new facilities.

Table S.1. (contd)

Resource Area	Impact Summary
Waste Generation and Disposition	Effluents and wastes generated during construction would be minimized to the extent practicable and would be managed using existing facilities. New and replacement facilities would result in minimal increases in industrial waste streams (e.g., liquid wastewater, radioactive and mixed waste volumes).
Accidents	Accidents in proposed facilities are unlikely. However, two accidents associated with hydrogen gas storage (i.e., a vapor cloud explosion and vapor cloud fire) were considered. Consequences could affect nearby onsite workers, but impacts would not pose undue risk to members of the general public.
Intentional Destructive Acts	Although an intentional act is unlikely, an intentional destructive act targeting the PNNL Richland Campus is possible. However, the Proposed Action would not increase the likelihood of an intentional destructive act or the resulting consequences.
Cumulative Impacts	The contribution of the Proposed Action to the cumulative impacts from other past, present, and reasonably foreseeable future actions in the vicinity of the PNNL Richland Campus would be low.

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ACRONYMS AND ABBREVIATIONS

ac	acre(s)
ACHP	Advisory Council on Historic Preservation
ACS	American Community Survey
AEC	Atomic Energy Commission
AIRFA	American Indian Religious Freedom Act
ANSI	American National Standards Institute
AQCR	Air Quality Control Region
ASIL	Acceptable Source Impact Level
Battelle	Battelle Memorial Institute
BLM	Bureau of Land Management
BPA	Bonneville Power Administration
BSEL	Bioproducts, Sciences, and Engineering Laboratory
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CGS	Columbia Generating Station
Ci	curie(s)
CO	carbon monoxide
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
DAHP	(Washington State) Department of Archaeology and Historic Preservation
dB	decibel(s)
dBA	A-weighted decibel(s)
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DOE-SC	U.S. Department of Energy, Office of Science
EA	environmental assessment
EDL	Engineering Development Laboratory
EDNA	environmental designation for noise abatement
EERE	Energy Efficiency and Renewable Energy
EIS	environmental impact statement
EMSL	(William R. Wiley) Environmental Molecular Sciences Laboratory
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESCP	Energy Sciences Capability Project
FEMA	Federal Emergency Management Agency
FR	Federal Register
ft	foot/feet

ft^2	square feet
ft^3	cubic feet
FY	fiscal year
g	gram(s)
gal	gallon(s)
GHG	greenhouse gas
^3H	tritium
ha	hectare(s)
HPS	Health Physics Society
in	inch(es)
IDPs	Inadvertent Discovery Plans
km	kilometer(s)
kW	kilowatt(s)
kWh	kilowatt hour(s)
L	liter(s)
LA	Limited Area
LCF	latent cancer fatality
LD	lethal dose
LFL	lower flammability level
LIGO	Laser Interferometer Gravitational-Wave Observatory
LSL	Life Sciences Laboratory
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
MAR	material at risk
MATH	Mathematics Building
MEI	maximally exposed individual
MeV	million electron volts
MGD	millions of gallons per day
mg/kg	milligram of medication per kilogram
mi	mile(s)
mi^2	square mile(s)
MOA	Memorandum of Agreement
mrem	millirem
MW	megawatt(s)
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act

NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act of 1969, as amended
NHPA	National Historic Preservation Act
NO_2	nitrogen dioxide
NOx	nitrogen oxides
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
O^3	ozone
OCA	Offsite Consequence Analysis
Pa	Pascals
Pb	lead
PDA	preservation designated area
PDLW	Process Development Laboratory West
PM	particulate matter
PNNL	Pacific Northwest National Laboratory
PNSO	(DOE) Pacific Northwest Site Office
PPA	Property Protection Area
ppm	parts per million
PSD	Prevention of Significant Deterioration
PSF Complex	Physical Sciences Facility Complex
psi	pound per square inch
psig	pounds per square inch gage
PSL	Physical Sciences Laboratory
Pu-239	plutonium-239
Pu-239E	plutonium-239 equivalent
R&D	research and development
RAEL	Radioactive Air Emissions License
RCRA	Resource Conservation and Recovery Act
ROB	Research Operations Building
RTL	Research Technology Laboratory
SHPO	State Historic Preservation Officer
SO^2	sulfur dioxide
TCP	traditional cultural property
TED	total effective dose
TNT	trinitrotoluene
TRC	total recordable case
TRIDEC	Tri-Cities Development Council

UIC	underground injection control
VOC	volatile organic compound
VRM	Visual Resource Management
WA Ecology	Washington State Department of Ecology
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDOH	Washington State Department of Health
WSU	Washington State University
yd^3	cubic yard(s)

DEFINITION OF TERMS

Background radiation. Radiation from (1) cosmic sources, (2) naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material), and (3) global fallout as it exists in the environment (e.g., from the testing of nuclear explosive devices).

Collective dose. The sum of the total effective dose equivalent values for all individuals in a specified population. Collective dose is expressed in units of person-rem.

Corrosive. A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the site of contact.

Cumulative effect. The impact on the environment from the incremental impact of the Proposed Action when added to other past, present, and reasonably future actions regardless of what agency (federal or non-federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

Curie (Ci). A unit of radioactivity equal to 37 billion disintegrations per second; also a quantity of any radionuclide or mixture of radionuclides having 1 curie of radioactivity.

Direct effects. Effects caused by the action and that occur at the same time and place.

Dispersible. Can separate and scatter.

Hazardous chemical. Any chemical that is a physical or health hazard.

- *Physical hazard* – any chemical for which there is scientifically valid evidence that it is a
  - flammable or combustible liquid
  - compressed gas
  - explosive
  - flammable solid
  - oxidizer
  - peroxide
  - pyrophoric
  - unstable (reactive) or water-reactive substance.
- *Health hazard* – any material for which there is statistically significant evidence that acute or chronic health effects may occur in exposed individuals. Such materials include the following:
  - carcinogens
  - mutagens
  - teratogens
  - toxic or acutely toxic agents
  - reproductive or developmental toxins
  - irritants
  - corrosives
  - sensitizers
  - liver, kidney, and nervous system toxins
  - agents that act on the blood-forming systems
  - agents that damage the lungs, skin, eyes, or mucous membranes.

Hazardous waste. Waste that contains chemically hazardous constituents regulated under Subtitle C of the Resource Conservation and Recovery Act, as amended (42 U.S.C. § 6901 et seq.) and regulated as a hazardous waste and/or mixed waste by the U.S. Environmental Protection Agency (40 CFR Part 261).

Highly toxic. To be classified as "highly toxic," a chemical must meet the following criteria: oral lethal dose (LD)-50 in white rats equal to or less than 50 mg/kg; dermal LD-50 in white rabbits equal to or less than 200 mg/kg; or inhalation LC-50 in white rats equal to or less than 200 ppm (for gases or vapors) or 2 mg/L (for dusts, fumes, or mists).

Indirect effects. Effects caused by the action that are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density, or growth rate and related effects on air and water and other natural systems, including ecosystems.

Latent cancer fatality (LCF). Death from cancer as a result of, and occurring sometime after, exposure to ionizing radiation or other carcinogens.

Limited Area (LA). Security area designated for the protection of classified matter and certain types of special nuclear material.

Low-level (radioactive) waste. Radioactive waste that is not high-level waste, spent nuclear fuel, transuranic waste, byproduct material (as defined in Section 11e[2] of the Atomic Energy Act of 1954, as amended [42 U.S.C. § 2011 et seq.]), or naturally occurring radioactive material.

Maximally exposed individual (MEI). A hypothetical member of the public residing near the PNNL Richland Campus who, by virtue of location and living habits, could receive the highest possible radiation dose from radioactive effluents released from the PNNL Richland Campus.

millirem. A unit of radiation dose equivalent that is equal to 1/1,000 of a rem.

Non-dispersible. Cannot separate and scatter.

Nuclear Hazard Category. U.S. Department of Energy (DOE) Hazard Categories for nuclear facilities are defined in DOE-STD-1027-92 (DOE 1997). Nuclear facilities are further designated as Nuclear Hazard Category 1, 2, or 3, depending on the level of risk associated with facility operations and the quantities of radioactive materials in the facility. Table A.1 in Attachment 1 of the standard specifies the threshold quantities of radioactive materials for Nuclear Hazard Category 2 and 3 facilities.

- **Nuclear Hazard Category 1** facilities include those where the hazard analysis indicates the potential for significant offsite consequences. Those facilities typically include larger reactors (designated as Category A reactors, or those that operate at a steady-state thermal power greater than 20 MW) and other facilities identified by DOE as having the potential for more severe accidents.
- **Nuclear Hazard Category 2** facilities include those where the hazard analysis indicates the potential for significant onsite consequences from accidents (including the potential for criticality) or other events, and which require onsite emergency planning.
- **Nuclear Hazard Category 3** facilities include those where the hazard analysis indicates the potential for only significant localized consequences. Hazard Category 3 nuclear facilities contain quantities of hazardous radioactive materials that meet or exceed Hazard Category 3 threshold values as identified in DOE-STD-1027 (DOE 1997), Table A.1, but are less than Hazard Category 2 threshold values. The maximum inventories for Category 3 facilities were established to exclude facilities that would be likely to have a significant radiological impact outside the facility.

> **Note:** Radiological facilities include those containing quantities of radioactive materials that do not meet or exceed the thresholds defined for Category 3 facilities in DOE-STD-1027 (DOE 1997). Radiological facilities are associated with the lowest risks to workers or members of the public and typically house activities involving small quantities of dispersible radioactive materials.

Oxidizer. A chemical that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

Person-rem. A unit of collective or population dose that is based on the sum of the total effective dose equivalent values for all individuals in a specified population.

Physical Sciences Facility Complex. A research complex on the north side of Horn Rapids Road.

PM_{10}. Particles having an aerodynamic diameter less than or equal to a nominal 10 micrometers.

$PM_{2.5}$. Particles having an aerodynamic diameter less than or equal to a nominal 2.5 micrometers.

PNNL Richland Campus. One of four PNNL geographic areas designated for PNNL operations. The PNNL Richland Campus refers to the collection of real property including the PNNL Site and the land and facilities within Battelle Land Richland approved for PNNL use. PNNL Richland Campus does not include the PNNL Marine Sciences Laboratory, the Hanford 300 Area, or PNNL other areas.

PNNL Site. U.S. DOE-owned land, reserved for PNNL use, located partly in Richland, Washington, but wholly in Benton County, Washington, and in proximity to the Hanford Site 300 Area and the Battelle Memorial Institute Land – Richland. The PNNL Site includes 41 ha (102 ac) of a preservation designated area which is not available for development. DOE's Office of Science is the Cognizant Secretarial Office. All facilities on this land are federally owned. The PNNL Site was developed from multiple separate land parcel acquisitions and reassignments.

Pollution prevention. The use of materials, processes, and practices that reduce or eliminate the generation and release of pollutants, contaminants, hazardous substances, and waste into land, water, and air. For DOE, this includes recycling activities.

Preservation designated area (PDA). An approximately 41 ha (102 ac) limited access area in the northern portion of the PNNL Richland Campus along the Columbia River north of Horn Rapids Road managed for protection of cultural and biological resources.

Property Protection Area (PPA). Access-controlled facilities established to protect government-owned property against damage, destruction, or theft.

Pyrophoric. Materials that spontaneously ignite in air at or below a temperature of 54.5°C (130°F).

rem. A unit of radiation total effective dose (TED) based on the potential for impact on human cells.

Risk. The product of the probability of occurrence of an event or activity and the consequences resulting from that event or activity. For example, an accident that is expected to occur once in 100 years and result in a 1 in 1,000 probability of LCF in the affected population would be associated with a risk of $(0.01\ y^{-1}) \times (0.001\ LCF) = 0.00001$ LCF/y, or a risk of LCF equal to 1 in 100,000 per year of operation.

Total effective dose (TED). The sum of the effective dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures). TED is expressed in units of rem.

Toxic. To be classified as toxic, a chemical must meet the following criteria: oral LD-50 in white rats greater than 50 mg/kg but less than 500 mg/kg; dermal LD-50 in white rabbits greater than 200 mg/kg but less than 1,000 mg/kg; or inhalation LC-50 in white rats greater than 200 ppm but less than 2,000 ppm (for gases or vapors) or greater than 2 mg/L but less than 20 mg/L (for dusts, fumes, or mists). Chemicals that have a higher LD-50 or LC-50 are considered to be nontoxic for the purposes of monitoring.

Toxic air pollutant. Any State of Washington Class A or Class B toxic air pollutant listed in Washington Administrative Code (WAC) 173-460-150 and 173-460-160. The term "toxic air pollutant" may include particulate matter and volatile organic compounds if an individual substance or a group of substances within either of these classes is listed in WAC 173-460-150 and/or 173-460-160. The term "toxic air pollutant" does not include particulate matter and volatile organic compounds as generic classes of compounds.

Transuranic waste. Radioactive waste containing more than 100 nanocuries (3,700 becquerels) of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for the following:

- high-level radioactive waste
- waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the U.S. Environmental Protection Agency, does not need the degree of isolation required by the 40 CFR Part 191 disposal regulations
- waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61.

Unstable (reactive). A chemical that in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shock, pressure, or temperature.

Water reactive. A chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

Xeriscaping. Landscaping in a style that requires little or no irrigation.

METRIC CONVERSION CHART

Into metric units			Out of metric units		
If you know	Multiply by	To get	If you know	Multiply by	To get
Length			**Length**		
inches	25.40	Millimeters	Millimeters	0.03937	inches
inches	2.54	Centimeters	Centimeters	0.393701	inches
feet	0.3048	Meters	Meters	3.28084	feet
yards	0.9144	Meters	Meters	1.0936	yards
miles (statute)	1.60934	Kilometers	Kilometers	0.62137	miles (statute)
Area			**Area**		
square inches	6.4516	square centimeters	square centimeters	0.155	square inches
square feet	0.09290304	square meters	square meters	10.7639	square feet
square yards	0.8361274	square meters	square meters	1.19599	square yards
square miles	2.59	square kilometers	square kilometers	0.386102	square miles
acres	0.404687	Hectares	Hectares	2.47104	acres
Mass (weight)			**Mass (weight)**		
ounces (avoir.)	28.34952	Grams	Grams	0.035274	ounces (avoir.)
pounds (avoir.)	0.45359237	Kilograms	Kilograms	2.204623	pounds (avoir.)
tons (short)	0.9071847	tons (metric)	tons (metric)	1.1023	tons (short)
Volume			**Volume**		
ounces (U.S., liquid)	29.57353	Milliliters	Milliliters	0.033814	ounces (U.S., liquid)
quarts (U.S., liquid)	0.9463529	Liters	Liters	1.0567	quarts (U.S., liquid)
gallons (U.S., liquid)	3.7854	Liters	Liters	0.26417	gallons (U.S., liquid)
cubic feet	0.02831685	cubic meters	cubic meters	35.3147	cubic feet
cubic yards	0.7645549	cubic meters	cubic meters	1.308	cubic yards
Temperature			**Temperature**		
Fahrenheit	subtract 32 then multiply by 5/9ths	Celsius	Celsius	multiply by 9/5ths, then add 32	Fahrenheit
Energy			**Energy**		
kilowatt hour	3,412	British thermal unit	British thermal unit	0.000293	kilowatt hour
kilowatt	0.94782	British thermal unit per second	British thermal unit per second	1.055	kilowatt
Force/Pressure			**Force/Pressure**		
pounds (force) per square inch	6.894757	Kilopascals	Kilopascals	0.14504	pounds per square inch
torr	133.32	Pascals	Pascals	0.0075	torr

06/2001

Source: *Engineering Unit Conversions*, M. R. Lindeburg, PE, Third Ed., 1993, Professional Publications, Inc., Belmont, California.

1.0 INTRODUCTION AND BACKGROUND

The National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. § 4321 et seq.) requires federal agency officials to consider the environmental consequences of their proposed actions before decisions are made. The U.S. Department of Energy (DOE) adheres to Council on Environmental Quality (CEQ) regulations (Title 40 of the Code of Federal Regulations [CFR] Parts 1500-1508) and DOE's own NEPA-implementing regulations (10 CFR Part 1021) in pursuit of NEPA compliance. This environmental assessment (EA) provides information and analyses of proposed DOE activities associated with the next 20 years of buildout of the Pacific Northwest National Laboratory (PNNL) Richland Campus (campus) located in Richland, Washington, (Figure 1.1). This EA discusses the purpose and need for the Proposed Action, description of the Proposed Action, alternatives to the Proposed Action that were identified but not discussed in detail, the No Action Alternative, affected environment, and the potential environmental impacts of both the No Action Alternative and the Proposed Action.

PNNL is managed by the Pacific Northwest Site Office (PNSO) for the DOE Office of Science (DOE-SC). The 269 ha (664 ac) PNNL Richland Campus (Figure 1.2) is located in Benton County in southeastern Washington State, 275 km (171 mi) east-northeast of Portland, Oregon; 270 km (168 mi) southeast of Seattle, Washington; and 200 km (124 mi) southwest of Spokane, Washington. It is located at the northern boundary of the City of Richland and south of the DOE-Richland Operations Office's (DOE-RL's) Hanford Site 300 Area. The campus north of Horn Rapids Road extends eastward to the Columbia River high-water mark. The PNNL Richland Campus is located southeast of an area recently conveyed from DOE-RL to the Tri-Cities Development Council (TRIDEC). In 2016, TRIDEC conveyed this land to the City of Richland, Port of Benton, and Energy Northwest for purposes of industrial development (Figure 1.2; Tangent 2017).

Under the Proposed Action, future development of the PNNL Richland Campus could provide an additional 1 million square feet in a number of state-of-the-art facilities and associated infrastructure. As envisioned, these facilities would allow DOE to meet its strategic research objectives over the next 20 years. Specific facility locations and final facility designs for the proposed buildout are speculative and still being determined; therefore, this EA provides bounding analyses of the Proposed Action. The data used for the analyses in this EA were developed using actual data from recently built and currently operating facilities at PNNL (e.g., the William R. Wiley Environmental Molecular Sciences Laboratory [EMSL] and the Physical Sciences Facility Complex [PSF Complex]) (DOE 2013a).

Information contained in this EA will be used by DOE-SC to determine if the Proposed Action represents a major federal action that would significantly affect the quality of the human environment. If the Proposed Action is determined to be a major action with potentially significant environmental impacts, an environmental impact statement (EIS) would be required to proceed with the action. If the Proposed Action is determined to not be a major action that could result in significant environmental impacts, a Finding of No Significant Impact would be issued, and the action could proceed.

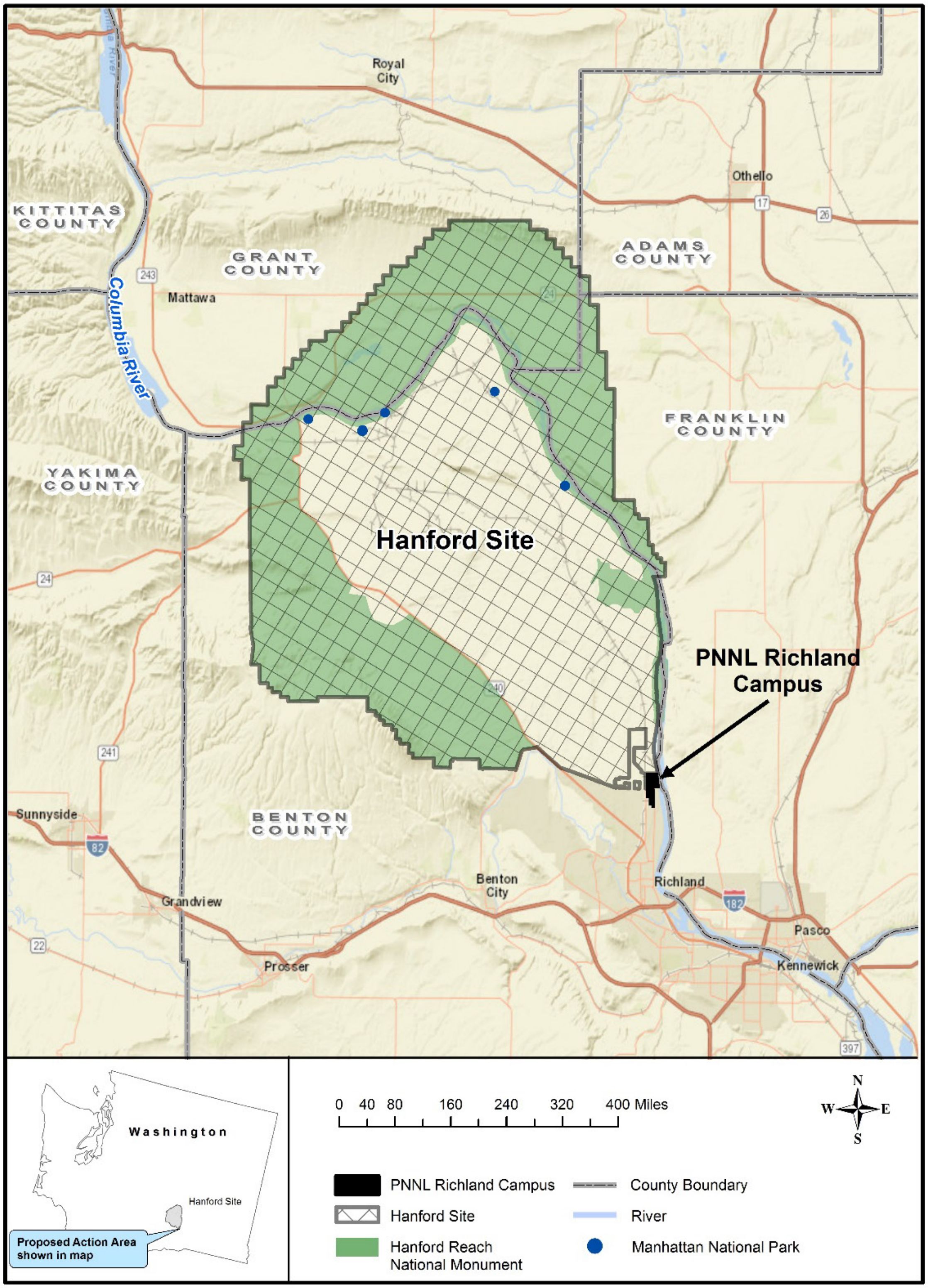

Figure 1.1. Hanford Site Location Map

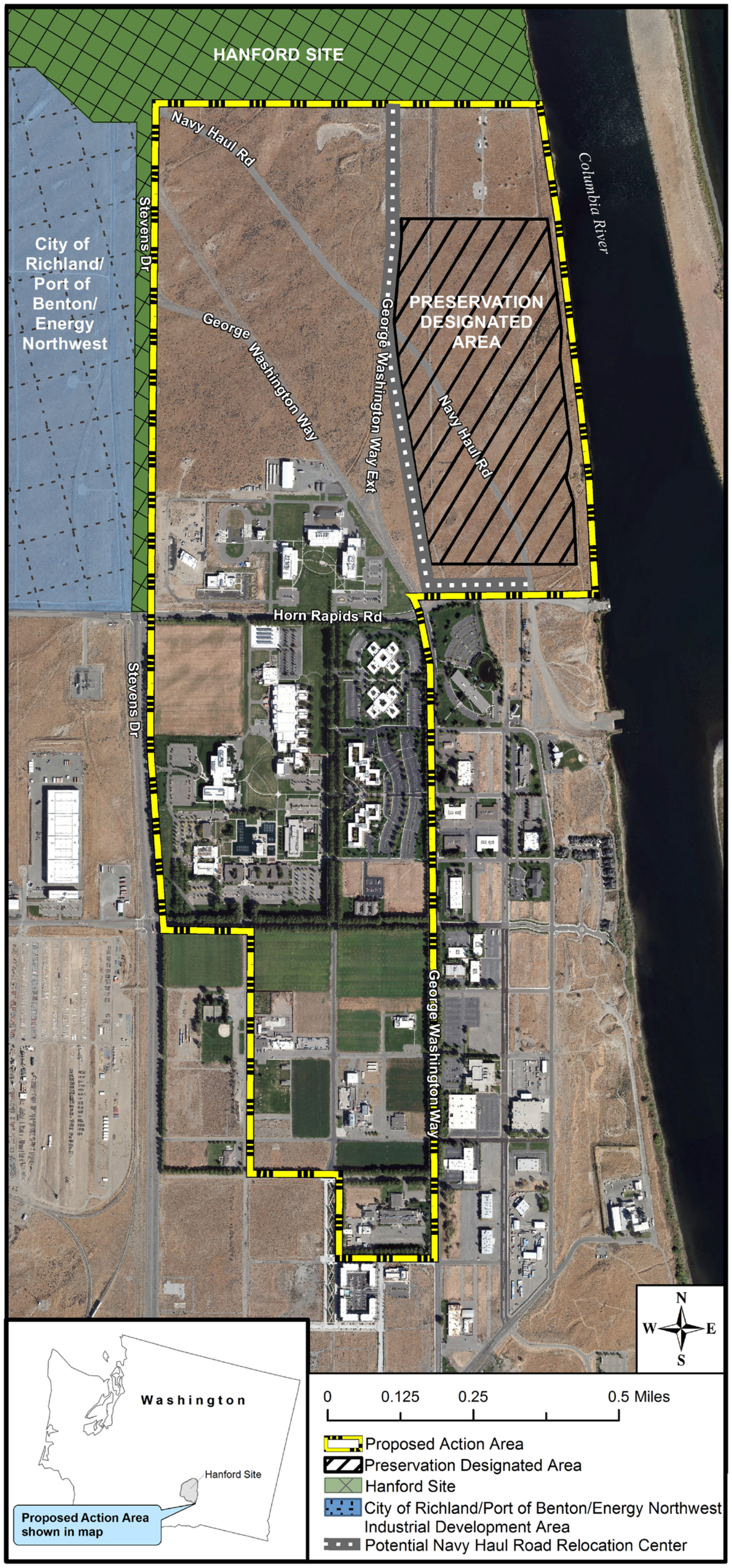

Figure 1.2. Proposed Action Area

1.1 Background

As one of 10 DOE-SC national laboratories, PNNL is a multi-program facility that conducts research in the areas of energy and environment, fundamental and computational science, and national security. Operated by Battelle Memorial Institute (Battelle) under contract to PNSO, PNNL also performs work for a diverse set of clients including the National Nuclear Security Administration; U.S. Department of Homeland Security; U.S. Nuclear Regulatory Commission; U.S. Environmental Protection Agency (EPA); other DOE Offices such as Environmental Management, Nuclear Energy, and Energy Efficiency and Renewable Energy (EERE); and many others. PNNL has more than 4,400 staff members and a 5-year average annual total operating cost of $880 million.

DOE development in and around the PNNL Richland Campus has been previously addressed in the following NEPA documents:

- Environmental Assessment for the Resiting, Construction, and Operation of the Environmental and Molecular Sciences Laboratory at the Hanford Site, Richland, Washington, DOE/EA-0959 (DOE 1994)
- Construction and Operation of a Physical Sciences Facility at the Pacific Northwest National Laboratory, Richland, Washington, DOE/EA-1562 (DOE 2007)
- Supplement Analysis to Final Environmental Assessment of Construction and Operation of a Physical Sciences Facility at the Pacific Northwest National Laboratory, Richland, Washington, DOE/EA-1562-SA-1 (DOE 2013b)
- Environmental Assessment for Future Development in Proximity to the William R. Wiley Environmental Molecular Sciences Laboratory, Pacific Northwest National Laboratory, Richland, Washington, DOE/EA-1958 (DOE 2013a)
- Proposed Conveyance of Land at the Hanford Site, Richland, Washington, DOE/EA-1915 (DOE 2015a).

In addition to development of the PNNL Richland Campus, DOE manages an approximately 41 ha (102 ac) limited access preservation designated area (PDA) in the northern portion of the PNNL Richland Campus along the Columbia River north of Horn Rapids Road for protection of cultural and biological resources (see Figure 1.2). Activities within the PDA during the proposed 20-year campus buildout would be limited to ongoing enhancement and protection of cultural and biological resources and occasional use of the existing Navy haul road. PNNL also manages an approximately 12 ha (30 ac) area in the northeast corner of the PNNL Richland Campus north of the PDA for protected materials storage and laboratory experiments (see Figure 1.2).

2.0 PURPOSE AND NEED FOR AGENCY ACTION

To meet the long-term federal agency mission need to enable discovery and advance science, DOE's Office of Science needs to provide laboratory space and associated infrastructure for existing research and development (R&D) capabilities at the PNNL Campus located in Richland, Washington. In addition, DOE would require facilities to support new research capabilities. To accomplish its scientific mission, PNNL requires a variety of facilities and equipment, including radiological and other specialized laboratories, advanced computational facilities, and office space. New and replacement facilities would be needed that could be adequately and appropriately secured, and that could be efficiently managed for the potential public risks associated with operations. New and replacement facilities should be constructed for efficient conduct of DOE's R&D mission, with considerations of minimizing energy use, life-cycle cost, and project uncertainty. The continuity of federal ownership and control should be considered in the siting and ownership of new and replacement facilities and infrastructure, along with the varying regulatory burdens associated with siting options.

3.0 PROPOSED ACTION DESCRIPTION AND ALTERNATIVES

3.1 Proposed Action

DOE proposes to develop the PNNL Richland Campus (campus) to allow PNNL to meet its current and anticipated future R&D needs. DOE proposes to construct and operate multiple buildings on the campus, including research laboratories, office space, support buildings, and associated infrastructure. The boundaries of the 269 ha (664 ac) campus are shown in Figure 1.2.

Under the Proposed Action evaluated in this EA, the facilities and infrastructure envisioned in the current *Pacific Northwest National Laboratory Richland Campus Master Plan* (PNNL 2017a) provide a bounding scenario for those that may be ultimately constructed and operated on the PNNL Richland Campus. The Proposed Action includes potential decontamination and demolition of buildings that DOE determines no longer support mission needs.

Under the Proposed Action, no activities would occur within the PDA except for actions related to the preservation and enhancement of cultural and biological resources, and continued use of the existing Navy haul road. Non-tribal, public access within the PDA would not be allowed without PNSO authorization.

An evaluation will be performed prior to the implementation decision for each new proposed development project to determine whether the scope and any associated impacts would be bounded by the scope and impacts described in this EA. Additional NEPA review would be conducted if it is determined that a new development proposal does not fall within the EA proposed action area (Figure 1.2), the development scope is different than that described in the following subsections of Section 3.1, or the environmental impacts are different than those described in Section 5.2.

3.1.1 PNNL Richland Campus Description

The proposed facilities and infrastructure that constitute the Proposed Action for this EA are based on the PNNL Richland Campus Master Plan (PNNL 2017a). Based on current building density, the campus has a carrying capacity of approximately 2 million square feet of new laboratory and office space. Of this carrying capacity, approximately 1 million gross square feet could be developed to replace capacity lost from exiting existing leases, replace capacity lost from vacating end-of-life facilities throughout the campus, and to support expanding research activities. The mix of types of proposed new facilities would generally match the following existing mix of PNNL's facility use:

- 40 percent – chemistry and biology laboratory facilities. Laboratories in these facilities are capable of analytical chemistry and biological research, typically performed at benchtop scale.
- 20 percent – computational and dry laboratory spaces.
- 20 percent – office buildings.
- 15 percent – radiological laboratory facilities. Laboratories in these facilities are capable of working with small amounts of dispersible radioactive material and sealed radioactive sources.
- 5 percent – warehouses, high-bay areas, storage areas, shops, and other support structures.

New buildings constructed in the next 20 years on the campus would typically be one or two stories high and constructed using a combination of brick/metal sided and glass fronts with earth-tone color combinations, similar to the exterior of the current PNNL buildings. New facilities with high bays could extend as tall as 15 m (50 ft) to accommodate relocated or new R&D projects. With the exception of exhaust stacks or potential new or replacement communication towers, no structures would be so high as to require nighttime lighting or any form of guy wires or tie downs. Some buildings may be constructed with basements; in those cases, the maximum excavation depth would be 15 m (50 ft). New infrastructure necessary to support the proposed buildout includes extension of service roads and utilities such as water (e.g., fire protection, potable, and irrigation), sanitary and process sewer, electrical power, communications, and natural gas.

While the actual construction schedule would be driven by funding availability, the plan could include continuous construction of smaller (< 1,860 m^2 [20,000 ft^2]) buildings, with the construction of an occasional larger (5,570 to 18,600 m^2 [60,000 to 200,000 ft^2]) building, for a total buildout of 92,900 m^2 (1.0 million ft^2). For purposes of impact assessment in this EA it is assumed that one to three buildings totaling approximately 6,970 m^2 (75,000 ft^2) could be under construction every year over the next 20 years, with an average construction time of 14 to 16 months per building whereas the larger buildings would take 2 to 3 years to complete. During this buildout period, PNNL staff would continue to use existing office and laboratory space until replacement capacity became available.

3.1.2 Building and Infrastructure Footprint

The impact analysis in this EA assumes that construction would occur in phases over the 20-year buildout period. At times during this process, land clearing and grading could occur simultaneously with building construction, post-construction landscaping, and operations and maintenance. Some existing buildings could be undergoing decontamination and demolition over the same period. Due to requirements such as infrastructure installation and foundation engineering, the entire campus (with the exception of the PDA north of Horn Rapids Road) could be impacted at some time during the 20-year buildout process. The amount of disturbed area at any one time would be dependent upon funding; however, at no time is it envisioned that the entire campus would be under construction in any given year. The current operational footprint and the anticipated operational footprint of the planned 20-year buildout is presented in Table 3.1.

Table 3.1. Operational Footprints within the PNNL Richland Campus[(a)]

	Operational Footprints		
Component	Current PNNL Facilities	Planned 20-Year Additions	Future Buildout
Buildings, including, for example, proximate loading docks and cooling towers	15 ha (37 ac)	Increase of 10–12 ha (25–30 ac)	25–27 ha (62-67 ac)
Roads and parking lots	29 ha (72 ac)	Increase of 20–22 ha (50–55 ac)	49–51 ha (122–127 ac)
Sidewalks	2 ha (4 ac)	Increase of 2 ha (3–4 ac)	3 ha (7–8 ac)
Irrigated area requiring a maximum water use of ~1 million gal/ac/y, if planted in grass[(b)]	75 ha (185 ac)	Decrease of 14–18 ha (35–45 ac)	57-61 ha (140–150 ac)
Open-space areas with grass or native vegetation[(c)]	148 ha (366 ac)	Decrease of 14–18 ha (35–45 ac)	130–134 ha (321–331 ac)

(a) Estimated acreages and conversions rounded for convenience.
(b) Includes lawn/grass and agricultural fields.
(c) Acreage includes undisturbed areas on the campus.

Three specific new facilities being considered by DOE as part of the 20-year campus buildout are two high-bay facilities and the Energy Sciences Capability Project (ESCP). Preliminary designs are discussed below as examples of new buildings that would be constructed as part of the proposed buildout. Final design and siting decisions for these facilities would depend on mission requirements, funding, and available siting options at the time of construction.

To meet the mission of the DOE's Bioenergy Technologies Office, PNNL conducts R&D of methods to convert bio-oil to liquid hydrocarbon fuels that could serve as gasoline, jet, and diesel blendstocks. As part of this program, the hydrotreater/distillation column is a capability developed by the Energy Processes and Materials Division at PNNL that produces a range of petroleum products from bio-oil feedstock.

PNNL's current hydrotreater/distillation column is a skid-mounted unit installed in a dedicated enclosure (about 9 m [30 ft] × 5 m [17 ft]) inside of the Process Development Laboratory West (PDLW) Facility high-bay work area. The hydrotreater/distillation column operates under high temperatures (typically up to 400°C) and pressures (typically up to 2,000 psig). During hydrotreatment, deoxygenation of bio-oil takes place to produce hydrocarbon products that are similar to gasoline, diesel, and jet fuel blendstock. Hydrotreatment is accomplished by adding hydrogen (supplied via a high-pressure compressor, storage bottles, and a distribution system) as feed along with the bio-oil in the presence of a catalyst. Distillation is then used to obtain the specific gasoline, diesel, and jet fuel blendstocks from the hydrotreated product. DOE is considering constructing a new approximately 650 m^2 (7,000 ft^2) facility in the undeveloped portion of the campus north of Horn Rapids Road (PNNL 2016a) to house the existing hydrotreater and future pilot-scale hydrotreaters. The new high-bay facility would include passive ventilation, hydrogen supply, nitrogen supply, electrical distribution, compressed air, and a water supply for a mist system. Facility safety setbacks would be developed based on a hazard assessment.

PNNL also has the need for a high-bay facility to support DOE's Wind and Water Power Technologies Office investments in Water Power Technologies to improve the biological performance (i.e., fish passage) of hydropower turbines, hydrokinetic devices, and related structures. The approximately 929 m^2 (10,000 ft^2) Water Power Technologies facility in the portion of the campus north of Horn Rapids Road (PNNL 2016a) would consolidate equipment currently located throughout PNNL that involves testing sustainable hydropower systems (e.g., fish respirometer; fish-turbulence test; fish strike, shear, and barotrauma test platforms; turbine test loop; and hydraulic testing capability) and have sufficient space and utilities to fully support testing of large (i.e., 1:25-scale) test beds, small hydro systems, and bioacoustics tag and tracking tools.

The ESCP Complex would contain a minimum of 40 laboratories and 152 office support spaces in a 120,000 square foot, multi-story building located on the campus, north of the Biological Sciences Facility. This complex would provide laboratory infrastructure to support catalysis research, including chemistry laboratories for chemical and nanomaterials synthesis, engineering process scale-up efforts, and high-resolution microscopy. Site construction for these facilities would include extension of electricity, water, sewer, communication, and other site utilities, and installation of road access, parking, sidewalks, and landscaping.

Some existing buildings on the PNNL Richland Campus, primarily south of Battelle Boulevard could undergo deactivation, decontamination, decommissioning and demolition during the 20-year buildout of the campus. Demolition activities within the scope of the River Corridor Project are included in the removal action work plan selected by the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA; 42 U.S.C. § 9601 et seq.), DOE/RL-2010-22, Revision 1 (DOE 2013c), *Action Memorandum for General Hanford Site Decommissioning Activities* (TPA-CN-0738).

Impacts from construction, operation and potential accidents are discussed in Chapter 5.0.

3.1.3 Radiological Facilities

No new facilities constructed during the 20-year buildout would be designated as either a Hazard Category 1, 2, or 3 nuclear facility. In the proposed new radiological facilities, dispersible and non-dispersible (e.g., sealed sources) radioactive materials used in research would remain consistent with types currently authorized under PNNL's Radioactive Air Emissions License (RAEL) 005. Such facilities would require a notice of construction (e.g., permit) from the Washington State Department of Health (WDOH). The current published list of radioactive materials handled or potentially handled at the campus can be found in the PNNL Campus Radioactive Air Emissions Report (Duncan et al. 2016). New radioisotopes are added to the license as necessary to meet changing DOE mission requirements.

> **DOE Nuclear Hazard Categories** (Source: DOE 2007)
>
> DOE Hazard Category 1, 2, and 3 facilities, as defined in DOE-STD-1027-92 (DOE 1997) are normally referred to as "nuclear facilities."
>
> **Hazard Category 1** facilities consist of those assigned the highest relative hazard levels (e.g., larger nuclear reactors). Category 1 facilities are associated with potential accidents that could produce significant consequences beyond the site boundary.
>
> **Hazard Category 2** facilities may involve work with significant quantities of dispersible radioactive materials. Category 2 facilities are associated with potential accidents that could produce significant consequences only within the site boundary.
>
> **Hazard Category 3** facilities involve work with smaller quantities of dispersible radioactive materials relative to those associated with Category 2 facilities. Category 3 facilities are associated with potential accidents that could only produce significant localized consequences.
>
> **Radiological** facilities contain less than Hazard Category 3 quantities of radioactive materials. Radiological facilities typically house activities involving small quantities of dispersible radiological materials.

The design and operations of the proposed radiological facilities would be governed by federal and state standards, such as but not limited to the following, from PNNL (2012):

- RAEL-005 would be updated for any new radiological emission points.
- Emissions of radionuclides to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive, in any year, an effective dose equivalent of 10 mrem/y (40 CFR Part 61 Subpart H, 61.92).
- Emissions of radionuclides in the air shall not cause a maximum effective dose equivalent of more than 10 mrem/y to the whole body to any member of the public (Washington Administrative Code [WAC] 173-480).

The monitoring requirements for emission from the new radiological facilities would be dictated under both federal and state regulations, such as but not limited to the following:

- EPA amended 40 CFR Part 61, Subpart H and 40 CFR Part 61, Appendix B Method 114.
- As referenced in Subpart H, the American National Standards Institute/Health Physics Society (ANSI/HPS) Standard N13.1-2011, *Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities* (ANSI/HPS 2011) requirements for major and minor emission points when new permitting actions are approved.
- WDOH amended WAC 246-247, *Radiation Protection—Air Emissions.*

Most, if not all, of the possible radiological-capable facilities would have sufficiently low limits on their radionuclide inventories such that active monitoring of their emissions would not be required. Total radioactive emissions from a facility can be categorized by their maximum potential dose impact to a public receptor. Potential impact categories are given a ranking from 1 to 5, with lower category numbers having greater potential impacts. New campus facilities would be a potential impact category 4, equivalent to a potential-to-emit of ≤0.001 mrem/y. At this level, the monitoring and sample analysis requirements would be limited to annual administrative review of building uses to confirm absence of radioactive materials in forms and quantities not conforming to prescribed specifications and limits (PNNL 2012).

Depending on mission requirements a portion of the buildings using radiological materials could be rated as potential impact category 2 facilities with potentials-to-emit of >0.1 and ≤5 mrem/y, requiring continuous sampling for record of emissions, with retrospective, offline periodic analysis. These facilities could have exhaust stacks as high as 11 to 14 m (35 to 45 ft), depending on whether the building is one or two stories, and require additional emission-control systems (e.g., high-efficiency particulate air filters and scrubbers and active monitoring systems) (PNNL 2012). The annual possession quantity and physical form of the radionuclides that could be used in a new radiological facility would be determined under a Notice of Construction Application to the WDOH, which would later be added to the campus radiological air emissions license (RAEL-005). As an estimate, Table 3.2 provides a representative inventory of radioactive materials by module, normalized to ^{239}Pu equivalent or tritium (^{3}H) equivalent curies (Ci), based on materials in use at the PSF Complex (DOE 2007).

Table 3.2. Representative PSF Complex Radioactive Material Inventory by Module (Inventory values in Ci Equivalent of ^{239}Pu or ^{3}H) (DOE 2007)

PSF Complex Module[(a)]	Sealed Source ^{239}Pu Equivalent (Ci)	Dispersible ^{239}Pu Equivalent (Ci)	Dispersible ^{3}H Equivalent (Ci)
Chemistry and Processing	0.00166	0.0158	0.00115
Materials Science & Technology	0.0	0.00937	162
Subsurface Science	0.0	0.266	0.0161
Radiation Detection	70.9	0.388	3.33
Certification and Dosimetry	51.1	0.225	27.7
Ultra-Trace	0.0	0.204	1.55
Total	122	1.19	195

(a) No "Shielded Operations" of DOE 2007 were implemented in actual PSF Complex operations, so were excluded from reporting here. A review of January 2017 PSF Complex inventories indicates the total inventories above remains conservative (overestimating).

Wastewater from radiological facilities are normally below the regulated levels for radioactive material content, but do have the potential for contamination in the event of a failure of an engineered barrier or administrative control. Current PNNL radiological facilities implement a retention process sewer system that collects wastewater from laboratory spaces where research with radioactive materials is performed. The wastewater is pumped into multiple retention tanks located in a mechanical room of the building. When a tank becomes full, a representative sample is collected and tested to verify the tank contents are below the screening criteria established in WAC 246-221-190 and Table III of WAC 246-221-290. If the analytical results indicate that the concentration is below the screening criteria, the wastewater is released to the City of Richland's sanitary sewer system via the building's process sewer system. If the results indicate the wastewater did not meet the screening criteria, the contents of the tank is transported to a waste treatment facility authorized or permitted to receive radiological material (Duncan et al. 2016). New radiological facilities would be expected to utilize a comparable system for wastewater discharge.

3.1.4 Chemical and Biological Laboratories

Of the likely future development, slightly less than half of the proposed square footage could be allocated to chemistry/biology laboratory facilities. Based on a 2017 review of the PNNL Chemical Management System database, the assumed chemical inventory that could be present on campus is provided in Table 3.3. The types and quantities of chemicals present in any facility and their usage rates would be expected to vary over time according to programmatic needs; however, because new facilities are intended to replace or consolidate existing facilities, current chemical usage provides a reasonable estimate of average inventories over the next 20 years. The quantities of hazardous chemicals present in the new facilities would be managed within applicable limits specified by the applicable National Fire Protection Association Code or the International Building Code (e.g., ICC 2014 or current standard) (DOE 2007). Explosives are managed in accordance with a DOE-approved site plan.

Table 3.3. PNNL Richland Campus Hazardous Chemical Inventory[(a)]

Chemical Hazard Group	Estimated Inventory
Flammable	
Gases (e.g., hydrogen)	1,138 kg (2,509 lb) (1,166 containers)
Solids (e.g., sodium sulfide)	1,236 kg (2,725 lb) (2,306 containers)
Liquids (e.g., alcohols)	2,399 kg (5,289 lb)
Liquefied Gas (e.g., propane)	(3,502 lb) (498 containers)
Oxidizing	
Gases (e.g., oxygen)	2,589 kg (5,707 lb) (430 containers)
Solids (e.g., nitrates)	453 kg (999 lb)
Liquids (e.g., hydrogen peroxide)	685 kg (1,511 lb)
Corrosive	
Gases (e.g., ammonia)	52 kg (114 lb) (102 containers)
Solids (e.g., silver nitrate)	4,112 kg (9,066 lb) (4,836 containers)
Liquids (e.g., acids)	19,673 kg (43,373 lb) (7,646 containers)
Unstable (Reactive)	
Gases (e.g., acetylene)	204 kg (451 lb)
Solids (e.g., calcium hypochlorite)	90 kg (199 lb)
Liquids (e.g., styrene)	114 kg (251 lb)
Water Reactive	
Solids (e.g., sodium)	239 kg (526 lb)
Liquids (e.g., trichlorosilane)	680 kg (1,500 lb)
Toxic	
Gases (e.g., nitric oxide)	62 kg (136 lb) (47 containers)
Solids (e.g., arsenic)	1,652 kg (3,642 lb) (3,375 containers)
Liquids (e.g., bromine)	1,142 kg (2,518 lb) (2,071 containers)
Highly Toxic	
Solids (e.g., sodium cyanide)	74 kg (163 lb) (700 containers)
Liquids (e.g., parathion)	100 kg (221 lb) (417 containers)
Pyrophoric	
Solids (e.g., lithium)	6 kg (12 lb) (102 containers)
Liquids (e.g., methyldichlorophosphine)	6 kg (12 lb) (126 containers)
Explosives or Blasting Agents (e.g., black powder)	10 kg (23 lb) (145 containers)
Organic-Peroxide	
Solids (e.g., benzoyl peroxide)	23 kg (50 lb)
Liquids (e.g., acrylic resins)	10 kg (22 lb)

(a) Inventory quantities are totals for each hazard group, based on data in the PNNL Chemical Management System database as of February 2017. Specific chemicals listed are examples of the types of chemicals included in each group. Numbers have been rounded.

Biomedical research is currently conducted at PNNL in support of federal agencies' research missions. This research is typically conducted in laboratories with biosafety containment levels specified by the Department of Health and Human Services' Centers for Disease Control and Prevention and the National Institutes of Health manual *Biosafety in Microbial and Biomedical Laboratories* (CDC and NIH 2009). Biosafety containment levels are ranked from one to four and are selected based on the agents or organisms used in the research. DOE does not currently operate any microbiological laboratory facilities at PNNL above biosafety level 2 (BSL-2). New facilities constructed during the 20-year buildout of the PNNL Richland Campus may include additional BSL-2 laboratory space. The Proposed Action does not include the construction or operation of laboratories with BSL-3 or BSL-4 containment. Development of BSL-3 or BSL-4 research laboratories would require a separate NEPA evaluation.

3.1.5 Site Preparation

Typical site preparation would consist of clearing and grubbing surface vegetation, installing soil-erosion controls, and removing superficial fill materials. Backfill materials would consist of crushed stone and structural fill, dense-graded aggregate, or other materials placed and compacted to levels recommended by the geotechnical engineer. Excavated soils would be stockpiled adjacent to building sites and would be re-used onsite to the maximum extent practical.

3.1.6 Utilities and Infrastructure

The utilities required to support the new facilities would be extensions of the current systems supplying the campus and would include the following:

- potable water distribution systems
- irrigation systems
- sewers, possibly including additional sewage lift station(s)
- natural-gas service, including mains and distribution system
- electrical service, including conduits, duct banks, vaults, switches, and services
- ductwork to provide fiber optic, telephone, and other communications connections
- possible upgrades to an existing substation or construction of a new substation.

The estimated energy and water needs at full buildout are provided in Table 3.4.

Table 3.4. Energy and Water Estimates for Full Buildout

Type of Building	Estimated Annual Electric Usage (kWh)	Estimated Average Monthly Demand (kW)	Estimated Annual Natural Gas Usage (Therms)[(a)]	Estimated Annual Water Usage (m^3 [10^6 gal])
R&D facilities and offices	27,599,435	3,151	375,891	140,000 (36.9)

(a) Therms – frequently used gas utility measure of gas consumption defined as 100,000 British thermal units.

The City of Richland would supply water, sewer, and electrical utilities for the proposed buildout. The current City of Richland electrical infrastructure that provides power to PNNL would need to be expanded over time to meet the projected future demand increase. Electrical infrastructure expansion may include an additional substation and/or additional transmission lines.

Sanitary wastes from restrooms, lunchrooms, and building mechanical spaces would be discharged to the City of Richland sewer system. Permitting is not required for these sanitary streams. Process wastewater from laboratory spaces would also be discharged to the City of Richland wastewater system and would meet City of Richland wastewater permitting limits. Process and sanitary wastewater systems would typically be segregated within each facility as part of the design process; thus, they are not combined. PNNL currently has permits with the City of Richland and it is anticipated that a similar permit(s) would be obtained for the future developments, or all could be incorporated into the existing PNNL permits.

Water needed during the March through September irrigating season would be Columbia River water from the Columbia River withdrawal system under existing water rights. The irrigated area on the PNNL Richland Campus is expected to decrease by 14 to 18 ha (35 to 45 ac) due to development of currently irrigated agricultural fields and increased use of xeriscaping and rock landscaping (see Table 3.1).

Based on current operations the buildout could also include standby diesel- or natural-gas-fueled generators to provide emergency backup power to meet mission critical needs. Any generator would normally operate no more than 50 hours annually for operational readiness and maintenance checks and consume less than 200 gal/y.

3.1.7 Access Roads and Parking Lots

Under the Proposed Action, as construction gradually extends north, the portion of George Washington Way from Horn Rapids Road to Stevens Drive could be eliminated to accommodate the buildout. Traffic flow on George Washington Way to the expanded campus and the Hanford Site would be rerouted to another main artery that would route traffic back to Stevens Drive. Future rerouting decisions would be coordinated with the City of Richland and DOE-RL when the need for this routing change arises.

George Washington Way would likely be the typical access route for construction deliveries into the new tracts as development progressed, until the buildout necessitated route relocation. At that time, deliveries would be made off Horn Rapids Road into the site until another intersection would be developed north of Horn Rapids Road on Stevens Drive to access the northern part of the future buildout area.

New service access roads and loading docks would be located to minimize traffic hazards on the main roadways. Support functions would be located in the same general vicinity as the main service courtyard area of new facilities because of the similar functional requirements for truck access and storage requirements. Parking areas would be sized to provide one parking space per employee, and additional visitor parking would amount to approximately 10 percent of the total employee parking. Parking spaces for disabled individuals would be provided in both the visitor and employee parking lots as required.

3.1.8 Navy Haul Road

As shown on Figure 1.2, a gravel road currently traverses the campus from southeast to northwest, beginning at the Port of Benton, crossing the undeveloped PDA, and then merging onto Stevens Drive. This route has been used since the 1980s to haul decommissioned, defueled Naval reactor compartment packages from barge transport to the 200 East Area Burial Grounds, Trench 94 disposal site.

Under the Proposed Action, the Navy would continue to use this haul road as needed into the foreseeable future. Transit time across the campus is typically less than one hour, occurring on weekends to the extent possible to minimize traffic disruption on the Hanford Site. Typically, one to five days prior to shipment the road would undergo minor maintenance and watering.

Pending a decision to proceed with the proposed buildout based on this EA, other DOE decision criteria, and future Navy mission requirements, there may be a need to relocate the Navy haul road within the boundaries of the campus. Because such a relocation decision would need to be based on factors such as final building layout designs, safety considerations, and other operation factors which are not available at this time, no specific route or alternatives for a new haul route are currently proposed. Although not part of the Proposed Action in this EA, the potential relocation of the Navy haul road in the campus north of Horn Rapids Road is considered one of the potential future site uses in the buildout of the campus. To preserve options for relocating the Navy haul road in the future, DOE would reserve an approximate 31 m (100 ft) wide corridor along the southern and western boundary of the PDA as a possible relocated route (see Figure 1.2). Other routes on undeveloped areas outside of the PDA, may be chosen depending on future Navy mission requirements, safety considerations, and the configuration of DOE facilities and roads at the time of relocation. Future relocation, expansion, or upgrade of the Navy haul road would be subject to DOE approval and would be assessed in a separate future NEPA review. The impacts of any relocation of the Navy haul road outside of the boundaries of the campus are considered as part of the cumulative impacts.

3.1.9 Post-Construction Reclamation

After each phase of building construction, all disturbed areas would be reclaimed with a combination of native and adaptive vegetation with limited areas of lawn grasses. Landscaping would transition from the manicured and ornamental characteristics found in the developed area of the current campus, to drought-tolerant native landscaping (i.e., use of indigenous plant materials that are low maintenance and require minimal watering).

While it is important to maintain some of the existing landscape character of the campus, future development on the campus would incorporate more drought-tolerant native landscape practices to improve campus sustainability. Increased use of xeriscaping and native and adaptive vegetation would reduce water consumption beyond an initial establishment period. Use of native landscaping is a commitment in the PNSO Cultural and Biological Resources Management Plan (DOE/PNSO 2015). Low-water irrigation systems may be installed for an establishment period only. Irrigated lawn areas would be limited to high-traffic areas that develop the spatial character of the campus and could double as amenity spaces for passive recreation and large events (PNNL 2017a).

3.1.10 Workforce

At the assumed rate of 1 to 3 buildings under construction every year, and based on recent construction experience on the campus, it is estimated that the peak construction workforce would be approximately 350 workers at any given time during the 20-year buildout. The total buildout is assumed to house approximately 1,500 to 2,000 staff. The transition into new facilities would occur slowly with an average of 25 to 75 staff per year relocated from old to new facilities, with a potential peak of approximately 250 staff per year, if a larger sponsor-funded facility was constructed.

3.1.11 Traffic

In addition to the maximum estimated workforce of approximately 350 construction workers at periods of peak construction, during some periods of construction there could be an additional 10 to 15 concrete trucks/day contributing to peak-hour traffic.

Because PNNL staffing is assumed to remain fairly flat under the Proposed Action, there would not be a noticeable increase in traffic due to changes in staffing levels at the PNNL Richland Campus. However, if some or all of the currently occupied privately owned and/or leased space near the campus is back-filled with new tenants, there could be an increase in traffic in the vicinity of the campus over the next 20 years.

3.1.12 Water Runoff and Spill Management

Under the Proposed Action, stormwater runoff from the proposed buildings, roads, and parking areas would be collected and discharged onsite to ground using a combination of surface swales, underground percolation beds, and underground injection control (UIC) wells. UIC wells used for discharge of stormwater to ground would be registered with Washington State Department of Ecology (WA Ecology). No additional stormwater would enter the City of Richland system.

Spill containment measures would be employed at laboratory facility loading dock areas to prevent contamination of stormwater. Such measures would include installation of spill containment trenches, staff training on spill prevention and response, and transporting chemicals or wastes in secondary containment. Overfill prevention systems and spill containment measures would also be provided at the fueling area for the diesel standby generator(s) (DOE 2007).

3.1.13 Pollution Prevention and Waste Minimization

Consistent with the requirements and guidance of regulations and Executive Orders (EOs), including the Pollution Prevention Act of 1990 (42 U.S.C. § 13101) and Planning for Federal Sustainability in the Next Decade (Executive Order 13693; 80 FR 15871), DOE incorporates pollution prevention, waste-minimization practices, and sustainability goals in construction and operation of all facilities. Pollution prevention is defined as the use of materials, processes, and practices that reduce or eliminate the generation and release of pollutants, contaminants, hazardous substances, and wastes into land, water, and air. Pollution prevention includes practices that reduce the use of hazardous materials, energy, water, and other resources along with practices that protect natural resources through conservation or more efficient use. Within DOE, pollution prevention includes all aspects of source reduction as defined by the EPA and incorporates waste minimization by expanding the EPA definition of pollution prevention to include recycling. Pollution prevention is applied to all DOE pollution-generating activities, including laboratory research, development, and demonstration projects.

Pollution prevention in construction and operation of the proposed facilities would be achieved through the following best practices:

- equipment or technology selection or modification, process or procedure modification, reformulation or redesign of products, substitution of raw material, waste segregation, and improvements in housekeeping, maintenance, training, and inventory control
- efficiency in the use of raw materials, energy, water, or other resources
- recycling to reduce the amount of waste and pollutants destined for release, treatment, storage, and disposal (DOE 2007).

3.1.14 Emergency Preparedness

The PNNL Emergency Management Plan is written in accordance with state and federal regulations to protect workers, public health and safety, and the environment in the event of an emergency affecting PNNL (2016b). For new facilities, building emergency procedures would be developed to describe types of hazards and operations associated with the facility as well as any administrative controls or engineered systems in place to mitigate the consequences of accidents or other off-normal events. Those controls would be commensurate with the level of risk associated with facility operations (DOE 2007).

PNNL-occupied facilities located on the campus north of Horn Rapids Road and southwest of George Washington Way are within the City of Richland, and emergency services are provided by the city. Emergency services for the undeveloped area north of Horn Rapids Road and George Washington Way are provided by the Benton County Sherriff's Department and the Hanford Fire Department.

3.1.15 Safeguards and Security

In accordance with requirements in DOE Order 470.4B, Change (Chg) 2, *Safeguards and Security Program* (DOE 2017a), and implementing guidance, PNNL currently maintains a comprehensive safeguards and security program. PNNL employs a graded physical protection program that is systematically planned, executed, evaluated, and documented as described in a safeguards and security plan. Under this approved program, DOE assets are appropriately protected from malevolent acts (e.g., theft, diversion, and sabotage) and from other events (e.g., natural disasters and civil disorder) by considering site and regional threats, protection-planning strategies, and protection measures (DOE 2007).

Based on threat assessments and protection-planning strategies, new facilities would be designed to provide the appropriate level of physical protection required by DOE for Property Protection Areas

(PPAs) and Limited Areas (LAs). PPAs would be established where required to protect government-owned property against damage, theft, or intentional destructive acts. Access control to PPAs would be implemented to protect employees, property, and facilities. Access control includes automated access control systems (i.e., proximity card readers and/or lock systems). Signs prohibiting trespassing would be posted around the perimeter and at each entrance to the PPA. Physical barriers (e.g., fences, walls, and doors) may be used to identify the boundary of the PPA.

LAs are security areas designated for the protection of classified matter and certain types of special nuclear material. LAs are defined by physical barriers encompassing the designated space and access controls to ensure that only authorized personnel are allowed to enter and exit the area. Physical barriers (e.g., fences, walls, and doors) may be used to identify the boundary of the LA. PNNL protection strategy for LAs typically consists of exterior and/or interior walls of commercial-grade construction, with the only criteria that the interior walls extend from the “true” floor to the “true” ceiling. General Services Administration-approved security containers would be used to store classified matter and some special nuclear materials.

PNNL would implement special security measures when warranted by an increased threat of intentional destructive acts or other events. The types and frequency of measures implemented would depend on the declared threat level and would employ a graded approach that involves actions by staff, onsite security personnel, and community emergency response agencies as applicable (DOE 2007).

3.2 No Action Alternative

Under the No Action Alternative, PNNL would not obtain replacement facilities for outdated existing facilities or provide new facilities for PNNL staff and existing and future research missions. Without new state-of-the-science facilities, under the No Action Alternative at some time during the next 20 years PNNL would be unable to provide the scientific research required to meet DOE-SC’s future mission needs.

3.3 Alternatives Evaluated but Dismissed from Detailed Analysis

To meet the future mission needs of DOE, the aging offices and laboratories currently occupied by PNNL must be updated and new facility space must be constructed. As part of its evaluation process DOE evaluated two additional siting alternatives:

- using existing federally owned facilities and land at or near the campus
- using existing privately owned facilities at or near the campus.

As explained in the following sections, because neither of these alternatives was determined to be a reasonable alternative to the proposed campus buildout, the environmental impacts were not evaluated in detail.

3.3.1 Using Existing Federally Owned Facilities

To meet future mission needs, DOE considered the option of relocating PNNL technical capabilities to other existing DOE-owned facilities. Because there is not enough existing facility space at the Hanford Site/300 Area to accommodate future DOE’s mission needs, other facilities dispersed across the Hanford Site were considered.

This alternative would not result in optimum co-location of technical capabilities on the campus to promote collaboration and efficient use of unique or common resources needed by different programs because it would result in fragmentation of the laboratory and isolation of research staff from other resources in existing PNNL facilities (DOE 2007). Older buildings at the Hanford Site were constructed for different purposes than DOE's current mission needs and would require upgrades to meet current building standards and mission requirements. Renovations would be costly and operations would be more limited and inefficient than in new purpose-built facilities. Current mission requirements may also conflict with ongoing remediation activities at the Hanford Site. The dispersed nature of Hanford Site facilities would also complicate security considerations associated with some of PNNL's proposed R&D activities.

3.3.2 Using Existing Privately Owned Facilities

Leasing facilities outside the PNNL Richland Campus could potentially meet DOE's need for additional facility space. However, DOE considers this option to have considerable uncertainty because of the number of leased facilities required to accommodate space needs and the lack of federal control over leased space. Renovations may be required to convert existing space to meet DOE's mission needs, and DOE's investment in these improvements would be lost on the expiration of the lease. In addition, the use of privately owned facilities may co-locate research activities with potential public risk with other public-use facilities. Further, privately owned facilities may be subject to regulatory restrictions in addition to those on federally owned land.

This alternative also would not result in optimum co-location of technical capabilities to promote collaboration and efficient use of unique or common resources needed by different programs because it would result in fragmentation of the laboratory and isolation of research staff from other resources in existing PNNL facilities.

4.0 AFFECTED ENVIRONMENT

The PNNL Richland Campus that would be developed under the Proposed Action is shown in Figure 1.2. Aspects of the site and its environs that might be affected by the development of the campus over the next 20 years are described in this section.

4.1 Land Use

The PNNL Richland Campus includes developed industrial areas and vacant undeveloped land. The campus is a relatively level parcel of land covering about 269 ha (664 ac). The undeveloped area north of Horn Rapids Road (51 ha [127 ac]) is covered with a mix of desert-adapted shrubs and grasses. The balance of the campus has been developed with PNNL facilities, with the exception of some remaining agricultural tracts. The portion of the campus north of Horn Rapids Road was designated as Industrial in a 1999 DOE Record of Decision (64 FR 61615) for the *Hanford Comprehensive Land-Use Plan EIS (HCP EIS)* (DOE 1999). With the exception of the PDA, which is designated as natural open space, the entire campus is within the City of Richland urban growth area (Benton County Washington 2015a) and designated by the City of Richland as a Business Research Park (City of Richland 2017a).

Land uses on the campus and in nearby areas (within 1.6 km [1 mi] of the campus) include the following:

- Existing PNNL facilities, including the EMSL and other research laboratories and support buildings.
- Businesses located east of George Washington Way and south of Horn Rapids Road, including the Penford potato starch production facility and other small laboratories and offices.
- The Columbia River, located due east, which supports a diverse mix of recreational uses.
- Willow Pointe, a community of residences along the Columbia River, south of Battelle Boulevard.
- The Port of Benton docking facility, located east of the campus on the Columbia River, used for transferring Naval reactor compartment packages and other materials destined for the Hanford Site. A haul road connecting the barge facility to Stevens Drive traverses the undeveloped area north of Horn Rapids from southeast to northwest.
- The Washington State University (WSU)-Tri-Cities branch campus, Hanford High School, and residential areas, located to the south and east.
- Occupied and undeveloped Hanford Site land.
- Industrially and agriculturally developed land located to the west and southwest (all zoned Industrial by the City of Richland) including the Horn Rapids Sanitary Landfill (closed).
- Innovation Center, a 40 ha (100 ac) business park, home to The Lofts at Innovation Center apartments, the University Square retail area, and other commercial sites.
- City of Richland/Port of Benton/Energy Northwest Industrial Development Area to the northwest.

4.2 Air Quality

The PNNL Richland Campus is in Benton County. Benton County, along with Franklin, Kittitas, Klickitat, Walla Walla, and Yakima Counties, are part of the South Central Washington Intrastate Air Quality Control Region (AQCR) (40 CFR 81.189). An AQCR is an area designated by the EPA for the attainment and maintenance of National Ambient Air Quality Standards (NAAQS). The EPA has set NAAQS for six "criteria" pollutants, including carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (PM), and sulfur dioxide (SO_2). All counties within the South Central Washington Intrastate AQCR are listed as "unclassified/attainment" or "better than national standards" for all criteria air pollutants (40 CFR 81.348). In general, air quality within this region is good, with some exceptions caused by blowing dust. Atmospheric dispersion also tends to be good; however, periods of stagnation can occur during the winter months.

4.2.1 Radiological Air Emissions

Federal regulations (40 CFR Part 61, Subpart H) require the measurement and reporting of radionuclides emitted from DOE facilities and the resulting offsite dose from those emissions. Those regulations impose a dose standard of 10 mrem/y to a maximally exposed individual (MEI) of the public, which is not to be exceeded. Washington State has adopted the 10 mrem/y federal dose standard (WAC 246-247-040(1)), but also requires inclusion of dose contributions from fugitive emissions, radon, and non-routine events (WAC 246-247-040(6)). Washington State, in addition to the MEI dose standard, also requires calculating the dose at the point of maximum annual air concentration in an unrestricted area where any member of the public may be (WAC 173-480).

Table 4.1 lists the total radiological MEI dose from PNNL Richland Campus radionuclide emissions for the past five years, including fugitive emissions, radon, and non-routine events (Anderson 2016). The MEI doses are well below the 10 mrem/y standard (see campus MEI dose, Table 4.1). PNNL also operates facilities that may emit radionuclides to the air (predominantly, Building 325 and Building 331, but also Building 318 and Building 361) north of the campus in the 300 Area of the adjacent Hanford Site. Total radiological MEI doses from these facilities are up to 0.28 mrem/y (see Hanford Site MEI dose, Table 4.1), and although higher than the PNNL Richland Campus MEI doses, are still significantly less than the 10 mrem/y standard.

Table 4.1. PNNL Operations Offsite MEI Doses (mrem/y) for 2011 through 2015.

Year	PNNL Richland Campus MEI Dose (mrem/y)	Percent of 10 mrem/y Standard	PNNL on Hanford Site MEI Dose (mrem/y)	Percent of 10 mrem/y Standard
2011	0.000017	< 0.01	0.024	0.2
2012	0.000010	< 0.01	0.025	0.3
2013	0.000020	< 0.01	0.13	1.3
2014	0.000030	< 0.01	0.28	2.8
2015	0.00026	< 0.01	0.13	1.3

Ambient air monitoring for radionuclides is required by Washington State (RAEL-005). At this time, PNNL maintains and operates five ambient air sampling stations. Four stations are on the campus, and one background station is located in Benton City, Washington.

Several privately or publicly owned facilities capable of generating airborne radioactive emissions are located within 29 km (18 mi) of the PNNL Richland Campus, including other sources on the Hanford Site, a low-level waste burial site operated by U.S. Ecology on the Hanford Site 200 Area plateau, the Energy Northwest Columbia Generating Station (CGS), the Test America laboratory, AREVA Federal Services LLC, Perma-Fix Northwest, Inc., and the Unitech Services, Inc. Radionuclide emissions from these facilities are separately regulated as required by applicable regulations.

4.3 Soils and Geological Resources

Soil survey information, including soil maps, are available for the majority of the United States via the Natural Resources Conservation Service (NRCS) Web Soil Survey (NRCS 2016a). Soil mapping in NRCS (2016a) is available only for the southern portion of the PNNL Richland Campus (the 40 percent of the campus area that lies south of Horn Rapids Road). Soils on the northern portion of the campus (and the Hanford Site itself) have not been mapped to date by the NRCS. About 70 percent of soils south of Horn Rapids Road map to the Burbank loamy fine sand unit, which has a farmland classification of "not prime farmland" (NRCS 2016a). Associated with the dominant Burbank loamy fine sand unit are areas of Finley fine sandy loam soils, classified as "prime farmland if irrigated" (NRCS 2016a). The Finley fine sandy loam unit occurs over about 20 percent of the southern portion of the PNNL Richland Campus, with the majority of these soils (about 9 ha [22 ac]) occurring in the irrigated fields south of Battelle Boulevard. About 7 percent of the southern campus soils are Quincy loamy sand, classified as "farmland of statewide importance" (NRCS 2016a), which designates land that does not meet the criteria for prime farmland, but is still valuable for production. The majority of these soils (about 5 ha [12 ac]) occur in the fields immediately south of Horn Rapids Road and east of Stevens Drive. Quincy loamy sand is the dominant soil unit west of the PNNL Richland Campus.

Duncan (2007) describes the characterization and distribution of surface soils on the Hanford Site based on the soil survey of Hajek (1966). According to information in Hajek (1966), the most common soil types in the area of the PNNL Richland Campus are Rupert sand and Burbank loamy sand, each of which may be associated with small areas of Ephrata sandy loam. Soil classifications change over time and documentation of the correlation between soil units in Hajek (1966) and the current soil map units documented in NRCS (2016a) could not be found. No Rupert series is listed in the NRCS official soil series descriptions (NRCS 2016b); however, it has been correlated with the Quincy series (Hajek 1966; PNNL 2017b). The Ephrata sandy loam soil identified in Hajek (1966) may be correlated with the Finley fine sandy loam soil found in the southern part of the PNNL Richland Campus.

Assuming the unmapped soils on the PNNL Richland Campus north of Horn Rapids Road occur similarly to the mapped soils on the southern portion of the campus, the majority of the soils on the northern portion of the PNNL Richland Campus would have a farmland classification of "not prime farmland." Approximately 20 percent of the soils on the northern campus (about 30 ha [75 ac]) would be classified as "prime farmland if irrigated," and 7 percent (about 10 ha [25 ac]) would be classified as "farmland of statewide importance." About one-half of the campus area north of Horn Rapids is open-space area and outside the PDA and the limited development area.

The gravel-dominated sediments of the Hanford Formation underlie the surface soils at the PNNL Richland Campus. The thickness of the Hanford sediments ranges from about 12 to 24 m (39 to 79 ft) north of Horn Rapids Road (DOE 2013d) and is expected to be similar across the southern portion of the campus (DOE 2016a). Hanford Formation sediments are typically very permeable to water. In general, the water table across the PNNL Richland Campus lies within the lower portion of the Hanford Formation sediments. Underlying the Hanford Formation are sediments of the Ringold Formation, which are generally finer-grained, more consolidated, and significantly less permeable to water flow than the sediments of the Hanford Formation.

4.4 Water Resources

This section describes the affected environment for water resources for the PNNL Richland Campus.

4.4.1 Surface Water

There are no naturally occurring surface waterbodies on the PNNL Richland Campus. The nearest waterbodies are the Columbia River, adjacent to the northern portion of the campus and about 0.5 km (0.3 mi) east of the southern portion of the campus and the Yakima River, about 5 km (3 mi) southwest of the PNNL Richland Campus. The flow rate and water surface elevation of the Columbia River near the PNNL Richland Campus are regulated by upstream dams, the nearest of which is Priest Rapids Dam. Columbia River flows near the campus are also influenced by the nearest downstream dam (McNary Dam), which has an impoundment that extends to the Hanford Site 300 Area. Columbia River discharge at the Hanford Site varies seasonally; average monthly discharge between 1960 and 2015 varied from about 2,200 m^3/s (78,000 ft^3/s) in September to 5,690 m^3/s (201,000 ft^3/s) in June (USGS 2015). The highest daily mean discharge over the same period was 15,100 m^3/s (533,000 ft^3/s) in June 1961 (USGS 2015). Daily discharge fluctuations from upstream dams can result in river stage fluctuations at the Hanford Site of up to 3 m (10 ft) during a 24-hour period (Duncan 2007).

The City of Richland operates groundwater-recharge basins located about 0.6 km (0.4 mi) south of the PNNL Richland Campus. These basins are used to infiltrate water pumped from the Columbia River, which is subsequently pumped from nearby groundwater wells as a city water supply (Duncan 2007).

4.4.2 Flooding

The Federal Emergency Management Agency (FEMA) floodplain map for Richland (FEMA 1984) extends north to Horn Rapids Road and indicates that the southern portion of the PNNL Richland Campus, with a ground-surface elevation of about 122 m (400 ft), would be unaffected by the 100-year flood. There is no direct estimate of the flood hazard at the northern portion of the PNNL Richland Campus, which is adjacent to the Columbia River and has a ground-surface elevation less than 122 m (400 ft) near the river. However, the shoreline is relatively steep, with the ground-surface elevation greater than 116 m (380 ft) at a distance of about 91 m (300 ft) from the river. Development is expected to occur further to the west of the Columbia River where the ground-surface elevation is about 122 m (400 ft) and would be unaffected by the 100-year flood.

Duncan (2007) states that the 100-year regulated flood discharge for the Columbia River along the northern boundary of the Hanford Site is estimated to be 12,500 m^3/s (440,000 ft^3/s); corresponding discharge at the PNNL Richland Campus will be somewhat larger. There are no direct estimates of the flood hazard at the PNNL Richland Campus for floods larger than the 100-year flood. However, based on modeling conducted in 1976, Duncan (2007) suggests that the campus would be unaffected by the probable maximum flood on the Columbia River, a discharge of about 39,600 m^3/s (1 million ft^3/s). A flood of this magnitude would result in a water surface elevation of 119 m (390 ft) at CGS, located about 12 km (8 mi) north of the PNNL Richland Campus (Energy Northwest 2011). The probable maximum flood has an unspecified, but very large return period (generally much greater than 500 years). The largest flood of record for the Columbia River occurred in 1894 with an estimated peak discharge of 21,000 m^3/s (742,000 ft^3/s) at the Hanford Site (Duncan 2007). The likelihood of a flood of this magnitude re-occurring has been reduced by the construction of upstream dams that regulate flow for flood control. The U.S. Army Corps of Engineers regulated standard project flood used at CGS is 16,100 m^3/s (570,000 ft^3/s) (Energy Northwest 2011). The standard project flood has an unspecified return period, usually greater than several hundred years (Linsley et al. 1992).

4.4.3 Groundwater

Groundwater in the region of the PNNL Richland Campus originates as recharge from rainfall and snowmelt, from excess irrigation, and from the Yakima River (DOE 2016a). The City of Richland's recharge basins and the Columbia River also contribute to groundwater in the immediate vicinity of the campus. Natural recharge rates for the soils occurring at the PNNL Richland Campus are low, 2.6 to 55.4 mm/y (0.1 to 2.2 in./y) depending on the type and amount of vegetation (Fayer and Walters 1995), so that the majority of groundwater at the campus likely originates offsite. Groundwater at the PNNL Richland Campus occurs in the unconfined aquifer of the Hanford and upper Ringold sediments and in deeper basalt-confined aquifers. The unconfined aquifer in the area of the site is about 5.6 to 9 m (18 to 30 ft) thick. Groundwater elevations measured during March 2015 varied from about 106 to 109 m (344 to 351 ft) across the campus (DOE 2016a). Over the long term, groundwater elevations across the campus have varied from 105 to 110 m (345 to 361 ft) (DOE 2016a), with elevations generally increasing from north to south. Groundwater elevations have consistently been less than 107 m (351 ft) north of Horn Rapids Road. With a ground-surface elevation of about 122 m (400 ft), depth to groundwater is normally more than 12 m (40 ft) across the campus, except near the Columbia River. Groundwater in the unconfined aquifer at the PNNL Richland Campus generally flows to the east and discharges to the Columbia River, but has a northerly flow component due to the influence of groundwater mounding beneath the City of Richland's recharge basins to the south. Groundwater flow is also influenced by the Columbia River stage. When the river stage is higher than the unconfined groundwater elevation, river water may flow into, and mix with, the groundwater. This mixing is not significant at the PNNL Richland Campus except near the river in the northeastern portion of the campus, where no development is expected.

Groundwater quality at the PNNL Richland Campus has been affected by Hanford Site activities, the Horn Rapids Sanitary Landfill (located about 0.7 km [0.4 mi] west of the campus), and other offsite activities. The latest Hanford Site groundwater monitoring report (DOE 2016a) describes groundwater quality at the PNNL Richland Campus based on contaminant measurements from wells located on and around the campus (DOE 2016a, 1100-EM Chapter). Tritium concentrations above background level (142 pCi/L) were reported in wells on and near the PNNL Richland Campus in 2015 (DOE 2016a). The highest concentrations, all less than the drinking water standard (20,000 pCi/L), were from Hanford Site 300 Area wells north of the PNNL Richland Campus. The maximum tritium concentration reported in 2015 for a well on the campus was 295 pCi/L (DOE 2016a). Nitrate concentrations have likely exceeded the 45 mg/L equivalent drinking water standard across the majority of the campus for a number of years, with the highest measured concentrations in the area near the Horn Rapids Sanitary Landfill (DOE 2016a). A nitrate concentration of 88.8 mg/L was reported for a well on the northern portion of the campus sampled in 2014 (DOE 2016a). Uranium concentrations in excess of the drinking water standard (30 μg/L) were measured in groundwater downgradient of the AREVA facility located about 0.3 km (0.2 mi) southwest of the Horn Rapids Sanitary Landfill (maximum observed concentration of 43.2 μg/L in 2015), and in 300 Area wells (observed concentration of 45.1 μg/L in 2015 at the nearest well, about 300 m [1,000 ft] north of the campus boundary) (DOE 2016a). Uranium concentrations in groundwater measured in wells on and adjacent to the PNNL Richland Campus have not exceeded 15 μg/L since 1987 (DOE 2016a). Trichloroethene concentrations near the Horn Rapids Sanitary Landfill and adjacent to the PNNL Richland Campus were less than 1 μg/L in 2015, near or below the detection limit (DOE 2016a).

4.5 Cultural and Historical Resources

Cultural and historic resources are the remains of past human activities and include prehistoric and historic-era archaeological sites, historic districts, and buildings, as well as any site, structure, or object that is at least 50 years old. Traditional cultural properties (TCPs), which are properties important for maintaining the culture of a living community of people, are also considered here. The National Register of Historic Places (NRHP)[1] is a list that recognizes cultural resources that have been deemed to have historic significance. To qualify as NRHP-eligible, a site must meet at least one of the four criteria detailed at 36 CFR 60.4, Criteria for Evaluation (Criterion A-D) and the site must also possess integrity.[2] Cultural resources that are either NRHP-eligible or NRHP-listed are afforded special attention under both NEPA (42 U.S.C. § 4321 et seq.) and National Historic Preservation Act (NHPA; 54 U.S.C. § 300101) because they require avoidance or mitigation of adverse impacts. NEPA must take into consideration

[1] "The NRHP means the National Register of districts, sites, building, structures, and objects significant in American history, architecture, archaeology, engineering, and culture that the Secretary of the Interior is authorized to expand and maintain pursuant to Section 101(1) of the National Historic Preservation Act of 1966, as amended" (36 CFR 67.2).
[2] The NPS defines integrity as the "… ability of a property to convey its significance" (NPS 2002).

impacts to all cultural resources and resources that have additional cultural value beyond NRHP-eligibility recognition (e.g., sacred sites and unique natural areas of aesthetic value).

This section presents background information on the prehistory and history of the Proposed Action area, along with a description of the archaeological sites, TCPs, and architectural resources located on the PNNL Richland Campus. It also describes the NRHP-eligibility status of each resource. An NHPA Section 106 review is being performed in parallel to this NEPA assessment, and would be completed in consultation with Tribal consulting parties, interested parties, the Washington State Historic Preservation Officer (SHPO), and the Advisory Council on Historic Preservation (ACHP).

The cultural resources of the Columbia Plateau are diverse, ranging from early pre-contact times to the Atomic Age. Of relevance to the PNNL Richland Campus are the historic contexts for three distinct cultural landscapes: the Native American Cultural Landscape, the Early Settlers and Farming Cultural Landscape, and the Manhattan Project and Cold War-Era Cultural Landscape.

Archaeological investigations conducted on the Columbia Plateau enabled the creation of a cultural chronology dating back to the end of the Pleistocene. Native Americans have lived in and around the region for thousands of years. More than 8,000 years of pre-contact human activity have left extensive archaeological deposits along the Columbia River and, to a lesser degree, the off-river interior.

Ethnographically, the Sahaptin-speaking Cayuse, Walla Walla, Palouse, Nez Perce, Umatilla, Wanapum, and Yakama used this locale in the Columbia Plateau region. During this period, local residents relied on a pattern of seasonal rounds that included semi-permanent residences in villages along major waterways during the winter months with a focus on harvesting salmon and other anadromous fish. Seasonal camps were used in the inland areas during the spring and summer months as small groups would travel into the canyons and river valleys to gather roots in the spring then into the mountains to gather ripening berries in late summer. In late fall, the seasonal cycle ended and families returned to the winter villages (Bard and McClintock 1996; Dickson 1999; Chatters 1980; and Galm et al. 1981).

Important cultural sites associated with both the pre-contact and ethnohistoric eras are located on the PNNL Richland Campus. Native American descendants of the area's original inhabitants continue to use portions of the PNNL Richland Campus for traditional cultural purposes and to access traditional resources and places located on the PNNL Richland Campus. These descendants include members of four federally recognized Tribes (i.e., the Yakama Nation, Nez Perce Tribe, Confederated Tribes of the Umatilla Indian Reservation [CTUIR], and the Confederated Tribes of the Colville Reservation) and the Wanapum (a non-federally recognized tribe that have strong ancestral, cultural, and historical ties to the PNNL Richland Campus).

Three of the federally recognized Tribes have treaties with the U.S. government. In June 1855, at Camp Stevens in the Walla Walla Valley, representatives of the United States negotiated treaties with leaders of the 14 Tribes and bands of what would become the Yakama Nation, one with the three Tribes that would become the CTUIR, and one with the Nez Perce Tribe. The U.S. Senate ratified the treaties in 1859. When signing the treaties, the three Tribes agreed to cede large blocks of land to the United States. The PNNL Richland Campus is located within the CTUIR's ceded lands. The Tribes retained certain lands for their exclusive use (the three reservations) and also retained certain rights and privileges to continue traditional activities outside the reservations. The Confederated Tribes of the Colville Reservation was established by Presidential Executive Order in 1872 and now includes descendants of 12 aboriginal Tribes including several with historical ties to the Hanford area (Palouse, Moses Columbia, and the Nez Perce of Chief Joseph's Band).

The Lewis and Clark expedition of 1805 began the Euro-American exploration and settlement of the general region. The explorers sought trade items from Native Americans and trade routes were established. It was not until the late 19th and early 20th centuries, however, that the area was intensively settled. During this period, settlers farmed and raised livestock, mined, and built settlements along the Columbia River. Historic archaeological resources mark the locations where gold mining, stock raising, farming, and drilling for natural gas took place from the 1850s to 1943. Near the PNNL Richland Campus, historical activity began in the early 1900s in the region around Richland to the south and the community of Fruitvale to the north, when farming communities expanded with the construction of large-scale irrigation projects, including canals.

Tribes used portions of the PNNL Richland Campus throughout the historical period up until 1943, when both Euro-American settlers and Native Americans were forced to relocate so that the federal government could develop the land for the Manhattan Project. The Tribes continue to have access to the PNNL Richland Campus for gathering, fishing, and ceremonial purposes.

The PNNL Richland Campus was originally part of the DOE Hanford Site, which the federal government created as part of the Manhattan Project in 1943. The Manhattan Project war effort rapidly transformed the Hanford Site from an isolated agricultural region to an industrial complex dedicated to producing plutonium eventually used in the first atomic bombs. Because of the importance of its national defense mission to world history, Hanford's Manhattan Project and Cold War-Era Cultural Landscape is critical for historical interpretation of this period on a national scale. The B Reactor, where the plutonium for the first atomic bomb was made; the 300 Area, where nuclear research and fuel fabrication was conducted (adjacent to the north boundary of the PNNL Richland Campus); and the 200 East and West Areas, where the plutonium was processed, are but a few of the historic remains from the Manhattan Project and Cold War landscape. DOE identified a National Register-eligible Hanford Site Manhattan Project and Cold War-Era Historic District that serves to organize and delineate the evaluation and mitigation of Hanford's plutonium-production built environment (DOE 1998). PNNL Richland Campus facilities are not part of this district.

In the late 1940s, portions of the PNNL Richland Campus south of Horn Rapids and the surrounding area were used as the North Richland Construction Camp. These areas consisted of construction housing for postwar Hanford Site development. In 1951, the property was transitioned to the U.S. Army, which expanded the camp to house personnel and equipment for the support of the air defense installations (anti-aircraft artillery sites) established on the Hanford Site. From 1951 to 1961 it was known as Camp Hanford (and/or the 3000 Area Camp). The anti-aircraft artillery sites were phased out during the late 1950s for the new NIKE missile installations. As such, Camp Hanford was no longer needed to support military defense of the site, and it was closed and deactivated in 1960 (DOE/PNSO 2015).

After decommissioning Camp Hanford, the U.S. Army demolished most of the buildings and transferred the land to the Atomic Energy Commission (AEC), which declared the land to be surplus property and transferred it to the City of Richland. As part of an economic diversification program in 1964, the AEC issued a call for contractors to operate the "Hanford Laboratories," which would conduct R&D in support of the Hanford Site and other missions. In 1965, Battelle was awarded its first contract to operate Hanford Laboratories. Battelle purchased 93 ha (230 ac) of the surplus land south of Horn Rapids Road from the City of Richland to build research facilities that would form the original PNNL Campus. The first four buildings were completed in October 1967: the Research Operations Building (ROB), Mathematics Building (MATH), Auditorium, and Physical Sciences Laboratory (PSL). As a separate part of the economic development program, Douglas Aircraft Company constructed the Research Technology Laboratory (RTL 520) and its support facilities on the approximately 47 ha (115 ac) of property that it purchased from the City of Richland. Construction of the RTL Complex was completed in 1966. The RTL Complex was eventually sold to Exxon Nuclear, which sold it to Battelle in 1981 for PNNL use.

4.5.1 Archaeological and Cultural Resources

An archaeological site is defined by DAHP as the presence of two or more artifacts or a cemetery, while an archaeological isolate is defined as the presence of a single artifact (DAHP 2015). Archaeological sites and isolates could be evaluated for NRHP eligibility, however, isolates are typically considered not eligible unless they are of exceptional value.[3]

The pre-contact era includes the period before European contact in the Americas. In the Columbia Plateau, the pre-contact era ended in the early 1800s, when Lewis and Clark traveled through the area. However, more intense European contact was not initiated until the mid-1800s. The historic era in the Columbia Plateau includes items from initial European contact (1800s) through the 1960s. In Washington State, "only those sites that meet the minimum National Register (36 CFR Part 60) age threshold (50 years of age or older) would be retained as historic archaeological records and assigned Smithsonian Trinomials by DAHP" (DAHP 2015).

Previous cultural resources field investigations within the northern portion of the PNNL Richland Campus (north of Horn Rapids Road) dating from the early 1980s through 2016 have identified various archaeological sites/isolates. A total of 13 archaeological isolates and 19 archaeological sites have been previously identified within the northern portion of the PNNL Richland Campus (Table 4.2). Four of the previously recorded isolates are associated with the pre-contact era (i.e., isolated lithic material) (Table 4.2). Only one of these isolates (45BN643) was collected and is currently being curated as part of PNSO's archaeological collection. The nine remaining previously recorded archaeological isolates consist of historic objects (i.e., insulators, bottles, cans, and other domestic items).

Four of the 19 previously recorded archaeological sites within the northern portion of the PNNL Richland Campus (north of Horn Rapids Road) are associated with the pre-contact era (i.e., three important villages/campsites and an area designated for relocated archaeological material) (Table 4.2). While these four sites remain unevaluated for listing in the NRHP, two of the three village/campsite areas are listed on the Washington State Heritage Register[4] as part of the Pre-Contact, Hanford South Archaeological District (portions of which overlap the northeastern part of the proposed PNNL Richland Campus).

Another of the previously recorded archaeological sites is the PDA, an area of cultural significance to regional Tribes, which lies within the northern portion of the PNNL Richland Campus (north of Horn Rapids Road). Since its discovery in 1994, a perimeter fence has been established around the outer boundary and the area has been designated as a PDA in recognition of the sensitive and important cultural and biological resources contained within the area. As stated in Section 1.1, activities within the PDA during the proposed 20-year campus buildout would be limited to ongoing enhancement and protection of cultural and biological resources and occasional use of the existing Navy haul road.

The remaining 14 previously recorded archaeological sites within the northern portion of the PNNL Richland Campus (north of Horn Rapids Road) are historic in age (Table 4.2). Ten of these are domestic trash/can scatters (six have been determined not eligible for listing in the NRHP and four are

[3] The NPS states "The quality of national significance is ascribed to districts, sites, buildings, structures, and objects that possess exceptional value or quality in illustrating or interpreting the heritage of the United States in history, architecture, archaeology, engineering, and culture and that possess a high degree of integrity of location, design, setting, materials, workmanship, feeling, and association…" (NPS 2002:50).

[4] The Washington State Heritage Register is an "official listing of historically significant sites and properties found throughout the state. The list is maintained by the Department of Archaeology & Historic Preservation and includes districts, sites, buildings, structures, and objects that have been identified and documented as being significant in local or state history, architecture, archaeology, engineering or culture." (DAHP 2017).

unevaluated). Two sites include domestic features: one is an NRHP-ineligible pile of cobbles and pipes and one is an unevaluated subterranean depression. One historic roadway (Horn Rapids Road) has been recorded within the PNNL Richland Campus and remains unevaluated for listing in the NRHP. Finally, a lateral of the Richland Irrigation Canal runs through the PNNL Richland Campus. The Richland Irrigation Canal supplied water to farmland between the horn of the Yakima River and the Columbia River within present day Richland, Washington. The canal was headed at Horn Rapids on the Yakima River and carried water east toward Richland (Cadoret et al. 1999). The Richland Irrigation Canal has been evaluated for listing in the NRHP and has been determined eligible.

Table 4.2. Previously Recorded Archaeological and Cultural Resources within the Northern Portion of the PNNL Richland Campus (north of Horn Rapids Road).

Smithsonian Trinomial Designation[(a)] or Associated Site Number	Context	Type	Description	NRHP Eligibility
45BN105	Pre-Contact	Site	Pre-contact campsite	Unevaluated; listed on the Washington State Heritage Register as part of the Hanford South Archaeological District
45BN1116	Historic	Site	Historic trash scatter	Unevaluated
45BN1117	Historic	Site	Historic trash scatter	Unevaluated
45BN1125	Historic	Site	Richland Irrigation Canal	Determined eligible
45BN1126	Historic	Site	Historic trash scatter	Determined not eligible
45BN1127	Historic	Site	Historic trash scatter	Determined not eligible
45BN1128	Historic	Site	Historic trash scatter[(b)]	Determined not eligible
45BN1129	Historic	Site	Historic trash scatter[(b)]	Determined not eligible
45BN1130	Historic	Site	Historic trash scatter[(b)]	Determined not eligible
45BN1134	Historic	Site	Low density can scatter	Unevaluated
45BN1363	Historic	Site	Historic trash scatter[(b)]	Determined not eligible
45BN1403	Historic	Site	Historic Horn Rapids Road	Unevaluated
45BN1426	Pre-Contact	Site	Culturally sensitive area	Unevaluated
45BN1735	Pre-Contact	Isolate	Pre-contact chopper	While these resources have not been formally evaluated for listing in the NRHP, isolates are typically considered not eligible
45BN1737	Historic	Isolate	Green glass insulator	While these resources have not been formally evaluated for listing in the NRHP, isolates are typically considered not eligible
45BN1937	Historic	Isolate	Milk bottle	While these resources have not been formally evaluated for listing in the NRHP, isolates are typically considered not eligible
45BN1938	Historic	Isolate	Hole-in-cap can	While these resources have not been formally evaluated for listing in the NRHP, isolates are typically considered not eligible
45BN1943	Historic	Site	Insulator concentration	Determined not eligible
45BN1945	Historic	Site	Subterranean depression	Unevaluated
45BN1950	Historic	Isolate	Birdcage	While these resources have not been formally evaluated for listing in the NRHP, isolates are typically considered not eligible
45BN1957	Pre-Contact	Site	Relocated pre-contact archaeological material	Unevaluated
45BN28/104	Pre-Contact	Site	Pre-contact village	Unevaluated; listed on the Washington State Heritage Register as part of the Hanford South Archaeological District
45BN511	Pre-Contact	Isolate	Pre-contact lithic material (flake)[(b)]	While these resources have not been formally evaluated for listing in the NRHP, isolates are typically considered not eligible

Table 4.2. (contd)

Smithsonian Trinomial Designation[(a)] or Associated Site Number	Context	Type	Description	NRHP Eligibility
45BN641	Pre-Contact	Isolate	Pre-contact cobble tool	While these resources have not been formally evaluated for listing in the NRHP, isolates are typically considered not eligible
45BN642	Pre-Contact	Site	Pre-contact campsite	Unevaluated
45BN643	Pre-Contact	Isolate	Lithic debitage[(c)]	While these resources have not been formally evaluated for listing in the NRHP, isolates are typically considered not eligible
H3-438[(d)]	Historic	Site	Pile of cobbles, boulders and pieces of ceramic pipe near the intersection of two old dirt roads[(e)]	Determined not eligible
HI-95-137[(f)]	Historic	Isolate	Gray enamelware bucket	While these resources have not been formally evaluated for listing in the NRHP, isolates are typically considered not eligible
HI-95-141	Historic	Isolate	Round tin canister with lid	While these resources have not been formally evaluated for listing in the NRHP, isolates are typically considered not eligible
HI-95-142	Historic	Isolate	Enamelware bucket or basin	While these resources have not been formally evaluated for listing in the NRHP, isolates are typically considered not eligible
HI-95-143	Historic	Isolate	Historic isolate	While these resources have not been formally evaluated for listing in the NRHP, isolates are typically considered not eligible
HI-95-144	Historic	Isolate	Colorless glass bottle with square base	While these resources have not been formally evaluated for listing in the NRHP, isolates are typically considered not eligible

(a) Due to its work in multiple states in the 1960s, the Smithsonian Institution developed a unified inventory numbering system to maintain systematic control over all collected data. The trinomial consists of three parts: 1) the state number, 2) the county alpha designation/abbreviation, and 3) the site number.
(b) Previously impacted from construction of the PSF Complex and no longer exists. This resource is not considered as part of this impact analysis.
(c) This item was collected and remains in the PNSO artifact collection; thus, it is not considered as part of this impact analysis.
(d) H3- numbers were a previous archaeological resource numbering system employed by the DAHP.
(e) Previously impacted from construction of the PSF Complex and no longer exists. This resource is not considered as part of this impact analysis.
(f) HI- numbers were temporary numbers assigned to archaeological isolates by the Hanford Cultural Resources Laboratory. These sites were recorded; however, formal documentation was never received by the DAHP for Smithsonian Trinomial designations.

One archaeological isolate (45BN511) and five archaeological sites (45BN1128, 45BN1129, 45BN1130, 45BN1363, and H3-438) were previously considered and subsequently impacted from the construction of the PSF Complex and, therefore, no longer exist. All five sites were determined not eligible for listing in the NRHP and an NHPA Section 106 review was completed for facility construction under the *Cultural Resources Review of PNNL Capability Replacement Laboratories Construction Site (HCRC# 2003-300-013)* (Kennedy 2004) and the associated EA for the *Construction and Operation of a Physical Sciences Facility at the Pacific Northwest National Laboratory, Richland, Washington* (DOE 2007) and Supplement Analysis (DOE 2013b).

An archaeological pedestrian survey and subsurface shovel testing of the northern portion of the PNNL Richland Campus (north of Horn Rapids Road, not including the PDA) was completed in spring 2016 as part of the NHPA Section 106 review for this project that is being performed in parallel with this NEPA assessment. At the time of this writing, it has not been completed and is therefore being described separately. This effort identified four newly recorded archaeological isolates and five archaeological sites (Table 4.3). The four archaeological isolates are associated with the historic era consisting of a beer bottle, two cans, and one rubber tire. While these resources have not been formally evaluated for listing in the NRHP, isolates are typically considered not eligible. Three of the five newly recorded archaeological sites consist of historic-era domestic trash scatters with the remaining two consisting of pre-contact lithic scatters. As part of the archaeological fieldwork, a total of six previously identified archaeological sites and three archaeological isolates were revisited, resulting in an update to the existing documentation for these resources. Five previously recorded archaeological isolates were not relocated during the fieldwork performed for this effort. Formal NRHP evaluations would be included in the NHPA Section 106 review for all archaeological sites that could potentially be impacted by project activities in the northern portion of the PNNL Richland Campus.

Table 4.3. Archaeological Resources Revisited and/or Identified During Archaeological Fieldwork in the Northern Portion of the PNNL Richland Campus (north of Horn Rapids Road)

Smithsonian Trinomial or Associated Site Number	Context	Type	Description	Previously/Newly Identified Resource	NRHP Eligibility
45BN1117	Historic	Site	Historic trash scatter	Previously identified	Unevaluated
45BN1125	Historic	Site	Richland irrigation canal	Previously identified	Determined eligible
45BN1126	Historic	Site	Historic trash scatter	Previously identified	Determined not eligible
45BN1127	Historic	Site	Historic trash scatter	Previously identified	Determined not eligible
45BN1937	Historic	Isolate	Milk bottle	Previously identified	While these resources have not been formally evaluated for listing in the NRHP, isolates are typically considered not eligible
45BN1938	Historic	Isolate	Hole-in-cap can	Previously identified	While these resources have not been formally evaluated for listing in the NRHP, isolates are typically considered not eligible
45BN1943	Historic	Site	Insulator concentration	Previously identified	Determined not eligible
45BN1945	Historic	Site	Subterranean depression	Previously identified	Unevaluated
45BN1950	Historic	Isolate	Birdcage	Previously identified	While these resources have not been formally evaluated for listing in the NRHP, isolates are typically considered not eligible
45BN1939	Historic	Isolate	Export beer bottle	Newly identified	While these resources have not been formally evaluated for listing in the NRHP, isolates are typically considered not eligible
45BN1940	Historic	Isolate	Rubber tire	Newly identified	While these resources have not been formally evaluated for listing in the NRHP, isolates are typically considered not eligible
45BN1941	Historic	Isolate	Hole-cap-can	Newly identified	While these resources have not been formally evaluated for listing in the NRHP, isolates are typically considered not eligible
45BN1942	Historic	Isolate	Flat top beer can	Newly identified	While these resources have not been formally evaluated for listing in the NRHP, isolates are typically considered not eligible

Table 4.3. (contd)

Smithsonian Trinomial or Associated Site Number	Context	Type	Description	Previously/Newly Identified Resource	NRHP Eligibility
45BN1944	Pre-Contact	Site	Pre-contact lithic material	Newly identified	Unevaluated
45BN1946	Pre-Contact	Site	Pre-contact lithic shatter	Newly identified	Unevaluated
45BN1947	Historic	Site	Historic trash scatter	Newly identified	Unevaluated
45BN1948	Historic	Site	Historic trash scatter	Newly identified	Unevaluated
45BN1949	Historic	Site	Historic trash scatter	Newly identified	Unevaluated

Previous cultural resources field investigations within the southern portion of the PNNL Richland Campus (south of Horn Rapids Road) dating from the 1990s through 2016 have documented one previously identified pre-contact archaeological site (45BN644). This site consists of a pre-contact rock feature discovered in the subsurface during archaeological monitoring of 1994 EMSL facility construction activities. Due to lack of temporal diagnostic material, the site was not formally recommended or determined to be NRHP eligible. The site is no longer extant because it was destroyed by EMSL facility construction activities (Table 4.4).

Table 4.4. Previously Recorded Archaeological and Cultural Resources within the Southern Portion of the PNNL Richland Campus (south of Horn Rapids Road)

Smithsonian Trinomial Designation[(a)] or Associated Site Number	Context	Type	Description	NRHP Eligibility
45BN644	Pre-contact	Site	Rock feature discovered in the subsurface during archaeological monitoring of the 1994 EMSL facility construction activities and is no longer extant. Resource is not considered as part of impact analysis.	Unevaluated

(a) Due to its work in multiple states in the 1960s, the Smithsonian Institution developed a unified inventory numbering system to maintain systematic control over all collected data. The trinomial consists of three parts: 1) the state number, 2) the county alpha designation/abbreviation, and 3) the site number.

An archaeological pedestrian survey and subsurface shovel testing of the undisturbed portions of the PNNL Richland Campus project area south of Horn Rapids Road was completed in spring 2017 as part of the NHPA Section 106 review for this project that is being performed in parallel with this NEPA assessment. This effort identified two newly recorded historic archaeological sites, both of which are associated with the Cold War-Era North Richland Construction Camp/Camp Hanford (Table 4.5). The 2017 subsurface investigations did not relocate 45BN644 and confirmed that it is no longer extant within the southern portion of the PNNL Richland Campus. Formal NRHP evaluations would be included in the NHPA Section 106 review for all archaeological sites that could potentially be impacted by project activities in the southern portion of the PNNL Richland Campus.

The results of these investigations will be presented in the associated and forthcoming NHPA Section 106 Cultural Resources Review for the current undertaking, which is being completed in parallel with the NEPA process.

Table 4.5. Archaeological Resources Revisited and/or Identified During Archaeological Fieldwork of the Northern Portion of the Richland Campus (north of Horn Rapids Road)

Smithsonian Trinomial Designation[(a)] or Associated Site Number	Context	Type	Description	Previously/Newly Identified Resource	NRHP Eligibility
45BN644	Pre-contact	Site	Rock feature discovered in the subsurface during archaeological monitoring of the 1994 EMSL facility construction activities and is no longer extant.	Previously identified. Not relocated and confirmed to no longer exist.	Unevaluated
HT-2017-235	Historic	Site	Foundation	Newly identified	Unevaluated
HT-2017-234	Historic	Site	Historic debris	Newly identified	Unevaluated

(a) Due to its work in multiple states in the 1960s, the Smithsonian Institution developed a unified inventory numbering system to maintain systematic control over all collected data. The trinomial consists of three parts: 1) the state number, 2) the county alpha designation/abbreviation, and 3) the site number.

4.5.2 Traditional Cultural Properties

One NRHP-eligible TCP, known as *Shu Wipa,* is located within and extends beyond the boundary of the PNNL Richland Campus (DOE 2015a). The National Park Service (NPS 2012) provides a definition of a TCP as follows:

> A Traditional Cultural Property (TCP) is a property that is eligible for inclusion in the National Register of Historic Places (NRHP) based on its associations with the cultural practices, traditions, beliefs, lifeways, arts, crafts, or social institutions of a living community. TCPs are rooted in a traditional community's history and are important in maintaining the continuing cultural identity of the community.

Shu Wipa is of cultural and historic importance to the Wanapum for traditional fishing, gathering, and ceremonial purposes (DOE 2015a). The southern portion of the PNNL Richland Campus (south of Horn Rapids Road) has witnessed a large degree of disturbance both historically and in more recent times. As such, this area retains almost no natural landscape features (i.e., natural resources and vegetation) and does not retain the qualities and values that the Wanapum have highlighted as integral to the overall condition of the TCP. In contrast, the northern portion of the PNNL Richland Campus (north of Horn Rapids Road) has witnessed some construction-related activity associated with the PSF Complex; however, it remains largely undisturbed with natural resources remaining relatively intact. The current state of this area preserves the values that make this TCP important to the Wanapum.

During a meeting between the Yakama Nation cultural resources staff and PNSO, and PNNL cultural resources staff, the Yakama Nation indicated that they have identified a TCP that is located within, and extends beyond, the boundary of the PNNL Richland Campus. While limited information on this TCP is available, the Yakama Nation have indicated that they hold cultural significance to this area and the abundant cultural resource material within it.

The CTUIR have identified a TCP in the vicinity of the PNNL Richland Campus, *Šúuwipa*. This area was traditionally used for materials and medicine gathering and as a traditional fishing area (Hunn et al. 2015).

4.5.3 Architectural Resources

Historically significant standing structures within the PNNL Richland Campus include components of the RTL Complex (RTL 520 and RTL 530), which have been determined to be NRHP-eligible. The RTL Complex includes several other service and support buildings that were determined to not be NRHP-eligible (see Table 4.6) . Impacts from remediation and demolition of the RTL Complex have been considered in the *Cultural Resources Review of the Remediation of Radiological Contamination at the Research Technology Laboratory (RTL) Complex, Pacific Northwest National Laboratory (PNNL) Campus, Richland, Washington* (Harvey et al. 2015). A Memorandum of Agreement (MOA) to resolve and mitigate these adverse effects to RTL 520 and RTL 530 was developed in consultation with DAHP and executed on March 23, 2017 (DOE/PNSO 2017a). In spring 2017, an architectural resources inventory was completed of the remaining 29 buildings located within the northern and southern portions of the PNNL Richland Campus. A total of 17 buildings were constructed after 1987 and do not meet the 50-year threshold for historic documentation requirements. Table 4.6 includes the 12 unevaluated buildings determined to have been constructed prior to 1987 and documented on Historic Property Inventory Forms (HPIFs).[5] Each of these 12 buildings will be evaluated for listing in the NRHP as part of the NHPA Section 106 review for the Proposed Action.

Table 4.6. Known Historic Architectural Resources within the PNNL Richland Campus

Acronym	Building Name	Date Constructed	NRHP Eligibility
AML	Atmospheric Measurement Laboratory	1973	Unevaluated
EDL	Engineering Development Laboratory	1970	Unevaluated,
LSL-2/LSL-2A	Life Sciences Laboratory 2 and Chemical Storage and Transfer Facility	1975	Unevaluated
MATH	Mathematics Building	1967	Unevaluated
Battelle Auditorium	Battelle Auditorium	1967	Unevaluated
BSRW	Battelle Receiving & Shipping Warehouse	1970	Unevaluated
CEL	Chemical Engineering Laboratory	1976	Unevaluated
GES	Grounds Equipment Storage	1987	Unevaluated
PDLE	Process Development Laboratory East	1979	Unevaluated
PDLW	Process Development Laboratory West	1981	Unevaluated
PSL	Physical Sciences Laboratory	1967	Unevaluated
ROB	Research Operations Building	1967	Unevaluated
RTL 510	Chemical and Flammable Storage	1966	Determined not eligible
RTL 520	PNL Research Technology Laboratory	1966	Determined eligible
RTL 530	RTL Radioactive Storage	1966	Determined eligible
RTL 550	RTL Technical Services	1966	Determined not eligible
RTL 560	RTL Utility Building	1966	Determined not eligible
RTL 570	RTL Autoclave Center	1966	Determined not eligible
RTL 580	RTL Crafts Shop	1966	Determined not eligible
RTL 590	RTL Warehouse	1966	Determined not eligible

4.6 Biological Resources

The PNNL Richland Campus comprises approximately 269 ha (664 ac) located in the lowest and most arid portion of the Columbia Plateau Ecoregion (EPA 2016), which supports native shrub-steppe vegetation, an estimated 60 percent of which has been converted to agriculture, and the remainder of which is mostly fragmented (FWS 2013; WWHCWG 2012–2015). An exception is the Hanford Site, which lies adjacent to, and just north and west of, the PNNL Richland Campus (Figure 1.1). The Hanford Site has been protected from agricultural use and development for more than 65 years. The portion of the PNNL Richland Campus to the north of Horn Rapids Road was formerly part of the Hanford Site before

[5] 1987 was established as the 50-year cut-off point for documentation, because the project time-frame extends 20 years into the future with an end date of 2037. Buildings built in 1987 will meet the 50-year threshold for historic documentation requirements by 2037.

being assigned to the DOE-SC (DOE/PNSO 2015). Thus, since 1943, this area was protected from agricultural use and development prior to transfer and is still dominated by native shrub-steppe vegetation outside of the PSF Complex. The portion of the PNNL Richland Campus to the south of Horn Rapids Road has been developed to various extents and consists of a mosaic of maintained landscapes, agricultural fields, and previously disturbed, early-successional habitats. Species discussed below that have been observed in these two areas are called by their common names; Latin names for these are provided in Appendix A. Latin names are provided in the below discussion only for species potentially occurring in these two areas that have not been observed.

4.6.1 Area South of Horn Rapids Road

Approximately 107 ha (265 ac) of the PNNL Richland Campus are located south of Horn Rapids Road, consisting of facilities, agricultural fields, and early-successional habitats (Figure 4.1). Most facilities are surrounded by landscaped vegetation consisting of planted lawn grass and ornamental trees and shrubs. The facilities are interspersed with irrigated cropland and early-successional habitats.

The landscaped vegetation and existing facilities provide suitable nesting habitat for approximately 25 avian species (see Appendix A) that are common in similar environments throughout the ecoregion. These include birds of prey that nest in trees (e.g., great-horned owl); upland game birds that nest in trees (e.g., Eurasian collared dove), on buildings (e.g., rock dove), or on the ground (e.g., killdeer; California quail; mourning doves); and perching birds that nest in trees (e.g., black-billed magpie, American robin, American crow, American goldfinch, in shrubbery (e.g., Brewer's blackbird), or on human structures (e.g., Eurasian starling, house sparrow, western kingbird).

Agricultural fields consist largely of alfalfa and pasture grass. The early-successional habitats are degraded remnants of shrub-steppe habitat and consist of those with only herbaceous species and those with both a shrub overstory and an herbaceous understory. The overstory of shrub fields consists only of rubber rabbitbrush. The understory of shrub fields and the herbaceous fields is comprised primarily of non-native cheatgrass. Gravel and remnants of cement foundations occur in places throughout the early-successional habitats and are indicative of some prior development. The early-successional habitats are relatively small and are substantially isolated from the expansive and more natural shrub-steppe habitat that exists west of Stevens Drive. Isolation and artificial substrate slow the habitat succession process typical of open expanses of shrub-steppe habitat that have not undergone development. Thus, while the early-successional habitats support some plant species typical of shrub-steppe communities (Table A.3 and Table A.4), they likely will not become mature shrub-steppe habitat with the 20-year period of the proposed buildout. Ground-nesting avian species (e.g., killdeer and mourning doves) may nest in early-successional habitats, on the margins of agricultural fields, and in adjacent non-vegetated areas.

Mammals that use landscaped areas includes eastern gray squirrel, eastern fox squirrel, and Nuttall's cottontail. The eastern gray squirrel and eastern fox squirrel were introduced to Washington State from the eastern United States and occur in many urban and developed areas (WDFW 2016a). Nuttall's cottontail is common in the Columbia Plateau Ecoregion and typically inhabits the perimeter area of PNNL facilities adjacent to or near areas of natural vegetation. Mammalian species that may use agricultural areas and early-successional habitats include mule deer, coyote, American badger, and northern pocket gopher.

There are no federally or state-listed species that use the area south of Horn Rapids Road, except possibly the bald eagle, a federal species of concern, and the long-billed curlew, a Washington State-monitored species (WDFW 2016b). Long-billed curlews have been observed foraging in agricultural fields and lawn areas; however, the species likely nests in shrub-steppe habitat on the west side of Stevens Drive and uses agricultural areas and early-successional habitats for foraging. Bald eagles have been observed perching in ornamental trees and open areas but do not nest there.

4.6.2 Area North of Horn Rapids Road

The approximately 161 ha (399 ac) of the PNNL Richland Campus located north of Horn Rapids Road are bounded to the north by the Hanford Site 300 Area, to the east by the Columbia River, to the west by the City of Richland/Port of Benton/Energy Northwest Industrial Development Area, and to the south by the developed area of the PNNL Richland Campus (Figure 1.2). Biological surveys have been conducted annually in portions of this area since 2009 (PNNL 2016c). Appendix A provides some of the data obtained from these surveys regarding plant communities and wildlife across the PNNL Richland Campus north of Horn Rapids Road between 2009 and 2016.

Uplands. The undeveloped portion of the PNNL Richland Campus north of Horn Rapids Road retains much of its native biodiversity and community structure. Plant communities are classified based on the dominant overstory (shrubs) and understory (grasses and forbs) species (Figure 4.1). Shrub-steppe plant communities in the undeveloped area include those dominated by climax shrubs such as big sagebrush and antelope bitterbrush, which are indicative of relatively little prior disturbance. Communities dominated by subclimax shrubs, such as rubber rabbitbrush and green rabbitbrush, are generally indicative of some prior disturbance. Plant communities dominated by non-native cheatgrass or snow buckwheat, a native perennial sub-shrub, are indicative of more extensive or more recent disturbance (e.g., mechanical disturbance or fire). The western side of the undeveloped area has been disturbed less than the eastern side, as indicated by the spatial extent of the above plant communities that represent such disturbance (Figure 4.1). The more mature and undisturbed shrub-steppe communities generally support greater plant species diversity. The southwest-to-northeast trending fingerlike mosaic of bitterbrush and sagebrush communities on the western side of the undeveloped area (Figure 4.1) is indicative of the direction of prevailing wind gusts (Hoitink et al. 2005) that shift loose soils into superficial swales and ridges. The bitterbrush communities tend to occur in the sandier swales while sagebrush communities tend to occur in the loamier soils on the slightly elevated ridges. The above shrub communities include native perennial bunchgrasses; those communities where they are more prevalent are indicated in Figure 4.1. The most common perennial bunchgrass is Sandberg's bluegrass; however, several stands of needle-and-thread grass dominate sandy swales, and Indian ricegrass is represented in several swales containing antelope bitterbrush. Snow buckwheat is prevalent in most big sagebrush, bitterbrush, and rabbitbrush communities (Figure 4.1), and cheatgrass is prevalent in all upland plant communities in the undeveloped area.

Common native forb species in the above plant communities include Carey's balsamroot, long-leaved phlox, yarrow, pale evening primrose, dune scurfpea, turpentine spring parsley, and daisy fleabane. Common non-native forbs include tumble mustard, Russian thistle, and several species listed as Class B and Class C noxious weeds by the State of Washington. Common Class B noxious weeds include diffuse knapweed, rush skeletonweed, Russian knapweed, burningbush, puncturevine, and yellow starthistle (WAC 16-750-011). Common Class C noxious weeds include field bindweed and Russian olive (WAC 16-750-015). Since 2010, PNNL has implemented a program to control populations of some of these weeds (Duncan et al. 2016).

Four relatively stable sand dune blowouts and mature shrub areas with relatively open sand exist in the project area (Figure 4.1). These provide suitable habitat for several species of rare spring ephemeral annual plants, including Great Basin gilia, loeflingia, rosy pussypaws, and Suksdorf monkeyflower (WDNR 2017). The areas were surveyed in 2012 (EAS 2013) and again in 2016 for this EA and these species were not observed, but this does not preclude possible future presence of these species.

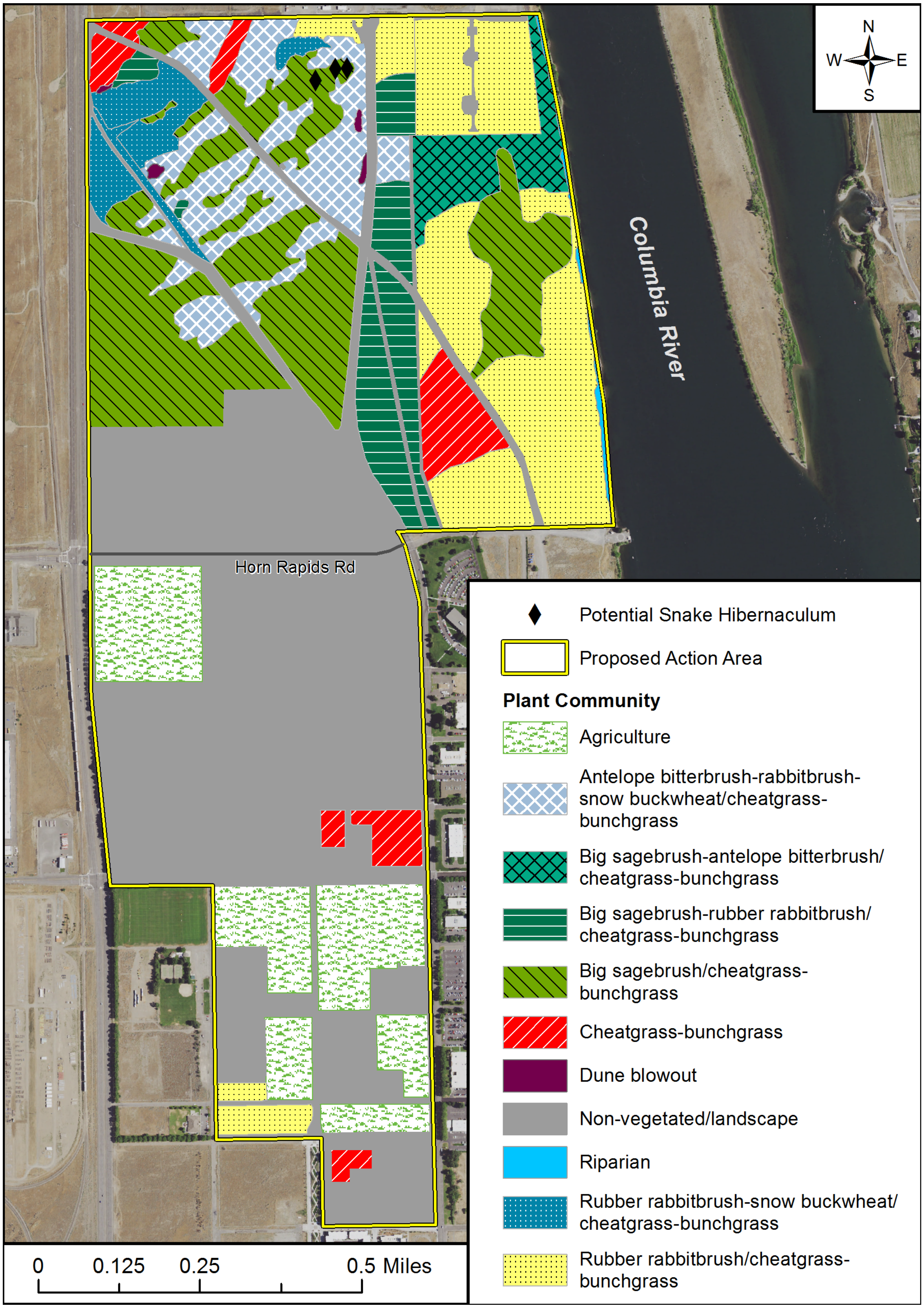

Figure 4.1. Habitat Polygons Located on the PNNL Richland Campus Based on 2016-17 Surveys.

Shrub-steppe plant communities north of Horn Rapids Road support a variety of wildlife, including coyote, mule deer, and northern pocket gopher. Migratory bird species that have been observed and likely nest in the shrub-steppe plant communities include, but are not limited to, ground-nesting birds such as mourning doves, horned larks, and western meadowlarks, and shrub-nesting birds such as lark sparrows. The more mature and undisturbed a shrub-steppe community is, the more valuable it generally is to wildlife (e.g., greater abundance of mature sagebrush and native plant species supports a more diverse assemblage of wildlife) (Dobler et al. 1996). Shrub-steppe forb communities support pollinators (79 FR 35901); however, little is known about them or their plant preferences.

Three potential snake hibernacula comprised of partially buried rubble exist in the project area (Figure 4.1). These may be suitable for snake species common in south-central Washington such as the western rattlesnake (*Crotalus viridis*) (Fitzner and Gray 1991), as well as some that are of concern to the State of Washington, such as the striped whipsnake (*Masticophis taeniatus,* Washington State candidate species) (WDFW 2016b). The potential hibernacula were surveyed in spring 2016 but no snake activity was observed. Lack of observation does not preclude possible future occupancy of the hibernacula.

Riparian Area. The riparian community along the Columbia River shoreline north of Horn Rapids Road (Figure 4.1) is limited to a narrow band near the water which consists of multilayered trees, shrubs, and herbaceous species. Common tree species include Siberian elm, white mulberry, poplars, and tree-of-heaven, which is a Class C noxious weed. Shrub willows and wild rose are common shrub species. Common herbaceous species include common St. Johnswort, Himalayan blackberry, and reed canarygrass, all of which are Class C noxious weeds, as well as Columbia tickseed, cocklebur, and chicory.

The riparian community potentially provides suitable habitat for several species of rare plants, including Columbia yellowcress, lowland toothcup, awned halfchaff sedge, grand redstem, Canadian St. John's-wort, and beaked spike-rush (Sackschewsky et al. 2014; WDNR 2017). Columbia yellowcress is known to occur in the riparian zone in the 300 Area, located just north of the project area. The other five species occur in the riparian area elsewhere along the Hanford Reach north of the 300 Area. None of the six species have been observed in the riparian zone in the PNNL Richland Campus (Sackschewsky et al. 2014), but this does not preclude possible future presence of these species.

Riparian habitats support a diverse assemblage of wildlife. The area is used for daytime perching by wintering bald eagles and by foraging osprey. A wintering population of bald eagles occupies the Hanford Reach of the Columbia River annually from approximately mid-November through mid-March. Bald eagles are known to perch in trees near the river within the project area but are not known to nest there (DOE 2013e). A large number of migratory bird species, including eastern kingbird, red-winged blackbird, and Bullock's oriole, use riparian trees and shrubs as nesting habitat. The area is also frequented by wading birds such as the black-crowned night-heron and great egret, and shorebirds such as the spotted sandpiper. Many migratory bird species use the riparian habitats for resting and feeding during spring and fall migration. Riparian forb communities support pollinators; however, little is known about them or their plant preferences.

Federal and State-Listed Species. Federal and state-listed wildlife and plant species known to occur or that potentially occur in the upland and riparian areas of the PNNL Richland Campus north of Horn Rapids Road were identified through the Washington Department of Fish and Wildlife (WDFW 2016b) and Washington Department of Natural Resources (WDNR 2017) and are listed in Table 4.7. The bald eagle, black-crowned night heron, American white pelican, osprey, sagebrush sparrow, black-tailed jackrabbit, American badger, and long-billed curlew were observed between 2009 and 2016 (see Appendix A). Bald eagles and black-crowned night herons have been observed perching in trees and foraging along the Columbia River shoreline but are not known to nest there. American white pelicans have been observed foraging along the Columbia River shoreline but are not known to nest there. Ospreys have been observed perching on utility poles in the uplands north of Horn Rapids Road but are not known to nest there. The species forages in the nearby Columbia River. The sagebrush sparrow is a sagebrush-obligate species (WDFW 2017), and is thus dependent upon mature shrub-steppe habitat (Vander Haegen et al. 2000) and may nest in the uplands. Black-tailed jackrabbits and badgers occupy shrub-steppe habitat and are known to occur in the uplands. Long-billed curlews have been observed in upland habitat north of Horn Rapids Road but are not known to nest there. In addition, a single burrowing owl was observed in 2006 but nesting was not observed (DOE 2007) and the species has not been observed since that time. Townsend's ground squirrel is known to occur just north of the PNNL Richland Campus in the southern periphery of the Hanford Site 300 Area. No federal or state-listed plant species were observed between 2009 and 2016.

Table 4.7. Wildlife and Plant Species of Conservation Concern Known to Occur or That Potentially Occur on the PNNL Richland Campus

Common Name[(a)]	Genus and Species	Federal Status[(b)]	State Status[(c)]
	Wildlife		
American white pelican	*Pelecanus erythrorhynchos*		Threatened
American badger	*Taxidea taxus*		Monitor
Bald eagle	*Haliaeetus leucocephalus*	Species of Concern	
Black-crowned night heron	*Nycticorax nycticorax*		Monitor
Black-tailed jackrabbit	*Lepus californicus*		Candidate
Burrowing owl	*Athene cunicularia*		Candidate
Loggerhead shrike	*Lanius ludovicianus*		Candidate
Long-billed curlew	*Numenius americanus*		Monitor
Northern sagebrush lizard	*Sceloporus graciosus*		Candidate
Osprey	*Pandion haliaetus*		Monitor
Sage sparrow	*Artemisiospiza nevadensis*		Candidate
Townsend ground squirrel	*Urocitellus townsendii townsendii*		Candidate
	Plants		
Awned halfchaff sedge	*Lipocarpha aristulata*		Threatened
Beaked spike-rush	*Eleocharis rostellata*		Sensitive
Columbian yellowcress	*Rorippa columbiae*	Species of Concern	Threatened
Grand redstem	*Ammania robusta*		Threatened
Great Basin gilia	*Aliciella leptomeria*		Threatened
Canadian St. Johnswort	*Hypericum majus*		Sensitive
Loeflingia	*Loeflingia squarrosa*		Threatened
Lowland toothcup	*Rotala ramosior*		Sensitive
Rosy pussypaws	*Calyptridium roseum*		Threatened
Suksdorf monkeyflower	*Erythranthe suksdorfii*		Sensitive

Sources: WDFW (2016b) and WDNR (2017)

(a) The bald eagle, black-crowned night heron, American white pelican, sagebrush sparrow, black-tailed jackrabbit, badger, and long-billed curlew were observed between 2009 and 2016 on the campus north of Horn Rapids Road (see above text and Appendix A). A single burrowing owl was observed in 2006 (see above text). Other species potentially occur there based on the availability of suitable habitat.

(b) Federal Species of Concern are those that may be in need of conservation actions, ranging from monitoring of populations and habitat to listing as federally threatened or endangered. Federal Species of Concern receive no legal protection and the classification does not imply that the species is being considered for listing as threatened or endangered (FWS 2015).

(c) Candidate animal species are those fish and wildlife species that the WDFW would review for possible listing as endangered, threatened, or sensitive (WDFW 2016b). Threatened plant species are those likely to become endangered in the near future in the State of Washington if factors contributing to population decline or habitat loss continue. Endangered plant species are in danger of becoming extinct or extirpated from the State of Washington. Sensitive species are vulnerable or declining and could become endangered or threatened in the state without active management or removal of threats (WDNR 2017).

4.7 Wetlands and Floodplains

The only naturally occurring surface waterbody in or adjacent to the PNNL Richland Campus is the Columbia River, which borders the project area on its east side (Figure 4.1). The riparian zone is narrow, generally less than 10 m (33 ft) wide, and ascends abruptly to a low-lying bluff or bank. The ground-surface elevation at the bluff is about 107 m (350 ft), which is the lowest in the project area. Floodplains in riverine systems are created by out-of-bank flooding. Daily discharge fluctuations from upstream dams can result in river stage fluctuations at the Hanford Site of up to 3 m (10 ft) during a 24-hour period (Duncan 2007). Daily and seasonal river fluctuations due to upstream dams affect the riparian zone but also do not flow out-of-bank. As discussed in Section 4.4.2, the FEMA floodplain map extends northward to about Horn Rapids Road (FEMA 1984). FEMA maps suggest that only the riparian zone would be affected by the 100-year flood but not the higher ground above the river bank (FEMA 1984). Thus, although the riparian zone is affected by daily and seasonal high water and periodic regulated flooding, because no out-of-bank flooding occurs, the project area does not contain a functional floodplain per the meaning of EO 11988 (42 FR 26951). In addition, according to the National Wetlands Inventory Database, no known wetlands exist within the riparian zone (FWS 2017).

4.8 Socioeconomics

Activities on the Hanford Site and the PNNL Richland Campus make a substantial contribution to the economic and social characteristics of the Tri-Cities and other parts of Benton and Franklin Counties. Historically, DOE and its contractors have been primary contributors to the local economy (other major contributors being Energy Northwest, Kadlec Regional Medical Center, and the agricultural community). Currently, PNNL employs approximately 4,400 people at several offices throughout the United States, with nearly 94 percent of the PNNL workforce residing in Washington State. (Niemeyer 2016).

Based on 2013 U.S. Census American Community Survey (ACS) population data, population totals for Benton and Franklin Counties were 178,992 and 81,835, respectively (USCB 2015a). From 2010 to 2014, Benton and Franklin Counties grew at a faster rate than Washington State as a whole. The state total percent change in population was 5 percent; Benton and Franklin Counties grew at 6.5 and 12.4 percent, respectively (USCB 2015b). Table 4.8 contains the 2013 ACS population estimates for the area within an 80 km (50 mi) radius of the campus by county as well as population forecasts through 2050.

Table 4.8. 2013 County Population Estimates and Projections for an 80 km (50 mi) Radius from the PNNL Richland Campus

	80 km (50 mi) Radius Portion[(a)]	80 km (50 mi) Radius Population Forecasts Based on County Population Forecasts					PNNL Extended Population Forecasts	
County	2013	2020	2025	2030	2035	2040	2045	2050
Adams	16,168	18,608	19,747	20,886	22,091	23,394	24,804	26,331
Benton	178,992	197,806	210,803	223,689	236,007	247,856	259,101	269,607
Columbia	214	213	211	207	202	197	191	185
Franklin	81,835	100,926	115,142	130,284	146,103	162,900	180,583	199,034
Grant	23,075	26,625	28,786	31,006	33,199	35,389	37,553	39,671
Kittitas	2,020	2,214	2,346	2,474	2,594	2,712	2,826	2,935
Klickitat	1,249	1,274	1,291	1,303	1,307	1,304	1,294	1,277
Walla Walla	49,379	51,546	52,952	54,298	55,467	56,534	57,492	58,334
Yakima	71,308	78,505	82,210	85,820	89,374	92,830	96,167	99,362
Umatilla	47,016	51,362	54,447	57,717	60,888	63,962	66,907	69,692
Morrow	8,603	9,438	9,978	10,526	11,023	11,476	11,879	12,226
80 Km (50 Mi) Radius Total	479,859	538,517	577,912	618,210	658,255	698,553	738,795	778,652

(a) Only the portion of the county within 80 km (50 mi) of the DOE PNNL Richland Campus is included.

PNNL has a documented economic impact on the State of Washington (Niemeyer 2016) with a Washington payroll in fiscal year 2015 of $412 million. PNNL generates over $24 million annually in state taxes. The total economic impact of all PNNL activities in Washington is over $1 billion annually, with the majority of that activity occurring in Benton and Franklin Counties. In addition, the study found that PNNL has spun off 71 companies currently doing business in Washington, representing over $567 million in annual revenue in the state.

Table 4.9 shows 2015 employment by industry for the Tri-Cities area. The Tri-Cities' economy is diverse, as indicated by significant employment across all industry sectors. The area has developed into a retail center that draws business from surrounding communities. It also has become a healthcare hub for those same communities.

Table 4.9. 2015 Tri-Cities Area Employment by Industry

Description	Benton County	Franklin County	Total
Employment by place of work			
Total employment (number of jobs)	104,154	40,954	145,108
By type			
Wage and salary employment	86,145	34,017	120,162
Proprietors employment	18,009	6,937	24,946
Farm proprietors employment	1,360	681	2,041
Nonfarm proprietors employment	16,649	6,256	22,905
By industry			
Farm employment	4,555	4,078	8,633
Nonfarm employment	99,599	36,876	136,475
Private nonfarm employment	86,240	30,449	116,689
Forestry, fishing, and related activities	2,223	(D)	2,223
Mining, quarrying, and oil and gas extraction	143	(D)	143
Utilities	156	(D)	156
Construction	6,059	2,337	8,396
Manufacturing	4,539	3,958	8,497
Wholesale trade	1,712	2,234	3,946
Retail trade	12,031	4,096	16,127
Transportation and warehousing	1,380	(D)	1,380
Information	902	227	1,129
Finance and insurance	3,111	660	3,771
Real estate and rental and leasing	3,942	1,362	5,304
Professional, scientific, and technical services	12,001	974	12,975
Management of companies and enterprises	406	29	435
Administrative and support and waste management and remediation services	10,496	1,676	12,172
Educational services	1,059	793	1,852
Health care and social assistance	11,984	3,188	15,172
Arts, entertainment, and recreation	2,203	520	2,723
Accommodation and food services	7,103	2,121	9,224
Other services (except public administration)	4,790	2,068	6,858
Government and government enterprises	13,359	6,427	19,786
Federal, civilian	765	463	1,228
Military	529	234	763
State and local	12,065	5,730	17,795
State government	1,500	1,636	3,136
Local government	10,565	4,094	14,659

Source: BEA 2016. Note: (D): Not disclosed.

4.9 Environmental Justice

Executive Order 12898, "Federal Action to Address Environmental Justice in Minority and Low-Income Populations," directs federal agencies to identify and address human health or environmental effects of federal actions, which might have disproportionately high and adverse effects on minority populations and low-income populations (59 FR 7629). U.S. Census Bureau data were used to identify minority populations as Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian and other Pacific Islander, other races, two or more races, and Hispanic or Latino.

According to the U.S. Census Bureau 2013 5-year ACS (USCB 2015a) population data, the population with an 80 km (50 mi) radius of the campus is estimated to be approximately 480,000 and includes approximately 33 percent minority persons (Nonwhite Hispanic and Latino, Asian, Native American, and African American). The Hispanic population is fairly well dispersed throughout the 80 km (50 mi) radius, with some population concentrated in the Washington cities of Pasco, Kennewick, Othello, Connell, Sunnyside, and Walla Walla, and the Oregon cities of Umatilla and Hermiston. In addition, some rural concentrations of Hispanic populations are located in Benton, Yakima, and Grant counties. Native Americans within the 80 km (50 mi) radius reside primarily in Yakima County on the Yakama Reservation near the town of Sunnyside. Some smaller concentrations of Native American populations reside in the Washington cities of Pasco, Kennewick, Walla Walla, and Connell, and the Oregon cities of Umatilla and Hermiston. In addition, some rural concentrations of Native Americans are located in Walla Walla County and in Grant County along the Columbia River near the community of Beverly. Table 4.10 illustrates the county distribution of minority and low-income populations. Figure 4.2 shows the distribution of minority populations within an 80 km (50 mi) radius of the campus. The minority percentages of statewide populations in the states of Washington and Oregon are 28 and 22 percent, respectively (USCB 2015a).

Based on 2013 5-year ACS data, the population within an 80 km (50 mi) radius of the campus includes 17 percent low-income residents (USCB 2015a). Figure 4.3 shows the distribution of low-income populations within an 80 km (50 mi) radius of the campus. The low-income percentages of statewide populations in the states of Washington and Oregon are 13 and 16 percent respectively.

Table 4.10. 2013 Minority and Low-Income Populations within 80 km (50 mi) of the PNNL Richland Campus

State	County	Total Population	Minority Population	Percent Minority	Poverty Population	Percent Poverty
Washington	Adams	16,168	4,658	29	3,889	24
	Benton	178,992	46,740	26	22,560	13
	Columbia	214	178	83	41	19
	Franklin	81,835	46,571	57	16,118	20
	Grant	23,075	7,613	33	5,083	22
	Kittitas	2,020	1,374	68	89	4
	Klickitat	1,249	826	66	390	31
	Walla Walla	49,379	13,928	28	7,951	16
	Yakima	71,308	18,483	26	18,392	26
Oregon	Morrow	8,603	3,899	45	1,544	18
	Umatilla	47,016	15,685	33	6,917	15
80 km (50 mi) Radius Total		479,859	159,955	33	82,974	17

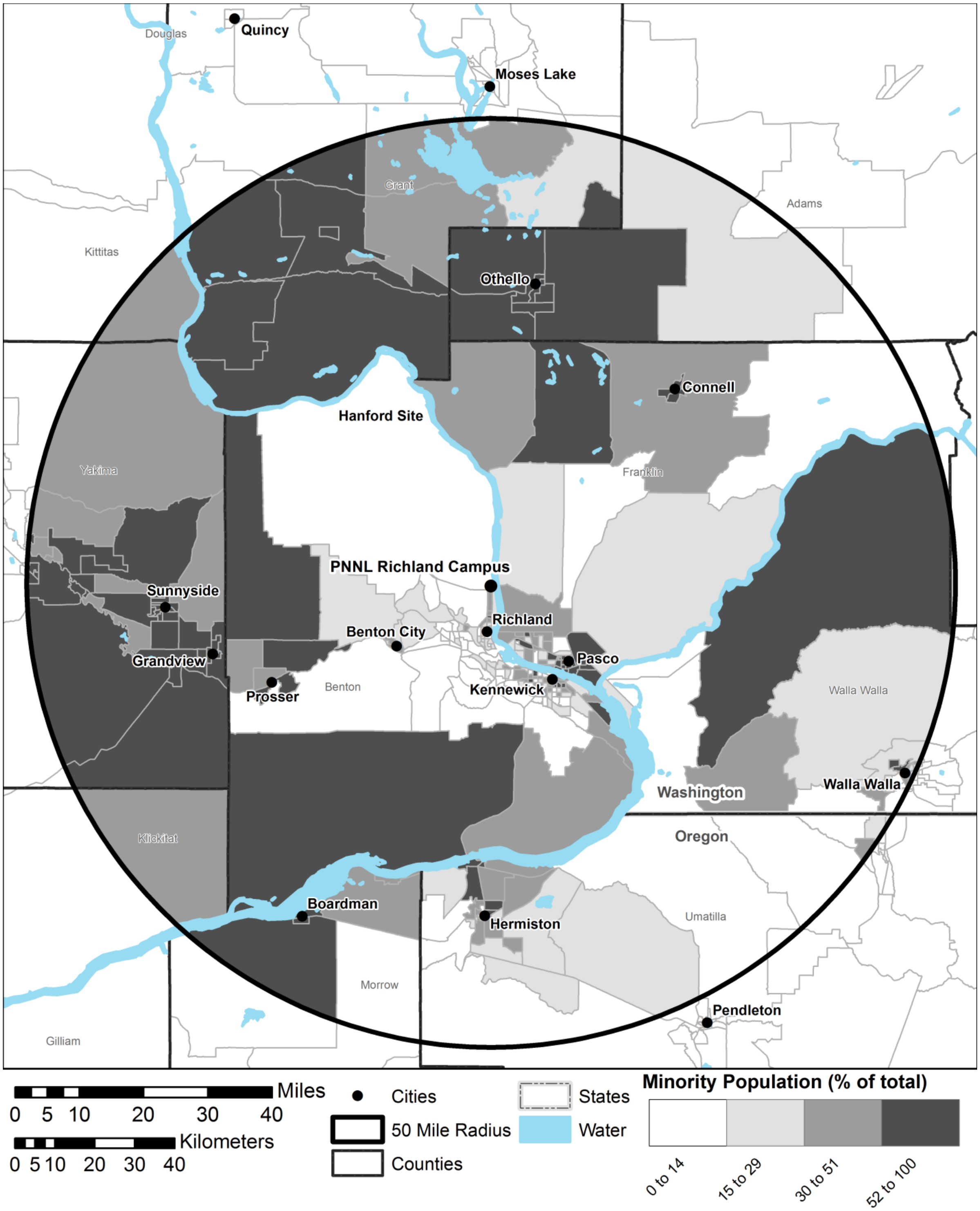

Figure 4.2. 2013 Minority Populations

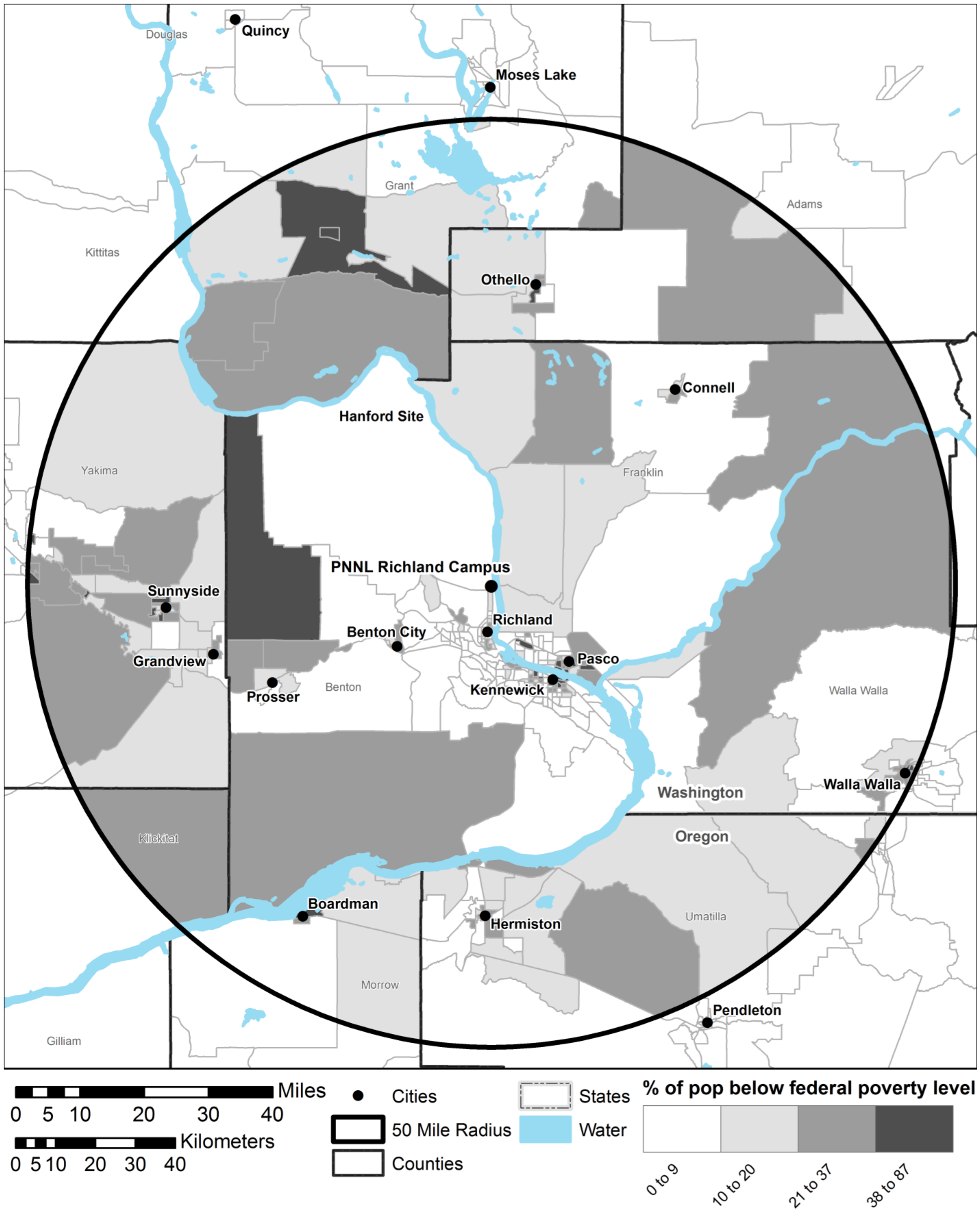

Figure 4.3. 2013 Low-Income Populations

4.10 Transportation and Traffic

The Richland-Kennewick-Pasco Tri-Cities area serves as a regional transportation and distribution center with major air, rail, highway, and river connections. Daily air passenger and freight services connect the area with most major cities via the Tri-Cities Airport, located in Pasco. Passenger rail service is provided by Amtrak, which has a station located in Pasco. Freight rail service adjacent to the PNNL Richland Campus is maintained and operated by the Tri-City & Olympia Railroad Company to the Battelle Boulevard crossing, and from that point north by DOE. The regional highway network in the vicinity consists of several main routes including a DOE-maintained road network within the Hanford Site; State Route 240, a six-lane highway that feeds to Stevens Drive in Richland; George Washington Way, a principal four-lane north-south arterial through Richland; and State Route 224 (Van Giesen Street), which is used by commuters residing in West Richland and Benton City to access the north-south arterial of Stevens Drive via Highway 240 (TCRY 2016).

The main road arteries that feed to the PNNL Richland Campus are Stevens Drive (from the west) and George Washington Way (from the east). Horn Rapids Road and Battelle Boulevard provide principal access from these arteries. The City of Richland (2017b) provided average daily traffic counts for 2016 and Benton County Washington (2015a) provided average weekday traffic counts for other years. These data are presented in Table 4.11. At peak periods, commuter traffic is often heavy on all primary routes to and from the Hanford Site and the PNNL Richland Campus.

Table 4.11. Traffic Counts for Principal Access Routes to the PNNL Richland Campus

Year of Traffic Count	Data Collection Point	Northbound or Eastbound (number of vehicles[a])	Southbound or Westbound (number of vehicles[a])
2011	Battelle Boulevard east of Stevens Drive	1,740	1,928
2010	Battelle Boulevard west of George Washington Way	1,312	1,351
2016	Battelle Boulevard west of Stevens Drive	840	817
2016	Horn Rapids Road east of Stevens Drive	748	588
2016	Horn Rapids Road west of George Washington Way	701	560
2007	George Washington Way south of Battelle Boulevard	2,832	3,226
2010	George Washington Way south of University Avenue	4,575	5,071
2016	George Washington Way north of Horn Rapids Road	920	898
2016	George Washington Way north of Spengler Street	6,441	6,748
2016	Stevens Drive north of Horn Rapids Road	3,827	3,872
2016	Stevens Drive north of Spengler Street	8,193	7,206
2016	Stevens Drive south of Battelle Boulevard	6,398	6,621
2016	Stevens Drive south of University Avenue	8,803	8,202
2011	University Avenue east of Stevens Drive	932	840

(a) 2016 values are average daily traffic; other years are average weekday-only traffic.
Source: Benton County Washington (2015a) and City of Richland (2017b).

4.11 Human Health and Safety

Over a 5-year period from 2011 to 2015, the total recordable cases[6] of injuries and illnesses at PNNL averaged 0.70 cases per 200,000 worker-hours (PNNL 2016d). For the 4,400 campus workers, this results in an average of 31 total recordable cases annually. The PNNL rate is lower than the average incidence rate for DOE sites (0.94 cases per 200,000 worker-hours for years 2012 to 2016) (DOE 2017b). For comparative purposes, the DOE average incidence rates were well below the Bureau of Labor Statistics rates for U.S. private industry of 3.3 cases per 200,000 worker-hours during the 5-year period from 2011 to 2015 (BLS 2016a).

Based on DOE (2016b), Exhibit 3-13, 2,413 PNNL workers were monitored for occupational radiation exposure in 2015. Of that number, 461 workers had a measurable total effective dose (TED).[7] The PNNL collective dose, which is an indicator of the overall workforce radiation exposure, was about 12.6 person-rem. For perspective, these 2,413 monitored individuals would have each received about 0.311 rem from natural terrestrial and cosmic radiation and inhalation of naturally occurring radon background radiation sources during 2015 (NCRP 2009) or a collective dose of about 750 person-rem from these natural background sources.

Radiation dose to members of the public are evaluated annually against the EPA standard of 10 mrem per year. Based on Duncan et al. (2016), the MEI for the campus was located 0.15 km (0.09 mi) south of the RTL Complex. The total dose to the MEI was 0.00026 mrem TED. The collective dose from campus air emissions for 2015 was 0.00027 person-rem for the 80 km (50 mi) population of 432,000 (Duncan et al. 2016). For perspective, the average dose to each individual in the Richland area from naturally occurring and man-made radiation sources is about 620 mrem/y. A general description of these sources and their contribution to the total average dose is shown in Figure 5.2 in Section 5.2.11.1.3.

4.12 Visual Resources

Visual resources are the natural and man-made physical features that give a particular landscape its character. Visual resources include landforms, vegetation, water, color, adjacent scenery, scarcity, and man-made modifications.

The PNNL Richland Campus is adjacent to the project area evaluated in detail and documented in the *Final Environmental Assessment for the Proposed Conveyance of Land at the Hanford Site* (DOE 2015a). Visually, the campus is not unlike that adjacent project area and the visual resource analysis conducted for that action is bounding on the analysis in this EA.

Evaluating the aesthetic qualities of an area is a subjective process because the value that an observer places on a specific feature varies depending on their perspective and judgment. DOE does not have a standardized approach to management of visual resources; therefore, the referenced assessment (DOE 2015a) used the U.S. Bureau of Land Management's (BLM's) Visual Resource Management (VRM) classification system, as summarized below (BLM 2014). The BLM VRM classification system was

[6] Total recordable cases are the total number of work-related injuries or illnesses that resulted in death, days away from work, job transfer or restriction, or other recordable cases, consistent with U.S. Occupational Safety and Health Administration definitions.

[7] The TED is defined as the sum of the dose from radiation sources internal and external to the body, reported in units of rem or mrem. Collective dose is the sum of doses to all individuals in a population and is reported in units of person-rem. For example, a dose of 1 rem TED to each of 10 workers would result in a collective dose of 10 person-rem.

chosen as representative of a federal agency methodology and the vistas at the campus are similar to the types of lands the BLM manages. A qualitative visual resource analysis was conducted to determine whether disturbances associated with project activities would alter the visual environment.

Classifications were derived from an inventory of scenic qualities, sensitivity levels, and distance zones for particular areas:

- Class I: Very limited management activity; natural ecological change.
- Class II: Management activities related to solitary small buildings and dirt roads may be seen, but should not attract the attention of the casual observer.
- Class III: Management activities may attract attention, but should not dominate the view of the casual observer; the natural landscape still dominates buildings, utility lines, and secondary roads.
- Class IV: Management activities related to clusters of two-story buildings, large industrial/office complexes, and primary roads, as well as limited clearing for utility lines or ground disturbances, may dominate the view and be the major focus of viewer attention.

The Visual Resource Inventory Manual (BLM 1986) identifies three mapping distance zones that qualitatively describe how landscapes are observed under good viewing conditions. These are the following:

- Foreground-middleground zone: Areas seen from highways, rivers, or other viewing locations less than 3 to 5 miles away. This is the point where the texture and form of individual plants are no longer apparent in the landscape.
- Background zone: Areas seen from beyond the foreground-middleground zone, but less than 15 miles away. Vegetation in this zone is visible just as patterns of light and dark.
- Seldom-seen zone: Areas that are hidden from view or not distinguishable and more than 15 miles away.

Based on the DOE (2015a) visual analysis, the lands north of Horn Rapids Road are consistent with a VRM Class III rating, and the lands south of Horn Rapids Road are consistent with a VRM Class IV rating. The natural landscape dominates areas north of Horn Rapids Road; however, some roads and minor development are present in the area. The campus is most visible from Horn Rapids Road to the south, and from Stevens Drive and George Washington Way. The primary landscape features in the background zone visible from the analysis area include Badger Mountain to the south and Rattlesnake Mountain to the west. Saddle Mountain and Gable Mountain to the northwest are in the seldom-seen zone.

From Figure 4.4, for the affected environment, the following sites that the Tribes identified as important in their summaries (see Appendix G of DOE 2015a) would or would not be visible (land highlighted or not highlighted in dark brown, respectively):

- Gable Mountain: The campus is in the seldom-seen zone and not discernible (too far away) from Gable Mountain.
- Rattlesnake Mountain: The campus is visible from the mountain, but at the farthest edge of the background zone where specific objects are not readily discernible in the landscape.
- Saddle Mountain: The campus is in the seldom-seen zone and not discernible (too far away) from Saddle Mountain. The Hanford Site 300 Area, the PNNL Richland Campus and the Horn Rapids Industrial Park provide an existing industrial development backdrop to the campus.

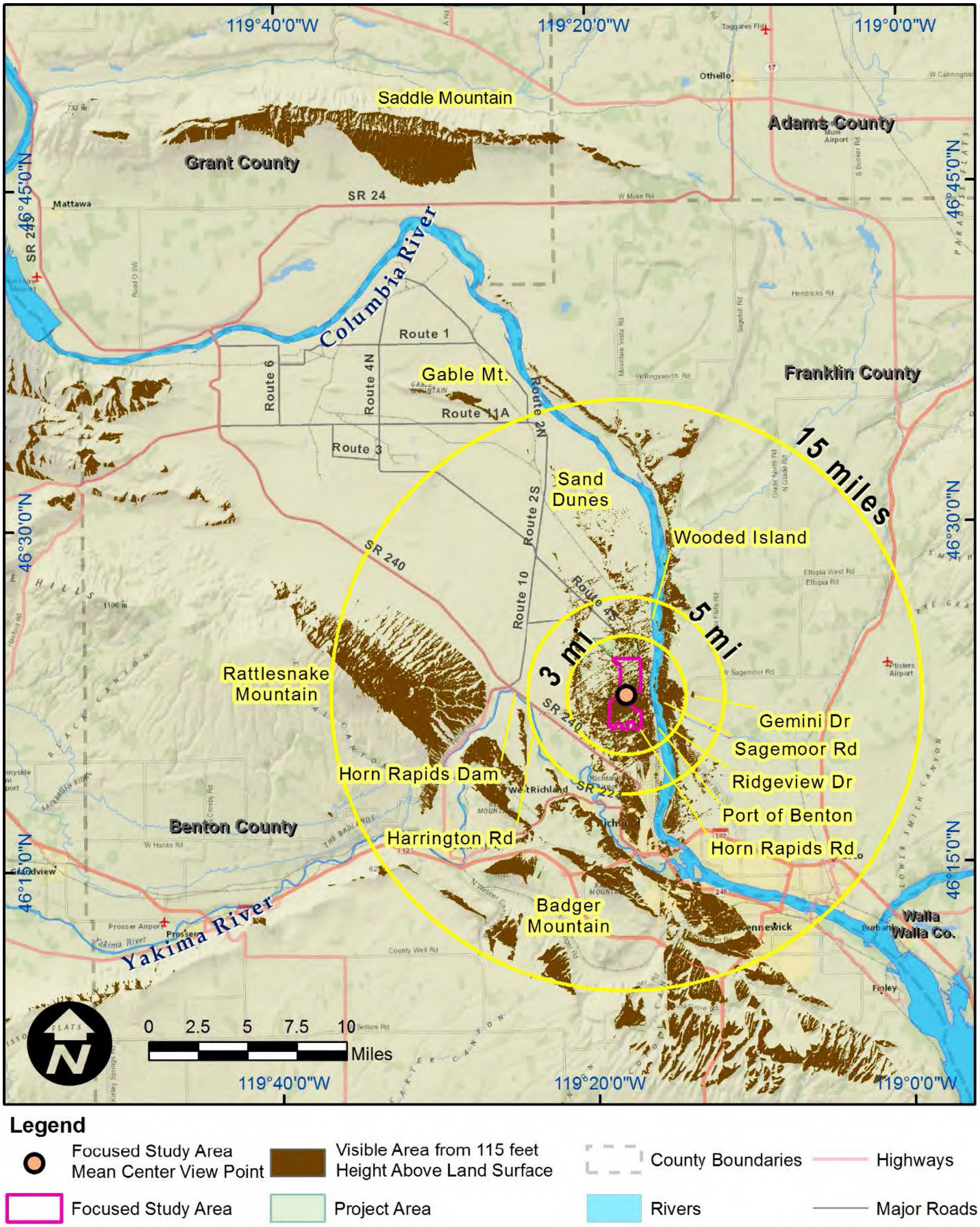

Figure 4.4. Viewshed as Seen from the Land Conveyance Focused Study Area adjacent to the DOE PNNL Richland Campus from a 35 m (115 ft) Elevation (DOE 2015a)

4.13 Noise and Vibration

The region of interest for acoustic noise, vibration, and electromagnetic frequencies includes the PNNL Richland Campus and the surrounding area, including the existing PNNL and Laser Interferometer Gravitational-Wave Observatory (LIGO) facilities. These facilities contain receptors that are sensitive to vibration (e.g., LIGO) and acoustic noise, vibration, and electromagnetic frequencies (e.g., EMSL quiet wing). The receptors have threshold levels much lower than those regulated for the protection of human health. A recent detailed noise impact assessment was completed for the Land Conveyance EA (DOE 2015a). The campus is immediately adjacent to the lands considered in that proposed action. Noise and vibration on the PNNL Richland Campus are regulated under the terms of the deed (DOE 2015b) between DOE and TRIDEC, which identifies the PNNL Noise Generation Standard (Exhibit H, Item 9) and the PNNL Vibration Standard (Exhibit H, Item 10). Acoustic noise and vibration from DOE activities within the region of interest occurs primarily from vehicle traffic, operation of the borrow pits, and heavy equipment operating at remediation and waste sites. Noise and vibration from non-DOE activities at Hanford (e.g., workers commuting to and from the CGS; vibration from regional dams; and operational noise from the AREVA facility, the Perma-Fix facility, and the U.S. Ecology commercial low-level [radioactive] waste disposal site) are also part of the existing background (ambient) sound and vibration environment near the campus.

Future development in the area (e.g., new industry, agriculture, offices, schools, residential areas, roads and other infrastructure) could result in variations in the levels of traffic noise from local roads and increased noise levels near these developments. The appendices to DOE (2015a) provide detailed discussion of nearby activities and facilities that are or would be sources of noise and vibration affecting the campus.

4.13.1 Acoustic Noise

Acoustic noise is generally understood as unwanted sound. Sound propagates through air and solid media (e.g., geologic materials, wood, and even liquids such as water). Through air, sound propagates as a compression wave and travels as fluctuations of air pressure above and below atmospheric pressure. Sound can also be described in terms of a "wave" of vibrating air particles where, at certain points along the wave, air particles are compressed and, at other points, the air particles are spread out. The human ear perceives sound as tones or frequencies. Shorter wavelengths are higher tones/frequencies and longer wavelengths are lower tones/frequencies. The sound pressure level is related to the amplitude of the wave, which is perceived as loudness. Noise may consist of a single or range of frequencies. A frequency-dependent sound pressure rating scale was developed with values given in decibels (dB) to reflect the variations in human sensitivity known as the A-weighting scale and values given in dBA. The threshold of audibility is generally within the range of 10 to 25 dBA for normal hearing.

The State of Washington defines noise as the "… intensity, duration and character of sounds from any and all sources" (RCW 70.107.020). RCW 70.107 and its implementing regulations (WAC 173-60 and WAC 173-62) define the management of environmental noise levels. Maximum noise levels are defined for the zoning of the area in accord with the environmental designation for noise abatement (EDNA). The Hanford Site is classified as a Class C EDNA on the basis of industrial activities. Unoccupied areas are also classified as Class C areas by default because they are neither Class A (residential) nor Class B (commercial). Maximum noise levels are established based on the EDNA classification of the receiving area and the source area. The Class C industrial receptor EDNA is 70 dBA for daytime hours (between 7:00 a.m. and 10:00 p.m.).

The Hanford Site is within Benton County, Washington. Chapter 6A.15 of the Benton County Code of Ordinances (BCC 6A.15) states that the policy of the county is to "minimize the exposure of its citizens to the adverse effects of excessive unwanted public nuisance noise and to protect, promote, and preserve the public health, safety, and welfare." However, a number of exemptions, such as sounds created by the temporary use of construction equipment, are allowed.

4.13.2 Ambient Noise Levels on the Campus

Wind is a primary contributor to background noise levels at Hanford. The entire Hanford Site experiences average wind speeds exceeding 12 mph. In addition to noise from wind, routine DOE field activities contribute to the existing noise environment. Background noise levels in undeveloped areas on the Hanford Site were measured to range between 24 and 36 dBA (Duncan 2007).

The NPS Natural Sounds and Night Skies Division performed sound modeling for the lands immediately adjacent to the campus (DOE 2015a). Using the methodology published in "A Geospatial Model of Ambient Sound Pressure Levels in the Contiguous United States" (Mennitt et al. 2014), the modeled ambient noise levels for the lands adjacent to the campus range between 26.6 and 27.6 dBA.

4.13.3 Vibration

Vibration is an oscillatory motion that can be described in terms of displacement, velocity, or acceleration. Ground-borne vibration could cause building floors to shake, windows to rattle, hanging pictures to fall off walls, and in some cases damage to buildings. Like acoustic noise, vibration from a single source may consist of a range of frequencies. There are no state or local government regulations for vibration. The Occupational Safety and Health Administration enforces vibration standards to protect workers and the only environmental standards are from the Federal Transit Administration for trains and mass transit to protect nearby structures, not for sensitive receptors, such as LIGO and PNNL equipment sensitive to vibration (e.g., EMSL).

4.14 Utilities and Infrastructure

The region of impact for utilities and infrastructure is the PNNL Richland Campus and the surrounding urban environment served by the City of Richland. Infrastructure consists of the systems and physical structures that enable a population in a specified area to function. Infrastructure is wholly human-made, with a high correlation between the type and extent of infrastructure and the degree to which an area is characterized as "urban" or developed. The availability of infrastructure and its capacity to support growth are generally regarded as essential to the economic growth of an area. Utilities and infrastructure include electric power supply, gas supply, water supply, and sewer and wastewater systems. The analysis to determine potential effects on infrastructure and infrastructure systems considers primarily whether a proposed action would exceed capacity or place unreasonable demand on a specific utility.

The campus is adjacent to the project area evaluated in detail and documented in DOE (2015a). The campus infrastructure resources are not unlike those of the adjacent project area and the analysis projecting future infrastructure needs in DOE (2015a) is bounding on the analysis in this EA.

The City of Richland would likely be the provider of electricity, water, and sewer system infrastructure to new facilities on the campus. In Richland, the Bonneville Power Administration (BPA) and the City of Richland own and operate eight substations with a summer capacity of 302,000 kV amperes. In 2013, the summer peak demand was approximately 218,000 kW. The City of Richland has recently updated its long range plan for electrical power delivery and plans to update its distribution system to meet future growth (DOE 2015a).

Based on a DOE assessment (DOE 2015a), the Richland Department of Public Works provides water, wastewater, and solid-waste-management services to the City of Richland. The City of Richland obtains about 82 percent of its water directly from the Columbia River, with the remaining water coming from groundwater wells and from a well field north of the city. Prior to consumption, water is stored in 15 reservoirs with a total capacity of about 95,000 m^3 (25 million gal). The city maintains approximately 520 km (1.7 million feet) of pipe. In 2013, the average daily use of water across the entire service area was 55,600 m^3 (14.7 million gal), and the peak daily use was 129,000 m^3 (34 million gal). Water drawn from the Columbia River is treated at the city's water treatment facility. The treatment facility has a capacity of up to 136,000 m^3/day (36 million gal/day). According to the City of Richland Comprehensive Plan, the city has water rights totaling 220,000 m^3/day (58 million gal/day), which is considered adequate to support any future growth of the city, assuming the treatment capacity expands to fully access the rights. A 61 cm (24 in.) main extends north and south along Stevens Drive, connecting to a 76 cm (30 in.) main that serves the Horn Rapids area (DOE 2015a).

Based on the most recent Comprehensive Water System Plan (City of Richland 2010), demand for the city's water is expected to increase 45 percent by 2028. On a maximum day in 2028, the city's system must provide 49 MGD and have the capability to hydraulically distribute and transmit over 52,000 gpm to meet peak-hour demand plus fire flow. Current supplies identified in the plan are expected to cover the anticipated 2028 demand projections (City of Richland 2010).

Richland's sewer collection system consists of gravity sewers, pump stations, and force mains that convey wastewater to the Richland Wastewater Treatment Facility. The treatment facility has a capacity of 43,200 m^3/day (11.4 million gal/day), and an average daily usage of about 20,800 m^3/day (5.5 million gal/day) (DOE 2015a). Treated wastewater is discharged to the Columbia River.

Based on the DOE assessment (DOE 2015a), Richland Fire and Emergency Services provides fire, emergency medical services and transport, and hazard mitigation services for the approximately 46,000 citizens of Richland, and emergency medical transport services for the approximately 18,000 citizens within Benton County Fire District 4. In addition, all services are extended to neighboring agencies through extensive automatic aid agreements in the region. Richland Fire and Emergency Services is made up of 56 uniformed officers and firefighters, of whom 26 are paramedics and 27 are emergency medical technicians. Richland Fire and Emergency Services shares borders with Kennewick, Pasco, Benton County Fire District 4, and the Hanford Fire Department.

5.0 ENVIRONMENTAL CONSEQUENCES

5.1 Factors Considered for Analysis

This EA considers the impacts and effects of constructing and operating new and replacement facilities and infrastructure on the PNNL Richland Campus over 20 years, and demolition of outmoded surplus facilities. The actual rate of future growth in facility space and staffing levels over the next 20 years, on a year-by-year basis or cumulatively at the end of 20 years, is uncertain. For a historical context, PNNL (including all non-Richland offices) employed 3,360 staff in 1997, 4,195 in 2008, and more recently, approximately 4,400 staff in 2016. While generally trending slightly upward over time, the long-term historical trend may or may not hold as an indicator of future expectations for growth. Future staffing levels at PNNL will be tied to federal budget priorities, with considerable year-to-year fluctuations. In addition, staffing levels are not always clear indicators of impact levels. For example, new facilities would incorporate energy efficiency measures in their design, and new floor plans would likely include higher staff density. In addition, flexibility in workplace and work schedule arrangements available to staff are likely to continue. As a result, energy and space savings may occur even with staff growth. For the purpose of assessing impacts of the proposed 20-year buildout, DOE assumes impact levels associated with staff size (e.g., energy consumption and traffic) would continue at their current level and that these levels are generally representative of impacts that would occur even with future staffing increases.

This EA considers the impacts and effects associated with the Proposed Action and with the No Action Alternative. Other alternatives that were considered but not addressed in detail are also described. The CEQ regulations (40 CFR Parts 1500-1508) define the impacts and effects that must be addressed and considered by federal agencies in satisfying the requirements of the NEPA process. These include direct, indirect, and cumulative impacts.

5.1.1 Direct and Indirect Effects

Direct effects are caused by the action and occur at the same time and place (40 CFR 1508.8).

Indirect effects are caused by the action and are later in time or farther removed in distance, and are reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density, or growth rate and related effects on air and water and other natural systems, including ecosystems (40 CFR 1508.8).

5.1.2 Cumulative Impacts

Cumulative impacts are those impacts on the environment that result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes those other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over time (40 CFR 1508.7).

The vicinity of the campus considered in the cumulative impact analysis is shown in Figure 5.1. Reasonably foreseeable actions in the vicinity of the campus that may contribute to cumulative impacts of implementing the Proposed Action are listed in Table 5.1. Detailed analyses of the cumulative incremental impacts of these foreseeable actions will be evaluated in each resource area in Sections 5.2 to 5.2.19.

Climate is defined as temporal and spatial patterns of variations in meteorology over a period of several decades (GCRP 2014). In May 2014, the U.S. Global Change Research Program published the Third National Climate Assessment: *Climate Change Impacts in the United States* (GCRP 2014). This report collected, evaluated, and integrated observations and research on climate change in the United States, including assessments of regional climate change in the Pacific Northwest.

Figure 5.1. Vicinity of the PNNL Richland Campus Considered in the Cumulative Impact Analysis

Table 5.1. Reasonable Foreseeable Future Actions

Action	Hectares (Acres)	Relative Location to PNNL Richland Campus
Commercial. Commercial storage, offices, and fabrication for Total Energy Management are under construction on Stevens Drive.	1 (2.5)[(a)]	S
Commercial/Residential. Tract A of Willow Pointe is zoned waterfront and is designated as commercial, multifamily, or residential development.	1.8 (4.4)	E
Industrial. A portion of Port of Benton land is set aside for a clean energy business (POB 2016).	81 (200)	N
Industrial. A Savage Logistics, LLC radioactive and hazardous waste transportation facility is currently under construction on Battelle Blvd.	2 (5)	W
Industrial. A warehouse owned by Bervin Vantage LLC is under construction in the Horn Rapids Master Plan Area (Henderson Loop).	0.3 (0.8)	SW
Industrial. PNNL RTL Complex facilities will undergo decommissioning and demolition (TPA-CN-0738).	0.52 (1.3)	S
Industrial. Property development and building upgrades are proposed for the Richland Innovation Center (POB 2013).	28.7 (71)	S
Industrial. Property development within the Port of Benton Technology and Business Campus will consider Cultural Sensitivity Zones within the area prior to development (POB 2013).	117 (290)	E
Industrial/Commercial. The Port of Benton Manufacturing Mall lands are available for commercial/industrial sale/lease; cultural evaluations, artifact collections, and other protective measures will be completed prior to development (POB 2013).	121 (300)	W
Industrial/Commercial/Infrastructure. The Horn Rapids Master Plan provides for land-use Open-Space designation, Industrial designation Commercial/Business Center designation. Proposed infrastructure for the entire Master Plan area to include water systems, sanitary sewer, irrigation water systems, an electrical substation, industrial and curbed roadways, a railroad crossing, and associated wetland mitigation plans (MacKay Sposito 2016).	998 (2,466)	SW
Industrial/Infrastructure. Lands transferred from TRIDEC to the City of Richland, Port of Benton, and Energy Northwest may include future industrial development and its infrastructure and rail (Tangent 2017).	664 (1,641)	W, NW
Infrastructure. A proposed natural-gas pipeline will connect to an existing pipeline north of Pasco, before traversing 16 km (10 mi) to cross under the Columbia River, and continue 32 km (20 mi) to the Hanford Site 200 East Area (77 FR 3255).	N/A	N
Infrastructure. Improvements to the City of Richland existing water mains and additional water distribution lines may be required to provide increased capacity.	N/A	S, Central
Public. Planned expansion of the WSU Tri-Cities campus includes student housing, academic buildings and laboratories, parking, an amphitheater, office facilities, a boat launch, recreational fields, and a central plant (TVA 2008). The student union building is currently under construction.	81 (200)	S
Recreational. The Horn Rapids Master Plan provides for parks, playgrounds, trails.	N/A	SW
Residential. 150 new Innovation Lofts Apartment units will opening 2017 (part of the Port of Benton Innovation Center).	1.7 (4.24)	S
Shoreline Management. Lands are owned by the U.S. Army Corps of Engineers along the Columbia River are leased to the City of Richland. The City of Richland coordinates with the U.S. Army Corps of Engineers for shoreline management.	N/A	E
Transportation. The current Navy Haul Road used to transport decommissioned, defueled Naval reactor compartment packages from barge passage to the disposal site may be relocated.	N/A	Central

(a) Hectares/acreages estimated.
N/A = not applicable.

The GCRP (2014) report predicts that climate change may occur in the Pacific Northwest over the 20-year buildout of the campus and beyond, and that eventually these changes may noticeably alter the baseline affected environment described in Chapter 4 of this EA. Climate change is a global phenomenon that the buildout of the PNNL Richland Campus would not appreciably alter. However, climate change may alter the baseline environment in which the proposed future development would occur.

GCRP (2014) identified potential changes in the regional environment that are relevant to the assessment of impacts from the Proposed Action, including:

- Changes in vegetation, aridity, and potential wildfires
- Changes in surface and groundwater availability and water temperature
- Changes in potential flooding hazards.

Changes to the affected environment and any associated considerations for the assessment of impacts of the Proposed Action are discussed in the resource areas below.

5.2 Environmental Impacts of Proposed Action

The following sections describe direct and indirect impacts of the Proposed Action as described in Section 3. The cumulative impacts of the Proposed Action along with the other foreseeable actions described in Section 5.1.2 are also evaluated.

5.2.1 Land Use

The potential construction and operation impacts of the Proposed Action on land use are evaluated in the following sections.

5.2.1.1 Construction Impacts

As discussed in Section 3.1, implementing the Proposed Action would involve construction and operation of the proposed facilities for conducting R&D activities. It is anticipated that the R&D activities planned for the proposed facilities would be relocated from PNNL-occupied facilities elsewhere on the 269 ha (664 ac) PNNL Richland Campus and from either leased facilities such as 2400 Stevens or 300 Area facilities.

The affected area of the PNNL Richland Campus is owned partly by DOE-SC and partly by Battelle, and the site is classified as a Business Research Park by the City of Richland (2017a). New facilities anticipated for the campus would be constructed and used in accordance with the Business Research Park designation. As shown in Table 3.1, the Proposed Action would increase the acreage used for buildings on the PNNL Richland Campus from the current 15 ha (37 ac) to 25 to 27 ha (62 to 67 ac). The open areas on the PNNL Richland Campus, with grass or native vegetation, currently include about 148 ha (366 ac); this would decrease by 14 ha (35 ac) to 18 ha (45 ac) in the planned 20-year buildout.

The campus is also identified as a City of Richland Urban Growth Area by Benton County (Benton County Washington 2015b). Although the federal government is not subject to local planning authority, the activities within the PNNL Richland Campus would be consistent with adjacent land uses planned by the City of Richland and Benton County; therefore, no incompatibility issues would be anticipated.

5.2.1.2 Operation Impacts

Impacts from operations would not vary from those expected for the current PNNL Richland Campus. These impacts include traffic and scheduled building and property maintenance activities. These activities would not further alter land uses. Under the Proposed Action, the relocation of staff to new facilities could create vacancies in facilities that are currently privately owned and/or leased. Whether or not such vacated facilities would be re-used, or abandoned and demolished over the course of the 20-year buildout would depend upon a variety of factors (e.g., the age and capabilities of a given facility and the economic conditions of the Tri-Cities [Richland, Kennewick, and Pasco, Washington] at the time a building would be vacated).

5.2.1.3 Cumulative Impacts

The anticipated land-use impacts of the Proposed Action were evaluated in the context of the reasonably foreseeable future actions identified in Table 5.1. Taken together, those actions and the Proposed Action result in cumulative land-use impacts to the local area, including the conversion of existing land uses to new uses and the clearing of vacant land. If the land disturbance expected from the proposed development of the campus would occur south of Horn Rapids Road, on lands previously disturbed or currently developed, the cumulative land-use impact would not be significant.

Land disturbance north of Horn Rapids Road would cause incremental conversion of previously undeveloped land from a natural state to a developed state. Though minor, this incremental impact has been accounted for in local land-use plans and development would proceed consistent with applicable zoning and regulations.

5.2.2 Air Quality

Potential impacts on air quality from the release of criteria air pollutants during construction and operation are described in this section. Impacts from the release of other chemicals and radionuclides are described in Section 5.2.11, Human Health and Safety.

5.2.2.1 Construction Impacts

For purposes of impact assessment in this EA it is assumed that 1 to 3 buildings totaling approximately 6,970 m^2 (75,000 ft^2) could be under construction every year over the next 20 years, with an average construction time of 14 to 16 months per building, whereas the larger buildings would take 2 to 3 years to complete. Continuous construction of smaller (<1,860 m^2 [20,000 ft^2]) buildings, with the construction of an occasional larger (5,570 to 18,600 m^2 [60,000 to 200,000 ft^2]) building, could occur for a total buildout of 92,900 m^2 (1.0 million ft^2). Therefore, it is assumed that one to three buildings could be under construction at any given time over the 20-year period.

The largest potential for air pollution during construction would be during site clearing. Site clearing would take a few months for each building, and would involve larger-horsepower diesel equipment, including scrapers, bulldozers, and backhoes. Dust would be generated during earthmoving activities and vehicle movement over unpaved areas. Local air pollution regulations require reasonable precautions be taken to prevent fugitive dust and include preventative measures such as frequent watering, the application of dust adhesion products, or other means. Building construction would take longer and involve concrete pumpers and cranes, as well as smaller-horsepower diesel equipment, such as portable lights and generators. The operation of this construction equipment would generate SO_2, NO_2, particulates, and other air pollutants, in a quantity that is comparable to other similar-sized construction projects. Emissions from mobile, non-road engines are regulated by federal fuel and design performance standards instead of through permitting. Releases would be intermittent and occur over several months. Since construction emissions are intermittent and temporary, and the area is in attainment with criteria air pollutants, no substantial air-quality impacts associated with implementing the construction phase of the Proposed Action are expected.

5.2.2.2 Operation Impacts

5.2.2.2.1 Criteria Air Pollutants

Natural-gas-fired boilers would be used for space heating, humidification, or process steam needs. All boilers would employ state-of-the-art, clean-burning technology and therefore would not be expected to require supplemental emission controls. At full buildout, up to eight diesel-fueled generators would provide electricity to some sites in the event of the loss of utility power. These generators would be required to employ Best Available Control Technology (EPA 1979) for emissions, including the use of ultra-low sulfur fuel.

Emissions of criteria pollutants from the PNNL Richland Campus were estimated based on a comparison with 2015 operational emissions from the existing PSF Complex, which includes the 3410, 3420, 3425, 3430, 3820 Buildings. The PSF Complex includes 23,200 m^2 (250,000 ft^2) of mixed office and laboratory space that is functionally similar to the facilities that would be constructed on the PNNL Richland Campus. At final buildout, 92,900 m^2 (1.0 million ft^2) of mixed office and laboratory space would be constructed. Therefore, the PSF Complex 2015 boiler emissions were scaled up by a factor of four to estimate the total operational emissions from the PNNL Richland Campus. The PSF Complex has one emergency generator at the 3425 Building; the 2015 emissions from this generator were multiplied by eight to estimate the total emissions expected from the emergency generators on the PNNL Richland Campus. Table 5.2 presents current PNNL Richland Campus emissions from current operations and the expected annual operational emissions from the new boilers and generators at final buildout.

Short-term increases in ambient air pollutant concentrations would be expected to result from fluctuations in the demand for boiler use for space heating, the use or testing of diesel-powered backup electrical power generators, and changing meteorological conditions. Impacts from the PSF Complex emissions were analyzed in the PSF EA (DOE 2007). Short-term and annual average air concentrations were modeled and compared to the NAAQS. The resulting concentrations were found to be well within (≤9 percent) of the NAAQS. Because the PNNL Richland Campus emissions would be approximately four times greater than emissions from the PSF Complex, the resulting criteria pollutant air concentrations would increase. However, they would still be below the NAAQS. Consequently, releases of criteria pollutants from the PNNL Richland Campus would not cause air-quality standards to be approached, and the area would continue to be in attainment with NAAQS.

The PNNL Richland Campus facilities would include some new chemistry and biology laboratories; some of which would be replacing existing leased or decommissioned facilities. Therefore, there would not be an appreciable change in criteria pollutants from R&D work. Table 5.2 provides an estimate of criteria emissions from existing R&D work at PNNL; these emissions are small, especially when compared to emissions from generators and boilers.

The future buildout of the PNNL Richland Campus does not involve a significant change in staffing levels at PNNL, as most staff would be relocating from existing leased or decommissioned facilities. Consequently, there would not be a significant change in vehicle emissions from the Proposed Action.

Table 5.2. Estimated Annual Emissions of Criteria Pollutants from the PNNL Richland Campus

Criteria Pollutant[(a)]	New Boilers Emissions (tons/y)[(b)]	New Generators Emissions (tons/y)[(b)]	New R&D Emissions (tons/y)[(b)]	Existing Emissions (tons/y)[(b)]	Total Emissions (tons/y)[(b)(c)]
NO_x	3.98	4.56	0.000024	7.66	16.2
CO	4.20	0.40	0.014	4.29	8.90
SO_2	0.043	0.0082	0.0011	0.031	0.083
THC (total hydrocarbons/VOC)	0.68	0.13	0.14	0.48	1.44
Particulates (total)	0.54	0.20	N/A	0.49	1.22
PM_{10}	0.54	0.20	N/A	0.49	1.22
Pb	0.000036	No vendor data	0.0000000031	0.000021	0.000057

(a) NO_x = nitrogen oxides; CO = carbon monoxide; SO_2 = sulfur dioxide; VOC = volatile organic compounds; PM_{10} = particulate matter less than 10 micrometers diameter; Pb = lead.
(b) To convert to tonnes multiply by 0.91.
(c) Total emissions are the sum of the new and existing emissions; this is a conservative estimate since new emissions include a subset of existing emissions that would be moved from decommissioned facilities to new facilities.

5.2.2.2.2 Greenhouse Gas Emissions

Stationary fuel combustion units would also be a source of greenhouse gas (GHG) emissions, primarily in the form of carbon dioxide, but also methane and nitrous oxide. Federal (40 CFR Part 98) and state (WAC 173-441) regulations require the reporting of annual GHG emissions from certain sources above threshold amounts (i.e., 25,000 tonnes [27,558 tons] per year [federal] and 10,000 tonnes [11,023 tons] per year [state]). The collection of GHG emissions data is intended to provide a better understanding of the sources of GHGs and to guide development of policies and programs to reduce emissions in the future.

Similar to the estimation of criteria pollutants, GHG emission estimates from the combustion units at the PSF Complex were scaled up (by a factor of four for boilers and a factor of eight for generators) to estimate GHG emissions from the new facilities on the PNNL Richland Campus. In 2016, GHG emissions from PSF Complex natural-gas boilers and diesel generators were 1,930 tonnes (2,127 tons) and 99 tonnes (109 tons), respectively. Therefore, annual GHG emissions from the new facility natural-gas boilers and diesel generators would be approximately 7,720 tonnes (8,509 tons) and 792 tonnes (873 tons), respectively. Total GHG emissions from the new facilities would be around 8,512 tonnes (9,383 tons). In 2016, annual GHG emissions from non-leased, campus facilities were approximately 5,406 tonnes (5,959 tons), which is below federal and state reporting levels. At final buildout, the new, DOE-owned facilities would add an additional 8,512 tonnes (9,382 tons) of GHG emissions per year, for a total of 13,900 tonnes (15,322 tons) per year. Therefore, the entire campus would likely exceed the state reporting level at some point during the facility buildout and would be subject to the GHG reporting requirements at that time.

5.2.2.3 Cumulative Impacts

The anticipated air-quality impacts of the Proposed Action were evaluated in the context of the reasonably foreseeable future actions identified in Table 5.1. Many of the projects identified in Table 5.1 are associated with the development of commercial business and multifamily residences. Air-quality impacts would be primarily from emissions of criteria pollutants from construction activities. These emissions would be intermittent and temporary, and not likely degrade the local air quality. Some of the industrial projects identified in Table 5.1 may be considered “major sources” and therefore be subject to

New Source Review Prevention of Significant Deterioration (PSD) air permitting requirements. New Source Review requires stationary sources of air pollution to get air permits before construction starts. PSD permitting applies to new major sources for pollutants where the area the source is located is in attainment or unclassifiable with the NAAQS. PSD does not prevent sources from increasing air emissions. Instead, PSD is designed to preserve the air quality, while protecting public health and ensuring economic growth. Because any major sources would need to be PSD permitted, and these emissions would need to meet the NAAQS, cumulative air-quality impacts from the PNNL Richland Campus in combination with the reasonably foreseeable future actions identified in Table 5.1 would be very low.

5.2.3 Soils and Geological Resources

This section describes the environmental impacts to soils and geological resources for the PNNL Richland Campus.

5.2.3.1 Construction Impacts

Environmental impacts to soils and geological resources result from construction activities that would include clearing, grading, and contouring to establish the final site topography. Construction would also require excavations for building footings and foundations, utilities, and infrastructure. Existing topsoil at the campus would be stripped and stockpiled for use in landscaping, consistent with current practices for other developed areas of the PNNL Richland Campus. Existing soils and sediments would be used in grading and contouring, so that no off-campus materials would be required for construction or landscaping. As stated in Section 3.1.2, the entire campus area, outside of the PDA, could be affected by construction. The maximum depth of disturbance for building excavations would be approximately 15.2 m (50 ft), allowing for basements and underground utility connections. Excavations to this depth would primarily be in the Hanford Formation sediments, but could extend to Ringold sediments depending on the location of the excavation. The Proposed Action would include periodic additions of road base materials onto the existing Navy haul road in the PDA, but no expansion or modifications of the existing route through the PDA.

Impacts to geological resources consist of the excavation of Hanford Formation (and possibly some Ringold Formation) sands and gravels, some or all of which may be used on site for grading. Approximately 720 m3 (940 yd3) offsite sand and gravel resources would be required for fill.

5.2.3.2 Operation Impacts

During operation of the proposed facilities, there would be no additional impacts to soils and geological resources beyond the construction impacts described above.

5.2.3.3 Cumulative Impacts

Impacts to soils resources mainly consist of reworking and redistributing existing surface soils on the campus. From the description in Section 4.3, about 9 ha (22 ac) of existing soils on the southern portion of the PNNL Richland Campus, and about 15 ha (37 ac) north of Horn Rapids Road that are classified as “prime farmland if irrigated” could be affected by construction. About 5 ha (12 ac) in the southern part of the campus and 5 ha (12 ac) in the northern part are classified as “farmland of statewide importance” and could be affected by construction. With development, these soils would be permanently altered. No surface soils would be mined for offsite uses and no offsite materials would be required.

The future actions identified in Table 5.1 would affect soil resources in the vicinity of the PNNL Richland Campus. However, because the Proposed Action would permanently alter only a small area of soils classified as "prime farmland if irrigated" or "farmland of statewide importance," and these areas are currently designated for non-agricultural land uses, the incremental contribution to cumulative impacts to soils and geological resources in the region would be minimal.

5.2.4 Water Resources

This section describes the environmental impacts to water resources for the PNNL Richland Campus.

5.2.4.1 Construction Impacts

As described in Section 4.4, the eastern boundary of the northern portion of the PNNL Richland Campus is located adjacent to the Columbia River, but no surface water resources exist on the campus itself. Water would be required during construction for activities such as dust suppression, but the amount used would be small and its use intermittent. Water for construction would be supplied from the existing City of Richland source or from the existing, permitted Columbia River withdrawal system

All development on the PNNL Richland Campus would take place above the Columbia River bank and thus outside the Columbia River floodplain. Development on the campus would thus not affect or be affected by flooding along the river. Therefore, DOE has determined that a formal floodplain assessment as described in 10 CFR Part 1022 is not required for the Proposed Action.

During construction, stormwater would be managed onsite with no discharge to either surface waters of the state or UIC wells. Construction activities on the campus would implement best management practices in accordance with the *Stormwater Management Manual for Eastern Washington* (WA Ecology 2004).

As described in Section 4.4, groundwater elevations increase toward the south across the PNNL Richland Campus and are consistently below 107 m (351 ft) north of Horn Rapids Road. With the ground surface at an elevation of about 122 m (400 ft) across the campus, depth to groundwater generally exceeds 15.2 m (50 ft) north of Horn Rapids Road. Because it is expected that any facilities requiring excavations as deep as 15.2 m (50 ft) would be located north of Horn Rapids Road, excavations are not expected to extend into the groundwater. If site-specific conditions indicate that a deep excavation may extend to groundwater, mitigation (e.g., raising the ground surface at the facility location) would be carried out to eliminate potential groundwater interaction and the need for excavation dewatering.

5.2.4.2 Operation Impacts

The City of Richland would supply potable water to the PNNL Richland Campus for most non-irrigation uses. A portion of the water supply for the Water Power Technologies activities in the high-bay building (see Section 3.1.2) may be from the existing, permitted Columbia River withdrawal system in the Hanford Site 300 Area. Future development is anticipated to replace existing structures, and any future increase in PNNL staffing levels would result in minimal change to the PNNL water use for non-irrigation purposes due to improved efficiencies (see Section 5.1). For example, per capita PNNL water use was reduced an average of four percent per year between 2011 and 2016. Average water use for all PNNL buildings (both leased buildings and those on campus) during 2016 was 383 m^3/day (101,000 gal/day). Future water use with full buildout would be similar. Therefore, the Proposed Action would have a small impact on water resources.

Water for irrigation would be supplied from the Columbia River withdrawal system under existing water rights or from the City of Richland. As indicated in Table 3.1, future development of PNNL Richland Campus would decrease the currently irrigated area of the campus by approximately 20 to 25 percent. This reduction would occur due to development on currently irrigated agricultural fields and by using xeriscaping and rock landscaping, which require little or no irrigation, on a greater proportion of the new development. Compared to the amount of water used to irrigate all current PNNL buildings (both leased buildings and those on campus), the amount of irrigation water required for the full buildout is expected to be somewhat reduced due to increased use of xeriscaping and rock landscaping.

The only groundwater currently used to support operation of the PNNL Richland Campus is for the Biological Sciences Facility/Computational Sciences Facility Ground Source Heat Pump. Use of a ground source cooling system to support future PNNL facilities has been ruled out based on failed groundwater testing at the PSF Complex, proximity to Hanford groundwater contaminant plumes, potential thermal effects on the Columbia River, and associated monitoring costs. No additional groundwater would be used to support operation of the PNNL Richland Campus except potentially for landscape irrigation.

Water for sanitary use would be discharged to the City of Richland sewer system, would not require permitting, and would be similar to the existing facilities. Laboratory process water would also be discharged to the City of Richland sewer system, and would require an industrial wastewater permit issued by the City. It is anticipated that this permit would be similar to the existing PSF Complex, EMSL, and North Richland discharge permits, which include limitations on discharge flow rates, pH, and contaminant concentrations, monitoring and reporting requirements, and an accidental spill prevention plan. Adherence to the permit conditions is expected to minimize impacts from laboratory discharges.

As described in Section 4.4.3 groundwater beneath the PNNL Richland Campus contains concentrations of tritium, nitrate, and uranium above background levels. These contaminant plumes originated from activities to the north and west of the campus. Current PNNL facilities and operations do not contribute to the existing groundwater contaminant plumes, and future PNNL facilities and operations would not contribute to these plumes. During operation, stormwater would be managed onsite either by directing runoff to grass or gravel swales for infiltration, or by the use of UIC wells such as drywells and infiltration trenches (with perforated pipes). The use of UIC wells for stormwater management is regulated by WA Ecology, which includes the use of best management practices to protect groundwater and prevent the spread of any underlying groundwater contamination. Because stormwater management would occur onsite, adhere to best management practices, and be regulated under WA Ecology programs, impacts to surface water and groundwater would be minimal.

5.2.4.3 Cumulative Impacts

The future actions identified in Table 5.1 will increase water use in the vicinity of the PNNL Richland Campus. It is assumed that this water would be provided by the City of Richland and would primarily come from the Columbia River. Based on the estimated water use described by DOE (2015a), water use for the future actions identified in Table 5.1 are estimated to total about 4 MGD. As described in Section 4.14, the City of Richland's current Comprehensive Water System Plan (City of Richland 2010) expects demand for the city's water to increase 45 percent by 2028, to a peak demand of 49 MGD. Even if water use for all the actions identified in Table 5.1 are added to this expected increase, the city's existing water rights (58 MGD) would satisfy this additional demand, assuming the treatment capacity is expanded. Any small increase in water use required by the Proposed Action would come from the existing City of Richland supply and would be a minor fraction of Richland's current available capacity. No significant cumulative impacts to water resources are expected.

Changes in the timing of snowmelt and streamflow due to climate change are expected to reduce the overall supply of water in the northwest (GCRP 2014). Water availability in the late summer is expected to be most affected. Water supply is managed by WA Ecology to support a variety of competing uses, and adaptation to a reduced supply may be required in the future. However, water use of the Proposed Action is expected to remain a small fraction of the City of Richland water supply, and the water resources impact of the Proposed Action is expected to remain small.

Average temperatures in the northwest have increased approximately 1.3 °F over the last several decades (GCRP 2014). Should the average temperature continue to increase, irrigation water needs would be expected to raise commensurately. The increased use of xeriscaping/rock landscaping throughout the campus would offset this increased irrigation demand.

5.2.5 Cultural and Historical Resources

The following sections describe the environmental consequences for cultural and historic resources for the PNNL Richland Campus Future Development.

5.2.5.1 Archaeological Resources

The following sections evaluate the potential construction and operation impacts of the Proposed Action to archaeological resources on the PNNL Richland Campus.

5.2.5.1.1 Construction Impacts

As described in Section 4.5, there are 21 extant archaeological sites (i.e., 14 previously recorded archaeological sites plus the 7 newly recorded archaeological sites identified during the pedestrian survey) and 15 extant archaeological isolates (i.e., 11 previously recorded isolates plus the 4 newly recorded isolates identified during the pedestrian survey) located on the PNNL Richland Campus.[8]

Construction and future buildout of the PNNL Richland Campus would result in impacts to 10 archaeological sites and 11 archaeological isolates. Four of these archaeological sites (45BN1125, 45BN1126, 45BN1127, and 45BN1943) were previously determined not eligible for listing in the NRHP, and as such would require no mitigation if destroyed by construction-related activities. Six archaeological sites (45BN1117, 45BN1403, 45BN1945, 45BN1947, 45BN1948, and 45BN1949) remain unevaluated for listing in the NRHP. These sites would need to be evaluated for listing to determine if mitigation measures would be necessary to resolve adverse effects to NRHP-eligible properties, as per 36 CFR 800.6. As discussed in Section 4.5, archaeological isolates, while not formally evaluated for NRHP listing are typically considered not eligible unless they are of exceptional significance or archaeological value. Therefore, of the 11 isolates that would be impacted, none would require mitigation.

Seven archaeological sites would not be impacted by construction activities because no construction activities are planned in these areas and therefore would be avoided. These include three archaeological sites located along the shoreline (45BN28/104, 45BN105, and 45BN642), four archaeological sites (45BN1116, 45BN1134, 45BN1426, and 45BN1957) located in the PDA. Four isolates would not be impacted by construction activities (HI-95-143, 45BN641, , and 45BN1735) because they are located in the PDA and one (45BN1737) is located north of the PDA; these isolates would be avoided.

Two archaeological sites that are located south of Battelle Boulevard (i.e., HT-2017-234 and HT-2017-235) have not been evaluated for NRHP eligibility. The current PNNL Campus Master Plan (PNNL 2017a) does not envision any new construction occurring south of Battelle Boulevard; therefore, for the purpose of assessment of impacts in this EA it is assumed that these sites would be avoided in the future. If future plans change and these sites could be affected by campus development, the sites would be evaluated for NRHP eligibility and the impacts to these sites would be assessed in a future NHPA Section 106 review.

[8] These include archaeological sites that still exist and have not either been impacted by construction or collected. Therefore they do not include the five archaeological sites impacted by the PSF Complex (i.e., 45BN1128, 45BN1129, 45BN1130, 45BN1363, and H3-438) the one archaeological site impacted by the EMSL facility (i.e., 45BN644), the one isolate impacted by the PSF Complex (i.e., 45BN511), and the one isolate collected at the PSF Complex (i.e., 45BN643).

The PDA is an area that has been designated for preservation in recognition of the area's extreme cultural sensitivity to area Tribes. In addition, a portion of the PDA has been designated an archaeological site (45BN1426). The PDA would not be directly impacted by construction activities because no construction activities are proposed for this area. The PDA could be indirectly affected by construction activities due to alterations of the surrounding setting which could result in impacts to the overall condition and integrity of the PDA. The introduction of auditory (e.g., heavy equipment use and increased traffic), visual (e.g., excavation and removal of intact habitat in adjacent areas from construction-related activities and the use of flood lights) and emissions (e.g., increased traffic) related impacts all have the potential to effect the PDA and the Tribes' ability to practice traditional activities. The opportunities for Tribal access to that area would remain unchanged and in accordance with regulations and guidance listed above; however, construction would result in an impact to the overall condition of the property as well as the ability for Tribes to practice traditional and religious activities. Mitigation for indirect impacts to the PDA would be detailed in the forthcoming MOA for this undertaking, which will be drafted in consultation with ACHP, DAHP, and area Tribes (Appendix B).

Two archaeological sites located north of Horn Rapids Road (45BN1944 and 45BN1946) are located in an area that would be impacted by construction activities, but all archaeological materials associated with these sites were collected and relocated to an area in the PDA in consultation with area Tribes and DAHP. Also these sites would therefore not be impacted by construction activities because their physical attributes are no longer present. The location where the archaeological material was relocated would be avoided and no impacts to these relocated materials/resources would result from construction activities.

An MOA will be drafted in consultation with SHPO, the ACHP, and consulting parties to address protective requirements and associated mitigation options to resolve adverse effects to these NRHP-eligible properties from ongoing operations-related activities. When possible, avoidance of cultural resources would be implemented as a mitigation option. As a protective measure for unknown cultural resources, archaeologists may monitor excavations as appropriate, and site maintenance and operations personnel may be trained and/or instructed to watch for artifacts. Inadvertent discovery plans (IDPs) for both human remains and archaeological materials would be developed and implemented in the event that these materials were discovered inadvertently during construction and associated activities. IDPs and any required work controls would be detailed in the NHPA Section 106 review and associated MOA. All work would be completed in accordance with the PNSO Cultural and Biological Resources Management Plan (DOE/PNSO 2015).

5.2.5.1.2 Operation Impacts

Operational impacts to archaeological sites are expected to be minimal. There are nine archaeological sites (i.e., 45BN28/104, 45BN105, 45BN642, 45BN1116, 45BN1134, 45BN1424, 45BN1957, HT-2017-234, and HT-2017-235) and four isolates (i.e., HI-95-143, 45BN641, 45BN1735, and 45BN1737) that would not be impacted from construction activities; however, because they would remain intact, they have the potential to be impacted by ongoing operations.

Operational activities occurring north of the PDA would avoid impacts to the one archaeological isolate located within the area (i.e., 45BN1737). Operational activities are limited to storage of small amounts of explosives and other materials inside established structures. These activities would be located away from this archaeological isolate. In addition, no operational activities would occur near the three village sites (i.e., 45BN28/104, 45BN105, and 45BN642) located along the river shore as no operational activities are proposed for this area.

Operational activities proposed for the PDA include fence maintenance and habitat-enhancement projects, which would be conducted in cooperation with the Tribes and have the potential to impact both the PDA and the archaeological sites (45BN28/104, 45BN105, 45BN642, 45BN1116, 45BN1134, 45BN1424, and 45BN1957) and archaeological isolates (HI-95-143, 45BN641, and 45BN1735). Specific impacts associated with these activities are unknown, but appropriate mitigations and avoidance measures would be carried out within the context of future NHPA Section 106 reviews. The PDA may be indirectly affected from operations-related activities taking place in areas adjacent to the PDA and could include the introduction of visual- (e.g., excavations, diminishment of viewshed, and infrastructure), auditory (e.g., heavy machinery, increased personnel, and increased traffic) and emissions (e.g., increased traffic and personnel) related impacts. Mitigation for these impacts would be addressed in the forthcoming MOA. No operational activities are proposed along the Columbia River shoreline, therefore no operational-related impacts would occur on these sites. Impacts from operations-related activities would be addressed in the Cultural Resources Review and associated MOA. Mitigation would be proposed for any NRHP-eligible properties that could be impacted by operations-related activities.

As stated above, an MOA will be drafted in consultation with DAHP, the ACHP, and consulting parties to address protective requirements and associated mitigation options to resolve adverse effects to these NRHP-eligible properties from ongoing operations-related activities. When possible, avoidance of cultural resources would be implemented as a mitigation option. As a protective measure for unknown cultural resources, archaeologists may monitor excavations as appropriate, and site maintenance and operations personnel may be trained to watch for artifacts. IDPs for both human remains and archaeological materials would be developed and implemented in the event that these materials were discovered inadvertently during operations and associated activities. IDPs and any required work controls would be detailed in the NHPA Section 106 review and associated MOA. In addition, PNSO has a Cultural and Biological Resources Management Plan (DOE/PNSO 2015), which provides for the protection of cultural resources in accordance with all cultural-resource-related federal laws including the Native American Graves Protection and Repatriation Act (NAGPRA; 25 U.S.C. § 3001 et seq.), American Indian Religious Freedom Act (AIRFA; 42 U.S.C. § 1996), Archaeological Resources Protection Act (ARPA), and NHPA (54 U.S.C. § 300101).

5.2.5.2 Traditional Cultural Properties

The following sections describe the potential construction and operations impacts to TCPs on or near the PNNL Richland Campus.

5.2.5.2.1 Construction Impacts

As described in Section 4.5, *Shu Wipa* overlaps and extends beyond the PNNL Richland Campus. *Shu Wipa* has been, and continues to be, of cultural and historical importance to the Wanapum for traditional activities and ceremonial purposes (DOE 2015a). Construction and associated activities would have both direct and indirect (e.g., visual, auditory, and emissions) effects on the portions of the TCP that overlap the PNNL Richland Campus, including impacts to the overall condition of the TCP, traditional subsistence, and archaeological resources (especially in the areas north of Horn Rapids Road). Construction activities would include the removal of surface vegetation (especially in the northern portion of the PNNL Richland Campus), which would result in the removal and destruction of natural resources, some of which may include culturally important plant species. This would result in the direct loss of culturally important resources affecting the overall integrity and condition of the TCP. Construction and related activities would result in alterations to the natural setting of *Shu Wipa*. For example, changes to the landscape, including removal of surface vegetation; disturbances from construction equipment (e.g., use of heavy machinery); and changes to the natural setting, including the introduction of visual intrusions (e.g., flood lights and the presence of buildings, parking lots, and associated infrastructure) would alter the overall feeling, condition, and experience of the TCP by introducing visual-, auditory-, and emissions-related impacts. Mitigation for impacts to the TCP and associated archaeological resources (both direct and indirect) would be detailed in the forthcoming MOA for this undertaking, which would be drafted in consultation with ACHP, DAHP, and area Tribes.

While limited information is available regarding the currently undocumented Yakama Nation TCP, construction-related impacts are considered similar to those above. Communication with the Yakama Nation cultural resources staff have indicated that any ground-disturbing activities within the TCP and/or related cultural resources would be considered an adverse effect. Mitigation for impacts to the TCP and associated archaeological resources would be detailed in the forthcoming MOA for this undertaking, which would be drafted in consultation with ACHP, DAHP, and area Tribes.

The CTUIR TCP, *Šúuwipa*, is located within the vicinity of the project area (Hunn et al. 2015); however, discussions with the CTUIR cultural resources staff have indicated that construction activities would likely not impact this resource.

While no access constraints would result from construction, the Proposed Action may limit the Tribes' ability to practice traditional and religious activities on the PNNL Richland Campus. Construction-related activities would reduce the overall footprint of potential areas of interest to the Tribes for traditional use (due to the disturbance, construction, and buildout of large portions of previously undisturbed land on the campus). However, PNSO would continue to facilitate access to members of the Wanapum, Yakama Nation, CTUIR, Colville, and Nez Perce Tribes to gather traditional resources and for practicing traditional cultural and religious ceremonies in accordance with AIRFA, Tribal treaty rights, DOE Order 144.1 (DOE 2009), DOE Policy 141.1 (DOE 2001), and EO 11593, EO 13175, and EO 13007 (36 FR 8921, 65 FR 67249, and 61 FR 26771, respectively) and the PNSO Cultural and Biological Resources Management Plan (DOE/PNSO 2015). Mitigation for impacts to the TCP would be addressed in the forthcoming MOA for this undertaking, which would be drafted in consultation with ACHP, DAHP, and area Tribes.

Pursuant to 36 CFR 800.6, an MOA would be drafted in consultation with DAHP, the ACHP, and other parties to address protective requirements and associated mitigation options to resolve adverse effects to these NRHP-eligible properties. As a protective measure for unknown cultural resources, archaeologists may monitor excavations as appropriate, and site construction workers may be trained and/or instructed to watch for artifacts. IDPs for both human remains and archaeological materials would be developed and implemented in the event that these materials were discovered inadvertently during construction and construction-related activities. IDPs and any required work controls will be detailed in the NHPA Section 106 review and associated MOA. In addition, PNSO has a Cultural and Biological Resources Management Plan that provides for the protection of cultural resources in accordance with all cultural-resource-related federal laws including NAGPRA, AIRFA, ARPA, and NHPA (DOE/PNSO 2015).

5.2.5.2.2 Operation Impacts

Operations-related activities have the potential for both direct and indirect impacts on the *Shu Wipa* TCP (DOE 2015a). Upon completion of construction-related activities routine operations could potentially include small excavations (i.e., utility repair/maintenance), surface/vegetation removal (i.e., landscaping revisions), and routine maintenance that could have a direct impact to the TCP. These would likely be small in size and scope and incremental in nature and are unlikely to be significant. Indirect effects to the TCP associated with operations likely include the introduction of visual-, auditory-, and emissions-related impacts on and adjacent to areas of the TCP that would compromise the qualities that make *Shu Wipa* significant to the Wanapum for traditional and ceremonial uses. These indirect impacts could prohibit area Tribes from using these areas to practice traditional and ceremonial activities.

While limited information is available regarding the currently undocumented Yakama Nation TCP, operations-related impacts are considered similar to those above. In addition, as described above, Yakama Nation cultural resources staff have indicated that any ground disturbance within the TCP and/or related cultural resources would be considered an adverse effect. Therefore, operational activities that are ground-disturbing in nature would likely result in an impact to the Yakama Nation TCP. Mitigation for impacts to the TCP would be addressed in the forthcoming MOA for this undertaking, which would be drafted in consultation with ACHP, DAHP, and area Tribes.

The CTUIR TCP, *Šúuwipa*, is located within the vicinity of the project area (Hunn et al. 2015), however, discussions with the CTUIR cultural resources staff have indicated that operations-related activities would likely not impact this resource.

While no access constraints would result from operations, operations-related activities may have an impact on the Tribes' ability to practice traditional and religious activities on the PNNL Richland Campus. Activities associated with ongoing operations have the potential to introduce visual-, auditory-, and emissions-related impacts to areas of significance to the Tribes (including the PDA and the *Shu Wipa* TCP). These activities are likely to be minimal, small in size and temporary in nature and would likely not have an impact. PNSO would continue to facilitate access to members of the Wanapum, Yakama Nation, CTUIR, Colville, and Nez Perce Tribes to gather traditional resources and for practicing traditional cultural and religious ceremonies in accordance with all applicable laws, regulations, and guidance. Mitigation for impacts to the TCP will be addressed in the forthcoming MOA for this undertaking, which will be drafted in consultation with ACHP, DAHP, and area Tribes.

As stated above, a MOA will be drafted in consultation with DAHP, the ACHP, and other parties to address protective requirements and associated mitigation options to resolve adverse effects to these NRHP-eligible properties from ongoing operations-related activities. When possible, avoidance of cultural resources would be implemented as a mitigation option. As a protective measure for unknown cultural resources, archaeologists may monitor excavations as appropriate, and site maintenance and operations personnel may be trained and/or instructed to watch for artifacts. IDPs for both human remains and archaeological materials would be developed and implemented in the event that these materials were discovered inadvertently during construction and associated activities. IDPs and any required work controls will be detailed in the NHPA Section 106 review and associated MOA. In addition, PNSO has a Cultural and Biological Resources Management Plan which provides for the protection of cultural resources in accordance with all cultural-resource-related federal laws including NAGPRA, AIRFA, ARPA, and NHPA (DOE/PNSO 2015).

5.2.5.3 Architectural Resources

The following sections describe the potential construction and operation impacts to historic buildings on the PNNL Richland Campus.

5.2.5.3.1 Construction Impacts

As described in Section 4.5, 20 historic buildings are located on the PNNL Richland Campus. Of these, eight have been formally evaluated for NRHP eligibility (i.e., RTL 510, RTL 520, RTL 530, RTL 550, RTL 560, RTL 570, RTL 580, and RTL 590); two have been formally determined to be NRHP-eligible (i.e., RTL 520 and RTL 530) and six have been formally determined not NRHP-eligible (i.e., RTL 510, RTL 550, RTL 560, RTL 570, RTL 580, and RTL 590). Impacts from remediation and demolition of the RTL Complex have been considered in the *Cultural Resources Review of the Remediation of Radiological Contamination at the Research Technology Laboratory (RTL) Complex, Pacific Northwest National Laboratory (PNNL) Campus, Richland, Washington* (Harvey et al. 2015). An MOA to resolve and mitigate these adverse effects to the NRHP-eligible RTL 520 and RTL 530 was executed on March 23, 2017 in consultation with the Washington State DAHP. The demolition and remediation of the RTL Complex is not being considered as part of the scope for the current EA.

The remaining 12 historic buildings, 6 of which are located between Horn Rapids Road and Battelle Boulevard and 6 of which are located south of Battelle Boulevard, remain unevaluated for NRHP eligibility. These buildings would need to be evaluated for listing to determine if mitigation measures would be necessary to resolve adverse effects to NRHP-eligible properties, as per 36 CFR 800.6. However, there will be no construction impacts to historic buildings located north of Horn Rapids Road because there are none located in this portion of the PNNL Richland Campus. Construction-related activities proposed on lands located between Horn Rapids Road and Battelle Boulevard include construction of new facilities and minor modifications to existing facilities. Therefore, impacts to historic buildings are possible, but no building demolition is anticipated to occur north of Battelle Boulevard. Currently, the future use of specific facilities located south of Battelle Boulevard is unknown and ranges from re-use/alteration to abandonment/demolition. A programmatic agreement and associated treatment plan will be developed in consultation with the Washington DAHP, ACHP, and interested parties, to avoid, reduce, or mitigate potential adverse effects NRHP-eligible historic buildings on the PNNL Richland Campus.

5.2.5.3.2 Operation Impacts

Direct impacts to NRHP-eligible buildings from operations-related activities may include building modifications and/or alterations. These activities are not likely to have a significant impact on NRHP-eligible buildings; however, a programmatic agreement and associated treatment plan will be developed in consultation with the Washington DAHP, ACHP, and interested parties to avoid, reduce, or mitigate any adverse effects to these NRHP-eligible properties on the PNNL Richland Campus.

5.2.5.4 Cumulative Impacts

The anticipated cultural resource impacts of the Proposed Action were evaluated in the context of the reasonably foreseeable future actions identified in Table 5.1. Taken together, those actions and the Proposed Action would result in cumulative cultural resource impacts to the PNNL Richland Campus vicinity. Impacts from development, construction, and operations would result in the loss of archaeological resources, which are non-renewable regardless of NRHP significance.. In addition, impacts to the integrity of the surrounding landscape and traditional and cultural resources would result in cumulative impacts to the *Shu Wipa* TCP and the Yakama Nation TCP. Any impacts to NRHP-eligible resources will require mitigation and will be addressed in MOAs being developed as part of the ongoing NHPA Section 106 review.

5.2.6 Biological Resources

The buildout would occur over 20 years and may convert some or most areas within the PNNL Richland Campus currently occupied by natural vegetation (Figure 4.1) to landscaped facilities. The buildout may also replace existing landscaped facilities, agricultural areas, early-successional habitats, and non-vegetated areas with newer landscaped facilities or infrastructure. The potential effects of habitat conversion north of Horn Rapids Road would differ from those of the habitat conversion south of Horn Rapids Road based on the habitats and associated wildlife that would be affected (see Section 4.6). Effects would depend on the type and relative value of the habitat. Four categories of habitats are present across the PNNL Richland Campus. They are presented below in order of decreasing ecological value:

1. potential habitat for Washington threatened and endangered plants or animals that includes the riparian zone of the Columbia River, dune blowouts, mature shrub-steppe (habitat polygons with big sagebrush [Figure 4.1] and/or antelope bitterbrush [Figure 4.1] as the dominant shrubs), and potential snake hibernacula (Figure 4.1)
2. intermediate shrub-steppe (habitat polygons with rubber rabbitbrush [Figure 4.1] as the dominant shrub)
3. areas of primarily non-native plants (habitat polygons with cheatgrass [Figure 4.1] as dominant)
4. non-vegetated areas, agricultural fields, and landscaped facilities (Figure 4.1).

These four resource categories are depicted in Figure 5.2.

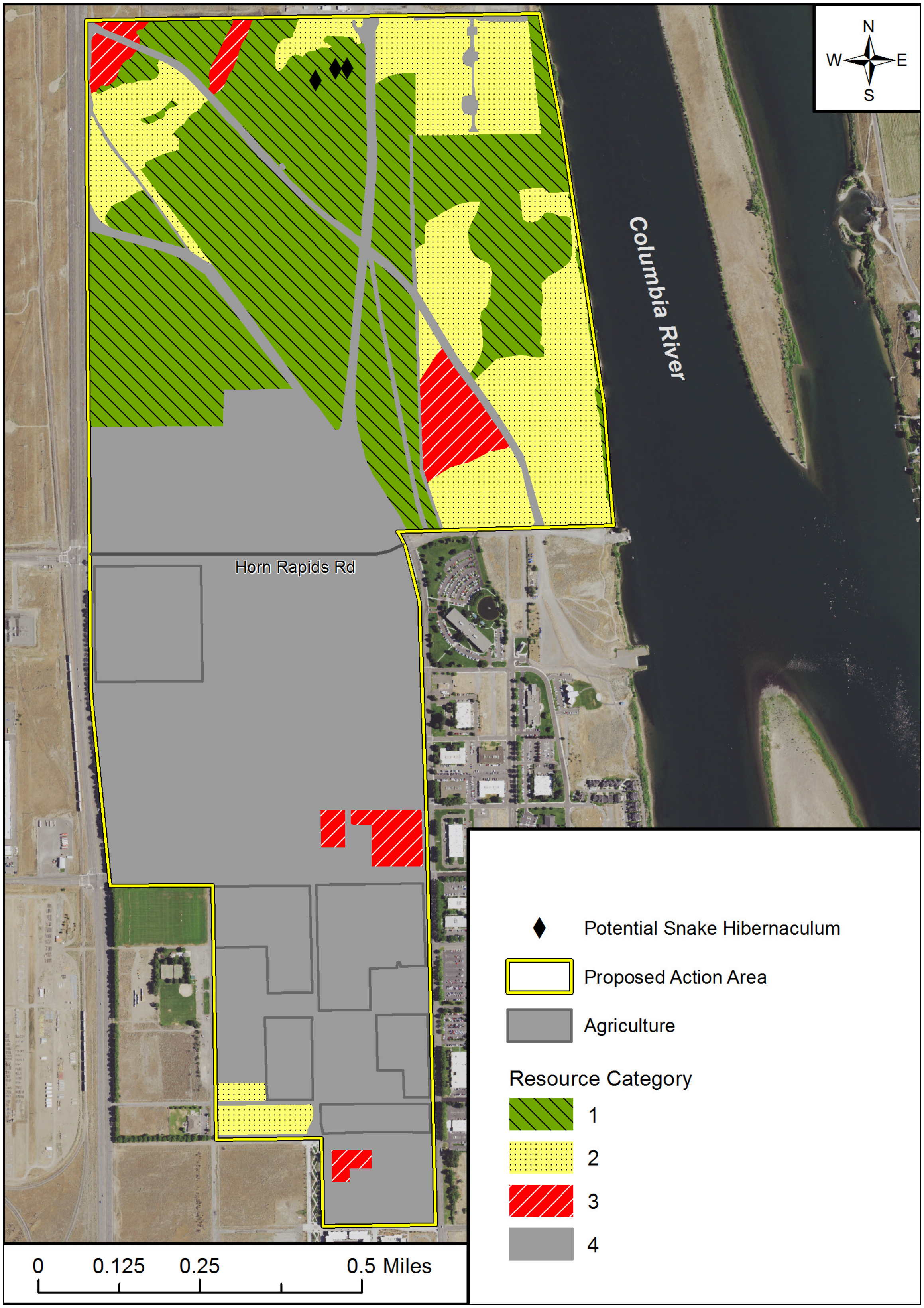

Figure 5.2. Categories of Habitat Resources Located on the PNNL Richland Campus.

5.2.6.1 Construction Impacts

5.2.6.1.1 Area North of Horn Rapids Road

Development would take place west of the George Washington Way Extension and possibly in the uplands north of the PDA. Thus, there would be no development in the PDA or along the Columbia River shoreline. Table 5.3 shows the affected acreages and/or the number of affected locations by biological resource and biological resource category.

Table 5.3. Resource Categories That Would Be Disturbed by Development North of Horn Rapids Road.

Resource Category	Resource	Affected Ha (Ac)/ Number of Locations	Habitat Use or Potential Use[(a)]
1 – Potential rare plant habitat	Dune blowouts	0.35 (0.87), 4 locations	Suitable habitat for rare plants listed as threatened or endangered by the State of Washington
1 – Potential rare plant habitat	Riparian area	none	Suitable habitat for rare plants listed as threatened or endangered by the State of Washington
1 – Mature shrub-steppe	Habitat dominated by big sagebrush or bitterbrush	54.2 (134.4)	Suitable habitat for rare plants and shrub-steppe wildlife (e.g., ground- and shrub-nesting birds) including mature shrub-steppe obligate bird species
1– Potential snake hibernacula	Partially buried rubble with interstices potentially suitable as hibernation sites	3 locations	Potentially suitable habitat for local snake species, including those of concern to the State of Washington
2 – Intermediate shrub-steppe	Habitat dominated by rubber rabbitbrush	17.3 (42.8)	Shrub-steppe wildlife, including ground- and shrub-nesting birds
3 – Areas of primarily non-native annual plants	Habitat dominated by cheatgrass	2.4 (5.8)	Steppe wildlife, including ground-nesting birds
4– Non-vegetated areas, agricultural fields, and landscaped facilities	Gravel parking lots, laydown areas, ornamental vegetation, alfalfa and pasture fields, facilities	32.6 (80.6)	Ground-nesting birds and birds that nest in ornamental vegetation and on man-made structures

(a) See Section 4.6 for a more detailed description.

Potential Rare Plant Habitat. Four relatively stable dune blowout areas could be removed by development (Table 5.3). These areas support mature shrub-steppe and native forbs. They are suitable habitat for rare plant species but are currently unoccupied (see Section 4.6). The four dune blowout areas each do not exceed 0.11 ha (0.28 ac). Larger similar dune blowout areas occur nearby on the Hanford Site. Thus, removal of the four dune blowouts in the project area would represent a relatively small loss of suitable habitat for rare plants. The mature shrub-steppe that would remain east of George Washington Way would provide 24.7 ha (60.5 ac) of suitable habitat for rare plants; however, it is currently unoccupied (see Section 4.6). Large expanses of mature shrub-steppe occur nearby on the Hanford Site. Thus, removal of this habitat in the project area would represent a relatively small loss of suitable habitat for rare plants.

The Columbia River riparian area would not be affected by development (Table 5.3) and would thus continue to provide suitable habitat for the rare plant species discussed in Section 4.6.

Mature Shrub-Steppe. Mature shrub-steppe includes areas dominated by big sagebrush and/or antelope bitterbrush (Section 4.6). In general, these areas have greater native plant species and wildlife diversity than less mature and more recently disturbed shrub-steppe habitat (i.e., intermediate shrub-steppe and areas of primarily non-native annual plants) (Section 4.6). About 54.2 ha (134.4 ac) of mature shrub-steppe (Table 5.3) could be removed by development. About 24.7 ha (60.5 ac) of mature shrub-steppe would remain east of the George Washington Way extension. The remaining mature shrub-steppe would be even more isolated (already isolated to the north by the Hanford Site 300 Area, to the east by the Columbia River, and to the south by the City of Richland) from other similar habitat in the vicinity by the development that would occur immediately to the west of the George Washington Way extension. The reduction in size and distribution and the increase in isolation would tend to degrade the remaining mature shrub-steppe by making it more susceptible to invasion by weedy species (Section 4.6), which would reduce its suitability for native forbs (including the rare species noted in Section 4.6 and any associated pollinators [79 FR 35901]) and bunchgrasses and would make the habitat less valuable to wildlife (Dobler et al. 1996). In particular, sagebrush-obligate species (e.g., the sagebrush sparrow; WDFW 2017), which are dependent on mature shrub-steppe habitat, would be affected (Vander Haegen et al. 2000). A mitigation action plan describing the approach for mitigating the loss of mature shrub-steppe (which includes the dune blowouts noted above) is provided in Appendix C.

Potential Snake Hibernacula. Three potential snake hibernacula (Figure 4.1) could be removed by development. These sites are currently unoccupied (Section 4.6). Occupied snake hibernacula occur nearby on the Hanford Site and are critical for maintaining local snake populations, including those of species of concern to the State of Washington (Section 4.6) (Lindsey et al. 2013). Removal of the three potential hibernacula in the project area would represent a relatively small loss of potentially suitable habitat, and would not affect snake populations unless occupied. Although snakes have not been observed using these hibernacula, this does not preclude possible future occupancy by snakes.

Intermediate Shrub-Steppe. Intermediate shrub-steppe includes areas dominated by rubber rabbitbrush (Section 4.6). About 17.3 ha (42.8 ac) of intermediate shrub-steppe could be removed by development. About 22.4 ha (55.4 ac) of intermediate shrub-steppe would remain east of the George Washington Way extension. The remaining intermediate shrub-steppe would be even more isolated from other similar habitat on the Hanford Site by the development that would occur immediately to the west of the George Washington Way extension. The reduction in size and distribution and the increase in isolation would tend to degrade the remaining intermediate shrub-steppe by making it more susceptible to invasion by weedy species (Section 4.6), which would reduce native forbs (and any associated pollinators [79 FR 35901]) and bunchgrasses and make the habitat less valuable to wildlife (Dobler et al. 1996).

Areas of Primarily Non-Native Annual Plants. Areas of primarily non-native annual plants are dominated by cheatgrass (Section 4.6). About 2.4 ha (5.8 ac) of this habitat type could be removed by development. About 4.1 ha (10.1 ac) of this habitat type would remain east of the George Washington Way extension.

Non-Vegetated Areas, Agricultural Fields, and Landscaped Facilities. About 32.6 ha (80.6 ac) of non-vegetated areas and landscaped facilities currently exist in the southwest corner of the project area. These may be replaced by new facilities with xeriscaping. No agricultural fields exist north of Horn Rapids Road.

Wildlife. Wildlife present west of the George Washington Way extension (Section 4.6) could suffer direct mortality, disturbance, and displacement. In general, less-mobile animals (e.g., small burrowing mammals and unfledged birds) would incur greater direct mortality than those that are more mobile (e.g., adult birds and mid-sized to large mammals). Disturbances below lethal levels may adversely affect wildlife behaviors (e.g., movement, feeding, sheltering, and reproduction). Some mobile wildlife may also disperse into similar habitats in nearby areas, such as that remaining east of the George Washington Way extension or on the Hanford Site. Similar habitats, if suitable, may already be occupied, and resources would then need to be partitioned among a greater number of individuals, which may lead to competition resulting in increased predation, decreased fecundity, and population declines. Thus, wildlife that disperses into areas of similar habitat may also effectively be considered lost. Losses of wildlife, whether by direct mortality, disturbance, or displacement, would likely be greater due to removal of mature shrub-steppe than intermediate shrub-steppe and especially areas occupied primarily by non-native annual plants. Installation of facilities and xeriscaping would increase habitat for avian species that nest on man-made structures and decrease habitat for shrub- and ground-nesting species (Section 4.6). A mitigation action plan describing the approach for mitigating potential impacts to wildlife, including migratory birds, is provided in Appendix C. The plan would involve biological surveys to ascertain occupancy by wildlife prior to land clearing. If needed, measures would be implemented to avoid or minimize potential impacts to wildlife, including migratory birds.

Noxious Weeds. Construction activities, especially ground clearing, could lead to a proliferation of noxious and invasive weed species (Section 4.6). PNNL maintains an active noxious weed control program (Duncan et al. 2016) and it is expected that this program would continue in the future. Additional controls (described in the mitigation action plan in Appendix C) would be implemented as needed to minimize the introduction and spread of noxious weeds by construction equipment.

5.2.6.1.2 Area South of Horn Rapids Road

The four highest habitat types present north of Horn Rapids Road (grouped collectively under category #1 described in the introduction to Section 5.2.6) are absent south of Horn Rapids Road (Table 5.4). Agricultural areas are present only south of Horn Rapids Road (Table 5.4). Acreages of the categories of habitats that would be affected by development are listed in Table 5.4.

Table 5.4. Resource Categories That Would Be Disturbed by Development South of Horn Rapids Road

Resource Category	Resource	Affected Ha (Ac)	Habitat Use or Potential Use
2 – Intermediate shrub-steppe	Habitat dominated by rubber rabbitbrush	2.3 (5.7)	Shrub-steppe wildlife, including ground- and shrub-nesting birds
3 – Areas of primarily non-native annual plants	Habitat dominated by cheatgrass	3.1 (7.8)	Steppe wildlife, including ground-nesting birds
4 – Non-vegetated areas, agricultural fields, and landscaped facilities	Gravel parking lots, laydown areas, ornamental vegetation, alfalfa and grass hay fields, facilities	101.6 (251.2)	Ground-nesting birds and birds that nest in ornamental vegetation and on human-made structures

Intermediate Shrub-Steppe. Intermediate shrub-steppe includes areas dominated by rubber rabbitbrush (Section 4.6). About 2.3 ha (5.7 ac) of intermediate shrub-steppe could be removed by development. No intermediate shrub-steppe vegetation would remain on the PNNL Richland Campus south of Horn Rapids Road.

Areas of Primarily Non-Native Annual Plants. Areas of primarily non-native annual plants are dominated by cheatgrass (Section 4.6). About 3.1 ha (7.8 ac) of this habitat type could be removed by development. No areas of primarily non-native annual plants would remain on the PNNL Richland Campus south of Horn Rapids Road.

Non-Vegetated Areas, Agricultural Fields, and Landscaped Facilities. All 101.6 ha (251.2 ac) currently comprising non-vegetated areas, agricultural fields, and landscaped facilities may be removed and replaced with new facilities and xeriscaping. Facility demolition would temporarily reduce nesting habitat for avian species that nest on man-made structures (Section 4.6). However, an increase in new facilities may create more nesting habitat for such species. Replacement of the current landscaping with xeriscaping would permanently reduce nesting habitat for avian species that nest in ornamental trees and shrubs (Section 4.6), but may increase habitat for ground-nesting species. Removal of agricultural fields would remove some habitat for ground-nesting birds, particularly along field margins. This may also remove foraging habitat for the long-billed curlew, a Washington State-monitored species (WDFW 2016b) (Section 4.6). However, ample foraging habitat for this species exists nearby on the Hanford Site.

Noxious Weeds. The PNNL program to control the spread of noxious and invasive weeds (that could result from construction activities) described in Section 5.2.6.1.1 would also be implemented in the project area south of Horn Rapids Road.

Stockpiled Soils. Stockpiled soils could be a source of fugitive dust. Fugitive dust generation would be minimized to the extent practicable by employing construction best management practices. Stockpiled soils may be utilized by local wildlife such as migratory birds, which could be adversely affected when soil is moved or re-used. Stockpiled soils would undergo a biological survey to ascertain occupancy by wildlife prior to re-use onsite or transport offsite for disposal in local commercial landfills. If needed, measures would be implemented to avoid potential impacts to wildlife, including migratory birds.

5.2.6.1.3 Operation Impacts

During operation of the proposed facilities, there would be no additional impacts to biological resources beyond the construction impacts described in the Section 5.2.6.1.

5.2.6.2 Cumulative Impacts

The development areas depicted in the project vicinity in Figure 5.1 and the projects described in Table 5.1, especially the City of Richland/Port of Benton/Energy Northwest Industrial Development Area and projects associated with the Horn Rapids Master Plan would tend to further isolate the shrub-steppe and associated wildlife that may remain in the project area after the buildout. Existing shrub-steppe and wildlife in the project area are currently isolated to the north by the Hanford Site 300 Area, to the east by the Columbia River, and to the south by the City of Richland. The increase in isolation from west of Stevens Drive would increase travel distances to intact shrub-steppe habitat for mobile wildlife displaced by the buildout and dispersing from the project area. Increased isolation would also tend to further degrade any shrub-steppe that may remain in the project area by making it more susceptible to invasion by weedy species (Section 5.2.6.1.1) (and less likely to be colonized by native plant species from shrub-steppe located greater distances to the west), which would reduce native forbs and bunchgrasses and make the habitat less valuable to wildlife.

Development in the project area would remove a small fraction of shrub-steppe compared to that which would be removed by the actions in the vicinity listed in Table 5.1 and to the substantive past actions that isolated it from the north (development of the 300 Area) and from the south (development of the City of Richland). Thus, the buildout would provide a small incremental impact to shrub-steppe habitat and associated wildlife when added to other past, present, and reasonably foreseeable future actions.

The climate of the Columbia Basin is characterized by warm summers with little precipitation, followed by cold winters during which most of the annual precipitation falls. Average temperatures in the northwest have increased approximately 1.3 °F over the last several decades (Mote et al. 2014). Should the average temperature continue to increase, some adverse effects could be seen in the native vegetation communities of the Columbia Basin, especially in periods of drought. Hotter, drier summers would increase evapotranspiration that could weaken perennial or woody plants, and increase the risk of fire, both of which would reduce native shrubs and perennials and favor invasive annual species such as cheatgrass. These changes would likely be discernible only over a much larger scale (regional) than the project area, and any changes on the PNNL campus would be insignificant compared to the habitat conversion that would result from the facility buildout.

5.2.7 Wetlands and Floodplains

There are no wetlands or floodplains in the project area (Section 4.7). Therefore, there would be no direct, indirect, or cumulative impacts to wetlands or floodplains due to the Proposed Action. Because there would be no impacts, DOE determined that a formal floodplain and wetland assessment as described in 10 CFR Part 1022 is not required.

5.2.8 Socioeconomics

The following sections describe the environmental consequences for socioeconomics for the PNNL Richland Campus. Potential impacts on socioeconomics as a result of construction and operation of the proposed facilities and infrastructure are described in the following sections.

5.2.8.1 Construction Impacts

As described in Section 3.1, the precise design of the proposed facilities is not known, other than the construction of 92,900 m^2 (1 million ft^2) of floor space. Because the precise design of the facilities is not known, reasonable approximations were made based on other, similar types of recent local construction. An estimated average of approximately 175 construction workers would be employed over a 20-year period with a peak workforce of approximately 350 workers. Peak conditions would occur with the construction of buildings having 18,600 to 23,200 m^2 (200,000 to 250,000 ft^2) of floor space and would last 24 to 36 months.

Based on construction workforce estimates, construction activities would likely have little effect on the existing community. Total employment in Benton and Franklin Counties in November 2016 was approximately 125,000, with an unemployment rate averaging approximately 6.6 percent (BLS 2016b). Thus, even if construction creates additional service sector jobs, the total increase in employment likely would be under 1 percent of the current employment level. Therefore, adverse impacts to related community services and infrastructure, including housing and schools, would not be expected.

5.2.8.2 Operation Impacts

The proposed facilities would house existing research staff and a minimal number of new research staff. Existing staff initially would be relocated from other leased facilities near the campus. As campus facilities are replaced, relocated staff would move into the newly constructed facilities. Consequently, no impacts on socioeconomics or community infrastructure would be expected from operations associated with implementing the Proposed Action.

5.2.8.3 Cumulative Impacts

The anticipated socioeconomic impacts of the Proposed Action were evaluated in the context of the reasonably foreseeable future actions identified in Table 5.1. Taken together, those actions and the Proposed Action result in cumulative socioeconomic impacts to the local area (e.g., increased economic activity, employment, traffic, and increased demand on community infrastructure and services). However, as discussed for the Proposed Action, the likely incremental impacts of construction worker employment would be minor in the context of the activities listed in Table 5.1. There would be no net change in operations employment from the Proposed Action.

5.2.9 Environmental Justice

The following sections describe the environmental consequences for environmental justice for the PNNL Richland Campus. Potential impacts on socioeconomics as a result of construction and operation of the proposed facilities and infrastructure are described below.

5.2.9.1 Construction Impacts

Section 4.9 presents the baseline assessment of environmental justice conditions within 80 km (50 mi) of the PNNL Richland Campus. This EA has not identified pathways by which any human health or environmental impacts would adversely affect minority or low-income populations. The Proposed Action would not result in disproportionately high and adverse effects on minority or low-income populations. Given the “adverse” criterion is not met, the “disproportionately high” criterion is not a consideration. Hence, thresholds for environmental justice related impacts are not reached. Some Tribal resources may be affected by the Proposed Action; these impacts are discussed in Section 5.2.5.

5.2.9.2 Operations Impacts

Operational impacts of the proposed facilities and/or additions and proposed infrastructure are expected to be similar to those from ongoing PNNL operations. Currently, there are no know impact pathways associated with PNNL operations that have been determined to affect low-income or minority populations disproportionately; therefore, operation of the proposed facilities and/or additions and proposed infrastructure is not expected to have the potential for disproportionately high and adverse impacts on minority or low-income groups as defined in Section 4.9.

5.2.9.3 Cumulative Impacts

Taken together, the activities in Table 5.1 would be expected to have cumulative impacts physical and socioeconomic impacts to residents and commuters using the access routes for those activities. These impacts are discussed in Section 5.2.10. Beneficial socioeconomic impacts would be derived from the economic activity associated with these activities including employment, income generation, and tax revenue impacts. These impacts are discussed in Section 5.2.8. Because these impact pathways are not specific to low-income or minority populations, disproportionately high and adverse impacts to these groups would not be expected.

5.2.10 Traffic and Transportation

The following sections describe the environmental consequences for traffic and transportation for the PNNL Richland Campus.

5.2.10.1 Construction Impacts

As described in Section 3.1, the precise design of the planned facilities is not known other than approximately 92,900 m^2 (1 million ft^2) of new laboratory and office space.

While an actual construction schedule is dependent on mission need and funding authorities, for purposes of this EA it is assumed that 1.5 buildings would be constructed per year, with an average construction time of 14 to 16 months per building. It is estimated that an average of approximately 175 construction workers would be employed over a 20-year period with a peak workforce of about 350 workers.

Based on Section 3.1.2 and Figure 1.2, construction activities may occur anywhere within the PNNL Richland Campus footprint, except within the PDA. Thus, construction traffic impacts would be proportional to where development occurs. The impact analysis uses Horn Rapids Road access points as representative entry points to where construction activities are likely to occur. Depending on the actual site of new construction activities, other east-west entry points from George Washington Way or from Stevens Drive might be used (e.g., 5th Street). Battelle Boulevard and University Drive are other potential entry points. Construction traffic would be assumed to minimize use of Battelle Boulevard for campus entry, given the substantial current volume of PNNL staff using that entry point. University Drive could be used to enter the campus from the south, depending on the actual location of facilities to be constructed. The traffic counts for University Drive are not significantly different from those for Horn Rapids Road.

At the height of construction, as many as 350 additional vehicles may be going to and from the construction site. Assuming construction traffic would be distributed proportionally between the two ends of Horn Rapids Road, inbound traffic counts could increase to approximately 735 and 923 vehicles, respectively. This potential increase represents an approximately 23 to 31 percent increase over current average daily traffic on Horn Rapids Road at the peak of construction activities. During non-peak construction periods, the increase over current average daily traffic on Horn Rapids Road would be about 12 to 15 percent. These changes in traffic are relative to the most recent traffic estimates from the City of Richland, which are discussed in Section 4.10. Baseline traffic growth is expected to occur over the construction period and, therefore, traffic increases from construction activities would be less than the percentage increases discussed above.

Construction deliveries at the peak of construction are anticipated to result in multiple concrete truck deliveries for pouring building slabs, with up to 10 to 15 concrete trucks during a working day. Larger loads would also make deliveries (e.g., steel), but would not be expected to result in as many trips per day. Because these periods of peak delivery to the construction site would be of short duration and widely spaced over the years of buildout, increases to traffic from construction deliveries would be minor.

The impacts of traffic accidents involving construction workers traveling to and from the construction site were calculated using traffic accident statistics for Benton County compiled by the Washington State Department of Transportation (Washington State 2016). This report gives the collision, serious injury, and fatality rates for each county in the state. Benton County collision, serious injury, and fatality rates were 176.3, 3.35, and 0.65 per 100 million vehicle-miles traveled, respectively. On average, it was assumed that 175 workers per day would travel an average distance of 20 km (12 mi) one-way to the construction site. This distance encompasses most of the Tri-Cities region and accounts for the fact that most of the workers would travel a shorter distance and that some are likely to car-pool. Assuming workers make the trip 250 days per year over 20 years, the total distance traveled would be about 35 million km (~22 million mi). The impacts in terms of accidents, injuries, and fatalities are shown in Table 5.5.

Table 5.5. 20-Year Construction Traffic Accident Impacts

Number of Workers	Trips per Day	Avg. Distance (km)	Days per Year	No of Years	Total distance (km)	Accidents	Injuries	Fatalities
175	2	20	250	20	35,000,000	39	1 (0.73)	0 (0.14)

As shown in the table, when risk-weighted, perhaps one injury involving workers commuting to the construction site would occur during the construction period, resulting in no fatalities.

5.2.10.2 Operation Impacts

The proposed facilities would employ mostly existing research staff and a minimal number of new research staff under baseline conditions. Existing staff would be relocated from other operating facilities on the campus and from leased facilities, and the number of new staff is not expected to be significant. To address building access and avoid local congestion, it is likely that additional parking would be included in the development. Once operating, local traffic impacts would be limited to a potential change in traffic patterns by PNNL staff and result in only minimal impact overall.

5.2.10.3 Cumulative Impacts

The anticipated traffic impacts of the Proposed Action were evaluated in the context of the reasonably foreseeable future actions identified in Table 5.1. Taken together, those actions and the Proposed Action result in cumulative traffic impacts to the local area and natural degradation to roadways over time caused by vehicle use. However, as discussed for the Proposed Action, the likely incremental impacts of construction worker traffic would be minor in the context of total traffic volume on Stevens Drive and George Washington Way. There would be no net change in operation traffic from the Proposed Action. Thus, the Proposed Action's contribution to cumulative traffic impacts would not be significant.

5.2.11 Human Health and Safety

Impacts on health and safety from construction and operation of the PNNL Richland Campus are presented in this section. Radiological, chemical, and physical impacts are described in Sections 5.2.11.1, 5.2.11.2, and 5.2.11.3, respectively.

5.2.11.1 Radiological Impacts

Radiological impacts are described in the following sections. Impacts are reported as dose to the MEI and as collective dose to the population within 80 km (50 mi) of the campus.

5.2.11.1.1 Construction Impacts

No radiological impacts resulting from construction are anticipated. The radiological impact to construction workers would be negligible and would be similar to those described below for members of the public in a 80 km (50 mi) radius of the PNNL Richland Campus.

5.2.11.1.2 Operation Impacts

Routine Operations

Radiological operations for new facilities would be similar to current operations. The expected impacts to the members of the public and biota from routine operations would be similar to current impacts. Current radiological emissions are presented in the PNNL Annual Site Environmental Report for calendar year 2015 (Duncan et al. 2016) and earlier years, as well as historical experience with the 300 Area laboratories at the Hanford Site where PNNL conducts R&D activities. As discussed in Section 3.1.2.1, DOE's experience indicates that operation (or modification) and subsequent decommissioning of such devices normally pose no potential for significant environmental impacts (61 FR 6414). Facilities constructed north of Horn Rapids Road would remain within the area where meteorology is characterized by 300 Area meteorological data. The ambient air monitoring program for radionuclides would be modified as necessary to adequately account for new facilities. The dose to the MEI resulting from radiological emissions is expected to remain well below the 10 mrem annual regulatory standard.

Estimates of human health consequences following exposure to ionizing radiation are expressed in terms of probability of latent cancer fatality (LCF) for individuals or number of LCFs for populations, and are based on a dose-to-LCF factor of 0.0006 LCF per person-rem for both workers and the public (ISCORS 2002). Consequences for populations are also expressed as risk of LCF in the population, accounting for the estimated frequency of an event that results in exposure of the population to radiation. In estimating the risk from accidents, the frequency of an event is usually designated by a range and is characterized as either "Anticipated" (frequency ranging from 1 in 100 to 1.0 per year), "Unlikely" (frequency ranging from 1 in 10,000 to 1 in 100 per year), or "Extremely Unlikely" (frequency ranging from 1 in 1,000,000 to 1 in 10,000 per year). Events expected to occur with a frequency lower than 1 in 1,000,000 per year are not considered for purposes of safety analysis. For routine activities or exposure of populations to background radiation, the estimated frequency of the exposure is assumed to be 1.0.

Workers − Radiological impacts on worker health and safety from future operations were estimated to be bounded based on 5 years of recent experience from PNNL R&D activities, which are expected to be representative of activities that would be conducted in the PNNL Richland Campus following future development. Worker doses over the 5-year period from 2011 to 2015 are presented in Table 5.6 (Buckner et al. 2015; REMS 2017).

Table 5.6. Worker Doses from PNNL R&D Activities (Buckner et al. 2015; REMS 2017)

	Number of Workers with Measured Doses by Category (mrem)							
Year	Not Measurable	Less than 100	100 to 250	250 to 500	500 to 750	750 to 1,000	1,000 to 2,000	Total Worker Collective Dose (person-rem)
2011	1,416	192	33	18	7	1	0	22
2012	1,380	198	21	16	5	0	0	18
2013	1,935	367	36	8	0	0	0	15
2014	1,937	441	21	9	3	0	0	16
2015	1,978	430	28	3	0	0	0	13

At the dose levels presented in Table 5.6, the inferred probability of an LCF for the maximally exposed worker over a 30-year career (at 1 rem/y) would be 0.02, with no (0.3) inferred LCFs for the worker population as a whole over a 30-year period, assuming a 5-year average collective dose of 16.8 person-rem per year. For perspective, 10 LCFs would be inferred to occur among this work force from naturally occurring sources of radiation during this same period, assuming a 5-year average annual workforce of 1,729 individuals and a TED of 0.311 rem to each individual resulting from natural background sources.

Public − Based on results calculated for releases of radioactive materials to air from PNNL facilities, as presented in the PNNL 2015 Annual Site Environmental Report (Duncan et al. 2016), the annual dose (exclusive of background) to the MEI in the public would be similar to current doses and far below the 10 mrem regulatory dose standard. If an individual were to be exposed for 30 years at current dose levels, the total dose (0.0078 mrem) would result in a negligible expectation of a LCF (0.0000000047 or about 1 fatality per 200 million persons). For perspective, that individual would have received over 9,000 mrem from natural background radiation sources over a 30-year period, from which the probability of a LCF would be less than 0.006.

5.2.11.1.3 Cumulative Impacts

Based on the results of analyses presented in this section, cumulative radiological impacts are expected to be minimal. The area of most probable influence associated with operation of the PNNL Richland Campus would consist principally of the northern portion of the City of Richland and the rural area of Franklin County in an easterly direction across the Columbia River from the PNNL Richland Campus.

The past Hanford Site activities that had the largest impact on the area of interest were the operation of the fuel fabrication facilities, production reactors, separations and product finishing plants, and R&D facilities employed on the site in support of national defense programs. Environmental impacts manifested themselves principally as a result of the release of radioactive material to air, water, and ground that occurred during production of nuclear materials for national defense during World War II and the subsequent Cold War era.

Ongoing or planned actions that might also have a radiological impact on the same area of interest would include those associated with the following operations:

- Comprehensive Environmental Response, Compensation, and Liability Act (42 U.S.C. § 9601 et seq.) remediation projects and remediation of the river corridor in the southeastern portion of the Hanford Site
- ongoing waste management and cleanup of the Hanford Site in general
- CGS, a nuclear power plant located north of the 300 Area and operated by Energy Northwest
- Perma-Fix Northwest, a radioactive and mixed waste treatment facility
- AREVA, a nuclear fuel fabrication plant
- Unitech Services Group (material processing and waste-management services)
- Test America (environmental testing services)
- Bioproducts, Sciences, and Engineering Laboratory (BSEL), a joint WSU and PNNL project located on the WSU-Tri-Cities campus

As indicated earlier, the maximum annual dose to the MEI resulting from the PNNL Richland Campus emissions would be about 0.00026 mrem. In 2015, the combined annual contribution to radiation dose from all of the above-named nearby sites of potential releases would have yielded a total dose of <0.5 mrem to an individual located on the PNNL Richland Campus. Based on the most recent 5-year average, routine PNNL Richland Campus operations would result in a total collective annual dose of about 0.0063 person-rem to the population within an 80 km (50 mi) radius. For perspective, the average dose to each individual in the Richland area from naturally occurring and man-made sources is about 300 mrem/y. A general description of these sources and their contribution to the total average dose is shown in Figure 5.3.

Table 5.7 shows a broader view of collective radiological impacts on human health and safety within the affected population, including the projected contribution from PNNL Richland Campus.

Based on the dose estimates in Table 5.7, whether PNNL R&D activities are carried out at the PNNL Richland Campus or not at all, there would be no appreciable difference in cumulative impacts on human radiological health and safety. Therefore, operation of the PNNL Richland Campus would result in minimal net change to cumulative impacts on the surrounding environment.

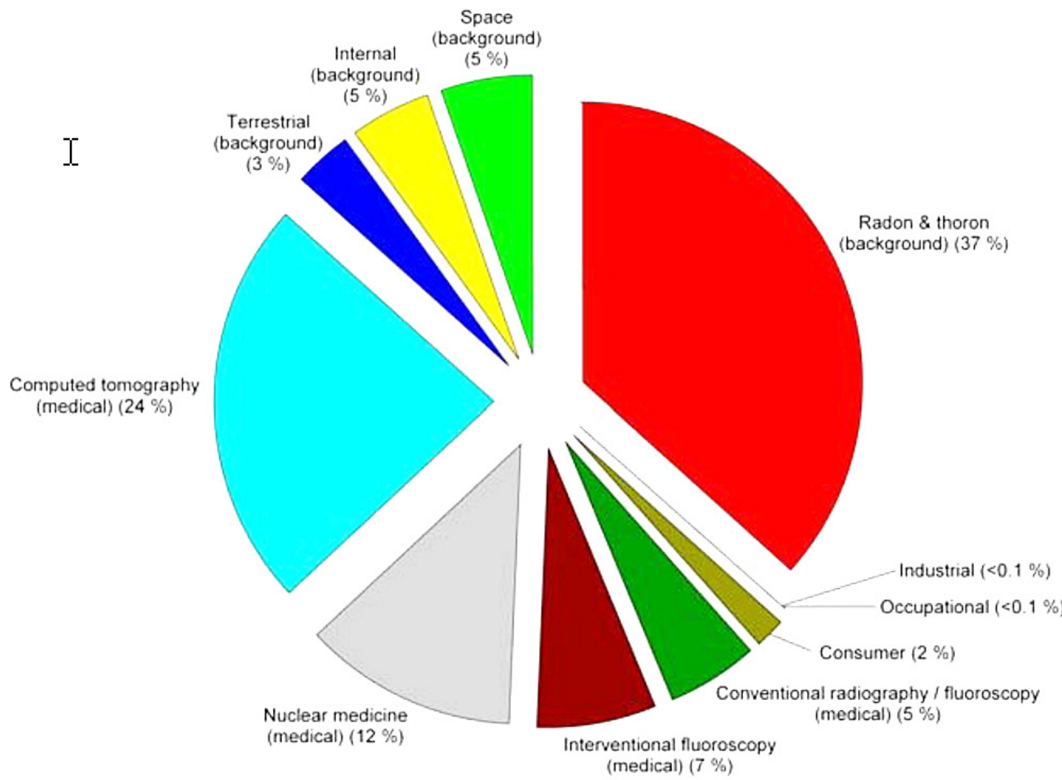

Figure 5.3. Sources of Radiation Exposure (Reprinted with permission of the National Council on Radiation Protection and Measurements, http://ncrponline.org/ [NCRP 2009])

Table 5.7. Estimated Past, Present, and Reasonably Foreseeable Collective Population Dose and Health Effects in the Hanford Environs from Release of Radioactive Material to the Atmosphere[(a)]

Source of Impacts	Dose (person-rem)	Inferred Latent Cancer Fatalities[(a)]
Hanford production operations 1944−1988 (DOE 1995)[(b)]	100,000	60
Hanford post-production operations 1989–2005 (DOE 1990–2006)[(b,c)]	9	0.0054
Hanford operations (2006–2015)[(d)]	5.4	0.0032
PNNL Campus operations (2010–2015)[(e)]	2.8	0.0017
Ongoing (2016) and Proposed Operations		
PNNL Campus R&D (20-year projection, 2016–2035)[(e)]	0.13	0.000078
Hanford R&D operations (20-year projection, 2016−2035)[(d)]	11.8	0.0071
CGS, U.S. Ecology Commercial Low-Level Waste Disposal, and other Non-DOE commercial sources (20-year projection: 2016–2035)[(f)]	10.7	0.0064
2016–2017 Plutonium Finishing Plant stabilization[(g)]	7.6	0.0046
Reasonably Foreseeable Operations		
Vitrification plant operations[(h)]	400	0.24
Cumulative Totals		
Hanford production operations (1944–1988)	100,000	60
Post-production to date Hanford and PNNL operations (1988–2015)	8.2	0.0049
Hanford Vitrification plant operations	400	0.24
20-year projected Hanford and PNNL operations (2016–2035)	19.6	0.012
20-year projected, non-DOE sources (2016–2035)	10.7	0.0064

Table 5.7. (contd)

Source of Impacts	Dose (person-rem)	Inferred Latent Cancer Fatalities[a]
Perspective		
20-year cumulative background dose (e.g., 2016–2035)[i]	2,688,000	1,600

(a) Based on 0.0006 inferred LCFs per person-rem. Values rounded to two significant figures.
(b) Assumes constant population of about 380,000. All doses given to one significant figure.
(c) Based on Hanford Site Environmental Reports for calendar years 1989 through 2005 (available at http://msa.hanford.gov/page.cfm/EnviroReports).
(d) Based on Hanford Site Environmental Reports for calendar years 2011 through 2015 (assumed 5 years at Hanford, then moving operations to the PNNL Campus for the next 15 years; available at http://msa.hanford.gov/page.cfm/EnviroReports).
(e) Based on PNNL Campus radioactive air emissions reports for calendar years 2011 through 2015 (available at http://www.pnnl.gov/about/RAE_compliance_reports/).
(f) Based on Energy Northwest CGS for calendar year 2015 (Energy Northwest 2016).
(g) MEI dose (0.000013 rem) times the 2010 80-km (50-mi) population centered at the central 200 Area (586,500) (Hamilton and Snyder 2011).
(h) Based on earlier NEPA documents (1996).
(i) Based on the 2010 80 km (50 mi) population centered at the 300 Area (432,117).

5.2.11.2 Chemical Impacts

Chemical impacts resulting from construction, operation, and cumulative impacts are described in Sections 5.2.11.2.1, 5.2.11.2.2, and 5.2.11.2.3, respectively.

5.2.11.2.1 Construction Impacts

Minimal chemical impacts resulting from construction are anticipated and would primarily be related to emissions from construction equipment and related construction activities. The chemical impact to construction workers would be negligible and similar in nature to normal construction and finishing activities (e.g., painting).

5.2.11.2.2 Operation Impacts

Anticipated impacts on health and safety of both workers and the public from exposure to non-radioactive hazardous chemicals for routine operations and accident conditions at the PNNL Richland Campus are considered in this section.

As discussed in Section 3.1.4, chemical quantities and types anticipated for use in facilities within the PNNL Richland Campus would be similar to existing uses at PNNL. Table 3.3 provides an estimated inventory of hazardous chemicals at the PNNL Richland Campus. Work would be performed in laboratories designed for safe use of chemicals, including equipment such as ventilation-controlled fume hoods and worker protective clothing. WA Ecology regulates the emissions of 395 chemicals under WAC 173-460, "Controls for New Sources of Toxic Air Pollutants." The anticipated emissions of those chemicals from the proposed R&D activities would be similar to PSF Complex emissions evaluated for the PSF Complex EA (DOE 2007). Concentrations were calculated for the points of nearest potential public exposure using the EPA Industrial Source Complex dispersion model (DOE 2007). The results are presented in Table 5.8, which shows the annual average and 24-hour average ambient air concentration for the 20 toxic air pollutants that were the highest percent of their respective health-risk based Acceptable Source Impact Levels (ASILs) as listed in that regulation. Based on the small percentages of ASILs estimated, and the fact that the sum of fractions for all the air toxic pollutants to be used in future facilities is less than one, it is concluded that impacts on public health from the release of chemicals from routine operations would be minimal.

Table 5.8 Estimated Concentrations of PNNL Richland Campus Laboratory Toxic Air Pollutant Emissions

	Ambient Air Concentrations		
Chemical	Annual Average, μg/m^3	24-Hour Average, μg/m^3	Percent of ASIL
Hydrogen Chloride	0.00024	0.10	1.42
Chlorodifluoromethane	0.021	8.7	0.73
Lead Compounds	0.0000068	0.0029	0.58
Diborane	0.0000044	0.0019	0.50
Polyaromatic Hydrocarbons	0.0000000027	0.0000011	0.24
Chloroform	0.000078	0.033	0.18
Phosphine	0.0000054	0.0023	0.18
Nitrogen Trifluoride	0.00040	0.17	0.17
Ammonia	0.00037	0.15	0.15
Acrylic Acid	0.00000072	0.00030	0.10
Methylene Chloride	0.00053	0.22	0.10
Boron Trifluoride	0.000017	0.0071	0.08
1,2-Epoxybutane	0.000025	0.011	0.05
Toluene	0.00044	0.19	0.05
Vinyl Chloride	0.0000043	0.0018	0.04
Trichloroethylene	0.00019	0.081	0.03
Chromium	0.000000022	0.0000093	0.03
Nitric Acid	0.000010	0.0043	0.03
Carbon Tetrachloride	0.000017	0.0071	0.03
Hexafluoroacetone	0.0000013	0.00053	0.02

Note: to convert m^3 to ft^3, multiply by 35.3147.

As a research laboratory, PNNL recognizes that it has many buildings where chemicals are used and/or stored for research operations and maintenance activities and therefore has introduced controls to avoid potential hazards include training, inventory control procedures, approvals prior to chemical requisitioning, and work procedures for chemicals use, including adequate safety requirements. Because management practices and activities at the PNNL Richland Campus are anticipated to be similar in nature to current practices and activities, the potential impacts from use of hazardous chemicals are expected to remain low.

5.2.11.2.3 Cumulative Impacts

Chemical impacts resulting from construction and operation of the PNNL Richland Campus were found to be small and would generally be similar to those from current PNNL activities. Therefore, operation of the PNNL Richland Campus would result in minimal net change to cumulative chemical impacts on the surrounding environment.

5.2.11.3 Physical Impacts

Physical impacts resulting from construction, operation, and cumulative impacts are described in Sections 5.2.11.3.1, 5.2.11.3.2, and 5.2.11.3.3, respectively.

5.2.11.3.1 Construction Impacts

Construction of the PNNL Richland Campus would require approximately 175 workers per year over a 20-year period. During the 2 or 3 peak years of construction, 350 workers per year are anticipated. Based on the 2015 Washington State Department of Labor & Industries total recordable case (TRC) rate for non-residential construction (i.e., 3.5 cases of injury/illness per 200,000 labor-hours; WLNI 2016), about 6.1 cases of injury/illness might occur per year during construction of the PNNL Richland Campus. The TRCs of occupational injury and illness anticipated from the construction activities during average and peak years are indicated in Table 5.9. The national TRC rate for all construction workers is also 3.5 per 200,000 labor-hours (BLS 2016a). No fatalities are expected during an average (less than 0.02) or peak (less than 0.04) construction year based on the 2015 national fatality rate for construction workers of 10.1 per 200 million labor-hours (BLS 2016c)

Table 5.9. Number of Total Recordable Cases Resulting from Construction and Operations Activities

	Assumption	Workers	TRC rate per 200,000 Worker-Hours	Total Recordable Cases Per Year	Basis for Rate Assumed
Annual Construction	Average all years	175	3.5[a]	6.1	Washington State, non-residential construction 2015
	Peak year	350	3.5[a]	12.3	
Annual Operations	Workers at new facilities	1,500 – 2,000	0.70	10.5 – 14.0	PNNL (2011 – 2015)
	Total campus workers	4,400	0.70	30.8	
Cumulative Physical Impacts					
			TRC per Year	Years	Cumulative TRC
	Construction workers		6.1	20	123
	Operations-campus workers				
	New facilities only		10.5 – 14.0	20	210 – 280
	All campus facilities		30.8	20	616
	Total Cumulative Total Recordable Cases			**20**	**739**

(a) Reported as rate per 100 fulltime-equivalent workers. Each worker is assumed to work 8 hours per day for 250 days per year, equivalent to a TRC rate per 200,000 worker-hours.

The rate of increase, if any, in the number of total campus workers over the next 20 years is uncertain; however, additional construction workers would be employed during building projects. Table 5.9 indicates the annual number of TRC cases for the campus workers (31 cases) and construction workers (7 to 13 cases), rounding up. The campus worker cases are based on the average TRC rate for PNNL employees from 2011 to 2015, 0.7 TRC per 200,000 labor-hours (DOE 2017b). The construction worker TRC rate, described in the preceding paragraph, is greater than the typical campus worker due to the more physical nature of the work. If the 2015 recordable cases rate for private industry is assumed for both campus and construction workers (3.0 cases per 200,000 worker-hours) (BLS 2016a), 100 additional cases would occur each year.

5.2.11.3.2 Operation Impacts

When the buildout is completed, the buildings would house 1,500 to 2,000 staff. Assuming that the PNNL average incidence of 0.70 cases of injury/illness per 200,000 labor-hours (Section 4.11) is still representative in 20 years and that the workers work 250 days per year, approximately 11 to 14 injuries per year might be expected (Table 5.9).

5.2.11.3.3 Cumulative Impacts

Physical impacts resulting from construction and operation of the PNNL Richland Campus were found to be small and would generally be similar to those from current PNNL activities. Table 5.9 indicates the cumulative impact to construction workers and campus workers over the 20-year buildout period. Total campus employment is not expected to change, but construction workers would add to campus-related employment numbers. Therefore, operation of the PNNL Richland Campus would result in approximately 20 percent more TRCs of injury and illness due to cumulative physical impacts on workers. Based on employment levels and the time frame considered, no fatalities are expected.

5.2.12 Visual Resources

The visual resource analysis focuses on the degree of contrast between the Proposed Action and the surrounding landscape, the sensitivity levels of key observation points, and the visibility of the Proposed Action from those key observation points (see Figure 4.3) in reference to the PNNL Richland Campus. The distances from key observation points to the affected area were also considered, as distance could diminish the degree of contrast and visibility. To determine the range of the potential visual effects, the viewshed analysis considered the potential effects in light of the aesthetic quality of surrounding areas, as well as the visibility of possible activities and facilities from key observation points. The detailed assessment performed by DOE (2015a) bounds the impacts expected for the campus (see Section 4.11).

5.2.12.1 Construction Impacts

During construction, equipment and activities would be visible within the campus; however, as expected, visibility would diminish as a function of the viewer's distance. Construction activities would be similar to activities occurring in the 300 Area to the north and in the City of Richland to the south. The campus would be partially visible from Stevens Drive on the west, George Washington Way on the east, and from roadways on the interior of the campus. These vantage points do not offer unique or distinctive views or serve as viewpoints for sensitive viewers.

As noted in Section 4.11, the campus has a mix of Class III and Class IV viewshed characteristics. Depending on the location of anticipated facilities, development could result in a change in the VRM classification of the campus from Class III to Class IV, as the buildings and infrastructure on the built-out site would become the primary focus for viewers. This development would be consistent with development in the 300 Area to the north and in the City of Richland to the south. In both areas, the existing buildings and structures are similar in height to the potential representative facilities. If construction occurred south of Horn Rapids Road, it is likely that the Class IV viewshed characteristics would be maintained. The area to the west of the campus is primarily undeveloped and the Proposed Action would change the visual environment.

Development would be consistent with the visual resources goals of the City of Richland Comprehensive Land Use Plan (City of Richland 2008). The plan states as a goal that development should recognize and preserve established major vistas, as well as protect natural features such as rivers, ridgelines, steep slopes, major drainage corridors, and archaeological and historic resources.

5.2.12.2 Operation Impacts

Once the campus is developed, key observation points that the Tribes identified as important in their summaries (see Appendix G of DOE 2015a) would or would not be visible (land highlighted or not highlighted in dark brown, respectively, in Figure 4.4). The views from these key observation points would not change to any extent in reference to baseline conditions.

5.2.12.3 Cumulative Impacts

The anticipated visual resource impacts of the Proposed Action were evaluated in the context of the reasonably foreseeable future actions identified in Table 5.1. Taken together, those actions and the

Proposed Action result in cumulative visual impacts to the local area. However, as discussed for the Proposed Action, the likely impacts of the Proposed Action would be minor in the context of the existing viewshed. Thus, the Proposed Action's contribution to cumulative visual resource impacts would not be significant.

5.2.13 Noise and Vibration

Impacts of the Proposed Action from construction and operations would be managed to maintain applicable standards. Specific impacts are discussed in the following sections.

5.2.13.1 Construction Impacts

A detailed noise impact assessment was completed for DOE (2015a). The PNNL Richland Campus is immediately adjacent to the lands considered in DOE (2015a). Construction activities would generate noise typical of using heavy equipment (modeled as the simultaneous use of two 300-HP diesel-fueled bulldozers) and transport of materials. Noise impacts are assessed by establishing regions of influence for residential, commercial, and industrial receptors and are presented briefly as follows.

The nearest residential area to the construction area would be the Willow Pointe housing development, located approximately 0.4 km (0.25 mi) east of the campus at its closest point, along the Columbia River, and the Lofts and Commons Apartments near the southern campus boundary. The Washington State maximum permissible environmental noise levels (WAC 173-60) limit daytime noise to 60 dBA for residential locations.

The commercial limit of 65 dBA would apply to facilities on campus (WAC 173-60). Existing campus buildings could be affected by noise from potential construction activities, depending on where on campus those activities take place. In addition, an onsite guest house that accommodates up to 81 overnight visitors is located on campus. Attenuation of noise by the walls and windows of proximate facilities would reduce inside noise levels, although episodic noise events or associated ground vibrations could disturb building occupants.

The Washington State maximum permissible environmental noise limit for industrial receptors is 70 dBA (WAC 173-60). Sounds originating from temporary construction sites as a result of construction activities are exempt from Washington State maximum permissible noise provisions during the hours of 7:00 a.m. to 10:00 p.m. If construction were to occur between 10:00 p.m. and 7:00 a.m., the maximum permissible environmental noise levels would be reduced by 10 dBA for residential, commercial, and industrial receptors (WAC 173-60).

Ground vibrations from using heavy equipment might have some impact on operation of the LIGO, located approximately 14 km (~9 mi) northwest of the campus and EMSL and other sensitive activities on the PNNL Richland Campus. Prior to construction, LIGO and other facility operators would be notified so that operators could take the extraneous ground vibrations from construction into account. Construction activities that generate noise and vibrations have the potential to affect R&D and facility equipment. Construction efforts would be coordinated with building operations and research staff to minimize impacts to ongoing operations.

5.2.13.2 Operation Impacts

Operations of new facilities (i.e., new office buildings and laboratory facilities including their heating systems, ventilation systems, and air conditioning systems including chillers and compressors) are not likely to produce appreciably greater amounts of acoustic noise or vibration than current facilities on the PNNL Richland Campus. The transport and loading and unloading of semi tractor-trailers onsite would generate acoustic noise and vibration. Vibration could result from trucks backing into loading docks and passing over speed bumps or other traffic calming devices (Appendix C in DOE 2015a). The duration of such vibrations would be intermittent.

Operation of proposed facilities would result in a minor increase in traffic volumes on the local roadway network, and consequently, an intermittent increase in noise levels from traffic sources along affected roadway segments. It is anticipated that noise levels from traffic would remain within industrial noise ordnance levels.

5.2.13.3 Cumulative Impacts

The anticipated noise impacts of the Proposed Action were evaluated in the context of the reasonably foreseeable future actions identified in Table 5.1. Taken together, those actions and the Proposed Action result in cumulative noise impacts to the local area. However, as discussed for the Proposed Action, the likely impacts of construction noise would be minor and kept within prescribed limits. There would be no net change in operations noise from the Proposed Action. Thus, the Proposed Action's contribution to cumulative noise impacts would not be significant.

5.2.14 Utilities and Infrastructure

The assessment of potential effects to infrastructure relies on identifying the current levels of service for existing infrastructure and comparing that to the expected infrastructure requirements from the construction and operation of the proposed facilities on the PNNL Richland Campus. Spatially, the analysis extends to the broader infrastructure systems that would be required for the new facilities. Temporally, the analysis considers those effects that would occur in the short term (construction of facilities) and those that would occur in the long term (operation of facilities). See the individual resource topics in this EA for discussions of anticipated impacts from construction, including utilities and infrastructure.

5.2.14.1 Construction Impacts

Under the Proposed Action, the campus would eventually hold new and existing PNNL facilities. Key infrastructure has been extended to new PNNL facilities north of Horn Rapids Road, and much of the existing campus is currently developed and has existing infrastructure; therefore, depending on actual facility locations, some additional infrastructure may have to be constructed. Electricity and natural gas are provided by the City of Richland and the Cascade Natural Gas Corporation, respectively. Construction assumptions are discussed at the beginning of this chapter. Land disturbances for all construction activities are described in Sections 3.1 and 5.2.1.

Water service for new facilities north of Horn Rapids Road, would be connected to existing supply lines installed to serve the first phase of the multi-phased industrial development. Future PNNL water use will require the construction of additional water supply infrastructure, overseen by the City of Richland, that is already planned to connect other future development in the PNNL Richland Campus vicinity.

Additional sewer line service would connect to recent infrastructure upgrades for any new PNNL facilities north of Horn Rapids Road. It is unlikely that the entire campus could be served by gravity flow; therefore, as the campus is developed, new sewer lift stations and associated forced mains would be required.

A fiber optic data communication network serves the City of Richland. It is anticipated that the network would be extended to the new facilities on the campus along existing and newly constructed access roads.

The City of Richland's Sandhill Crane Distribution Substation receives power from BPA's 115 kV transmission line that runs between the BPA White Bluffs Transmission Substation and the City of

Richland First Street Distribution Substation. The Sandhill Crane Distribution Substation is currently at capacity and the City of Richland plans to construct a new substation in the future on Kingsgate Way west of the Battelle Boulevard intersection (DOE 2015a). Depending on the rate of development within the campus and the adjacent lands, a second substation may be required at a future date. BPA would provide electrical transmission lines that would be needed for any new substation. The City of Richland likely would construct new distribution lines from the substations to serve the campus.

The City of Richland would work with natural gas providers to bring natural-gas service to the new facilities, as needed. Alternatively, supply to the PNNL Richland Campus may be obtained from the current DOE connection to Cascade Natural Gas in the 300 Area. When the City of Richland or another local jurisdiction considers a future need for additional infrastructure (e.g., gas lines to serve the area), it would conduct State Environmental Policy Act reviews for those actions.

5.2.14.2 Operation Impacts

Table 3.4 lists the expected utility service demands at full buildout of the campus. The projected water use at full buildout would be approximately 383 m^3/day (101,000 gal/day), which is about 0.7 percent of the City of Richland current average daily water use and 0.3 percent of the city's water treatment capacity (City of Richland 2010). The quantity of wastewater generated would be approximately 345 m^3/day (91,000 gal/day), or about 0.8 percent of the design capacity of the City of Richland Wastewater Treatment Facility. Similarly, electrical demand for all proposed facilities would be approximately 3,151 kW, or about 1.4 percent of the peak power demands in 2013. Construction of the new substations to the north and south of Horn Rapids Road, when needed, would assure that adequate load capacity exists for future demands on the power system in that area of the city.

The Proposed Action would result in new, long-term demand for utility services. New infrastructure and services would be provided and maintained by the City of Richland, Port of Benton, BPA, and Cascade Natural Gas Corporation, as applicable.

The City of Richland would provide solid waste disposal and recycling services to any new facilities on the campus. Although the Horn Rapids Sanitary Landfill is anticipated to reach capacity by 2018, the City of Richland is exploring alternative options for waste disposal and no effects on its ability to provide these services are anticipated (DOE 2015a).

5.2.14.3 Cumulative Impacts

The anticipated infrastructure impacts of the Proposed Action were evaluated in the context of the reasonably foreseeable future actions identified in Table 5.1. Taken together, those actions and the Proposed Action result in cumulative infrastructure impacts to the local area. However, the same utilities and jurisdictions cover the actions found in Table 5.1, and resources are planned to meet the demands of all the expected projects in the local area. Thus, the contribution of the Proposed Action to cumulative infrastructure impacts is anticipated in the planning processes of the affected jurisdictions, and would not be significant in the context of all planned infrastructure improvements.

Average temperatures in the northwest have increased approximately 1.3 °F over the last several decades (GCRP 2014). Should the average temperature continue to increase, long-term effects on the need for utility services may be observed. These effects are manifest over time as gradual but constant changes in the demand for water (irrigation), electricity (heating and cooling), and natural gas (heating). These resource needs are accounted for through the ongoing resource planning processes, which make incremental assessments of trends in demand and seek to acquire resources as needed in response to changing demand.

5.2.15 Waste Generation and Disposition

DOE utilizes a comprehensive approach to implementing the requirements of EO 13693 *Planning for Federal Sustainability in the Next Decade* (80 FR 15871) by integrating sustainability into the various phases of operations at PNNL. The PNNL sustainability program contains three focus areas: environmental stewardship, social responsibility, and economic prosperity. Waste-management activities associated with construction and facility operations would be conducted in accordance with the environmental stewardship portion of this program.

5.2.15.1 Construction Impacts

A majority of the construction waste and debris (e.g., cardboard, metal, wood, and concrete) would be recycled; however, approximately 1,530 m^3 (2,000 yd^3) might be disposed of at the Horn Rapids Sanitary Landfill. In addition, demolition of existing structures (primarily south of Battelle Boulevard) would result in approximately 1,990 m^3 (2,600 yd^3) of excess concrete and approximately 180,000 kg (397,000 lb) of excess metal, wood and sheetrock. The City of Richland notes that its 46 ha (114 ac) landfill could potentially be at capacity in 2018, and is evaluating the need to expand the existing space or utilizing long-haul services to a regional landfill (City of Richland 2011).

5.2.15.2 Operations Impacts

PNNL primarily generates general sanitary trash, hazardous wastes, and low-level wastes from R&D operations on the PNNL Richland Campus. PNNL maintains the capability on the campus to manage waste in accordance with federal and state regulatory requirements. Final disposition of all hazardous waste is performed offsite, and is contracted to commercial companies with permitted treatment, storage, and disposal facilities. Radioactive and mixed waste streams are also sent through Hanford Site for disposal. The types of waste generated in support of R&D operations in the proposed facilities under this action are anticipated to be similar to the PSF Complex. During 2016, 30,965 kg (68,266 lb) of hazardous waste and 26,484 kg (58,387 lb) of low-level radioactive wastes were generated at the PNNL Richland Campus. The addition of new facilities under the Proposed Action is estimated to not significantly alter PNNL's hazardous waste volumes (approximately ±5 percent), as the new facilities would house research relocated from other facilities in North Richland. The design of new facilities would incorporate areas to manage waste materials generated from R&D and operations.

Liquid wastes from new facilities would consist of process waste water and sanitary sewage. Both of these wastewater streams would be sent to the City of Richland's Publicly Owned Treatment Works for processing. Process wastewater generated as a part of facility operations would be permitted in accordance with the City of Richland Pretreatment Program (Richland Municipal Code 17.30); monitoring and reporting would be performed in accordance with applicable permit conditions. Process wastewater from the new facilities is anticipated to be similar in composition to the existing facilities. Past monitoring results (Duncan et al. 2016) demonstrate the ability for R&D and facility operations to maintain compliance with applicable wastewater permits.

Based on currently operating facilities actual annual waste-generation rates, the estimated annual waste volumes that would be generated from the new facilities when fully operational are show in Table 5.10.

Table 5.10. Current and Anticipated Annual Waste Volumes

Component (per year)	Operational Footprints: Current PNNL Facilities[a]	Operational Footprints: Planned 20-Year Additions[b]	Total Anticipated Volume
Nonhazardous solid waste	10,496 m^3 (13,728 yd^3)	524 m^3 (686 yd^3)	11,021 m^3 (14,414 yd^3)
Hazardous waste	30,965 kg (68,266 lb)	1,548 kg (3,413 lb)	32,513 kg (71,679 lb)
Low-level radioactive waste	26,484 kg (58,387 lb)	1,324 kg (2,919 lb)	27,808 kg (61,306 lb)

(a) Volumes include wastes generated on the PNNL Richland Campus and leased facilities in North Richland.
(b) Future buildout replaces leased facilities in North Richland, the incremental change in overall waste volumes may fluctuate approximately 5 percent.

5.2.15.3 Cumulative Impacts

Sanitary trash and hazardous wastes generated by PNNL would not increase significantly, as the proposed facilities are similar to existing operations. Future actions (Table 5.1) in the vicinity of the campus indicate the potential for an industrial park, manufacturing facilities, and housing developments. The future industrial park tenants and manufacturing operations could have the potential to generate hazardous waste, however hazardous wastes are typically sent to offsite treatment, storage, and disposal facilities. In addition, these future industrial/manufacturing operations and housing developments would generate sanitary wastes that would be sent to the City of Richland, but current capacities and planned growth of city infrastructure are anticipated to be able to accommodate projected waste volumes. The Proposed Action’s contribution to cumulative waste impacts would not be significant.

5.2.16 Accidents

Potential impacts from postulated accidents are described in this section. Impacts from the routine release of chemicals and radionuclides are described in Section 5.2.11, Human Health and Safety.

Section 3.0 discusses the Proposed Action, including a description of the proposed PNNL Richland Campus and the associated buildings and infrastructure requirements. Several new facilities would include radiological and chemical laboratories. In addition, DOE is considering a new project-specific high-bay facility that would house a hydrotreater to convert bio-oil to liquid hydrocarbon fuels that could serve as gasoline, jet and diesel blendstocks. Impacts from postulated accidents at facilities housing chemical laboratories, radiological laboratories, and the hydrotreater are discussed below.

5.2.16.1.1 Chemical Facilities

The PNNL Richland Campus would include new buildings that would have chemistry laboratories that may be capable of working with toxic chemicals. Some of these facilities would be replacing existing PNNL capability. In general, the quantity and type of chemicals would remain within the envelope of what is currently in use at PNNL.

Chemical work would be performed in laboratories designed for safe use of chemicals, including equipment such as ventilation-controlled fume hoods and worker protective clothing. WA Ecology regulates the emissions of toxic chemicals under WAC 173-460, “Controls for New Sources of Toxic Air Pollutants.” At PNNL, toxic chemicals are generally used in bench-scale projects, thus quantities at any one location tend to be small. Although laboratory-scale research activities are exempt from WAC 173-460 requirements, Section 5.2.11 analyzed the potential impacts from routine use of toxic chemicals using dispersion modeling of the site boundary. Air concentrations were well below the ASILs (WAC 173-460) for all toxic chemicals of any significance. Because toxic chemical quantities are expect to be small, no accident scenario is envisioned that would lead to an offsite consequence due to chemicals.

5.2.16.1.2 Radiological Facilities

The PNNL Richland Campus may include several new buildings that may be capable of working with radiological material. Some of these facilities may be replacing existing capability at the Laboratory. In general, the quantity and type of radioactive materials would remain within the envelope of what is currently authorized under PNNL's existing radioactive air permits. The current published list of radioactive materials handled or potentially handled at the campus can be found in the PNNL 2015 Annual Site Environmental Report (Duncan et al. 2016). The new facilities would be designated as less than Hazard Category 3 nuclear facilities. Nuclear Hazard Category 3 facilities include those where the hazard analysis indicates the potential for only significant localized consequences. Thus, no radiological accident scenario is envisioned that would lead to a significant offsite consequence.

5.2.16.1.3 High-Bay Facility

PNNL currently operates a hydrotreater inside of the PDLW high-bay work area. PNNL Richland Campus buildout is anticipated to include a new high-bay facility that would house the existing PDLW hydrotreater as well as new or replacement hydrotreater equipment or other biofuel processes.

The hydrogen needed for the high-bay facility is based on the requirements for a nominal hydrotreater run of approximately 60,000 standard cubic feet (scf). To provide adequate planning and operational flexibility, three potential scenarios for hydrogen gas were analyzed to estimate the amount of material at risk (MAR):

1. Cylinders: For this scenario, eight permanently placed refillable 12 packs (cradles) of high-pressure cylinders connected via a manifold are used to supply the building. The cylinders are assumed to contain 232 scf of hydrogen, for a total calculated MAR of 22,272 scf. This scenario most closely matches the configuration currently being used in the hydrotreater operations at PDLW.
2. Multi-tube storage racks: For this scenario, two multi-tube storage racks of 12 seamless swaged-ended vessels are assumed to supply the facility needs. The individual tubes are assumed to contain 1,650 scf of hydrogen, thus the total MAR based on both storage racks is 39,600 scf.
3. Tube trailer: For this scenario, a commercially available tube trailer closely matching the needs for a complete hydrotreater run is assumed to supply the building needs, with 61,800 scf of hydrogen. In addition, the 12-pack of high-pressure bottles evaluated in scenario 1 is included. The MAR for these bottles is 2,784 scf. As the actual sizing may be slightly larger depending on the trailer supplier and availability, a MAR value of 65,000 scf was used.

Table 5.11 summarizes the maximum amount of hydrogen gas that could be stored and handled in the high-bay facility hydrotreater. Various accident scenarios were evaluated with the quantities to assess potential offsite consequences. Two accident types—vapor cloud explosion and vapor cloud fire—resulted in the largest impact distances. However, these distances did not lead to any offsite consequences. The results of the accident scenarios are presented in the following sections.

Table 5.11. Material at Risk – Entire Inventory Release

Scenario	Total Hydrogen Volume (scf)	Total Hydrogen Mass[(a)] (kg)
Cylinders	22,272	53
Multi-tube storage racks	39,600	94
Tube trailer	65,000	154

(a) Mass calculated assuming a density of 0.00238 kg/scf at standard temperature (0°C) and pressure (101.325 kPa).

Vapor Cloud Explosion

The bounding scenarios presented in this section follow the guidance and methodologies presented in the EPA Risk Management Program Guidance for Offsite Consequence Analysis (OCA) (EPA 2009). For a vapor cloud explosion, the potential offsite hazard is from a threshold level of pressure (i.e., an overpressure) from a blast wave. Overpressure refers to the sudden onset of a pressure wave after an explosion. A pressure wave is caused by the energy released in the initial explosion; the pressure wave is nearly instantaneous and travels at the speed of sound. Pressure waves radiate outward and could generate hazardous fragments (e.g., building debris and shattered glass). At high overpressures, structural damage to buildings could occur. Sudden changes in pressure could also affect pressure-sensitive organs (e.g., ears and lungs). Per the OCA, the distance to 1 pound per square inch (psi) overpressure is the primary level of concern. An overpressure of 1 psi may cause partial demolition of houses (which could result in serious injuries to people) and shattering of glass windows (which may cause skin laceration from flying glass).

For a worst-case analysis, the total quantity of the flammable substance is assumed to form a vapor cloud. The entire contents of the cloud are assumed to be within the flammability limits, and the cloud is assumed to explode. For the worst-case, analysis, 10 percent of the flammable vapor in the cloud is assumed to participate in the explosion (i.e., the yield factor is 0.10). Consequence distances to an overpressure level of 1 psi were determined using Equation C-1 from the OCA; this equation is provided in Appendix D of the EA.

Table 5.12 provides the distance to 1 psi overpressure for the vapor cloud explosion based on the MAR listed in Table 5.11. The maximum distance to 1 psi is 125 m (410 ft) for the tube trailer scenario; this distance results in no offsite consequence.

Table 5.12. Vapor Cloud Explosion Distance to 1 psi Overpressure

Scenario	Hydrogen Mass (kg)	Distance to 1 psi (m)
Cylinders	53	87
Multi-tube storage racks	94	106
Tube trailer	154	125

Vapor Cloud Fire

The bounding scenarios presented in this section follow the guidance and methodologies presented in the EPA OCA (EPA 2009). For a vapor cloud fire, the potential offsite hazard is from thermal radiation (i.e., heat) from dispersion of a cloud of flammable vapor and the subsequent ignition of the cloud following dispersion. Such a fire could flash back and represent a heat radiation hazard to anyone in the area of the cloud. The distance to the lower flammability level (LFL) represents the maximum distance based on the total quantity of flammable material could be released from a vessel or pipeline at which the radiant heat effects of a vapor cloud fire might have serious consequences.

The analysis of vapor cloud fires follows the guidance in the OCA, which provides reference lookup tables for estimating the distance to the LFL based on an assumed stability class and wind speed. The methodology determines the distance to the flammable endpoint based on the release rate (lb/min) divided by the LFL concentration in (mg/L). For hydrogen, the LFL is 3.3 mg/L (EPA 2009). Because the method assumes that the vapor cloud release is in a steady state and that vapor cloud fires are nearly instantaneous events, the release duration is not a critical factor for estimating vapor cloud fire distances. For these calculations, it is assumed the entire inventory is released in 1 minute if the flow rate is not otherwise limited (i.e., choked flow). The choke flow release rate was calculated assuming a severed supply line of 0.5 in. Schedule 40 pipe and a bounding pressure; this equation is provided in Appendix D of the EA.

Table 5.13 provides the distance to the LFL for a vapor cloud fire based on the MAR listed in Table 5.11. The maximum distance to the LFL is 322 m (1,060 ft) for both the multi-tube storage racks and tube trailer scenarios; this distance results in no offsite consequence.

Table 5.13. Vapor Cloud Fire Distance to LFL

Scenario	Mass (kg)	Distance to LFL[a] (m)
Cylinders	53	161
Multi-tube storage racks	94	322
Tube trailer[b]	154	322

(a) Based on Table 26 of EPA-550-B-99-009 (EPA 2009).
(b) Choked flow limited release rate applies.

5.2.17 Intentional Destructive Acts

Prior to 2001, DOE NEPA documents did not typically include an analysis of intentional destructive acts. Following the events of September 11, 2001, DOE implemented measures to minimize the risk and consequences of potential intentional destructive acts on its facilities. Consistent with DOE guidance, DOE currently analyzes the potential impacts of intentional destructive acts in NEPA documents. DOE (2002) provided guidance for this analysis.

It is not possible to predict whether intentional destructive attacks would occur, or the nature or types of such attacks. Nevertheless, DOE has evaluated security scenarios involving intentional destructive acts to assess potential vulnerabilities and identify improvements to security procedures and response measures. Security at its facilities is a critical priority for DOE. Therefore, DOE continues to identify and implement measures to defend and deter attacks at PNNL. DOE maintains a system of regulations, orders, programs, guidance, and training that form the basis for maintaining, updating, and testing site security to preclude and mitigate any potential intentional destructive attacks.

Although an intentional act is unlikely, an intentional destructive act targeting the PNNL Richland Campus is possible. However, conservative assumptions inherent in the accidents analyzed in DOE facility-specific safety analysis reports and documented safety analyses (e.g., PNNL 2015a) assume initiation by natural events, equipment failure, or inadvertent worker actions. The accidents evaluated in these documents include earthquakes, fires, criticalities, and airplane crashes, all of which could cause a release of radiological materials or chemicals to the environment. Intentional destructive acts could also potentially cause a release of these materials to the environment; however, radiological inventories in new buildings would be less than Hazard Category 3 facilities and releases, should one occur, would not result in adverse impacts off the PNNL Richland Campus. If an intentional destructive act were to occur, the resulting consequences to workers and the public would be similar to those occurring from natural or human-caused events. In addition, the Proposed Action would not increase the likelihood of an intentional destructive act or the resulting consequences.

5.2.18 Environmental Sustainability

The DOE-Battelle Prime Contract for the management and operation of PNNL (DOE 2016c) incorporates applicable requirements from DOE Order 436.1, "Departmental Sustainability" (DOE 2011), including associated performance goals, objectives, and systems (Duncan et al. 2016).

DOE Order 436.1 (DOE 2011) was approved on May 2, 2011. The purpose of this Order is to

…1) ensure the Department carries out its missions in a sustainable manner that addresses national energy security and global environmental challenges, and advances sustainable, efficient and reliable energy for the future, 2) institute wholesale cultural change to factor sustainability and greenhouse gas (GHG) reductions into all DOE corporate management decisions, and 3) ensure DOE achieves the sustainability goals established in its Strategic Sustainability Performance Plan (SSPP) pursuant to applicable laws, regulations and Executive Orders (EO), related performance scorecards, and sustainability initiatives….

PNNL has incorporated these requirements through contract modifications, which include the development of an annual PNNL Site Sustainability Plan (e.g., PNNL 2015b), incorporation of sustainable acquisition requirements into applicable processes, and the development of an environmental management system that is certified to International Organization for Standardization (ISO) 14001:2015 standards.

The PNNL Site Sustainability Plan (e.g., PNNL 2015b), which identifies the status and accomplishments of sustainability projects related to DOE's sustainability goals, is prepared and submitted to DOE annually in accordance with DOE guidance. The PNNL Site Sustainability Plan includes Pollution Prevention Program activities, accomplishments, and continuous improvement opportunities (Duncan et al. 2016).

This already established approach to planning, implementing, and monitoring actions directed at meeting DOE sustainability goals and objectives would also be applied to the construction and operations of all facilities proposed for PNNL's future development.

5.2.19 Irreversible and Irretrievable Commitment of Resources

5.2.19.1 Construction Impacts

Construction of the facilities on the PNNL Richland Campus would require an irreversible and irretrievable commitment of the resources listed in Table 5.14.

None of these resources are unique or regionally in short supply and DOE use of these resources would not result in any shortage or impact to other regional users.

The proposed development on the campus would require the removal of existing shrub-steppe habitat. Mitigation relative to the removal of shrub-steppe environment is further discussed in Appendix C.

Table 5.14. Construction Resources with Irreversible and Irretrievable Commitments and Their Anticipated Usage

Resource	Commitment	Comment
Fill dirt	720 m^3 (940 yd^3)	The area being considered is generally flat, with small depressions and rises. As development occurs, the site would be graded and leveled using existing material. Existing topsoil would be piled and retained onsite for landscaping, as needed.
Concrete	36,200 m^3 (47,325 yd^3)	Construction contracts typically define the usage of local materials and materials with recycled content to meet high-performance sustainability standards.
Steel	4,360 tonnes (4,803 tons)	Construction contracts typically define the usage of local materials and materials with recycled content to meet high-performance sustainability standards.
Asphalt	50,700 tonnes (55,902 tons)	Construction contracts typically define the usage of local materials and materials with recycled content to meet high-performance sustainability standards.
Diesel	18,900 L (5,000 gal)	Diesel and gasoline fuel would be consumed by during the operation of construction vehicles and other construction-related equipment.
Gasoline	82,000 L (21,667 gal)	

5.2.19.2 Operation Impacts

Operation of the facilities on the PNNL Richland Campus would require an irreversible and irretrievable commitment of the resources listed in Table 5.15.

Table 5.15. Operation Resources with Irreversible and Irretrievable Commitments and Their Anticipated Usage

Resource	Commitment	Comment
Natural gas	379,688 Therms	Hot water heaters, boilers, and other facility equipment would be natural-gas fired. The value presented above represents annual consumption for the full buildout of facilities.

5.2.19.3 Cumulative Impacts

The anticipated resource impacts of the Proposed Action were evaluated in the context of the reasonably foreseeable future actions identified in Table 5.1. The future actions and the Proposed Action result in cumulative-resource impacts to the local area. The timing of future actions and the Proposed Action likely would occur relatively evenly over the 20-year span, such that the likelihood of “peak” demand for resources is not anticipated to be an issue. The impacts from the Proposed Action to resources in the region would be relatively minor in the context of total future development in the area.

5.3 Environmental Impacts of the No Action Alternative

Under the No Action Alternative, DOE would not obtain replacement facilities or provide new facilities for PNNL staff and existing and future research missions. PNNL would continue to occupy and operate the existing facilities on the PNNL Richland Campus. Existing facilities may be refurbished or demolished based on mission needs and life-cycle cost assessment.

5.3.1 Adverse Impacts

PNNL’s capability to support of the nation’s strategic goals in science, national security, energy, and the environment for DOE and other federal clients over the next 20 years would be substantially reduced. Declines in facilities and capabilities could lead to losses in new employment opportunities. The local community economic benefits associated with construction of new facilities and infrastructure would not be realized.

5.3.2 Beneficial Impacts

The shrub-steppe and other native habitat and cultural resources within the PNNL Richland Campus would be undisturbed, and emissions and noise from construction activities would not occur. The resource commitments necessary for the future buildout would not occur.

6.0 ENVIRONMENTAL PERMITS AND REGULATORY REQUIREMENTS

PNNL is required to carry out operations in compliance with all federal, state, and local laws and regulations; Presidential EOs; DOE Orders; and procedures (DOE/PNSO 2017b). Environmental regulatory authority over the DOE Office of Science and its laboratories is vested in federal, state, and local agencies.

Federal, state, and local laws apply to construction and operation of the proposed future facilities. The environmental regulatory framework includes requirements regarding planning for facilities to protect air and water quality, human health, and the environment. Based on the research capabilities in the proposed facilities, it is anticipated that the following environmental permits, consultations, or other regulatory compliance would be required for future construction and operations on the PNNL Richland Campus.

- **Industrial Wastewater Pretreatment Permit**. The City of Richland Pretreatment Program sets forth uniform requirements for industrial users of the Publicly Owned Treatment Works for the City of Richland and enables the city to comply with all applicable state and federal laws, including the *Federal Water Pollution Control Act* (commonly referred to as the *Clean Water Act*) (33 U.S.C. § 1251 et seq.) and the General Pretreatment Regulations (40 CFR Part 403). The regulatory driver is the City of Richland's Pretreatment Program, Richland Municipal Code 17.30, the *Richland Pretreatment Act*. Process wastewater streams from R&D activities would be permitted with the City of Richland, monitoring and reporting would be conducted in accordance with permit requirements.
- **Stormwater/Underground Injection Control Program**. WA Ecology regulates underground injection under Washington Administrative Code (WAC) 173-218, *Underground Injection Control Program*. The purpose of the program is to preserve and protect the waters of the state. Consistent with current PNNL operations, it is anticipated that UIC wells may be used for onsite management of stormwater and condensates. UIC wells would be constructed in accordance with Ecology requirements and registered with WA Ecology.
- **Construction Stormwater General Permit**. WA Ecology is delegated authority by EPA to implement the water quality permit. The regulatory drivers are *Water Quality Standards for Groundwaters of the State of Washington* (WAC 173-200) and the *Clean Water Act* (33 U.S.C. § 1251 et seq.). As a best management practice, construction activities would be performed in accordance with the *Stormwater Management Manual for Eastern Washington* (WA Ecology 2004).
- **Radioactive Air Emissions**. WDOH regulates radioactive air emissions under *Radiation Protection—Air Emissions* (WAC 246-247), *Ambient Air Quality Standards and Emission Limits for Radionuclides* (WAC 173-480), and *National Emission Standards for Hazardous Air Pollutants* (40 CFR Part 61 Subparts A and H and Appendix B, Method 114). PNNL currently maintains a radioactive air emissions license for R&D activities on the PNNL Richland Campus. As new radiological facilities are identified, permit applications identifying anticipated radioactive materials, potential environmental impacts, and proposed control technologies would be submitted under the existing license to WDOH for review and approval.
- **Non-Radiological Air Pollutant Notice of Construction Approval Order**. The Benton Clean Air Agency regulates air pollutants under *Regulation 1 of the Benton Clean Air Agency* (BCAA 2014) which implements *General Regulations for Air Pollution Sources* (WAC 173-400), *Operating Permit Regulations* (WAC 173-401), and *Controls for New Sources of Toxic Air Pollutants* (WAC 173-460). Under these regulations, a Notice of Construction Application shall be submitted to the Benton Clean Air Agency for review, and approval obtained before a new emission source may be constructed.

- **Protection of Plant and Animal Species**. The *Endangered Species Act* (16 U.S.C. § 1531 et seq.), *Bald and Golden Eagle Protection Act* (16 U.S.C. § 668 et seq.), and *Migratory Bird Treaty Act* (16 U.S.C. § 703-712) all identify requirements that must be met to protect native plant and animal species and the ecosystems upon which they depend.
- **Cultural and Historic Resource Protection**. Federal agencies must preserve and protect cultural resources in a spirit of stewardship to the extent feasible given the agency's mission. DOE responsibilities are defined by a number of regulations and policies, including the *National Historic Preservation Act* (54 U.S.C. § 300101 et seq.), the *Archaeological Resources Protection Act of 1979* (16 U.S.C. § 470aa et seq.), the *Native American Graves Protection and Repatriation Act* (25 U.S.C. § 3001 et seq.), and the *DOE Native American Indian and Alaska Native Tribal Government Policy* (DOE 2006).
- **Transportation.** Transportation of hazardous materials on the PNNL Richland Campus and shipments to offsite entities is conducted in accordance with Title 49 of the Code of Federal Regulations, *Transportation* requirements (49 CFR). PNNL uses trained staff to execute shipments under an internal transportation program.
- **Hazardous and Radioactive Waste.** Hazardous and radioactive wastes generated on the PNNL Richland Campus are temporarily accumulated in portions of the facilities that are designed and managed to prevent releases or other hazards. For hazardous wastes, this temporary accumulation is for 90 days or less, and a similar time frame is generally followed for radioactive waste as well. Hazardous waste is then shipped to offsite facilities for treatment and ultimate disposal. Radioactive waste is shipped to the Hanford Site or commercial facilities for treatment and ultimate disposal. This practice is not expected to change during the buildout of facilities under this EA. Temporary accumulation areas are likely to be constructed in facilities or groups of facilities generating wastes, and such areas in facilities being closed would be cleaned up in accordance with federal and state requirements.

7.0 PUBLIC, AGENCIES, AND TRIBAL GOVERNMENT NOTIFICATIONS

On February 9, 2016, and December 29, 2016, DOE sent NEPA (42 U.S.C. § 4321 et seq.) notifications of its intention to prepare this EA to interested parties on its stakeholder list, and the recipients were invited to send their questions or comments regarding the EA to DOE for consideration. The notification briefly identified an anticipated timeframe for the draft EA and a point of contact for questions and comment submittal.

In parallel with the release of the notifications under NEPA, on February 9, 2016, and December 29, 2016, DOE sent out notifications under the NHPA; 54 U.S.C. § 300101, Section 106, informing potentially affected stakeholders that the Proposed Action could affect historic and traditional cultural properties within the Area of Potential Effects and that the consultation process under Section 106 would be conducted in parallel with the preparation of this EA.

NEPA distribution list:

- Advisory Council on Historic Preservation
- Applied Process Engineering Laboratory
- Benton and Franklin Counties
- Benton Clean Air Agency
- Benton Conservation District
- Benton Franklin Health District
- Bureau of Land Management
- CH2MHill Hanford Plateau Remediation Company
- Cities of Richland, Pasco, Kennewick, and West Richland
- Columbia Riverkeeper
- Confederated Tribes of' the Colville Reservation
- Confederated Tribes of the Umatilla Indian Reservation
- Energy Northwest
- Federal and Washington State Congressional Representatives
  - Federal District Offices
- Hanford Advisory Board
- Hanford Challenge
- Hanford History Project
- Hanford List Serve
- Heart of America Northwest
- Inheriting Hanford
- Labor Unions
  - Central Washington Building Trades Council
  - Hanford Atomic Metal Trades Council
- League of Women Voters of Benton-Franklin Counties
- Libraries
  - DOE Public Reading Room
  - Public/Local
  - University Libraries
    - Branford Price Millar Library (Portland State University)
    - Foley Center Library, Gonzaga University
    - Suzzallo Library (University of Washington)
- LIGO Hanford Observatory
- Local businesses/industry near the campus

- Kindercare Learning Center
  - Pacific EcoSolutions, Inc.
  - Penford Food Ingredients
  - Perma-Fix Northwest
- Lower Columbia Basin Audubon Society
- Mission Support Alliance
- Museums
  - East Benton County Historical Society and Museum
  - The Reach Museum
- Nez Perce Tribe
- Oregon Department of Energy
- Port of Benton
- Private citizens
- Puget Sound Naval Shipyard and Navy Puget Sound Naval Shipyard and Intermediate Maintenance Facility
- State of Oregon Department of Environmental Quality
- Tapteal Greenway Association
- Tri-Cities Industrial Development Council
- Tri-City Regional Chamber of Commerce
- U.S. Army Corps of Engineers
- U.S. Department of Energy
  - Headquarters
  - Richland Operations Office
  - Office of River Protection
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- U.S. Geological Survey Forest and Rangeland Ecosystem Science Center
- Universities/Colleges
  - Washington State University – Tri-Cities
  - Heritage University
  - Columbia Basin College
- Visit Tri-Cities
- Wanapum
  - Wanapum Heritage Center
- Washington Closure Hanford
- Washington Department of Archaeology and Historic Preservation
- Washington Physicians for Social Responsibility
- Washington River Protection Solutions
- Washington State Department of Ecology
- Washington State Historic Preservation Office
- Yakama Nation

NHPA Distribution list:

- Advisory Council on Historic Preservation
- Confederated Tribes of' the Colville Reservation
- Confederated Tribes of the Umatilla Indian Reservation
- Hanford History Project
- Museums
  - East Benton County Historical Society and Museum

  - The Reach Museum
- National Park Service
  - Intermountain
  - Manhattan Project National Historical Park
  - Pacific West
- Nez Perce Tribe
- Pacific Northwest National Laboratory
- State of Oregon Department of Environmental Quality
- The Hanford History Partnership
- U.S. Department of Energy
  - Chicago Office
  - Richland Operations Office
  - Pacific Northwest Site Office
- Wanapum
- Washington State Department of Archaeology & Historic Preservation
- Washington State Historic Preservation Officer
- Washington State University
- Yakama Nation

Area of Potential Effects Distribution list.

- Confederated Tribes of' the Colville Reservation
- Confederated Tribes of the Umatilla Indian Reservation
- Hanford History Project
- Museums
  - East Benton County Historical Society and Museum
  - The Reach Museum
- National Park Service
  - Intermountain
  - Pacific West
- Nez Perce Tribe
- Pacific Northwest National Laboratory
- U.S. Department of Energy
  - Richland Operations Office
  - Pacific Northwest Site Office
- Wanapum
- Washington State Department of Archaeology & Historic Preservation
- Yakama Nation

7.1 Responses Received

EAs do not require public scoping; however, in response to DOE's notifications, DOE received five responses. Overall, the responses focused on topics that can be grouped into the general categories as follows:

- Range of alternatives
  - Include a range of reasonable alternatives that meet the stated purpose and need, and that are responsive to the issues identified during the scoping process.
  - Quantify impacts of each alternative action and determine corresponding mitigation measures.
  - Select feasible alternatives that minimize environmental degradation.

- Environmental effects
  - Include environmental effects and mitigation measures.
- Water resources and impacts
  - Disclose waters in the analysis area and vicinity that proposed developments may impact, nature of the potential impacts, and pollutants likely to affect those waters.
  - Assess whether proposed facilities would affect drinking water and sources. If they would be impacted, the EA would need to include contaminants of concern and measures to take to protect drinking water and related source areas.
  - Address potential effects of facility discharges on surface and groundwater quality.
  - If facilities would be zero discharge, disclose the amount of process water that would be disposed of onsite and explain methods of onsite containment.
  - If evaporation ponds would be used for disposal of wastewater, indicate how seepage into groundwater will be prevented.
  - Identify the storm design containment capacity of ponds, explain how overflow in larger storm events will be managed, and discuss potential environmental impacts (i.e., drainage channels affected, water quality, and biological resources) in the event of overflow.
  - Disposal of wastewater or other fluids into the subsurface is also subject to the requirements of the UIC program and permits may be required, depending on project specifications and federal and/or state requirements.

    Any project construction that would disturb a land area of one or more acres also requires a National Pollutant Discharge Elimination System permit for discharges to waters of the United States.
  - Document the project's consistency with applicable storm water permitting requirements and discuss specific mitigation measures that may be necessary or beneficial in reducing adverse impacts to water quality.
  - Consider low-impact development techniques[9] during project activities due to their potential to reduce stormwater volumes and mimic natural conditions.

    Discuss conservation measures to implement to reduce water demands. Facility designs should maximize conservation measures such as appropriate use of recycled water for landscaping, xeriscaping, and water conservation education.
  - Discuss water reliability for future development projects, factoring in the effects of climate change.
- Hazardous materials, solid and other waste
  - Address potential direct, indirect, and cumulative impacts of hazardous waste from construction and operation of the proposed project.
  - Identify projected hazardous waste types and volumes, and expected storage, disposal, and management plans.

[9] http://v1v..·w.epa.gov/polluted-runotT-nonpoint-source-pollution/urban-runoff-low-in1pact-development

- – Identify any hazardous materials sites within the project's study area, if any, and evaluate whether those sites would impact the project in any way.
- – Address radionuclide and chemical contamination in soil and/or groundwater within the analysis area and vicinity, and whether anticipated projects may result in a disturbance of radioactive contaminants or their release into the environment.
- – Address other contaminants to expect as an issue of concern in the area. To the extent that contamination may be an issue of concern, the EA should identify feasible measures to take to avoid, reduce or mitigate these impacts.

  If development projects in the analysis area would involve use of pesticides and herbicides, the EA should address any potential toxic hazards related to the application of the chemicals, and describe actions to take to assure that impacts by toxic substances released to the environment would be minimized.

- Aquatic resource and impacts
  - – Describe all waters of the United States, including wetlands that could be affected by proposed development activities and their locations in the project area, preferably using maps.
  - – Include data on acreages and channel lengths, habitat types, values, and functions of the waters and related wetlands. If the projects would result in impacts to aquatic resources (e.g., filling of wetland), then DOE would need to work with the U.S. Army Corps of Engineers to determine if projects would need a Clean Water Act (33 U.S.C. § 1251 et seq. [Federal Water Pollution Control Act of 1972]) Section 404 permit.

    Include information explaining why activities would be located in floodplains, alternatives considered, and steps taken to reduce impacts to floodplains.
- Habitat, vegetation, and wildlife
  - – describe the current quality and capacity of habitat, its use by wildlife in the proposed project area, especially avian populations.

    The EA should:
    - ○ Identify species, describe their critical habitat and potential impacts.
    - ○ Discuss blasting and excavation needs, methods, and control of effects, and mitigation of impacts.
    - ○ Indicate Best Management Practices to protect resources and role of the Hanford Site Biological Resources Management Plan (DOE 2013f).
    - ○ Include a vegetation management plan to address control of invasive plants, including prevention, early detection of invasion, and control procedures for the species. The plan should be consistent with Executive Order 13112, *Invasive Species* (64 FR 6183).
    - ○ Cover revegetation activities that could take place on part of the 34 ha (83 ac) (near the river) per the land conveyance MOA (Appendix K in DOE 2015a).
- Air-quality impacts
  - – Address air-quality protection. The types of fuels to be used during construction activities, increased traffic during operations, and related VOCs and NOx emissions, should be disclosed and the relative effects on air quality and human health evaluated.

- Dust particulates from construction activities and ongoing operation of roadways are important concerns. The EA should evaluate air-quality impacts, and detail mitigation steps to take to the impacts. If, during construction of projects, there would be burning of cleared vegetation, then the EA should include a smoke management program that would be followed to reduce public health impacts and potential ambient air-quality exceedances.

  Because of the presence of radionuclides in the area, the EA should include the most current information regarding radionuclide emissions affecting the analysis area, consistent with the Federal Clean Air Act (42 U.S.C. § 7401 et seq.) and the EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP; 40 CFR Part 61) requirements.
- Evaluate mitigation measures to reduce radionuclide emissions to the greatest extent practicable, including for the No Action Alternative, and discuss DOE's current efforts to limit, control and reduce radionuclide emissions.

- **Cumulative effects**
  - Assess impacts over the entire area of impact and consider the effects of the proposed project when added to other past, present, and reasonably foreseeable future projects in and outside the analysis area, including those by entities not affiliated with DOE. There are five key areas to consider:
    1. Resources, if any, that are being cumulatively impacted.
    2. Appropriate geographic area and the time over which the effects have occurred and will occur.
    3. All past, present, and reasonably foreseeable future actions that have affected, are affecting, or would affect resources of concern.
    4. A benchmark or baseline.
    5. Scientifically defensible threshold levels.
- **Endangered Species Act (ESA)**
  - Identify the endangered, threatened, and candidate species under the ESA (16 U.S.C. §1531 et seq.), and other sensitive species within the project area.
  - Describe critical habitats and how the proposed project will meet all requirements under ESA, including consultation with the Fish and Wildlife Service and, if applicable, the National Oceanographic Atmospheric Administration.
- **Climate change effects**
  - Concern that continued increases in GHG emissions resulting from human activities contribute to climate change.
  - Consider how resources affected by climate change could potentially influence proposed developments and vice versa.
  - Quantify and disclose GHG emissions from the project and discuss mitigation measures to reduce emissions.
  - Discuss sustainability and demonstrate how the Proposed Action will be consistent with federal goals.

- **Mitigation and pollution prevention measures**
  - Include all reasonable mitigation and pollution prevention measures.
- **Coordination with land-use planning activities**
  - Discuss how the Proposed Action would support or conflict with the objectives of federal, state, Tribal or local land-use plans, policies and controls in the analysis area and vicinity.
  - Address existing constraints in the analysis area; for example, power lines and utility Right-Of-Ways, floodplains, and how acceptable land uses will be consistent with Comprehensive Environmental Response, Compensation, and Liability Act (42 U.S.C. § 9601 et seq.) activities at the Hanford Site, and the ability to obtain construction and operating permits and licenses.
- **Coordination with Tribal governments**
  - Describe the process and outcome of government-to-government consultation between DOE and each of the Tribal governments within the analysis area, issues that were raised (if any), and how those issues were addressed in the selection of the proposed alternatives.
  - Address the National Historic Preservation Act (54 U.S.C. § 300101) and Executive Order 13007, *Indian Sacred Sites* (May 24, 1996; 61 FR 26771).
- **Environmental justice and public participation**
  - Include an evaluation of environmental justice populations within the geographic scope of the analysis area. If such populations exist, the EA should address the potential for disproportionate adverse impacts to minority and low-income populations, and the approaches used to foster public participation by these populations.
- **Consultations/notifications**
  - Commenters asked to be included on future distribution reports and to be forwarded any relevant (i.e., cultural) reports.

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APPENDIX A– BIOLOGICAL RESOURCE DATA

Biological resource survey polygons are shown in Figure A.1. The biological resource survey polygons in Figure A.1 that correspond to the habitat polygons in Figure 4.1 above are listed in Table A.1. The biological resource survey polygons in Figure A.1 that correspond to the habitat resource categories in Figure 5.2 above are listed in Table A.2. Dominant overstory and understory plant species are listed for the survey polygons in Table A.3. All plant species observed in the survey polygons are listed in Table A.4. Bird species, mammal species, and plant species observed north of Horn Rapids Road from 2009 through 2015 are listed in Table A.5, Table A.6, and Table A.7.

Figure A.1. Biological Resource Survey Polygons across the PNNL Richland Campus from Surveys Conducted in 2016-17. Polygon numbers correspond to those presented in Table A.2 and Table A.3.

Table A.1. Survey Polygon Numbers in Figure A.1 Corresponding to Habitat Polygons in Figure 4.2.

Habitat Polygon from Figure 4.1	Survey Polygon Number from Figure A.1
Agriculture	200, 203, 204, 206, 207, 210
Antelope bitterbrush-rabbitbrush-snow buckwheat/cheatgrass-bunchgrass	13, 14, 15, 17, 28, 102, 103, 112a, 119, 120, 122
Big sagebrush-antelope bitterbrush/ cheatgrass-bunchgrass	109
Big sagebrush- rubber rabbitbrush/ cheatgrass-bunchgrass	10, 25, 104, 106, 112, 133
Big sagebrush / cheatgrass-bunchgrass	16, 20, 27, 29, 107, 110, 114, 115, 117, 124, 131, 132
Cheatgrass-bunchgrass	3, 19, 26, 118, 201, 202, 211
Dune blowout	5, 24, 30, 129
Riparian	111
Rubber rabbitbrush-snow buckwheat/ cheatgrass-bunchgrass	2, 4, 116, 130
Rubber rabbitbrush / cheatgrass-bunchgrass	6, 9, 11, 100, 101, 105, 108, 208, 209

Table A.2. Survey Polygon Numbers in Figure A.1 Corresponding to Resource Category Areas in Figure 5.2.

Habitat Resource Category from Figure 5.2	Survey Polygon Number from Figure A.1
1	5, 10, 13, 14, 15, 16, 17, 20, 24, 25, 27, 28, 29, 30, 102, 103, 104, 106, 107, 109, 110, 111, 112, 112a, 114, 115, 117, 119, 120, 122, 124, 129, 131, 132, 133
2	2, 4, 6, 9, 11, 100, 101, 105, 108, 116, 130, 208, 209
3	3, 19, 26, 118, 201, 202, 211
4	200, 203, 204, 206, 207, 210

Table A.3. Dominant Plant Species (≥1 percent canopy cover) for Habitat Polygons Located on the PNNL Richland Campus Based on 2016–17 Surveys (Figure A.1). Polygons 2-133 are located north of Horn Rapids Road. Polygons 201-211 are located south of Horn Rapids Road.

Polygon Number	Survey Date(s)	Surveyors	Dominant Shrub Species Common Name[(a)]	Dominant Shrub Species Latin Name[(a)]	Approximate Percent Cover	Dominant Herbaceous Species Common Name[(a)]	Dominant Herbaceous Species Latin Name[(a)]	Percent Cover
2	2/3; 4/7; 5/2/2016	K. Hand; C. Duberstein	rubber rabbitbrush	*Ericameria nauseosa*	2	snow buckwheat	*Eriogonun niveum*	25
						cheatgrass	*Bromus tectorum*	20
3	2/52016	J. Becker; K. Hand; C. Duberstein	none	none	none	cheatgrass		40
						Jim Hill's tumblemustard	*Sisymbrium altissimum*	25
						Sandberg bluegrass	*Poa secunda*	5
4	2/10/2016	K. Hand	rubber rabbitbrush		1	cheatgrass		60
						prickly Russian thistle	*Salsola tragus*	5
						snow buckwheat		2
5	1/28; 4/11; 5/2/2016	K. Hand	none	none	none	lemon scurfpea	*Psoralidium lanceolatum*	10
						snow buckwheat		5
						shy gilia cheatgrass	*Gilia sinuata*	5 5
6	1/28/2016	J. Becker; K. Hand	rubber rabbitbrush		8	cheatgrass prickly Russian thistle		50 5
						Jim Hill's tumblemustard		2
9	1/28; 4/11/2016	J. Becker; K. Hand; C. Duberstein	rubber rabbitbrush; green rabbitbrush antelope bitterbrush	 *Chrysothamnus viscidiflorus* *Purshia tridentata*	10 2 1	cheatgrass; snow buckwheat		42 5
10	1/28; 4/11/2016	J. Becker; K. Hand; C. Duberstein	big sagebrush rubber rabbitbrush	*Artemisia tridentata*	9 5	cheatgrass;		50
11	2/3/2016	J. Becker; K. Hand	rubber rabbitbrush		20	cheatgrass		25
						Sandberg bluegrass		10

Table A.3. (contd)

Polygon Number	Survey Date(s)	Surveyors	Dominant Shrub Species Common Name[(a)]	Dominant Shrub Species Latin Name[(a)]	Approximate Percent Cover	Dominant Herbaceous Species Common Name[(a)]	Dominant Herbaceous Species Latin Name[(a)]	Percent Cover
13	2/5;2/9/16	J. Becker; K. Hand	rubber rabbitbrush		5	cheatgrass		45
			antelope bitterbrush		5	snow buckwheat		10
			green rabbitbrush		5	Sandberg bluegrass		5
						prickly Russian thistle		2
						Jim Hill's tumblemustard		3
						needle-and-thread grass	*Hesperostipa comata*	1
14	2/5/2016	J. Becker; K. Hand	antelope bitterbrush		3	snow buckwheat		3
						cheatgrass		50
			green rabbitbrush		2	prickly Russian thistle		5
						needle-and-thread grass		5
15	2/3; 2/5/2016	J. Becker; K. Hand	antelope bitterbrush		3	cheatgrass		40
			green rabbitbrush		2	snow buckwheat		3
16	2/5/2016	J. Becker; K. Hand	big sagebrush		15	cheatgrass		60
						Sandberg bluegrass		5
17	4/7/2016	C. Duberstein	antelope bitterbrush		5	cheatgrass		60
			green rabbitbrush		1	Sandberg bluegrass		15
						snow buckwheat		1
19	2/5; 4/7/2016	J. Becker; K. Hand	none			cheatgrass		60
						Sandberg bluegrass		5
						prickly Russian thistle		1
20	2/3; 4/7/2016	J. Becker; K. Hand; C. Duberstein	big sagebrush		14	cheatgrass		50
24	2/10/2016	J. Becker	rubber rabbitbrush		3	cheatgrass		32
						snow buckwheat		4
						lemon scurfpea		5
						Sandberg bluegrass		2
25	2/10/2016	J. Becker; K. Hand	big sagebrush		10	cheatgrass		60
			rubber rabbitbrush		2	Sandberg bluegrass		10
						prickly Russian thistle		5
						Russian knapweed	*Acroptilon repens*	2

Table A.3. (contd)

Polygon Number	Survey Date(s)	Surveyors	Dominant Shrub Species Common Name[(a)]	Dominant Shrub Species Latin Name[(a)]	Approximate Percent Cover	Dominant Herbaceous Species Common Name[(a)]	Dominant Herbaceous Species Latin Name[(a)]	Percent Cover
26	2/10; 4/7/2016	K. Hand; C. Duberstein	none			cheatgrass		60
						prickly Russian thistle		5
						Russian knapweed		2
27	4/6/2016	C. Duberstein	big sagebrush		10	cheatgrass		80
28	2/10; 4/6; 5/2/2016	J. Becker; K. Hand; C. Duberstein	antelope bitterbrush		5	cheatgrass		40
						snow buckwheat		5
			rubber rabbitbrush		2			
			green rabbitbrush		2			
29	4/6/2016	C. Duberstein	big sagebrush		10	cheatgrass		70
						Sandberg bluegrass		10
30	2/9/2016	K. Hand	rubber rabbitbrush		5	cheatgrass		5
						snow buckwheat		7
			antelope bitterbrush		2	threadleaf phacelia	*Phacelia linearis*	2
						lemon scurfpea		10
100	5/3/17	J. Becker; K. Hand	rubber rabbitbrush		3	cheatgrass		75
						Sandberg bluegrass		10
						bulbous bluegrass	*Poa bulbosa*	3
101	5/1/2017	J. Becker; K. Hand	rubber rabbitbrush		3	cheatgrass		70
						bulbous bluegrass		17
102	4/5/2106	C. Duberstein	antelope bitterbrush		2	cheatgrass		55
						Sandberg bluegrass		10
			green rabbitbrush		1			
						snow buckwheat		1
103	3/28/2016	K. Hand	rubber rabbitbrush		15	cheatgrass		25
						Sandberg bluegrass		15
			antelope bitterbrush		2			
						snow buckwheat		10
104	4/12 and 5/11/2016 5/1/2017	K. Hand C. Duberstein J. Becker	big sagebrush		5	cheatgrass		57
			rubber rabbitbrush		2	Sandberg bluegrass		3
			green rabbitbrush		1	bulbous bluegrass		5
						snow buckwheat		4
105	5/1/17	J. Becker; K. Hand	rubber rabbitbrush		3	cheatgrass		70
						bulbous bluegrass		10
						Sandberg bluegrass		5
						sand dropseed	*Sporobolus cryptandrus*	5
						snow buckwheat		1

Table A.3. (contd)

Polygon Number	Survey Date(s)	Surveyors	Dominant Shrub Species Common Name[(a)]	Dominant Shrub Species Latin Name[(a)]	Approximate Percent Cover	Dominant Herbaceous Species Common Name[(a)]	Dominant Herbaceous Species Latin Name[(a)]	Percent Cover
106	2/5/2016	J. Becker	big sagebrush rubber rabbitbrush		5 15	cheatgrass snow buckwheat		50 1
107	3/28; 3/30;; 5/11/2016	K. Hand; N. Freeman-Cadoret	big sagebrush		18	cheatgrass Sandberg bluegrass		45 5
108	5/1/17	J. Becker; K. Hand	rubber rabbitbrush green rabbitbrush		7 1	cheatgrass sand dropseed bulbous bluegrass Sandberg bluegrass		50 17 5 2
109	5/3/17	J. Becker; K. Hand	big sagebrush antelope bitterbrush green rabbitbrush		3 3 2	cheatgrass Sandberg bluegrass snow buckwheat bulbous bluegrass needle-and-thread grass		50 10 2 1 1
110	5/3/17	J. Becker; K. Hand	big sagebrush rubber rabbitbrush		15 1	cheatgrass Sandberg bluegrass bulbous bluegrass		50 7 2
111[(b)]			See footnote			See footnote		
112	4/11/2016	C. Duberstein	big sagebrush rubber rabbitbrush		13 3	cheatgrass Sandberg bluegrass		70 8
112a	5/3/2017	J. Becker; K. Hand	antelope bitterbrush green rabbitbrush rubber rabbitbrush		1 2 2	cheatgrass Sandberg bluegrass snow buckwheat needle-and-thread grass		60 15 2 2
114	2/10; 4/6/2016	J. Becker C. Duberstein	big sagebrush		10	cheatgrass		80
115	3/28; 4/5/2016	K. Hand; C. Duberstein	big sagebrush		25	cheatgrass Sandberg bluegrass		35 10
116	3/31/2016	C. Duberstein	rubber rabbitbrush		4	cheatgrass Sandberg bluegrass snow buckwheat		75 4 2
117	3/28/2016	K. Hand	big sagebrush		20	cheatgrass Sandberg bluegrass needle-and-thread grass		40 8 1
118	5/1/17	J. Becker; K. Hand	none			cheatgrass Sandberg bluegrass		80 3

Table A.3. (contd)

Polygon Number	Survey Date(s)	Surveyors	Dominant Shrub Species Common Name[(a)]	Dominant Shrub Species Latin Name[(a)]	Approximate Percent Cover	Dominant Herbaceous Species Common Name[(a)]	Dominant Herbaceous Species Latin Name[(a)]	Percent Cover
119	3/28; 3/30/2016	K. Hand; N. Freeman-Cadoret	antelope bitterbrush green rabbitbrush		5 1	cheatgrass snow buckwheat Sandberg bluegrass		35 10 10
120	3/28; 3/29/2016	K. Hand	rubber rabbitbrush antelope bitterbrush green rabbitbrush		10 8 2	cheatgrass snow buckwheat Sandberg bluegrass Indian ricegrass fineleaf hymenopappus	 *Achnatherum hymenoides* *Hymenopappus filifolius*	35 10 10 5 2
122	4/26/2017	J. Becker	rubber rabbitbrush green rabbitbrush antelope bitterbrush		2 2 1	cheatgrass Sandberg bluegrass snow buckwheat		50 25 10
123	3/28/2016	K. Hand	rubber rabbitbrush green rabbitbrush		5 2	cheatgrass Sandberg bluegrass snow buckwheat needle-and-thread grass		25 20 5 2
124	4/26/2017	J. Becker	big sagebrush		15	cheatgrass Sandberg bluegrass snow buckwheat		70 5 1
129	5/2/2016	K. Hand	rubber rabbitbrush		10	cheatgrass fineleaf hymenopappus		5 5
130	2/10; 3/28; 4/7; 5/2/2016	K. Hand C. Duberstein	rubber rabbitbrush		13	cheatgrass Sandberg bluegrass snow buckwheat		20 15 10
131	4/26/2017	J. Becker	big sagebrush green rabbitbrush		15 1	cheatgrass needle-and-thread grass		70 1
132	4/26/2017	J. Becker	big sagebrush		10	cheatgrass needle-and-thread grass Sandberg bluegrass		60 15 5
133	4/26/2017	J. Becker	big sagebrush rubber rabbitbrush		20 5	cheatgrass Sandberg bluegrass bulbous bluegrass		50 10 2
201	4/25/2017	J. Becker; K. Hand	none			cheatgrass bulbous bluegrass		65 3

Table A.3. (contd)

Polygon Number	Survey Date(s)	Surveyors	Dominant Shrub Species Common Name[(a)]	Dominant Shrub Species Latin Name[(a)]	Approximate Percent Cover	Dominant Herbaceous Species Common Name[(a)]	Dominant Herbaceous Species Latin Name[(a)]	Percent Cover
202	4/25/2017	J. Becker; K. Hand	none			cheatgrass bulbous bluegrass		90 5
208	4/24/2017	J. Becker; K. Hand	rubber rabbitbrush		15	cheatgrass		40
209	4/24/2017	J. Becker; K. Hand	rubber rabbitbrush		15	cheatgrass bulbous bluegrass sand dropseed		55 2 1
211	4/24/2017	J. Becker; K. Hand	none			bulbous bluegrass cheatgrass sand dropseed		40 25 5

(a) Nomenclature according to U.S. Department of Agriculture (USDA 2017), Natural Resource Conservation Service Plants Database (http://plants.usda.gov/java/)
(b) Dominant species and cover estimates not provided for habitat polygon 111 (riparian zone of the Columbia River), where dominant species vary widely north of Horn Rapids Road. Species observed in 2015 are indicated in Table A.4.

Table A.4. Plant Species for Habitat Polygons Located on the PNNL Richland Campus Based on 2016–17 Surveys (Figure A.1). Polygons 2-133 are located north of Horn Rapids Road. Polygons 201-211 are located south of Horn Rapids Road.

		Polygon Number[b,c]														
Species Name[a]	Common Name[a]	2	3	4	5	6	9	10	11	13	14	15	16	17	19	20
Achillea millefolium	common yarrow					X	X	X		X	X		X	X		
Achnatherum hymenoides	Indian ricegrass	X	X		X	X	X			X			X		X	X
Acroptilon repens[e]	Russian knapweed					X				X						
Allium sp.	onion						X			X						
Ambrosia acanthicarpa	flatspine bur ragweed						X	X		X						
Amsinckia sp.	fiddleneck		X			X	X	X		X	X	X	X	X	X	X
Amsinckia tessellata	bristly fiddleneck						X	X		X				X	X	
Artemisia tridentata	big sagebrush	X						9	+	X		X	15	X	X	14
Asparagus officianalis	garden asparagus									X						
Astragalus caricinus	buckwheat milkvetch									X						
Balsamorhiza careyana	Carey's balsamroot									X			+			X
Bassia scoparia[e]	burningbush		X												X	
Bromus tectorum	cheatgrass	20	40	60	5	50	42	50	22	45	50	40	60	60	60	50
Centaurea diffusa[e]	diffuse knapweed	X					X			X					X	
Chondrilla juncea[e]	rush skeletonweed					X				X				X	X	
Chrysothamnus viscidiflorus	green rabbitbrush	X	X	X		X	2	X	+	5	2	2	X	1		
Cryptantha sp.										X						
Cryptantha circumscissa	matted cryptantha	+			X		X	X		X						
Cryptantha pterocarya	wingnut cryptantha				X		X									
Delphinium nuttallianum	upland larkspur									X						
Descurainia pinnata	western tansymustard						X			X				X		X
Descurainia sophia	herb sophia					X										
Draba verna	spring draba						X	X		X				X		
Elaeagnus angustifolia	Russian olive					X										
Ericameria nauseosa	rubber rabbitbrush	2	+	1	X	8	10	5	15	5	X	+	+	X	+	X
Eriogonum niveum	snow buckwheat	25	1	2	5		5	+	+	10	3	3	1	1	X	X
Erodium cicutarium	redstem stork's bill									X					X	
Erysimum asperum	western wallflower				X					X						
Fritillaria pudica	yellow fritillary									X					X	
Gilia sinuata	shy gilia				5					X						

Table A.4. (contd)

Species Name[(a)]	Common Name[(a)]	Polygon Number[(b,c)]														
		2	3	4	5	6	9	10	11	13	14	15	16	17	19	20
Hesperostipa comata	needle-and-thread grass		X					X		1	5	+	+			X
Holosteum umbellatum	jagged chickweed						X	X		X				X	X	
Hymenopappus filifolius	fineleaf hymenopappus									X		X				
Juniperus sp.	juniper					X										
Lactuca serriola	prickly lettuce					X				X					X	
Lomatium macrocarpum	bigseed biscuitroot														X	
Machaeranthera canescens	hoary aster	X	X		X		X	X		X	X	X	X	X	X	
Microsteris gracilis	pink microsteris				X		X			X						
Morus alba	white mulberry					X										
Oenothera pallida	pale evening primrose		X		X		X		X	X		X		X		
Opuntia polyacantha	plains pricklypear						X	X	X	X			X	X		X
Phacelia hastata	silverleaf phacelia	X					X			X						
Phacelia linearis	threadleaf scorpionweed				X					X						
Phlox longifolia	longleaf phlox						X	X		X				X		
Plantago patigonica	woolly plantain									X						
Poa sp.	bluegrass									X						
Poa bulbosa	bulbous bluegrass	X					X	X	X	X		X		X		
Poa secunda	Sandberg bluegrass	X	5	X	1	X	X	X	10	5	X	X	5	15	5	X
Pseudoroegneria spicata	bluebunch wheatgrass							X					X		X	X
Psoralidium lanceolatum	lemon scurfpea				10		X			X						
Pteryxia terebinthina	turpentine wavewing			X						X				X		
Purshia tridentata	antelope bitterbrush	X		+	X		1	X	X	5	3	3		5		
Robinia pseudoacacia	lack locust					X										
Salsola tragus	prickly Russian thistle		X	5		5	X	X	X	2	5	X	X		1	X
Sisymbrium altissimum	tall tumblemustard	X	10	X		2	X	X	X	3	+	3	1	1	1	X
Sphaeralcea munroana	Munro's globemallow									X						
Sporobolus cryptandrus	sand dropseed			X	X	X	X	X	X	X		X		X	X	
Tragopogon dubius	yellow salsify									X						
Triteleia grandiflora	largeflower triteleia				X		X	X		X				X	X	

Table A.4. (contd)

Species Name[a]	Common Name[a]	Polygon Number[b,c]											
		24	25	26	27	28	29	30	100	101	102	103	104
Achillea millefolium	common yarrow							X	X	X		X	X
Achnatherum hymenoides	Indian ricegrass	X	X										X
Acroptilon repens[e]	Russian knapweed		2	2				X					
Ambrosia acanthicarpa	flatspine bur ragweed							X					
Amsinckia sp.	fiddleneck								X	X		X	X
Amsinckia tessellata	bristly fiddleneck		X		X		X	X	X	X		X	X
Artemisia tridentata	big sagebrush		10	+	10	X	10		X	X	X		5
Balsamorhiza careyana	Carey's balsamroot												X
Bassia scoparia[e]	burningbush		X			X				X			
Bromus tectorum	cheatgrass	32	60	60	80	40	70	5	75	70	55		57
Centaurea diffusa[e]	diffuse knapweed					X			X	X			X
Chondrilla juncea[e]	rush skeletonweed		X	X	X	X		X	X	X			X
Chrysothamnus viscidiflorus	green rabbitbrush	X	X		X	2		X	X		1	X	1
Comandra umbellata	bastard toadflax										X		
Cryptantha circumscissa	matted cryptantha	X				X		+					X
Descurainia pinnata	western tansymustard							X				X	
Draba verna	spring draba		X		X		X		X	X		X	X
Ericameria nauseosa	rubber rabbitbrush	3	2	+	X	2	X	5	3	3	+		2
Erodium cicutarium	redstem stork's bill								X				X
Eriogonum niveum	snow buckwheat	4	X			5	X	7			1		4
Erysimum asperum	western wallflower							X					
Fritillaria pudica	yellow fritillary				X								
Hesperostipa comata	needle-and-thread grass	X	X	X	X	X	X	X		X		X	X
Hymenopappus filifolius	fineleaf hymenopappus												X
Holosteum umbellatum	jagged chickweed				X		X		X	X			X
Lactuca serriola	prickly lettuce								X	X			X
Lomatium macrocarpum	bigseed biscuitroot												X
Machaeranthera canescens	hoary aster		X			X		X	X	X		X	X
Melilotus officianalis	sweetclover												X
Oenothera pallida	pale evening primrose							X				X	X
Opuntia polyacantha	plains pricklypear					X					X	X	
Phacelia hastata	silverleaf phacelia	X											
Phacelia linearis	threadleaf phacelia							2					
Phlox longifolia	longleaf phlox				X		X	X					X
Plantago patigonica	woolly plantain		X										X

Table A.4. (contd)

		Polygon Number[b,c]											
Species Name[a]	Common Name[a]	24	25	26	27	28	29	30	100	101	102	103	104
Poa bulbosa	bulbous bluegrass		X		X	X	X		3	17	+		5
Poa secunda	Sandberg bluegrass	2	10	X	X		10	X	10	+	1		3
Poa sp.	bluegrass											X	
Pseudoroegneria spicata	bluebunch wheatgrass				X			X					X
Psoralidium lanceolatum	lemon scurfpea	5						10			X		
Pteryxia terebinthina	turpentine wavewing				X	X					X	X	X
Purshia tridentata	antelope bitterbrush		X		X	5		2			2		+
Salsola tragus	prickly Russian thistle	+	5	5	X	X	X		X	X			X
Sisymbrium altissimum	tall tumblemustard	X	+	X	X	X	X	X	X	X		X	X
Sphaeralcea munroana	Munro's globemallow									X			
Sporobolus cryptandrus	sand dropseed	X	X			X			+	+		X	X
Tragopogon dubius	yellow salsify								X	X			X
Triteleia grandiflora	largeflower triteleia				X				X	X	X		X

Table A.4. (contd)

Species Name[(a)]	Common Name[(a)]	Polygon Number[(b,c)]														
		105	106	107	108	109	110	111[d]	112	112a	114	115	116	117	118	119
Achillea millefolium	common yarrow	X	X	X	X	X	X	X	X	X	X	X		X	X	X
Achnatherum hymenoides	Indian ricegrass	X		X		X		X		X			X			
Acroptilon repens[(e)]	Russian knapweed		X					X							X	
Ailanthus altissima	tree-of-heaven							X								
Allium sp.	onion					X										
Allium schoenoprasum	wild chives							X								
Amsinckia sp.	fiddleneck	X	X	X	X	X	X			X		X		X		
Amsinckia lycopsoides	tarweed fiddleneck							X								
Amsinckia tessellata	bristly fiddleneck	X	X		X	X	X		X	X	X	X			X	
Artemisia campestris	field sagewort							X								
Artemisia dracunculus	tarragon							X								
Artemisia tridentata	big sagebrush	X	5	18		3	15	X	13		10	25		20	X	
Asparagus officianalis	garden asparagus							X	X							
Astragalus caricinus	buckwheat milkvetch	X										X				
Balsamorhiza careyana	Carey's balsamroot	X	X	X					X		X	X				X
Bassia scoparia[(e)]	burningbush		X				X								X	
Bromus tectorum	cheatgrass	70	50	45	50	50	50	X	70	60	80	35	75	40	80	35
Centaurea diffusa[(e)]	diffuse knapweed	X	X		X			X							X	
Chondrilla juncea[(e)]	rush skeletonweed	X	X	X		X	X	X	X			X	X		X	X
Chrysothamnus viscidiflorus	green rabbitbrush	+	X	X	1	2	+		X	2	X	X	X			1
Cirsium sp.	thistle							X								
Clematis ligusticifolia	western white clematis							X								
Convolvulus arvensis	field bind weed							X								
Crepis atribarba	slender hawksbeard								X					X		
Cryptantha circumscissa	matted cryptantha	X														
Delphinium nuttallianum	upland larkspur								X			X				X
Descurainia pinnata	western tansymustard	X		X					X			X				X
Descurainia sophia	herb sophia			X				X				X				
Draba verna	spring draba	X	X	X	X	X	X		X	X	X	X	X	X	X	X
Eleocharis sp.	spikerush							X								
Elymus elymoides	squirreltail															
Elymus lanceolatus	thickspike wheatgrass							X	X			X				
Epilobium paniculatum	tall annual willowherb								X							
Ericameria nauseosa	rubber rabbitbrush	3	15	X	7	+	1	X	3	2	X	X	4	X		X
Eriogonum niveum	snow buckwheat	1	1	X	+	2	+	X	+	2	X	X	2	X	X	10

Table A.4. (contd)

Species Name[(a)]	Common Name[(a)]	Polygon Number[(b,c)]														
		105	106	107	108	109	110	111[d]	112	112a	114	115	116	117	118	119
Ericameria teretifolia	green rabbitbrush							X								
Erodium cicutarium	redstem stork's bill	X	X		X	X			X						X	
Erysimum asperum	western wallflower															
Gaillardia aristata	blanketflower			X				X								
Gilia sinuata	shy gilia					X										
Hesperostipa comata	needle-and-thread grass	X	+	X	X	1	+	X	X	2	X		X	1		X
Holosteum umbellatum	jagged chickweed	X	X	X	X	X			X	X	X	X	X		X	X
Hymenopappus filifolius	fineleaf hymenopappus	X													X	
Hypericum perforatum	common St. Johnswort							X								
Iris missouriensis	Rocky Mountain iris							X								
Lactuca serriola	prickly lettuce	X	X	X	X	X			X			X			X	
Lepidium densiflorum	common pepperweed							X								
Lepidium perfoliatum	clasping pepperweed							X								
Lomatium macrocarpum	bigseed biscuitroot			X								X				
Machaeranthera canescens	hoary aster	X	X		X	X	X	X	X	X		X				
Medicago sativa	alfalfa								X							
Melilotus officianalis	sweetclover		X													
Microsteris gracilis	pink microsteris			X								X				X
Morus alba	white mulberry							X								
Oenothera pallida	pale evening primrose	X				X	X	X	X				X			
Opuntia polyacantha	plains pricklypear		X	X		X						X		X		X
Phacelia hastata	silverleaf phacelia	X				X							X			
Phalaris arundinacea	reed canarygrass							X								
Phlox longifolia	longleaf phlox		X	X		+	X		X	X	X	X				X
Plantago patagonica	woolly plantain	X	X			X	X	X		X						
Poa bulbosa	bulbous bluegrass	10	X		5	1	2	X	X	X	X	X			+	
Poa secunda	Sandberg bluegrass	5	X	5	2	10	7	X	8	15	X	10	4	8	3	10
Polemonium micranthum	annual polemonium			X												
Prunus virginiana	chokecherry							X								
Pseudoroegneria spicata	bluebunch wheatgrass		X	X			X		X	X		X		X		
Psoralidium lanceolatum	lemon scurfpea					X		X	X							
Pteryxia terebinthina	turpentine wavewing			X			X		X			X		X	X	X
Purshia tridentata	antelope bitterbrush	X	+	X	X	3	X	X	X	1	X					5
Rhus glabra	smooth sumac							X								
Robinia pseudoacacia	black locust							X								

Table A.4. (contd)

Species Name[(a)]	Common Name[(a)]	Polygon Number[(b,c)]														
		105	106	107	108	109	110	111[d]	112	112a	114	115	116	117	118	119
Rosa woodsia	Woods' rose							X								
Rubus armeniacus	Himalayan blackberry							X								
Rumex salicifolius	willow dock							X								
Rumex venosus	veiny dock							X								
Salix exigua	narrowleaf willow							X								
Salsola tragus	prickly Russian thistle	X	X			X	X				X	X	X		X	
Sisymbrium altissimum	tall tumblemustard	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Solanum dulcamara	climbing nightshade							X								
Solidago canadensis	Canada goldenrod							X								
Sphaeralcea munroana	Munro's globemallow	X	X					X						X		
Sporobolus cryptandrus	sand dropseed	5	X	X	17	+	X	X	X		X	X	X		X	X
Taraxacum officinale	common dandelion		X													
Tragopogon dubius	yellow salsify	X		X			X	X				X	X		X	
Triteleia grandiflora	largeflower triteleia	X	X			X	X		X	X	X	X	X		X	
Verbascum thapsus	common mullein							X								

Table A.4. (contd)

Species Name[a]	Common Name[a]	Polygon Number[b,c]								
		120	122	123	124	129	130	131	132	133
Achillea millefolium	common yarrow	X	X					X	X	X
Achnatherum hymenoides	Indian ricegrass	5		X	X	X		X		
Amsinckia sp.	fiddleneck						X			
Amsinckia tessellata	bristly fiddleneck		X		X			X	X	X
Artemisia tridentata	big sagebrush	X	+	X	15			15	10	20
Astragalus caricinus	buckwheat milkvetch	X				X				
Balsamorhiza careyana	Carey's balsamroot		X					+		
Bassia scoparia[e]	burningbush						X			
Bromus tectorum	cheatgrass	35	50	25	70	5	20	70	60	50
Centaurea diffusa[e]	diffuse knapweed				X		X			
Chondrilla juncea[e]	rush skeletonweed	X	X		X		X	X	X	X
Chrysothamnus viscidiflorus	green rabbitbrush	2	2	2	+	X	X	1		X
Cryptantha sp.	cryptantha		X							
Cryptantha circumscissa	matted cryptantha	X				X				
Delphinium nuttallianum	upland larkspur		X							
Descurainia pinnata	western tansymustard	X								
Draba verna	spring draba	X		X	X		X	X	X	X
Elymus elymoides	squirreltail					X				
Ericameria nauseosa	rubber rabbitbrush	10	2	5	+	10	13	+	+	5
Eriogonum niveum	snow buckwheat	10		5	1		10	+	+	X
Erodium cicutarium	redstem stork's bill				X		X		X	X
Erysimum asperum	western wallflower	X								
Gilia sinuata	shy gilia					X				
Hesperostipa comata	needle-and-thread grass	+	X	2	X	X	X	1	15	
Holosteum umbellatum	jagged chickweed	X	X		X		X	X	X	X
Hymenopappus filifolius	fineleaf hymenopappus	2				5				
Lactuca serriola	prickly lettuce				X					
Layia glandulosa	tidytips		X							
Microsteris gracilis	pink microsteris						X			
Oenothera pallida	pale evening primrose	X				X	X			
Opuntia polyacantha	plains pricklypear	X	X							
Phacelia hastata	silverleaf phacelia	X		X		X	X			
Phlox longifolia	longleaf phlox		X		X			X	X	
Plantago patagonica	woolly plantain						X			
Plectritis macrocera	longhorn plectritis		X		X			X		

Table A.4. (contd)

		Polygon Number[b,c]								
Species Name[a]	Common Name[a]	120	122	123	124	129	130	131	132	133
Poa bulbosa	bulbous bluegrass		X		X	X	X	X	X	2
Poa secunda	Sandberg bluegrass	10	25	20	5		15	+	5	10
Pseudoroegneria spicata	bluebunch wheatgrass				X			X		
Pteryxia terebinthina	turpentine wavewing	X	X							
Purshia tridentata	antelope bitterbrush	8	1		+	+	X	+	+	+
Salsola tragus	prickly Russian thistle				X					
Sisymbrium altissimum	tall tumblemustard	X	X	X	X		X	X	X	X
Sphaeralcea munroana	Munro's globemallow	X				X				
Sporobolus cryptandrus	sand dropseed		X	X			X			
Tragopogon dubius	yellow salsify				X					
Triteleia grandiflora	largeflower triteleia	X	X		X					
Vulpia sp.	sixweeks						X			

Table A.4. (contd)

Species Name[(a)]	Common Name[(a)]	Polygon Number[(b,c)]				
		201	202	208	209	211
Achillea millefolium	common yarrow			X	X	X
Amsinckia sp.	fiddleneck	+	X	X	X	X
Amsinckia tessellata	bristly fiddleneck	+	X		X	X
Bromus tectorum	cheatgrass	65	90	40	55	25
Centaurea diffusa[(e)]	diffuse knapweed	X		X	X	X
Chondrilla juncea[(e)]	rush skeletonweed		X	X	X	
Chorispora tenella	blue mustard	X	X		X	
Convolvulus arvensis	field bind weed					X
Cryptantha circumscissa	matted cryptantha				X	
Descurainia pinnata	western tansymustard			X	X	
Descurainia sophia	herb sophia	X				
Draba verna	spring draba	X		X	X	X
Ericameria nauseosa	rubber rabbitbrush			15	15	+
Erodium cicutarium	redstem stork’s bill	+	+	X	X	X
Grindelia columbiana	Columbia River gumweed				X	X
Holosteum umbellatum	jagged chickweed	X	X	X	X	X
Hordeum jubatum	foxtail barley	X				
Lactuca serriola	prickly lettuce	X	X	X	X	X
Lamium amplexicaule	henbit deadnettle	X				
Machaeranthera canescens	hoary aster			X	X	
Medicago sativa	alfalfa					X
Melilotus officianalis	sweetclover		X		X	
Oenothera pallida	pale evening primrose				X	
Phacelia hastata	silverleaf phacelia				X	
Plantago patigonica	woolly plantain				X	X
Plantago lanceolata	English plantain		X			X
Poa bulbosa	bulbous bluegrass	3	5	X	2	40
Poa secunda	Sandberg bluegrass			X	X	
Salsola tragus	prickly Russian thistle		X			
Sisymbrium altissimum	tall tumblemustard	+	X	X	X	X
Sphaeralcea munroana	Munro's globemallow				X	X
Sporobolus cryptandrus	sand dropseed			X	1	5

Table A.4. (contd)

Species Name[a]	Common Name[a]	Polygon Number[b,c]				
		201	202	208	209	211
Taraxacum officinale	common dandelion	X	X			X
Tragopogon dubius	yellow salsify	X	X	X	X	X

(a) Nomenclature according to USDA (2017), Natural Resource Conservation Service Plants Database. http://plants.usda.gov/java/
(b) X= present
(c) + =<1 percent cover; numeric indicators are estimated percent cover
(d) Cover estimates not provided for habitat polygon 111 (riparian zone of the Columbia River), where cover varies widely north of Horn Rapids Road. Species present in 2015 are indicated.
(e) Noxious Weed Class B = Prevent spread and contain or reduce existing populations (WAC 16-750-011)

Note: All plant species observed on the approximate southern two-thirds of the portion of the project area located north of Horn Rapids Road during 2009–2015 are listed in Appendix C of Duncan et al. (2016).

Note: None of these species is state- or federally listed.

Table A.5. Birds Species Observed North of Horn Rapids Road, 2009–2015.

Species Name	Common Name
Actitis macularia	spotted sandpiper
Agelaius phoeniceus	red-winged blackbird
Artemisiospiza nevadensis[(a)]	sagebrush sparrow
Anas platyrhynchos	mallard
Ardea herodias	great blue heron
Asio flammeus	short-eared owl
Branta canadensis	Canada goose
Buteo jamaicensis	red-tailed hawk
Calidris bairdi	Baird's sandpiper
Calidris mauri	western sandpiper
Callipepla californica	California quail
Carpodacus mexicanus	house finch
Carduelis tristis	American goldfinch
Casmerodius albus	great egret
Charadrius vociferus	killdeer
Chordeiles minor	common nighthawk
Circus cyaneus	northern harrier
Colaptes auratus	northern flicker
Columbus livia	rock dove
Corvus brachyrhynchos	American crow
Corvus corax	common raven
Eremophila alpestris	horned lark
Haliaeetus leucocephalus[(b)]	Bald eagle
Hirundo pyrrhonota	cliff swallow
Hirundo rustica	barn swallow
Icterus galbula	Bullock's oriole
Larus californicus	California gull
Melospiza melodia	song sparrow
Mergus merganser	common merganser
Numenius americanus[(c)]	long-billed curlew
Nycticorax nycticorax[(c)]	black-crowned night-heron
Pandion haliaetus[(c)]	osprey
Passer domesticus	house sparrow
Pelecanus erythrorhynchos[(d)]	American white pelican
Phasianus colchicus	ring-necked pheasant
Pica pica	black-billed magpie
Riparia riparia	bank swallow
Sturnella neglecta	western meadowlark
Sturnus vulgaris	European starling
Turdus migratorius	American robin
Tyrannus tyrannus	eastern kingbird
Tyrannus verticalis	western kingbird
Zenaida macroura	mourning dove
Zonotrichia leucophrys	white-crowned sparrow

(a) State Candidate
(b) Federal Species of Concern
(c) State Monitor
(d) State Threatened

Table A.6. Mammal Species Observed north of Horn Rapids Road, 2009–2015.

Species Name	Common Name
Canis latrans	coyote
Castor canadensis	beaver
Erithizon dorsatum	porcupine
Lepus californicus[a]	black-tailed jackrabbit
Odocoileus hemionus	mule deer
Perognathus parvus	Great Basin pocket mouse
Sylvilagus nutalli	mountain cottontail
Taxidea taxus[b]	badger
Thomomys talpoides	northern pocket gopher

(a) State Candidate
(b) State Monitor
Note: None of these species is federally listed.

Table A.7. All Plant Species Observed north of Horn Rapids Road, 2009–2015.

Species Name[a]	Common Name[a]
Achillea millefolium	common yarrow
Achnatherum hymenoides	Indian ricegrass
Acroptilon repens[b]	Russian knapweed
Agoseris heterophylla	annual mountain dandelion
Agropyron cristatum	crested wheatgrass
Ailanthus altissima[c]	tree-of-heaven
Allium schoenoprasum	wild chives
Amaranthus albus	prostrate pigweed
Ambrosia acanthicarpa	flatspine bur ragweed
Amsinckia lycopsoides	tarweed fiddleneck
Amsinckia tessellata	bristly fiddleneck
Artemisia campestris	field sagewort
Artemisia dracunculus	tarragon
Artemisia lindleyana	Columbia river mugwort
Artemisia tridentata	big sagebrush
Asclepias speciosa	showy milkweed
Asparagus officinalis	garden asparagus
Astragalus caricinus	buckwheat milkvetch
Balsamorhiza careyana	Carey's balsamroot
Bassia scoparia[b]	burningbush
Bromus tectorum	cheatgrass
Cardaria draba	whitetop
Centaurea diffusa[b]	diffuse knapweed
Chaenactis douglasii	hoary false yarrow
Chamaesyce serpyllifolia	thymeleaf sandmat

Table A.7. (contd)

Species Name[a]	Common Name[a]
Chenopodium leptophyllum	narrowleaf goosefoot
Chenopodium rubrum	red goosefoot
Chondrilla juncea[b]	rush skeletonweed
Chorispora tenella	blue mustard
Cichorium intybus	chichory
Cirsium sp.	thistle
Clematis ligusticifolia	western white clematis
Comandra umbellata	bastard toadflax
Convolvulus arvensis[c]	field bind weed
Conyza canadensis	Canadian horseweed
Coreopsis tinctoria var. atkinsoniana	Columbia tickseed
Crepis atribarba	slender hawksbeard
Cryptantha circumscissa	matted cryptantha
Cryptantha flaccida	weak-stemmed cryptantha
Cryptantha fendleri	Fendler's cryptantha
Cryptantha pterocarya	winged cryptantha
Dalea ornata	Blue Mountain prairie clover
Descurainia pinnata	western tansymustard
Descurainia sophia	herb sophia
Delphinium nuttallianum	upland larkspur
Draba verna	spring whitlowgrass
Eleocharis sp.	spikerush
Elymus elymoides	squirreltail
Elymus lanceolatus	thickspike wheatgrass
Epilobium brachycarpum	tall annual willowherb
Equisetum sp	horsetail
Ericameria nauseosa	rubber rabbitbrush
Ericameria teretifolia	green rabbitbrush
Erigeron filifolius	threadleaf fleabane
Eriogonum niveum	snow buckwheat
Eriogonum vimineum	broom buckwheat
Erodium cicutarium	redstem stork's bill
Fritillaria pudica	yellow fritillary
Gaillardia aristata	blanketflower
Gilia sinuata	shy gilia
Gratiola neglecta	American hedge-hyssop
Grayia spinosa	spiny hopsage
Gypsophila paniculata[c]	baby's breath
Hesperostipa comata	needle-and-thread grass
Holosteum umbellatum	jagged chickweed
Hymenopappus filifolius	fineleaf hymenopappus
Hypericum perforatum	common St. Johnswort
Iris missouriensis	Rocky Mountain iris
Koeleria macrantha	prairie junegrass
Lactuca serriola	prickly lettuce
Lagophylla rammosissima	rabbitleaf
Layia glandulosa	tidytips

Table A.7. (contd)

Species Name[a]	Common Name[a]
Lepidium densiflorum	common pepperweed
Lepedium latifolium[b]	broadleaf pepperweed
Lepidium perfoliatum	clasping pepperweed
Leptodactylon pungens	prickly phlox
Leymus cinereus	basin wildrye
Logfia arvensis	field fluffweed
Lomatium macrocarpum	bigseed desertparsley
Machaeranthera canescens	hoary aster
Malus pumila	apple
Medicago sativa	alfalfa
Melilotus officianalis	sweetclover
Mentzelia albicaulis	whitestem stickleaf
Microsteris gracilis	pink microsteris
Morus alba	white mulberry
Oenothera pallida	pale evening primrose
Opuntia polyacantha	plains pricklypear
Orobanche corymbosa	flat-top broomrape
Phacelia hastata	silverleaf phacelia
Phacelia linearis	threadleaf scorpionweed
Phalaris arundinacea[c]	reed canarygrass
Phlox longifolia	longleaf phlox
Plantago lanceolata	English plantain
Plantago patigonica	woolly plantain
Plectritis macrocera	white cupseed
Poa bulbosa	bulbous bluegrass
Poa secunda	Sandberg bluegrass
Polygonum convolvulus	climbing bindweed
Plantago patigonica	woolly plantain
Prunus virginiana	chokecherry
Pseudognaphalium stramineum	cottonbatting plant
Pseudoroegneria spicata	bluebunch wheatgrass
Psoralidium lanceolatum	lemon scurfpea
Pteryxia terebinthina	turpentine wavewing
Purshia tridentata	antelope bitterbrush
Robinia pseudoacacia	black locust
Rosa woodsii	Woods' rose
Rubus armeniacus[c]	Himalayan blackberry
Rumex salicifolius	willow dock
Rumex venosus	veiny dock
Salix exigua	narrowleaf willow
Salsola tragus	prickly Russian thistle
Senecio vulgaris	common groundsel
Sisymbrium altissimum	tall tumblemustard
Solidago canadensis	Canada goldenrod
Solanum dulcamara	climbing nightshade
Sphaeralcea munroana	Munro's globemallow
Sporobolus cryptandrus	sand dropseed

Table A.7. (contd)

Species Name[a]	Common Name[a]
Stephanomeria paniculata	tufted wirelettuce
Tragopogon dubius	yellow salsify
Tribulus terrestris[b]	puncturevine
Triteleia grandiflora	Douglas clusterlily
Ulmus pumila	Siberian elm
Verbascum thapsus	common mullein
Vulpia microstachys	small sixweeks
Vulpia octoflora	slender sixweeks
Zigadenus venenosus	meadow death camas

(a) Nomenclature according to USDA (2017), Natural Resource Conservation Service Plants Database. http://plants.usda.gov/java/.
(b) Noxious Weed Class B = Prevent spread and contain or reduce existing populations (WAC 16-750-011)
(c) Noxious Weed Class C = Weeds widespread, control methods available but not normally required (WAC 16-750-015).

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APPENDIX B– CULTURAL RESOURCE MITIGATION

[PLACEHOLDER FOR MEMORANDUM OF AGREEMENT]

APPENDIX C – MITIGATION ACTION PLAN FOR PNNL RICHLAND CAMPUS FUTURE DEVELOPMENT, RICHLAND WASHINGTON

C.1 INTRODUCTION

Consistent with the phased buildout approach assessed in the Pacific Northwest National Laboratory (PNNL) Richland Campus Future Development Environmental Assessment (EA), the U.S Department of Energy (DOE) Pacific Northwest Site Office (PNSO) proposes to construct and operate multiple buildings on the campus, including research laboratories, office space, support buildings, and associated infrastructure. Site development includes infrastructure upgrades needed to support the operations of the planned facilities, including installation of new roads, parking lots, and utilities (e.g., water, natural gas, electric, sewer, and communications). Construction and installation of infrastructure would precede building construction, and may proceed in phases large enough to accommodate multiple buildings constructed over several years, as occurred with Phase 2 of the Physical Sciences Facility Complex construction (DOE 2013). Construction of the new facilities and associated infrastructure will involve clearing and grading the footprint of the buildings and infrastructure, as well as clearing and grading land areas needed to support construction activities and material laydown during construction.

The total land area available for new facilities and associated infrastructure on the PNNL Richland Campus (campus) is 269 ha (664 ac). Habitats types in this area have been grouped into four resource categories (Figure C.1). Mature shrub-steppe habitat (described in Section 4.6) comprises all of resource category 1 outside the riparian zone of the Columbia River and is the subject of this mitigation action plan.

C.1.1 Environmental Effects

PNSO has developed a biological resource management policy for the PNNL Richland Campus that includes mitigation for loss of priority habitats (DOE/PNSO 2015). Shrub-steppe is one of the priority habitat types within Washington State (WDFW 2008/2016). The proposed campus future development includes the potential to clear approximately 54.2 (134.4)of mature shrub-steppe within the campus. These 54.2 (134.4)include the 26 ha (64 ac) of mature shrub-steppe already evaluated in the previous EA for *Construction and Operation of a Physical Sciences Facility at the Pacific Northwest National Laboratory, Richland, Washington* (DOE 2007).

Construction activities may occur on campus at various times over the next 20 years. The annual migratory bird nesting season begins around March 1 and extends through July 31; however, the locations and types of areas (e.g., shrub habitat or light poles) used by migratory birds for nesting may change from year to year based on species-specific factors and changing site conditions. Construction activities could potentially impact nesting birds. Ground-disturbing activities, such as those associated with the proposed work also present the potential for transporting, spreading, and increasing noxious weed species. Several species of Washington State – Class B and Class C noxious weeds (WAC 16-750-011) are located in portions of the proposed project area (Section 4.6 and Appendix B).

C.1.2 Function of the Mitigation Action Plan

This mitigation action plan describes the compensatory mitigation and monitoring commitments under DOE resource management guidelines for the clearing and grading of areas that will result in the loss of mature shrub-steppe habitat on the PNNL Richland Campus (resource category 1 outside the Columbia River riparian zone). Mature shrub-steppe occurs only north of Horn Rapids Road and is juxtaposed with areas of intermediate shrub-steppe (resource category 2) that occur nearby. The spatial extent of mature shrub-steppe may be used for buildout planning. However, note that intermediate shrub-steppe

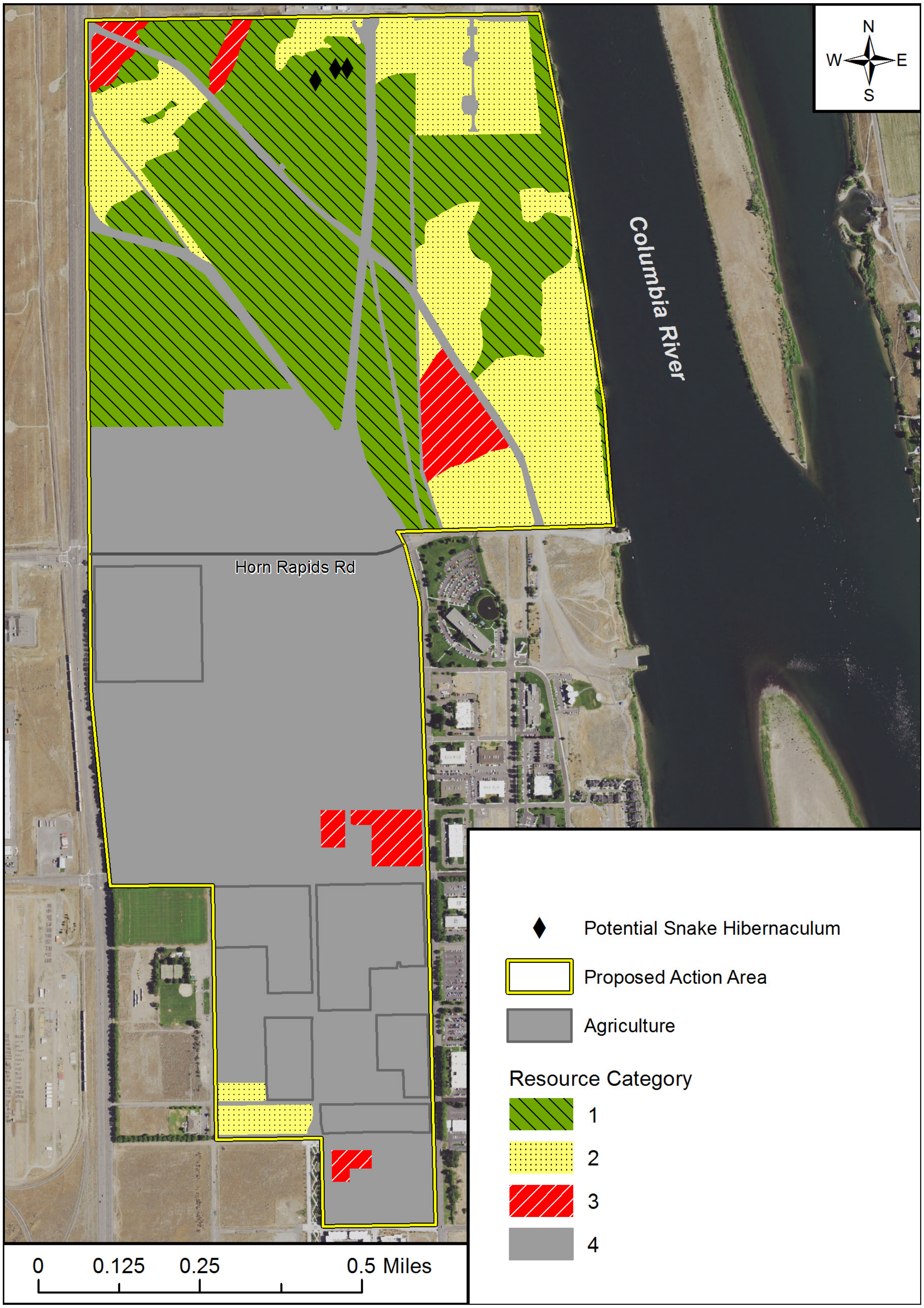

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Figure C.1. Categories of Habitat Resources Located on the PNNL Richland Campus may gradually become mature shrub-steppe within the 20-year period of the buildout. Thus, the actual extent of mature shrub-steppe that may be eligible for mitigation will be determined by a biological resources review conducted prior to each phase of buildout.

The purpose of this plan is to provide guidance for defining the following:

- mitigation requirements
- methods DOE will use to accomplish the mitigation actions
- metrics used to measure the success or failure of the mitigation actions.

The commitments made in this mitigation action plan are designed to mitigate for the loss of shrub-steppe habitat, classified as priority habitat by the Washington State Department of Fish and Wildlife (WDFW 2008/2016), by replacement of the lost habitat value, reduction or elimination of the potential spread of noxious weeds, and avoidance of potential impacts to nesting migratory birds. This general mitigation action plan provides a framework for future development of individual mitigation action plans that address the needs of each phase of buildout over the next 20 years.

Note that this general, or any subsequent, buildout-phase-specific mitigation action plan will not supersede or be additive to an existing mitigation action plan that covers the same land area, such as the similar *Mitigation Action Plan for Phase II Build Out, North Federal Campus, PNNL Site, Richland Washington* (see Appendix B of the *Supplement Analysis to the Final Environmental Assessment of Construction and Operation of a Physical Sciences Facility at the Pacific Northwest National Laboratory, Richland, Washington* [DOE 2013]). Mitigation will occur only once for destruction of shrub-steppe habitat on lands covered by more than one mitigation action plan.

C.1.3 Mitigation Action Plan Annual Reporting

Commitments in this mitigation action plan include implementation of the mitigation measures and monitoring to assure that the mitigation actions achieve defined success standards. Beginning in the year following the initiation of site clearing and grading for each development phase, the status, endpoints, and effectiveness metrics for implementation of mitigation and/or monitoring results for this project will be included in the Annual NEPA Planning Summary (e.g., DOE 2016) and PNNL Annual Site Environmental Report (e.g., Duncan et al. 2016).

C.2 MITIGATION ACTIONS

Under current guidelines for the management of cultural and biological resources on the PNNL Richland Campus (DOE/PNSO 2015), impacts to important biological resources are to be avoided or minimized if possible. Therefore, when possible, development phases will be designed to avoid or minimize impacts to priority habitats and species. This could include developing lower quality habitat areas in preference to higher quality areas, or it could include timing the development to minimize impacts to migratory birds. It is PNSO policy that compensatory mitigation will be performed for unavoidable impacts (DOE/PNSO 2015). Potential environmental effects of the proposed campus buildout activities and the mitigation actions planned to avoid and minimize impacts to biological resources are summarized in Table C.1.

Table C.1. Summary of Mitigation and Avoidance Measures

Environmental Resource	Mitigation Measure	Responsible Organization
Priority habitat	Conduct compensatory mitigation to replace and restore mature shrub-steppe habitat at a ratio of 3 replacement acres for every 1 ac of habitat destroyed. Develop an implementation plan and schedule as part of project planning and identify location(s) of compensatory mitigation. Develop a monitoring plan tailored to the specific compensatory mitigation action, and implement the monitoring plan for a minimum of 5 years.	PNSO and PNNL
Wildlife	Conduct biological surveys as needed before and during the project to identify potential impacts to wildlife, especially migratory birds. Schedule ground-disturbing activities to occur outside the nesting season to the extent feasible. Project staff will work with PNNL biologists to avoid any impacts to migratory nesting birds.	PNSO and PNNL
Noxious weeds	Avoid and minimize the spread of noxious weeds and non-native invasive species by minimizing off-road travel to avoid the spread of seeds. Construction equipment used to clear areas where noxious weeds are known to exist will be inspected and cleaned as necessary to prevent transport of seeds. Revegetation seeding will be reviewed by biologists to assure that seed mixes do not contain noxious weeds or other non-native invasive species that could potentially escape into native habitats.	PNNL and Subcontractor

C.2.1 Compensatory Mitigation Actions

The nature of some of the potential buildout activities (i.e., clearing, grading, and construction of new facilities and infrastructure) associated with buildout in mature sagebrush steppe portions of the campus is such that loss of mature shrub-steppe habitat cannot be avoided or rectified and, thus, will require compensatory mitigation.

DOE/PNSO will compensate for the loss of mature shrub-steppe at a minimum ratio of 3:1 (i.e., for each unit of mature shrub-steppe lost, a minimum of 3 units of mature shrub-steppe will be replaced or recreated). Compensatory mitigation will not be performed for individual actions that remove less than 0.4 ha (1 ac) of habitat, such as installation of a ground water well. Several methods may be used to develop habitat that meets the criteria for mature shrub-steppe stands (required shrub densities and condition of the herbaceous understory). For planning purposes, a replacement unit for late-successional (mature) shrub-steppe will consist of the following or equivalent:

- 1,500 shrubs/ha (600 shrubs/ac)
- 1,500 forbs/ha (600 forbs/ac)
- native perennial grass understory (either already present or planted).

PNSO will consider all available options for implementing the mitigation actions, including but not limited to, PNNL-led restoration efforts, teaming with other agencies (e.g., the U.S. Fish and Wildlife Service or Washington Department of Fish and Wildlife), and third-party contracting through organizations such as the National Fish and Wildlife Foundation.

Sufficient land area for in-kind mitigation is not available on the PNNL Richland Campus, except for some portions of the preservation designated area that could receive habitat enhancement. PNSO and/or its collaborators may also identify the most suitable nearby locations for compensatory mitigation actions within Benton or Franklin County.

Compensatory mitigation actions will be implemented such that the mitigation actions occur on sites that can achieve in-kind habitat replacement, are relatively near the PNNL Richland Campus, and are not expected to be disturbed or destroyed by future anthropomorphic activities. Siting considerations for mitigation actions include the following:

- sites within DOE-administered or managed lands or on the Hanford Reach National Monument meet many of siting objectives (i.e., in-kind replacement, near to the PNNL Richland Campus, and would remain in federal control)
- the mitigation area is located near, within, and/or surrounding lands that possess significant habitat value
- the mitigation area is in an area designated for conservation or preservation.

Conduct of compensatory mitigation on lands other than the Hanford Reach National Monument or outside of lands owned and managed by DOE would require that protection provisions (e.g., deed restrictions or conservation easements) be included as part of the land-use agreements.

C.2.2 Monitoring

Monitoring is critical to determining if the objectives of compensatory mitigation actions have been met. Individual monitoring plans will be produced as part of the individual mitigation action plans that will be developed for each phase of buildout over the next 20 years. Each buildout phase monitoring plan will include a description of the specific metrics that will be used to measure mitigation success, and specific success criteria or target objectives for each metric at various intervals for at least 5 years. Monitoring metrics may include measures such as survivorship of transplanted material, plant density or cover in seeded areas, plant growth or shrub height, or other ecologically meaningful metrics.

If compensatory mitigation is performed via a third-party contractor arrangement, development and implementation of monitoring plans will be a required part of the statement of work for that contract.

C.2.3 Contingency Planning

If monitoring determines that one or more of the success criteria have not been met, additional mitigation actions will be performed to address areas where success was not achieved.

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APPENDIX D– CALCULATIONS SUPPORTING THE HYDROGEN ACCIDENT ANALYSIS

This appendix provides supporting calculations that were used in the high bay facility hydrogen accident analysis. Two bounding accident types were considered—vapor cloud explosion and vapor cloud fire. The supporting calculations are presented below.

D.1 VAPOR CLOUD EXPLOSION

The vapor cloud explosion scenario follows the guidance and methodologies presented in the Environmental Protection Agency (EPA) Risk Management Program Guidance for Offsite Consequence Analysis (OCA) (EPA 2009). For worst-case analysis, the total quantity of the flammable substance is assumed to form a vapor cloud. The entire contents of the cloud are assumed to be within the flammability limits, and the cloud is assumed to explode. The OCA method assumes 10 percent of the flammable vapor in the cloud participates in the explosion (i.e., the yield factor is 0.10). Consequence distances to an overpressure level of 1 pound per square inch (psi) may be determined using the following equation, which is based on the trinitrotoluene (TNT)-equivalency method (EPA 2009 Appendix C, Equation C-1):

$$D = 17\ x\ (0.1\ x\ W\ x\ HC_f\ x\ HC_{TNT})^{1/3}$$

where:

D = distance to overpressure of 1 psi (m)

W = weight of flammable substance (kg)

HC_f = heat of combustion of flammable substance (hydrogen: 119,950 kJ/kg; EPA 2009,Exhibit C-1)

HC_{TNT} = heat of explosion of TNT (4,680 kJ/kg; EPA 2009,Section C.1)

The distance to a 1 psi overpressure is provided in Section 5.2.16 for each scenario.

D.2 VAPOR CLOUD FIRE

The vapor cloud fire scenario follows the guidance and methodologies presented in the EPA OCA (EPA 2009). For a vapor cloud fire, the potential offsite hazard is from thermal radiation (i.e., heat) from dispersion of a cloud of flammable vapor and the subsequent ignition of the cloud following dispersion. The distance to the lower flammability level (LFL) represents the maximum distance based on the total quantity of flammable material could be released from a vessel or pipeline at which the radiant heat effects of a vapor cloud fire might have serious consequences. The LFL for hydrogen gas is 3.3 mg/L (EPA 2009, Exhibit C-2).

The OCA calculation of the distance to the LFL requires the estimation of a flammable gas release rate into the air. The release rate is the limiting condition of the entire inventory released in one minute or the choked flow release rate. The choked flow release rate for a gaseous release from a tank or pipe is given as (EPA 2009, Section 9.1):

$$QR = HA\ x\ P_t\ x\ \frac{1}{\sqrt{T_t}}\ x\ GF$$

where:

QR = release rate (lb/min)

HA = hole or puncture area (in^2; assume severed supply line of 0.5 in. Schd. 40 pipe, or 0.302 in.^{2})

P_t = tank pressure (pounds per square inch absolute [psia]; assume 3,000 psia is bounding tank pressure in all scenarios)

T_t = tank temperature (K; assume ambient temperature of 298.15 K)

GF = gas factor (hydrogen: 5.0; EPA 2009, Exhibit C-2)

Based on the above equation and assumptions, the choked flow release rate (QR) for the hydrogen accident scenario was calculated to be 262 lb/min. The choked flow release rate was compared to a release rate assuming the entire inventory was released in one minute:

Table D.1. Hydrogen Accident Scenario Mass and Calculated Release Rates

Scenario	Mass (kg)	Mass (lb)	1-minute Release Rate (lb/min)	Choked Flow Release Rate (lb/min)	Limiting Release Rate (lb/min)
Cylinders	53	116	116	262	116
Multi-tube storage racks	94	207	207	262	207
Tube trailer[(a)]	154	340	340	262	262

(a) Choked flow limited release rate applies.

The OCA method for determining the distance to the LFL involves first taking the limiting release rate from Table D.1 and dividing it by the LFL for hydrogen (3.3 mg/L; EPA 2009, Exhibit C-2). The resulting values are then used in a reference table (EPA 2009, Table 26) for a neutrally buoyant gas that assumes neutral atmospheric stability and a wind speed of 3.0 m/s. LFL distances are provided in Section 5.2.16 for each scenario.

D.3 REFERENCES

EPA (U.S. Environmental Protection Agency). 2009. *Risk Management Program Guidance for Offsite Consequence Analysis.* EPA-550-B-99-009, Office of Solid Waste and Emergency Response, Washington, D.C. Accessed February 1, 2017, at https://www.epa.gov/sites/production/files/2013-11/documents/oca-chps.pdf.