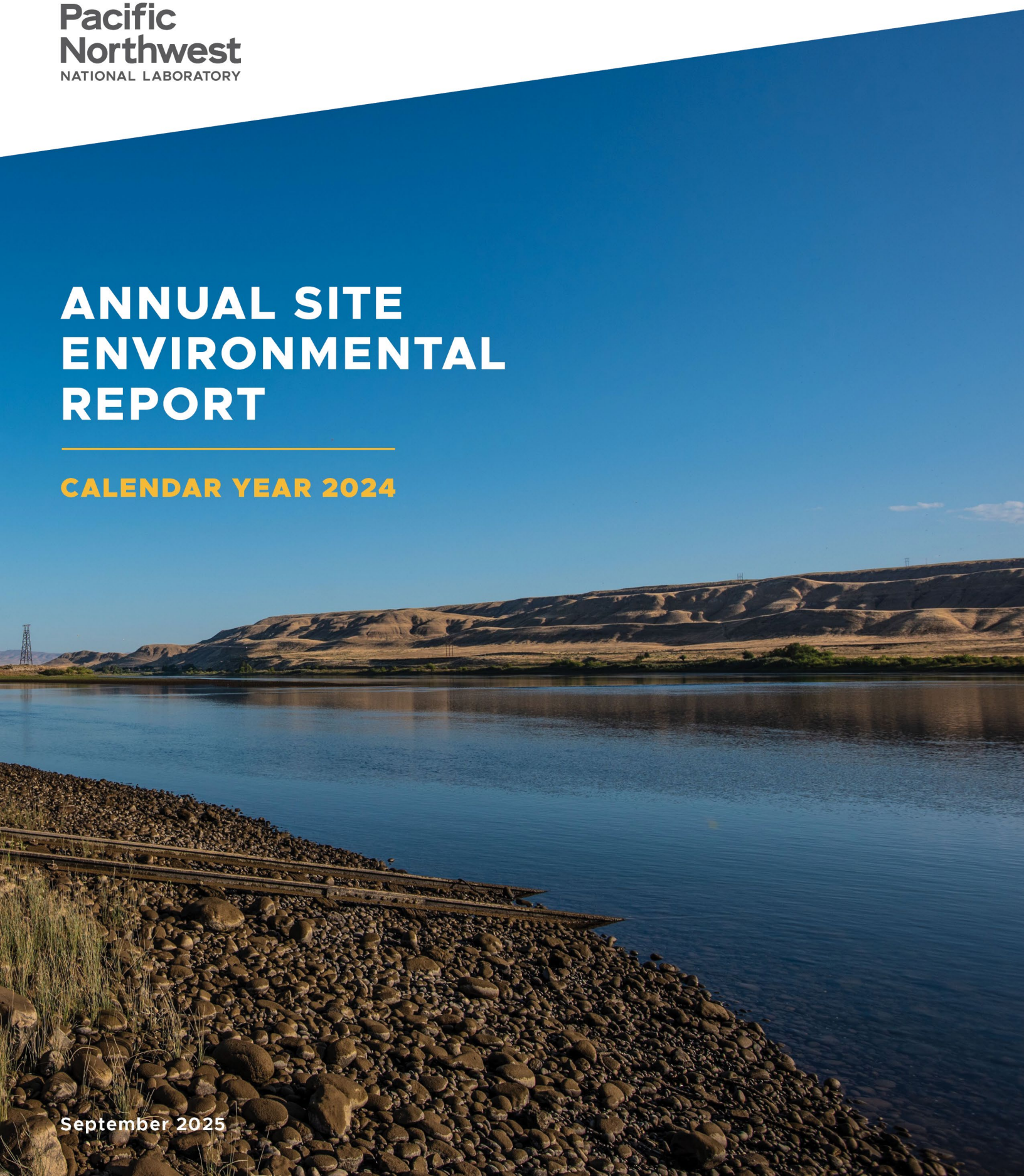
Pacific Northwest
NATIONAL LABORATORY

ANNUAL SITE ENVIRONMENTAL REPORT

CALENDAR YEAR 2024



September 2025

DISCLAIMER

PACIFIC NORTHWEST NATIONAL LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC05-76RL01830

Printed in the United States of America

Available to DOE and DOE contractors from
the Office of Scientific and Technical Information,
P.O. Box 62, Oak Ridge, TN 37831-0062
www.osti.gov
ph: (865) 576-8401
fox: (865) 576-5728
email: reports@osti.gov

Available to the public from the National Technical Information Service
5301 Shawnee Rd., Alexandria, VA 22312
ph: (800) 553-NTIS (6847)
or (703) 605-6000
email: info@ntis.gov
Online ordering: http://www.ntis.gov

PNNL-38156

Pacific Northwest National Laboratory Annual Site Environmental Report for Calendar Year 2024

September 2025

TR Hay
SF Snyder
CA Duberstein
ES Norris
JM Barnett
JL Blake
C Counts
KM Mendez
KD Hand
J Su-Coker
RA Del Mar
LE Bisping
TW Moon
EA Raney
CJ Duchsherer
DL Edwards
RS Wiegman
SR Horn
L Dinh
JA Stephens
C Ramos
M Peterson

Prepared for
the U.S. Department of Energy
under Contract DE-AC05-76RL01830

Pacific Northwest National Laboratory
Richland, Washington 99354

Pacific Northwest National Laboratory Annual Site Environmental Report for 2024

Can We Make This Report More Useful to You?

We want to make this report useful and easy to read. To help us in this effort, please take a few minutes to let us know if the PNNL Annual Site Environmental Report meets your needs. Email us at pnsomanager@science.doe.gov, or print this page and mail it to:

Tom McDermott
Pacific Northwest Site Office, P.O. Box 350 MS K9-42, Richland, WA 99352

How do you use the information in this report?

☐ To learn general information about PNNL

☐ To learn about doses from PNNL activities

☐ To send to others outside the Tri-Cities area

☐ To learn about site compliance

☐ Other: _____

Does this report contain:

☐ Enough detail ☐ Not enough detail ☐ Too much detail

Is the technical content:

☐ Too concise ☐ Too wordy ☐ Uneven ☐ Just right

Is the text easy to understand?

☐ Yes ☐ No

If no, is it: ☐ Too technical ☐ Too detailed ☐ Other_____

Is the report comprehensive?

☐ Yes ☐ No

If no, please identify any issues you believe are missing in the Other Comments section below.

Other Comments:

_____

_____

_____

What is your affiliation?

☐ U.S. DOE ☐ Media ☐ State Agency ☐ Federal Agency

☐ Public Interest Group ☐ Member of Native American Nation ☐ Local Agency

☐ Member of the public ☐ University ☐ Industry

Executive Summary

Pacific Northwest National Laboratory (PNNL), one of the U.S. Department of Energy (DOE) Office of Science's 10 national laboratories, provides innovative science and technology development in the areas of energy and the environment, fundamental and computational science, and national security.

PNNL prepares an Annual Site Environmental Report to meet the requirements of DOE Order 231.1B, *Environment, Safety and Health Reporting*, and DOE Order 458.1, *Radiation Protection of the Public and the Environment*, thus assuring that the public is informed of any PNNL-Richland campus or PNNL-Sequim campus event that could adversely affect the health and safety of the public, site staff, or the environment.

The report provides a synopsis of ongoing environmental management performance and compliance activities for operations that occur at the PNNL-Richland campus in Richland, Washington, and at the PNNL-Sequim campus near Sequim, Washington. It describes the location of and background for each facility; addresses compliance with applicable DOE, federal, state, and local regulations, and site-specific permits; documents environmental monitoring efforts and their status; presents potential radiation doses to staff and the public in the surrounding areas; and describes DOE-required data quality assurance methods used for data verification.

Compliance with Federal, State, and Local Laws and Regulations in 2024

PNNL is subject to many federal, state, and local environmental laws, regulations, guidance decrees, DOE requirements, and Executive Orders, as well as numerous site-specific permits. Detailed requirements are integrated into PNNL projects by means of environmental compliance representatives assigned to assess and assist with each project. During 2024, PNNL continued to exhibit an excellent compliance record. Required reports were submitted, necessary reviews and permits for research and support activities were obtained, all sitewide permits were current, and authorized emission and discharge levels were kept within specified limits.

Environmental Performance

PNNL's environmental management system is integrated into PNNL's Integrated Safety Management Program, which assures that staff are aware of project scope, risks/hazards, and controls available to address the functions, processes, and procedures used to plan and perform work safely. PNNL is dedicated to responsible planning for and management of resources that could be affected by facility operations and exhibited excellent environmental performance in energy and water conservation, waste diversion, alternative fuel use, and high-performance building design in 2024.

Environmental Monitoring and Dose Assessment

PNNL monitors air and water quality to assure compliance with federal, state, and local regulatory requirements and permits. Focus areas for monitoring efforts are described below.

Air Emissions

Airborne emissions from PNNL facilities are monitored to assess the effectiveness of emission treatment and control systems, as well as pollution management practices. Emissions are managed compliant with standards for exposure to workers and members of the public. The Benton Clean Air Agency implements and enforces most federal and state requirements on the PNNL-Richland campus, and the Olympic Region Clean Air Agency implements and enforces most federal and state requirements at the PNNL-Sequim campus for nonradioactive emissions. For radioactive emissions to air, the Washington Department of Health provides regulatory oversight. There were no unplanned releases of regulated substances or substances of concern from PNNL facilities in 2024.

Liquid Effluent Monitoring

Liquid effluent discharges from PNNL-Richland campus operations are monitored under permits issued by the City of Richland. Process wastewater from the PNNL-Sequim campus is treated at an on-site wastewater treatment plant prior to being discharged to Sequim Bay under a permit issued by the Washington State Department of Ecology. In 2024, there were no unplanned releases of regulated pollutants or contaminated wastewater from PNNL facilities.

Drinking Water Monitoring

Drinking water quality at the PNNL-Sequim campus is monitored under a permit issued by the Washington State Department of Health. Drinking water is supplied by an on-site groundwater well and is untreated prior to distribution. In 2024, initial lead service line inventories were completed, and no lead piping was identified in the PNNL-Sequim campus water system. In addition, sampling of the PNNL-Sequim campus groundwater well for per- and polyfluoroalkyl substances (PFAS) was completed and all results were nondetectable. During 2024, the PNNL-Sequim campus drinking water system complied with drinking water standards and there were no noncompliance issues.

Radiological Release of Property

PNNL uses the preapproved limits derived from guidance in DOE Order 458.1, Chg 4, *Radiation Protection of the Public and the Environment*, when releasing property potentially contaminated with residual radioactive material. No property with detectable residual radioactivity that was above authorized limits was released to the general public from PNNL in 2024.

Radiation Protection of Biota

PNNL models environmental concentrations for air, soil, sediment, and water to consider impacts on biota from PNNL particulate radioactive releases to ambient air. The 2024 dose rate estimates for aquatic, terrestrial, and riparian animals and plants for both the PNNL-Richland and PNNL-Sequim campuses were well below the dose rate limits as established through DOE Order 458.1, Chg 4 guidance (1 rad/d [10 mGy/d] for both aquatic animals and terrestrial plants, and less than 0.1 rad/d [1 mGy/d] for both riparian animals and terrestrial animals).

Environmental Radiological Monitoring

Radioactive particulates in ambient air at the PNNL-Richland campus are monitored using a particulate air-sampling network. Radioactive gases are administratively managed. No radiological releases to the environment exceeded permitted limits in 2024, and there was no indication that any PNNL activities increased the ambient air concentrations at the particulate sampling locations.

Public Radiation Dose from All Pathways

The PNNL-Richland campus 2024 maximum exposed individual (MEI) member of the public location was 0.65 km (0.40 mi) south-southeast of the Physical Sciences Facility 3410 Building. Dose to the MEI from site radionuclide air emissions was 1.3×10^{-5} mrem (1.3×10^{-7} mSv). No other pathways contributed to MEI dose. In 2024, within the 80 km (50 mi) radius of the PNNL-Richland campus, the collective dose from radionuclide air emissions that originated from the campus was 1.3×10^{-4} person-rem (1.3×10^{-6} person-Sv).

The PNNL-Sequim campus MEI location for 2024 was 0.23 km (0.14 mi) west of the central emission location. Dose to the MEI from site emissions was 7.2×10^{-13} mrem (7.2×10^{-15} mSv). The 80 km (50 mi) collective dose for PNNL-Sequim campus emissions was 2.0×10^{-12} person-rem (2.0×10^{-14} person-Sv).

The total dose from radioactive air emissions to either the PNNL-Richland campus or PNNL-Sequim campus MEI is well below the federal and state standard of 10 mrem/yr

(0.1 mSv/yr). The total dose from all pathways (air emissions, liquid effluent releases, and other pathways) is well below the limit of 100 mrem/yr (1 mSv/yr).

Environmental Nonradiological Program Information

PNNL nonradiological air emissions are below levels that require stack monitoring; compliance is achieved by conforming to permit conditions. There was no nonradiological air emission permit exceedance or noncompliance occurrence at either the PNNL-Richland campus or PNNL-Sequim campus in 2024.

Natural and Cultural Resource Management

Protection and management of cultural and biological resources on PNNL lands is implemented through internal cultural and biological resource protection procedures, which are updated to reflect relevant changes in applicable laws and regulations and compliance methods. The *Pacific Northwest Site Office Cultural and Biological Resources Management Plan* provides guidance related to protecting and managing biological and cultural resources at PNNL.

Three federally endangered and threatened fish species—Upper Columbia River spring-run Chinook salmon, Upper Columbia River steelhead, and bull trout—are known to occur or potentially occur in the Columbia River Hanford Reach, adjacent to the PNNL-Richland campus. Ten federally endangered or threatened animal species are known to occur on or near the PNNL-Sequim campus:

- marbled murrelet
- bull trout
- Hood Canal summer-run chum salmon
- North American green sturgeon
- Pacific eulachon
- Puget Sound bocaccio
- Puget Sound Chinook salmon
- Puget Sound steelhead
- Puget Sound yelloweye rockfish
- Taylor’s checkerspot butterfly.

The range of the island marble butterfly has been refined, as this species is no longer found near the PNNL-Sequim campus. In 2024, the monarch butterfly was proposed for listing as a threatened species, and Suckley’s cuckoo bumble bee was proposed for listing as an endangered species. The PNNL-Richland and PNNL-Sequim campuses are within the ranges of both these species. The western population of the yellow-billed cuckoo also includes both PNNL campuses, but this bird has been functionally extirpated from Washington State for almost 100 years. Additionally, all of Clallam County, Washington, including the PNNL-Sequim campus, is within the range of the northwestern pond turtle, a species proposed for listing as a threatened species in 2023. This species is not known to reside within the PNNL-Sequim campus.

All PNNL projects involving soil or vegetation disturbance or work outdoors are routinely evaluated to determine their potential to affect biological resources prior to implementation. A total of 119 biological resource reviews were completed in 2024 at the PNNL locations: PNNL-Richland campus (38), PNNL-Sequim campus (26), and other locations (55). A total of 162 environmental permits or authorizations for PNNL research activities were acquired in calendar year 2024.

The PNNL cultural resources program supported 116 projects in 2024—26 occurred at the PNNL-Richland campus, 27 occurred at the PNNL-Sequim campus, and 63 occurred at other locations. Annual conditions monitoring also was conducted at both campuses during 2024. Minor disturbances were noted during monitoring specified under Section 110 of the National Historic Preservation Act of 1966. The issues did not result in adverse impacts to cultural or historic resources.

Groundwater Protection

Groundwater monitoring is no longer required for environmental compliance at either the PNNL-Richland campus or the PNNL-Sequim campus.

Quality Assurance

The comprehensive quality assurance programs and plans at PNNL, which include quality control procedures and method verification, assured reported data were reliable and met all quality control and quality assurance objectives. Sampling and monitoring activities performed under PNNL's Environmental Management Program in 2024 included collecting samples of water, wastewater, radiological air emissions, ambient air, and environmental dosimeters. Chain-of-custody procedures tracked the transfer of samples from points of collection to accredited analytical laboratories.

Contributors

Compilation of the Pacific Northwest National Laboratory Annual Site Environmental Report involved the collaboration and expertise of numerous staff members at PNNL. Principal contributors and their subject matter specialties included the following:

TR Hay	Project Leader, Coordination, Editing and Reviewing throughout, Executive Summary, Compiling Introduction
SF Snyder	Document Review/Coordination, Demographics, Ambient External Dose Monitoring, Peer Review, Distribution Assist
CA Duberstein, ES Norris	Project Management, *National Environmental Policy Act*, Environmental Setting and Ecology, Biological Resources
JM Barnett	Air Quality, Radiation Protection of Biota, Environmental Radiological Monitoring and Permits, Assist Non-Radiological Monitoring
JL Blake, CA Counts, A Waller	Copyediting and Formatting
KM Mendez	Cultural and Historic Resources
KD Hand	Environmental Setting and Ecology, Compliance Summary, Permit List, Biological Resources, Noxious Weed Control
J Su-Coker, RA Del Mar	Environmental Management System and Energy Resiliency and Efficiency
LE Bisping	Environmental Radiological Monitoring
TW Moon	Groundwater Protection, Liquid Effluent Monitoring, DOE Order 458.1 Reporting
EA Raney	Water Quality, Liquid Effluent Monitoring, Contributor Compliance Summary, QA Assist
CJ Duchsherer	Nonradiological Air Emissions, Permit List
RS Wiegman, SR Horn	Permitting, Environmental and Waste Management Regulations, Statutes
L Dinh	Quality Control and Assurance
JA Stephens	Radiation Protection
J Hargraves	ASER Guidance QA
C Ramos	Distribution

Acronyms and Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
µg/L	microgram per liter
µrem/hr	microrem per hour
µSv	microsievert
325RPL	325 Building Radiochemical Processing Laboratory
A	
ac	acre
AIM	American Innovation and Manufacturing Act
ALARA	as low as reasonably achievable
ANSI/HPS	American National Standards Institute/Health Physics Society
AQSS	Acquisition Quality Support Services
ASME	American Society of Mechanical Engineers
ASO	Analytical Support Operations (laboratory)
B	
BCAA	Benton Clean Air Agency
BP	Before Present
BPA	Bonneville Power Administration
Bq	becquerel
Btu	British thermal unit
C	
CAA	*Clean Air Act*
CBRMP	Cultural and Biological Resources Management Plan
CCR	California Code of Regulations
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFE	Carbon-Free Electricity
CFR	Code of Federal Regulations
Ci	curie
cm	centimeter
CMP	coastal zone management program
CWA	*Clean Water Act*
CY	calendar year
D	
d	day
DoD	U.S. Department of Defense

DOE	U.S. Department of Energy
DOE-RL	DOE-Richland Operations Office
DOE-SC	DOE Office of Science
dpm	disintegrations per minute
DQO	data quality objective
E	
EAC	Energy Attribute Certificates
ECHO	Enforcement & Compliance History Online
EDE	effective dose equivalent
EISA	*Energy Independence and Security Act of 2007*
EM	Effluent Management
EMP	Environmental Management Plan
EMS	environmental management system
EMSL	William R. Wiley Environmental Molecular Sciences Laboratory
EPA	U.S. Environmental Protection Agency
EPCRA	*Emergency Planning and Community Right-to-Know Act of 1986*
ERP	Environmental Research Permitting
ESA	*Endangered Species Act of 1973*
EWTPG	Effluent, Waste, and Transportation Programs Group
F	
FEMA	Federal Emergency Management Agency
FR	Federal Register
FSOAA	*Forest Service Organic Administration Act*
ft	foot (feet)
ft^2	square foot (feet)
ft^3	cubic foot (feet)
FY	fiscal year
G	
g	g-force
gal	gallon
GBq	gigabecquerel
GEL	General Engineering Laboratories
GLM	General Laws of Massachusetts
gpd	gallon per day
gsf	gross square foot (feet)
GSL	Grid Storage Launchpad
Gy	gray

H	
ha	hectare
HASQARD	Hanford Analytical Services Quality Assurance Requirements Document
HDI	How Do I….?
HFC	hydrofluorocarbon
HTB	Heat Transfer Building
I	
IEC	International Electrotechnical Commission
ILA	industrial, landscaping, and agricultural
in.	inch(es)
ISO	International Organization for Standardization
K	
kg	kilogram (1,000 grams)
km	kilometer
km^2	square kilometer
kW	kilowatt
L	
L	liter
L/min	liter per minute
LAC	Louisiana Administrative Code
lb.	pound
LEPC	Local Emergency Planning Committee
M	
m	meter
m^2	square meter
m^3	cubic meter
m/s	meter per second
MAPEP	Mixed-Analyte Performance Evaluation Program
MBTA	*Migratory Bird Treaty Act of 1918*
MEI	maximum exposed individual
mGy/d	milligray per day
mi	mile
mi^2	square mile
min	minute
MMPA	*Marine Mammal Protection Act of 1972*
mph	miles per hour
MRAD	Multimedia Radiochemistry Proficiency Testing
mrem	millirem

mrem/yr	millirem per year
MSFCMA	*Magnuson–Stevens Fishery Conservation and Management Act*
mSv	millisievert
mSv/yr	millisievert per year
N	
NA	not applicable
NEPA	*National Environmental Policy Act of 1969*
NESHAP	National Emission Standards for Hazardous Air Pollutants
NHPA	*National Historic Preservation Act of 1966*
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NQA	nuclear quality assurance
O	
OAR	Oregon Administrative Rules
ORCAA	Olympic Region Clean Air Agency
OSLD	optically stimulated luminescence dosimeter
P	
PCB	polychlorinated biphenyl
pCi	picocurie
pCi/L	picocurie per liter
pCi/m^3	picocurie per cubic meter
pCi/mL	picocurie per milliliter
PFAS	per- and polyfluoroalkyl substances
PIC-5	Potential Impact Category 5
PNL	Pacific Northwest Laboratory
PNNL	Pacific Northwest National Laboratory
PNSO	Pacific Northwest Site Office
PSF	Physical Sciences Facility
PV	photovoltaic
Q	
QA	quality assurance
QAP	quality assurance plan
QC	quality control
R	
R&D	research and development
RAEL	radioactive air emission license
RCRA	*Resource Conservation and Recovery Act of 1976*

RCW	Revised Code of Washington
RESL	Radiological and Environmental Sciences Laboratory
RHA	*Rivers and Harbors Appropriations Act of 1899*
S	
s	second
SDWA	*Safe Drinking Water Act of 1974*
SEPA	*State Environmental Policy Act*
SERC	State Emergency Response Commission
SMA	*Shoreline Management Act of 1971*
Sv	sievert
T	
TSCA	Toxic Substances Control Act
U	
U.S.	United States
USACE	U.S. Army Corps of Engineers
U.S.C.	U.S. Code
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
W	
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WDOH	Washington State Department of Health
WUI	water use intensity
Y	
yr	year
Z	
ZEV	zero-emission vehicle

Contents

Figures

Tables

1.0 INTRODUCTION

The United States (U.S.) Department of Energy (DOE) requires that all its site facilities develop annual site environmental reports to comply with DOE Order 231.1B, Chg 1, *Environment, Safety and Health Reporting*, and DOE Order 458.1, Chg 4, *Radiation Protection of the Public and the Environment*. DOE is committed to environmental protection, compliance, energy resiliency, and efficiency, and efforts to assure the validity and accuracy of compliance monitoring data.

This report provides a synopsis of calendar year (CY) 2024 information related to environmental management performance and compliance efforts at Pacific Northwest National Laboratory (PNNL). It summarizes site compliance with federal, state, and local environmental laws, regulations, policies, directives, permits, and orders and provides environmental management performance benchmarks and their status to the public, regulatory agencies, community officials, Native American Tribes, and public interest groups.

PNNL—one of 10 DOE Office of Science (DOE-SC) national laboratories—provides innovative science and technology solutions in energy and the environment, fundamental and computational science, and national security disciplines. Operated by Battelle Memorial Institute (Battelle) under contract to DOE-SC's Pacific Northwest Site Office (PNSO), PNNL 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), DOE Office of Environmental Management, and other federal agencies, state agencies, and private industry. PNSO is responsible for program implementation, acquisition management, and laboratory stewardship at PNNL. Through its oversight role, PNSO manages the safe and efficient operation of PNNL while enabling the pursuit of visionary research and development (R&D) in support of complex national energy and environmental missions. There are three DOE offices within the Richland area. Two are responsible for the Hanford Site, whereas the Pacific Northwest Site Office oversees PNNL.

As part of PNNL's commitment to environmental stewardship, staff members conduct surveillance and monitoring tasks to confirm compliance with established standards and specific permit limits, as well as to provide information regarding any impacts on the environment from operations.

1.1 Location

PNNL has facilities on the PNNL-Richland campus in Richland, Washington, and on the PNNL-Sequim campus near Sequim, Washington (Figure 1). Environmental activities at other locations also fall under PNNL's responsibility (e.g., a permitted waste storage and treatment unit on the Hanford Site). In addition, PNNL conducts research at other satellite offices, including Seattle, Washington; Portland, Oregon; and off-site locations, such as College Park, Maryland. Of these locations, only the Richland and Sequim campuses have laboratory operations with the potential to emit materials. The other locations are business and research offices.

Figure 1. PNNL Office Locations

1.1.1 PNNL-Richland Campus

The PNNL-Richland campus covers approximately 269 ha (664 ac) and is in Benton County in southeastern Washington State, 275 km (170 mi) east-northeast of Portland, Oregon; 275 km (170 mi) southeast of Seattle, Washington; and 200 km (125 mi) southwest of Spokane, Washington. It is fully encompassed by the City of Richland boundary and is south of the DOE-Richland Operations Office's (DOE-RL's) Hanford Site 300 Area (Figure 2). Adjacent to the Columbia River, the PNNL-Richland campus encompasses land owned by DOE-SC and Battelle. PNNL also leases facilities located on privately owned land and on the campus of Washington State University Tri-Cities, located just south of the PNNL-Richland campus. In 2024 groundbreaking began on the new research and development structures, which will be located north of the PNNL main campus and south of the Hanford 300 area.

Figure 2. PNNL-Richland Campus

1.1.2 PNNL-Sequim Campus

The PNNL-Sequim campus is located at the mouth of Sequim Bay, near the town of Sequim on the northern portion of the Olympic Peninsula in Clallam County, Washington. The campus is 74 km (46 mi) northwest of Seattle, Washington, and 47 km (29 mi) southwest of Victoria, British Columbia. It encompasses an area of 47 ha (117 ac) owned by Battelle Memorial Institute in FY2024, including the main portion on the west shore of Sequim Bay; Bugge Spit, which projects northward; most of Travis Spit, which forms the northern boundary of Sequim Bay; and a shoal in the bay called The Middle Ground (Figure 3). A federal acquisition was underway in FY2024 that will transfer a portion of this land, including the facilities and associated tidelands, to DOE. A portion of the research pier facility in Sequim Bay resides within aquatic land leased from the Washington Department of Natural Resources (WDNR).

Figure 3. PNNL-Sequim Campus and Nearby Environment

1.2 Background and Mission

The following sections provide a summary of the history and mission of PNNL.

1.2.1 PNNL-Richland Campus

In January 1965, Battelle was awarded the Pacific Northwest Laboratory (PNL) contract to operate the Hanford Site laboratories. In addition, Battelle invested its own funds to construct facilities to conduct non-Hanford Site research to promote R&D in the Pacific Northwest. In the late 1970s, research expanded to include energy, health, environment, and national security ventures. PNL contributed to robotics, environmental monitoring, material coatings, veterinary medicine, and the formation of new plastics.

In 1995, PNL joined the DOE national laboratory system and was renamed Pacific Northwest National Laboratory. Over the years, PNNL researchers have developed versatile technologies, and received numerous R&D 100 Awards, Federal Laboratory Consortium Awards, innovation awards, and patents for their R&D work and contributions.

PNNL is operated by Battelle for DOE-SC's PNSO, which was established in 2003. PNSO is responsible for overseeing all PNNL activities and monitoring the Laboratory's compliance with applicable laws, policies, and orders. Research efforts on the PNNL-Richland campus include development and analysis of high-performance materials for energy, construction, and transportation technologies and systems; national-security-related radiation detection methodologies, including optics/infrared spectroscopy, electromagnetics/radiography, and acoustics/ultrasonics; systems biology research, which develops comprehensive monitoring programs and performs environmental and biotechnology research; visual analytics technologies; cyber analytics; and critical infrastructure assessment and protection.

1.2.2 PNNL-Sequim Campus

In 1967, Battelle acquired acreage on Sequim Bay on the Strait of Juan de Fuca in the Puget Sound, near Sequim, Washington. As part of Battelle's commitment to developing research facilities to benefit the region and serve the environment, the Marine Research Laboratory was constructed to provide facilities for marine-related work involving biology, physiology, histology, chemistry, physics, and engineering. In 1973, the Marine Research Laboratory opened; it was later renamed Marine Research Operations, then Marine Sciences Laboratory. It is now referred to as the PNNL-Sequim campus.

In October 2012, the PNNL operating contract was revised, giving DOE exclusive use of the PNNL-Sequim campus, consolidating operations under PNSO oversight. Currently, researchers at the Sequim campus provide innovative science and technology solutions critical to the nation's energy, environmental, and security future. Capabilities are based on expertise in biotechnology, biogeochemistry, ecosystems science, toxicology, and Earth systems modeling. In addition, a scientific dive team supports in-water research and analysis. The research laboratories encompass more than 1,400 m^2 (15,000 ft^2) of area, which includes an innovative wastewater treatment system that treats up to 909 L (200 gal) per minute of seawater to remove chemical and biological impurities before returning the water to Sequim Bay. Research efforts include studying algal biofuels, climate change, biofouling/biocorrosion, and environmental monitoring; quantifying the transport, fate, and effects of chemicals in marine environments; predicting and analyzing coastal risks/hazards; and developing detection and signatures against threats.

1.3 Demographics

The PNNL-Richland campus is in Benton County, Washington, south of the Hanford Site, in an area that is primarily flat, semi-arid, and restricted from public access. Residents north and east of the Hanford Site generally live on farms or in farming communities. Residents south, southwest, and west of the PNNL-Richland campus live in the urban communities of Richland, Kennewick, Pasco, and West Richland. Richland is the only community adjacent to the PNNL-Richland campus.

Demographic information from 2024 indicates Benton County (217,850 people) and Franklin County (102,300 people) populations combined accounted for 2.7% of Washington's population (WOFM 2024). Based on 2020 U.S. Census population data, the population within an 80 km (50 mi) radius of the PNNL-Richland campus is estimated to be about 605,419 (Rose et al. 2023). This population estimate is used to calculate radiation dose to the public (see Section 4.1 of this report).

The PNNL-Sequim campus is in Clallam County, Washington, on the Olympic Peninsula in the northwestern corner of Washington State. An estimated 78,550 people lived in Clallam County in 2024, equivalent to approximately 1.0% of Washington's population (WOFM 2024). The city of Sequim, the nearest population center to the PNNL-Sequim campus, had a population of 8,405 people in 2024 (WOFM 2024). Based on 2020 U.S. Census population data, the population within an 80 km (50 mi) radius of the PNNL-Sequim campus is estimated to be about 2,936,180 (Rose et al. 2023). This population estimate is used to calculate the radiation dose to the public (see Section 4.1 of this report).

1.4 Environmental Setting – PNNL-Richland Campus

The land and associated geology, hydrology, seismicity, and meteorology of the PNNL-Richland campus locale, as well as the flora and fauna and land and water habitats of the ecoregion, are described in the following sections.

1.4.1 Environmental Locale

The lands containing the PNNL-Richland campus have experienced varying degrees of previous disturbance. Upland areas affected by lower levels of prior disturbance principally support native shrub-steppe vegetation, while more heavily disturbed uplands support more invasive, nonnative vegetation. Other areas have undergone complete habitat conversion and contain facilities bordered by landscaping or xeriscaping. The portion of the Columbia River riparian zone on the PNNL-Richland campus is largely undisturbed and supports both native and nonnative vegetation.

The PNNL-Richland campus is in the Columbia Basin, an intermontane region between the Cascade Range and the Rocky Mountains. The campus lies above a gentle syncline formed by the intersection of the Yakima Fold Belt, a series of anticlinal ridges and synclinal valleys, and the gently west-dipping Palouse Slope, which contains few faults and low-amplitude, long-wavelength folds. The uppermost basalt flow is part of the Ice Harbor Member of the Saddle Mountains Basalt Formation, and the relatively thin overlying sediment layers consist of Ringold Formation and Hanford Formation sediments. These sediment layers are predominantly coarse sandy alluvial deposits mantled by windblown sand. A generalized suprabasalt stratigraphic column showing what underlies the PNNL-Richland campus is shown in Figure 4. The stratigraphic column for the upper Ringold and Hanford Formations is based on information

obtained from the drilling of 11 boreholes within the footprint of the Biological Sciences Facility/Computational Sciences Facility on the PNNL-Richland campus (Freedman et al. 2010).

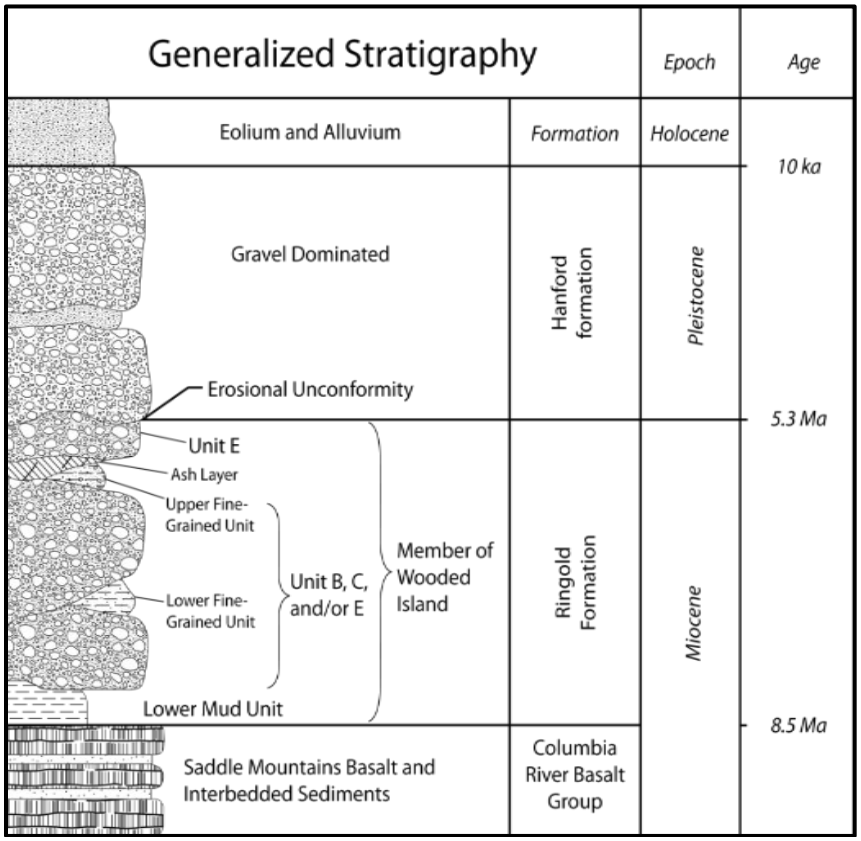


Figure 4. Generalized Stratigraphic Column Depicting the Stratigraphy Underlying the PNNL-Richland Campus (modified from Reidel et al. 1992; Thorne et al. 1993; Lindsey 1995; Williams et al. 2000; DOE-RL 2002; and Williams et al. 2007)

The Hanford Formation, a highly permeable mixture of sand and gravel deposited by Ice Age floods during the late Pleistocene period, comprises unconsolidated sediments that range from boulder-sized gravel to sand, silt, and clay. Late Miocene- to Pliocene-age sediments of the Ringold Formation underlie the Hanford Formation. The Ringold Formation displays lower hydraulic conductivity and is texturally and structurally distinct from the overlying Hanford Formation. Ringold Formation sediments contain sands, gravels, and muds that typically are more consolidated and less permeable than those in the Hanford Formation. Basalt underlying the Ringold Formation has a very low vertical hydraulic conductivity and forms an aquitard between the base of the unconfined aquifer and the confined aquifers within the basalt formations.

The general direction of groundwater flow under the PNNL-Richland campus is east-northeast toward the Columbia River (Figure 5). The unconfined aquifer beneath the PNNL-Richland campus is predominantly in the Ringold Formation; however, depending on the water table elevation, the aquifer may inundate portions of the Hanford Formation. The vadose zone below the PNNL-Richland campus is about 15 m (49 ft) thick; its thickness generally decreases with proximity to the Columbia River as the ground surface slopes toward the river. This zone consists of unsaturated sediments between the ground surface and the water table, predominantly within the Hanford Formation (Newcomer 2007).

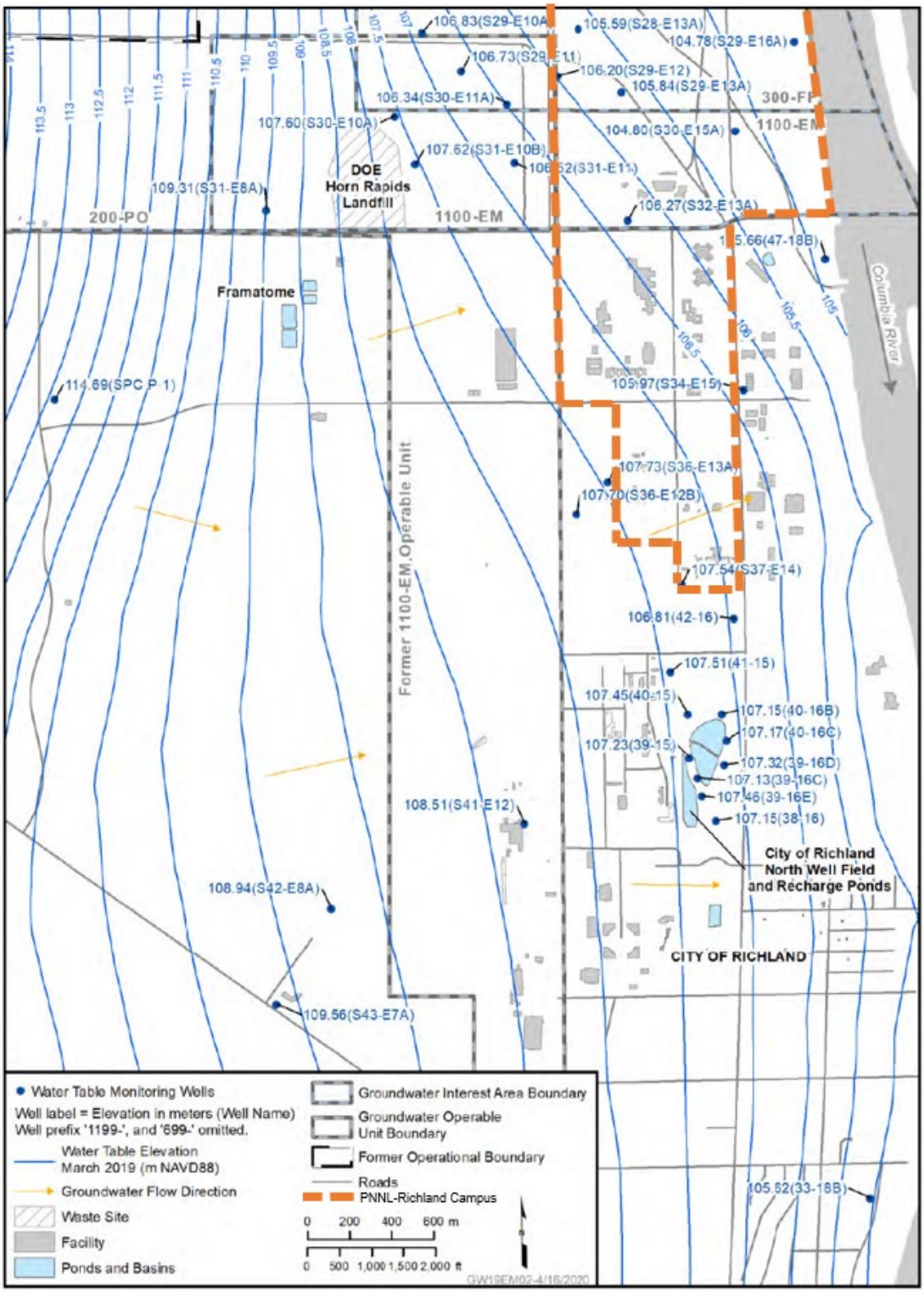


Figure 5. Water Table Elevations (m) (modified from DOE-RL 2020). Groundwater flow direction is normal to the water table contour lines. The approximate PNNL-Richland campus is outlined in orange (northern portion not shown).

While Columbia River floods have occurred in the past, the likelihood of recurrence of large-scale flooding has been reduced by the construction of dams upstream. The largest flood on record for the Columbia River occurred in 1894 and had an estimated peak discharge of 21,000 m^3/s (742,000 ft^3/s) at the Hanford Site. The largest recent flood took place in 1948 and had an estimated peak discharge of 20,000 m^3/s (700,000 ft^3/s) (Duncan 2007). Exceptionally high runoff during the spring of 1996 resulted in a maximum discharge of nearly 11,750 m^3/s (415,000 ft^3/s) (Duncan 2007). The floodplain associated with the 1894 flood has been modeled based on topographic cross-sections of the river; no portion of the PNNL-Richland campus was within this area.

The probable maximum flood has an unspecified but very large return period (generally greater than 500 years). Based on modeling from 1976, the Hanford Site would be unaffected by the probable maximum flood on the Columbia River, a discharge of about 40,000 m^3/s (1.4 million ft^3/s) (Duncan 2007). A flood of this magnitude would result in a water-surface elevation of 119 m (390 ft) at the Columbia Generating Station, located about 12 km (7.5 mi) north of the PNNL-Richland campus (Energy Northwest 2011). The standard project flood, a flood that would occur during the combination of the harshest meteorological and hydrological conditions, has an unspecified return period, usually greater than several hundred years (Linsley et al. 1992). The regulated standard project flood used by the U.S. Army Corps of Engineers for the Columbia Generating Station is 16,100 m^3/s (570,000 ft^3/s) (Energy Northwest 2011). 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) (Duncan 2007); corresponding discharge at the PNNL-Richland campus would be somewhat larger. The Federal Emergency Management Agency (FEMA) floodplain maps extend only to the southern boundary of the PNNL-Richland campus (FEMA 1984). However, FEMA maps suggest that the PNNL-Richland campus, with a ground-surface elevation of about 122 m (400 ft) above mean sea level would be unaffected by a 100-year flood.

The seismicity of the PNNL-Richland campus vicinity is relatively low compared to other regions of the Pacific Northwest, as determined by the rate and magnitude of historical events. The largest known earthquake in the region occurred in 1936 near Milton-Freewater, Oregon, approximately 103 km (64 mi) from the PNNL-Richland campus (Duncan 2007). This earthquake had a Richter magnitude of 5.75 and a maximum Modified Mercalli Intensity of VII (very strong shaking). Susceptibility to liquefaction is rated as very low or low for the entire PNNL-Richland campus (WDNR 2021). The U.S. Geological Survey has identified ash as the only volcanic hazard in the vicinity of the PNNL-Richland campus (WDNR 2021).

The rain-shadow effect of the Cascade Range, west of Yakima, influences the climate at the PNNL-Richland campus. North of the PNNL-Richland campus, the Rocky Mountains and ranges in southern British Columbia protect the region from severe, cold polar air masses moving southward across Canada and the winter storms associated with them. Daily meteorological data are collected at a weather station maintained by the DOE Hanford Site meteorological staff, located just north of the PNNL-Richland campus.

Regional weather in CY 2024 was warm with typical winds and precipitation, based on measurements at the nearby Hanford Site's central monitoring station. Normal regional monthly average temperatures range from a low of -4.3°C (24.2°F) in the winter to a high of 26.5°C (79.7°F) in the summer. The maximum high temperature in 2024 was 43°C (109°F), measured at the central Hanford meteorological station; the minimum was -19°C (-2°F). The average annual temperature near the PNNL-Richland campus in 2024 was 13.1°C (55.5°F), which is 0.7°C (1.2°F) above the average of 12.4°C (54.3°F). The annual relative humidity near the

PNNL-Richland campus generally is highest in the colder months and lowest in the warmer months (DOE 2025). Precipitation for 2024 was19.6 cm (7.73 in.), 8% above average (18.2 cm [7.15 in.]) (Snyder, Bisping, Klein, et al. 2025). Regional winds are primarily toward the northwest, northeast, and north-northeast, with winds toward the south-southeast less predominant than typical. Regional average wind speeds in 2024 were typical, averaging about 3.6 m/s (8.1 mph). Fog has been recorded during every month of the year at the Hanford Meteorology Station; however, fog occurs mostly from November through February. Additional visibility reductions can occur in the form of windblown dust; the region has averaged four dust storms per year for the entire period of record (1945–2020).

Atmospheric dispersion is a function of wind speed, wind duration and direction, atmospheric stability, and mixing depth. Dispersion conditions are generally good if winds are moderate to strong, the atmosphere is of neutral or unstable stratification, and there is a deep mixing layer. Historically, good dispersion conditions associated with neutral and unstable stratification exist approximately 57% of the time at the Hanford Site during summer (Poston et al. 2011). During winter, moderate to extremely stable stratification exists (approximately 66% of the time).

1.4.2 Ecology

The PNNL-Richland campus is in the lowest and most arid portion of the Columbia Plateau Ecoregion (EPA 2024). The portion of the PNNL-Richland campus north of Horn Rapids Road (Figure 6) was previously part of the Hanford Site and has been protected from agricultural use and development since 1943. The southern one-third of this area has been developed, and the remainder is still mostly dominated by native shrub-steppe vegetation and thus retains much of its native biodiversity and community structure.

These areas are dominated by climax shrubs such as big sagebrush (*Artemisia tridentata*) and bitterbrush (*Purshia tridentata*), with a noticeable component of native forbs and perennial bunchgrasses within an introduced annual grass understory. The portion of the PNNL-Richland campus south and just north of Horn Rapids Road has been developed to various extents and consists of a mosaic of buildings surrounded by maintained landscapes, abandoned agricultural fields, and previously disturbed, early successional habitats dominated by introduced annual grasses or subclimax shrubs, such as common rabbitbrush (*Ericameria nauseosa*) (Figure 6). The more mature and undisturbed shrub-steppe communities generally support greater plant species diversity. Approximately 171 plant species, 40 bird species, and 10 mammal species have been observed in upland portions of the PNNL-Richland campus (see species lists in Appendix A). A relatively undisturbed riparian community exists along the Columbia River shoreline north of Horn Rapids Road (Figure 6). This riparian community is limited to a narrow band of multilayered trees, including Siberian elm (*Ulmus pumila*), white mulberry (*Morus alba*), and poplars (*Populus* spp.); shrubs such as coyote willow (*Salix exigua*) and rose (*Rosa woodsii*); and herbaceous and grass species. Species diversity is high in the riparian zone given its relatively small area. Approximately 87 plant species, 29 bird species, and 5 other wildlife species have been observed in the riparian zone of the PNNL-Richland campus (Appendix A).

Priority habitats are those habitat types or elements that have unique or significant value to a diverse assemblage of species. Both the shrub-steppe and riparian habitats are listed by the Washington Department of Fish and Wildlife (WDFW) as priority habitats for the state and are priorities for management and conservation (WDFW 2023).

Figure 6. Terrestrial Habitats and Vegetation Cover Types of the PNNL-Richland Campus

The Hanford Reach of the Columbia River is adjacent to the eastern edge of the PNNL-Richland campus. This river supports a diverse fish and invertebrate community, including three species listed under the *Endangered Species Act of 1973* (ESA). The Columbia River is designated as critical habitat for these species under the ESA (50 CFR 226.212; 75 FR 63898). Federally and state-listed wildlife and plant species known to occur or that potentially occur on or near the PNNL-Richland campus were identified using sources from WDFW (2024) and Washington Natural Heritage Program (WNHP 2024) and are listed in Table 1. Of these, the sagebrush sparrow (*Artemisiospiza nevadensis*), loggerhead shrike (*Lanius ludovicianus*), and black-tailed jackrabbit (*Lepus californicus*) have been observed within undeveloped upland portions of the PNNL-Richland campus (see Appendix A). The American white pelican (*Pelecanus erythrorhynchos*) is common within the Hanford Reach, as well as the Columbia River adjacent to the PNNL-Richland campus.

Table 1. Wildlife, Fish, and Plant Species of Conservation Concern Known to Occur or that Potentially Occur Near the PNNL-Richland Campus

Common Name	Genus and Species	Federal Status[a]	State Status[b]
Wildlife			
Ferruginous hawk	*Buteo regalis*		Endangered
American white pelican	*Pelecanus erythrorhynchos*		Sensitive
Common loon	*Gavia immer*		Sensitive
Black-tailed jackrabbit	*Lepus californicus*		Candidate
Burrowing owl	*Athene cunicularia*		Candidate
Loggerhead shrike	*Lanius ludovicianus*		Candidate
Northern sagebrush lizard	*Sceloporus graciosus*		Candidate
Sagebrush sparrow	*Artemisiospiza nevadensis*		Candidate
Desert striped whipsnake	*Coluber taeniatus*		Candidate
Fish			
Bull trout	*Salvelinus confluentus*	Threatened	Candidate
Upper Columbia River spring -run Chinook salmon	*Oncorhynchus tshawytscha*	Endangered	
Upper Columbia River steelhead	*Oncorhynchus mykiss*	Threatened	Candidate
Invertebrates			
Monarch butterfly	*Danaus plexippus*	Proposed Threatened	Candidate
Suckley's cuckoo bumble bee	*Bombus suckleyi*	Proposed Endangered	
Plants			
Awned halfchaff sedge	*Lipocarpha aristulata*		Sensitive
Large St. Johns-wort	*Hypericum majus*		Sensitive
Columbian yellowcress	*Rorippa columbiae*		Threatened

Sources: WDFW (2024) and WNHP (2024)

[a] Federally threatened species are likely to become an endangered species within the foreseeable future throughout all or a significant portion of their range. Federally endangered species are in danger of extinction within the foreseeable future throughout all or a significant portion of their range (USFWS 2022).

[b] State candidate animal species are fish and wildlife species that the WDFW will review for possible listing as endangered, threatened, or sensitive (WDFW 2024). State threatened animal species are native to the state of Washington and are likely to become endangered within the foreseeable future throughout a significant portion of their range without cooperative management or removal of threats (WDFW 2024). State threatened plant species are those that are likely to become endangered within the near future in Washington if the factors contributing to their population decline or habitat loss continue. State sensitive plant species are those that are vulnerable or declining and could become endangered or threatened in the state without active management or removal of threats (WNHP 2024).

1.5 Environmental Setting – PNNL-Sequim Campus

The land and associated geology, seismicity, and meteorology of the PNNL-Sequim campus, as well as the flora and fauna and land and water habitats of the ecoregion, are described in the following sections.

1.5.1 Environmental Locale

The PNNL-Sequim campus is located on Sequim Bay in Puget Sound and consists of forests, sandy beach shoreline, a bluff line, and developed areas with roads and structures, as well as The Middle Ground, a sandy shoal that is frequently submerged, and Travis Spit (Figure 3). Campus facilities include buildings on the shoreline and structures on an approximately 27 m (89 ft) high bluff overlooking Sequim Bay and Puget Sound.

In the vicinity below the PNNL-Sequim campus are Quaternary-age unconsolidated glacial and interglacial deposits to depths greater than 366 m (1,200 ft) (Thomas et al. 1999). The upland portion of the PNNL-Sequim campus has surficial deposits of glacial till 14,500 to 17,500 years old, designated as unstratified, poorly sorted, clayey, sandy silt up to 45.7 m (150 ft) thick, and averaging 9.1 m (30 ft) thick throughout the greater region (Schasse and Logan 1998). Beneath the surficial deposits are undifferentiated deposits from older glacial events and interglacial periods. Water-bearing units of coarse-grained sands and gravels are found in the unconsolidated deposits throughout the region, including in the vicinity of the PNNL-Sequim campus (Thomas et al. 1999). Tertiary-age sedimentary rock (primarily siltstone, sandstone, and mudstone) and volcanic rock (primarily basalt and basalt breccia) are beneath the unconsolidated deposits (Schasse and Logan 1998).

Earthquakes have been recorded in the vicinity of the PNNL-Sequim campus, and seismically active faults are located within 8 km (5 mi); the nearest fault trace is about 3.2 km (2 mi) to the southwest (WDNR 2021). The region is subject to significant seismic hazards, as evidenced by the estimated peak ground acceleration of 3.92 to 7.85 m/s^2 (0.4 to 0.8 *g*) and 2% probability of exceedance in 50 years (Petersen et al. 2015). Washington State has evaluated several earthquake scenarios, including modeling a magnitude 9.0 earthquake on the Cascadia Subduction Zone. An earthquake of that magnitude would result in a Modified Mercalli Intensity of VII (very strong shaking) in the PNNL-Sequim campus region (WDNR 2013). Susceptibility to liquefaction is rated as very low or low for both the uplands and shoreline areas of the PNNL-Sequim campus, except for Travis Spit and Bugge Spit north of the shoreline parking area, which are rated as moderate to high for liquefaction susceptibility (WDNR 2021). The shoreline area of the PNNL-Sequim campus and Travis Spit are subject to tsunami hazards (inundation) for the Cascadia Subduction Zone scenario (WDNR 2021). Although the glacial deposits at the PNNL-Sequim campus support the near-vertical slopes along the bluff at the site, landslides have been mapped in the region (WDNR 2021), suggesting a potential landslide hazard at the site. No volcanic hazard has been identified in the PNNL-Sequim campus region (WDNR 2021).

Daily meteorological data are collected at an automated weather station near Sequim, Washington, maintained by AgWeatherNet, an affiliate of Washington State University (WSU 2024). The region around the PNNL-Sequim campus is positioned in the rain shadow of the Olympic Mountains, so it generally receives less than 38 cm (15 in.) of rainfall annually despite its coastal location; rainfall in 2024 was 40.08 cm (15.78 in.). The region typically experiences cool, wet winters and warm, dry summers. From January 2009 to December 2020, average temperatures ranged from 4.6–14.7°C (40.3–58.5°F). Monthly

average temperatures in 2024 ranged from 4.4°C–14°C (40°F–57°F). The annual average temperature in 2024 was 9.3°C (48.7°F). Regional winds are primarily from the west to northwest.

1.5.2 Ecology

The PNNL-Sequim campus (Figure 3) lies in the Olympic Rain Shadow subdivision of the Puget Lowland Ecoregion, a north-south depression between the Olympic Peninsula and western slopes of the Cascade Mountains that flank the coastline of Puget Sound (EPA 2024). The PNNL-Sequim campus is in one of the driest areas in the region, owing to the rain-shadow effects of the Olympic Mountains. Timber harvesting and cultivation have removed and fragmented the original coniferous forest and prairie-oak woodland (WDFW 2005). Today, the region consists mostly of second-growth coniferous forest and agricultural fields; little of the original forest habitat remains (EPA 2024).

The PNNL-Sequim campus includes 26 ha (65 ac) of land and 21 ha (52 ac) of tidelands. Tideland habitat includes shoals, intertidal wetlands, and subtidal wetlands. The Middle Ground (Figure 7) is a 0.18 ha (0.46 ac) sandy shoal that is submerged except during lower tides and does not support vegetation (DOE-PNSO 2022).

Estuarine intertidal wetlands occur in a narrow band that circumscribes the shoreline of Sequim Bay, while adjacent estuarine subtidal wetlands occur in deeper water and make up the interior portion of Sequim Bay. Seagrass meadows consisting of eelgrass (*Zostera* spp.) occur in intertidal wetlands, labeled marine vegetation in Figure 7 (DOE-PNSO 2022), and serve as forage for birds, snails, and crab species. Some fish species use eelgrass for spawning, while other anadromous and forage fish use eelgrass beds for cover or to find food. Common aquatic species include fish species such as sole (*Parophrys vetulus*), sculpin (*Artedius fenestralis*), Pacific tomcod (*Microgadus proximus*), striped perch (*Embiotoca lateralis*), Pacific herring (*Clupea pallasii*), sand lance (*Ammodytes hexapterus*), and spiny dogfish (*Squalus acanthias*) (DOE-PNSO 2022).

Land habitat includes spits, beaches, and uplands. Travis Spit and Bugge Spit are located slightly above sea level and consist of sediments deposited during higher tides. They support mostly herbaceous vegetation consisting of forbs, including silver bursage (*Ambrosia chamissonis*), common yarrow (*Achillea millefolium*), Puget Sound gumweed (*Grindelia integrifolia*), bare-stemmed biscuitroot (*Lomatium nudicaule*), low glasswort (*Salicornia depressa*), and yellow sand verbena (*Abronia latifolia*); and grasses such as blue wildrye (*Elymus glaucus*) (DOE-PNSO 2022). A sandy beach lies at the base of an approximately 7.6 m (25 ft) high feeder bluff that overlooks Sequim Bay. The beach is maintained by longshore currents that erode the bluff. Beach vegetation is sparse, located mostly above tidal influence at the base and on the face of the bluff, and includes some of the tree and shrub species common in the uplands noted below (DOE-PNSO 2022).

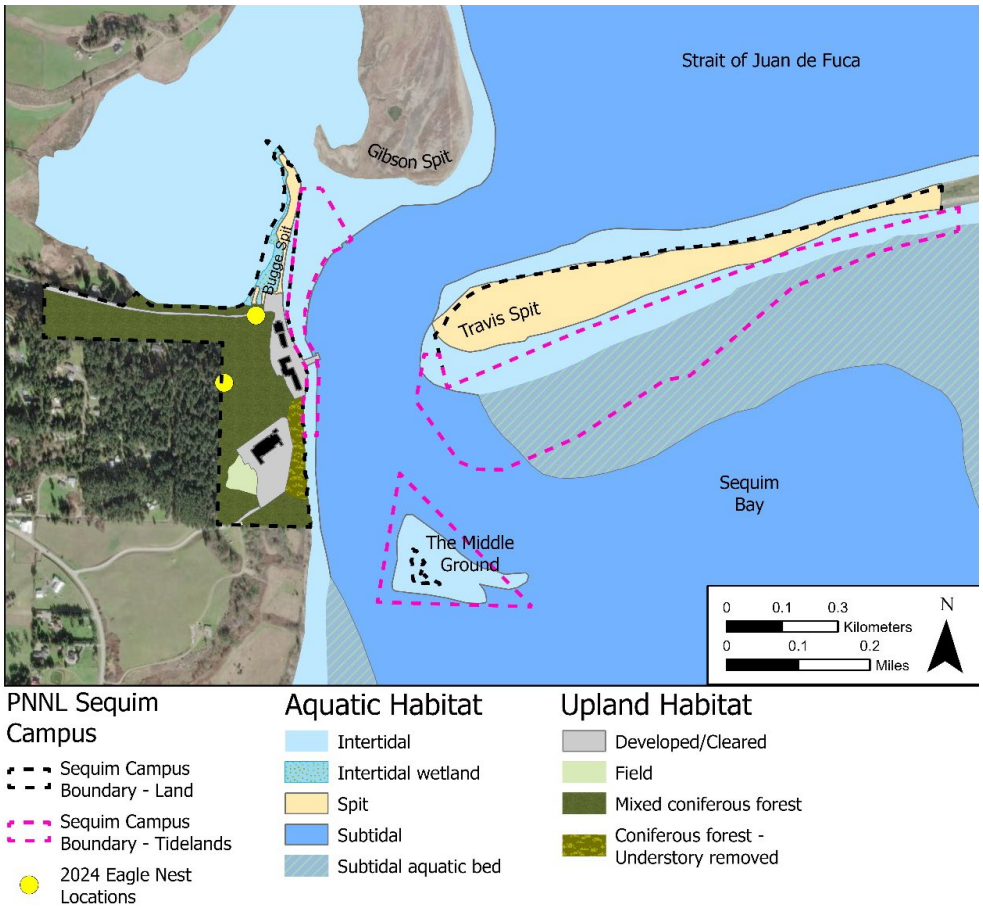


Figure 7. Habitats and Vegetation Cover Types at the PNNL-Sequim Campus

The uplands begin adjacent to and just above the spit and beach habitats, extending west of the facilities, and rising to approximately 46 m (150 ft) above sea level on the ridge above Washington Harbor Road (DOE-PNSO 2022). The uplands support mostly mixed coniferous forest habitat (Figure 7), most of which is mature, naturally regenerated second growth, estimated to be 100−160 years old (DOE-PNSO 2022). The dominant and subdominant canopy species are Douglas fir (*Pseudotsuga menziesii*) and western red cedar (*Thuja plicata*), respectively. Subcanopy tree species include red alder (*Alnus rubra*), bigleaf maple (*Acer macrophyllum*), madrone (*Arbutus menziesii*), grand fir (*Abies grandis*), Indian plum (*Oemleria cerasiformis*), and Rocky Mountain maple (*Acer glabrum*). Characteristic understory flora includes common snowberry (*Symphoricarpus albus*), Saskatoon serviceberry (*Amelanchier alnifolia*), ocean spray (*Holodiscus discolor*), vine maple (*Acer circinatum*), salal (*Gaultheria shallon*), Oregon-grape (*Berberis* spp.), western swordfern (*Polystichum munitum*), rose (*Rosa* spp.), blackcap (*Rubus leucodermis*), and redflower currant (*Ribes sanguineum*) (DOE-PNSO 2022). A vegetation survey conducted during 2024 yielded 27 species previously unrecorded on the campus, raising the total to175 plant species, 104 bird species, and 7 other wildlife species have been observed on the PNNL-Sequim campus (see species lists in Appendix B).

The relatively undisturbed nearshore areas of Puget Sound, including the Strait of Juan de Fuca, are listed by the WDFW as priority habitat for the state (WDFW 2023) and, therefore, are considered a priority for management and conservation (Clallam County 2018). Priority habitat zones include shore, intertidal, and subtidal, which include the tidelands, spits, beaches, and feeder bluffs, described previously (Clallam County 2018; WDFW 2023).

The tideland and land habitats provide potential habitat for several federally listed threatened, endangered, and/or candidate species (Table 2) (DOE-PNSO 2022). One avian species of conservation concern, as well as eight fish, three invertebrate, and one turtle species of conservation concern, are known to occur or potentially occur near PNNL-Sequim campus facilities. No plant species of state or federal concern are currently known to occur near the PNNL-Sequim campus. Sequim Bay is designated critical habitat for Puget Sound bocaccio (*Sebastes paucispinis*) and Puget Sound yelloweye (*Sebastes ruberrimus*) (79 FR 68042), bull trout (*Salvelinus confluentus*) (75 FR 63898), and Hood Canal summer-run chum salmon (*Oncorhynchus keta*) (50 CFR 226.212; 70 FR 52630).

Table 2. Animal Species of Conservation Concern Known to Occur or that Potentially Occur at and in the Vicinity of the PNNL-Sequim Campus

Common Name	Genus and Species	Federal Status[a]	State Status[b]
Wildlife			
Marbled murrelet	*Brachyramphus marmoratus*	Threatened	Endangered
Northwestern pond turtle	*Actinemys marmorata*	Proposed Threatened	Endangered
Fish			
Bull trout	*Salvelinus confluentus*	Threatened	Candidate
Hood Canal summer-run chum salmon	*Oncorhynchus keta*	Threatened	
North American green sturgeon	*Acipenser medirostris*	Threatened	
Pacific eulachon	*Thaleichthys pacificus*	Threatened	
Puget Sound bocaccio	*Sebastes paucispinis*	Endangered	
Puget Sound Chinook salmon	*Oncorhynchus tshawytscha*	Threatened	
Puget Sound steelhead	*Oncorhynchus mykiss*	Threatened	Candidate
Puget Sound yelloweye rockfish	*Sebastes ruberrimus*	Threatened	
Invertebrates			
Sunflower sea star	*Pycnopodia helianthoides*	Proposed Threatened	
Taylor's checkerspot butterfly	*Euphydryas editha taylori*	Endangered	Endangered
Monarch butterfly	*Danaus plexippus*	Proposed Threatened	Candidate
Suckley's cuckoo bumble bee	*Bombus suckleyi*	Proposed Endangered	
Sand-verbena moth	*Copablepharon fuscum*		Candidate
Makah copper	*Tharsalea mariposa spp.*		Candidate
Puget blue	*Icaricia icarioides blackmorei*		Candidate
Valley silverspot	*Argynnis zerene bremnerii*		Candidate
Western bumble bee	*Bombus occidentalis*		Candidate
Plants			
Pacific fringed thistle	*Cirsium remotofolium*		Sensitive

Source: WDFW (2023)

[a] Federally threatened species are likely to become an endangered species within the foreseeable future throughout all or a significant portion of their range. Federally endangered species are in danger of extinction within the foreseeable future throughout all or a significant portion of their range (USFWS 2022).

[b] State candidate animal species are those fish and wildlife species that the WDFW will review for possible listing as endangered, threatened, or sensitive (WDFW 2023). State endangered species are native to the state of Washington and are seriously threatened with extinction throughout all or a significant portion of their range within the state (WDFW 2023).

Several marine mammals, including harbor seal (*Phoca vitulina*), California sea lion (*Zalophus californianus*), Dall's porpoise (*Phocoenoides dalli*), and harbor porpoise (*Phocoena phocoena*), inhabit Sequim Bay (DOE-PNSO 2022). Each of these mammals is considered a priority species by the state, and priority areas comprise haul-outs used by California sea lions and harbor seals, and foraging areas and migration routes used by harbor porpoises and Dall's porpoises. Kiapot Point on the southwest tip of Travis Spit (Figure 3), located across the mouth of Sequim Bay from the PNNL-Sequim campus, is a haul-out area for harbor seals (DOE-PNSO 2022). Although rare, killer whales (*Orcinus orca*) have been observed in Sequim Bay.

1.6 Cultural Setting – PNNL-Richland Campus

The Richland campus contains significant archaeological and historic architectural resources. Portions of the campus including the seven original buildings that make up the PNNL Historic District and the Preservation Designated Area have been determined eligible for listing on the National Register of Historic Places. Consultation under the National Historic Preservation Act and the Native American Graves Protection and Repatriation Act established the Preservation Designated Area. This designation prohibits all activities, including development, research, and access. Consultation with the Washington State Historic Preservation Office and area Tribes is conducted prior to development or construction to ensure sensitive cultural and historic resources are protected (Mendez et al. 2018).

1.7 Cultural Setting – PNNL-Sequim Campus

The Sequim campus contains archaeological evidence of historic euro-American as well as pre-contact Native American land use. The campus is listed on the Washington State Historic Places list and has been determined eligible for listing on the National Register of Historic Places. The campus is considered a place of cultural significance to the Jamestown S'Klallam Tribe. Consultation under the National Historic Preservation Act established a No Activity Zone south of MSL-1 at the shoreline. This designation prohibits all activities, including development, research, and access. Consultation with the Washington State Historic Preservation Office and area Tribes is conducted prior to development or construction to ensure sensitive cultural and historic resources are protected (Renaud and Perrin 2023).

2.0 COMPLIANCE SUMMARY

Operations at PNNL in CY 2024 were conducted to comply with all applicable federal, state, and local environmental laws, regulations, and guidance; presidential Executive Orders; and DOE Orders, directives, policies, and guidance. PNNL endeavors to conduct operations in a manner that is protective of the environment.

The Enforcement & Compliance History Online (ECHO) database at https://echo.epa.gov is the EPA's official record of the current compliance status of a DOE site or specific facilities within the site, except where the Washington State Department of Ecology has been delegated responsibility for a program area. The ECHO-designated locations in Table 3 apply to the PNNL-Richland and PNNL-Sequim campuses.

Table 3. EPA ECHO Database Listing for PNNL Campuses

ECHO Facility Name	Facility Registry Service (FRS) ID	Program Area
Pacific Northwest National Laboratory Stevens	110025329133	RCRA
Pacific Northwest National Laboratory	110006473440	RCRA
Battelle Marine Sciences Laboratory[(a)]	110000828230	Wastewater, Stormwater, RCRA

[(a)] Synonymous with the PNNL-Sequim campus

The Washington State Department of Ecology has been delegated oversight of the wastewater program area by EPA. A search of the ECHO database for the "Battelle Marine Sciences Lab" indicates noncompliance for "failure to report." EPA acknowledges that the Washington State Department of Ecology received the reports and that the records are tracked within state agency's Water Quality Permitting Portal rather than the ECHO database. The Battelle Marine Sciences Lab wastewater and *Resource Conservation and Recovery Act of 1976* (RCRA) program areas comply with applicable regulations.

2.1 Compliance Status

Table 4 and Table 5 summarize PNNL's compliance with federal and state laws and regulations, respectively, and subsequent sections provide brief descriptions of each statute or regulation.

Table 4. Status of Federal Environmental Laws and Regulations Applicable to PNNL, 2024

Statute/Regulation	Compliance Activities	Report Section(s)
Air Quality and Protection		
The *Clean Air Act* (CAA) and its amendments regulate the release of air pollutants from facilities and unmonitored sources through permitting and air-quality restrictions.	• PNNL conducted operations under permits issued by the Washington State Department of Health (WDOH), Washington State Department of Ecology, Benton Clean Air Agency (BCAA), and Olympic Region Clean Air Agency (ORCAA). No events were reported for emissions of regulated substances to the air or substances of concern. • Radioactive air emissions were more than 100,000 times lower than the regulatory standard of 10 mrem/yr (0.1 mSv/yr) at both the PNNL-Richland campus and PNNL-Sequim campus.	2.4
The hydrofluorocarbon (HFC) phasedown requirements of the American Innovation and Manufacturing (AIM) Act of 2020 seek to reduce HFC consumption and production to 15% of a 2011–2013 baseline by 2036.	• PNNL uses HFCs primarily as refrigerants in chillers and other refrigeration appliances. Cleaning solvents used at PNNL also may contain HFCs. Refrigerants and products containing HFCs will be replaced by EPA-approved substitutes as they become available.	2.4.4
Cultural and Historic Resources		
The *National Historic Preservation Act of 1966* (NHPA) requires the establishment of programs to preserve and protect historical and cultural resources including sites, documents, buildings, artifacts, and records using permits, access restrictions, and other means.	• The PNNL cultural resources program completed compliance reviews for 116 projects – 26 on the PNNL-Richland campus, – 27 on the PNNL-Sequim campus, – 7 on the Hanford site, and – 56 at off-site locations.	2.6.3
DOE Policy 141.1, “Department of Energy Management of Cultural Resources.”	• PNNL implements this policy to protect and manage cultural resources by identifying impacts of unauthorized public use on prehistoric sites, protecting sensitive sites, and conducting annual monitoring activities. • Annual monitoring is conducted by PNNL cultural resources program to document evidence of potential impacts to archaeological, cultural or historic resources. • No evidence of impacts that would diminish the historic or archaeological significance of any observed resources was documented in 2024.	2.8, 2.6.2
Energy Independence		
The *Energy Independence and Security Act of 2007* (EISA) and *Energy Act of 2020* encourages U.S. energy independence and security, while promoting energy efficiency, conservation, and savings.	• PNNL evaluates buildings under EISA energy and water evaluation requirements. PNNL also implements stormwater management practices to promote water drainage and reduce runoff. • PNNL’s progress toward energy resiliency and efficiency in FY 2024 is summarized in the FY 2025 *Site Sustainability Plan* (PNNL 2024).	2.7.2, 2.5.2

Statute/Regulation	Compliance Activities	Report Section(s)
Environmental Safety and Health Reporting		
DOE Order 231.1B, *Environment, Safety, and Health Reporting*, requires the gathering, analysis, and reporting of information about environmental safety and health issues.	• PNNL monitors and conveys information via reports, emails, *myPNNL* articles, and staff meetings. • This PNNL Annual Site Environmental Report is a requirement of this Order.	1.0
DOE Order 414.1D, *Quality Assurance*, states the roles and requirements for quality assurance (QA) for work performed by DOE and its contractors.	• A PNNL internal document, *Quality Assurance Program Description/Quality Management M&O Program Description*, describes the Laboratory-level QA program that applies to all work performed by staff at PNNL, conforming to DOE Order 414.1D requirements.	7.0
Hazardous Materials and Waste Management		
The *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) provides regulations for the identification, assessment, and remediation of sites contaminated by hazardous materials.	• Neither the PNNL-Richland campus nor the PNNL-Sequim campus contains a PNNL CERCLA operable unit. • The PNNL-Richland campus is not part of any Hanford CERCLA operable unit and had no continuous releases.	2.2.2, 2.11
The *Emergency Planning and Community Right-to-Know Act of 1986* stipulates the public's right to information about hazardous materials in the community and the establishment of emergency planning procedures.	• PNNL submitted Tier-Two reports for both the Richland and Sequim campuses, providing information about potential hazards. • PNNL was not required to submit a Toxic Release Inventory Report for either campus.	2.2.1
The *Federal Insecticide, Fungicide, and Rodenticide Act* regulates the storage and use of pesticides.	• Licensed staff at PNNL or certified commercial applicators were used to purchase, store, and apply pesticides on the PNNL-Richland campus and PNNL-Sequim campus.	2.2.6
The RCRA requires hazardous waste to be tracked from generation to treatment, storage, or disposal (referred to as cradle-to-grave management).	• PNNL is responsible for one RCRA-permitted storage and treatment unit. PNNL generates hazardous waste in five RCRA facilities. • There were no regulatory inspections performed at the PNNL-Richland or PNNL-Sequim facilities during 2024.	2.2.4
The *Superfund Amendments and Reauthorization Act of 1986* amends and reauthorizes CERCLA.	• PNNL-Richland campus areas near the Hanford Site have been evaluated and require no further action. Groundwater near the PNNL-Richland campus is no longer required to be monitored for Hanford Site contaminant migration. • No contamination was identified at the PNNL-Sequim campus that would require response under CERCLA or the *Superfund Amendments and Reauthorization Act*.	2.2.2
The *Toxic Substances Control Act (TSCA)* requires the control and tracking of regulated hazardous chemicals, primarily polychlorinated biphenyls (PCBs) and chemicals with use deemed as unreasonable risk.	• PCB annual document logs and PCB annual reports were not required for PNNL-Richland and PNNL-Sequim campuses for 2024. • Five chemicals used at PNNL were subject to new regulations in 2024. PNNL began implementing measures to meet the new requirements.	2.2.5

Statute/Regulation	Compliance Activities	Report Section(s)
Radiation Protection		
DOE Order 435.1, *Radioactive Waste Management*, establishes requirements for managing high-level waste, transuranic waste, low-level waste, and mixed wastes.	• PNNL's Radioactive Waste Management Basis report identifies radioactive waste management controls through internal workflows and procedures, which then are implemented by staff at PNNL.	2.3.2,
DOE Order 458.1, *Radiation Protection of the Public and the Environment*, establishes requirements related to radiation protection of the public and the environment, including estimating radiological dose.	• PNNL implements programs to assure that facilities, emissions, effluents, and wastes are protective of the public, workers, and the environment.	2.3, 4.1, 4.2, 4.3
The Atomic Energy Act of 1954 encompasses the management of low-level and mixed low-level wastes and radioactive materials.	• PNNL's Radiation Protection Management and Operation Program includes safeguarding and monitoring radioactive materials through work controls, dosimetry, bioassay, and safety information.	2.3.3
Water Quality and Protection		
The *Clean Water Act* (CWA) seeks to maintain and improve surface water quality through criteria and permitting, including point-source discharges to U.S. surface waters and indirect discharges to sewer systems, as well as the discharge of dredged or fill material into U.S. waters and/or wetlands.	• PNNL conducted operations under permits issued by the Washington State Department of Ecology and the City of Richland. • The PNNL Richland Campus operated under 3 Industrial Wastewater Discharge Permits issued by the City of Richland • The PNNL Sequim campus operated under a National Pollutant Discharge Elimination System (NPDES) permit issued by the Washington State Department of Ecology. • The PNNL Sequim Campus operated under a Construction Stormwater General NPDES Permit for proper management of stormwater during construction of the PNNL Sequim Campus Storage Facility (MSL8). The Permit was issued by the Washington State Department of Ecology. • Permits were acquired for off-site scientific research studies as applicable.	2.5, 2.6.1, 7.3, 7.5
The *Safe Drinking Water Act of 1974* (SDWA) establishes standards and requirements for public drinking water systems.	• The PNNL-Richland campus receives all drinking water for use in laboratory and nonlaboratory spaces from the City of Richland. The city is responsible for meeting water quality standards under the SDWA. • At the PNNL-Sequim campus, drinking water is provided exclusively from an on-site well and PNNL implements the requirements of SDWA as part of the Group A operating permit for this water system. • At the PNNL-Sequim campus, an initial lead service line inventory was completed that identified the material of each service line in the drinking water distribution system.	2.5.2, 2.5.3, 7.3, 7.5
PFAS (Per- and polyfluoroalkyl substances) Emerging Contaminants	• In 2023, an underground tank containing wastewater with low levels of PFAS was emptied and removed on the Richland campus. In 2024, additional sampling for PFAS was completed to verify that the soil beneath the tank would not impact groundwater.	2.5.4
Wildlife and Ecosystems		

Statute/Regulation	Compliance Activities	Report Section(s)
The *Bald and Golden Eagle Protection Act of 1940* provides for the protection of bald and golden eagles.	• The U.S. Fish and Wildlife Service (USFWS) short-term eagle incidental take permit acquired for nesting bald eagles at PNNL-Sequim campus. Required monitoring, access restrictions, and reporting completed. • Biological resource reviews provided assurance that proposed actions did not adversely affect bald or golden eagles.	2.6.1
The *Coastal Zone Management Act of 1972* encourages the development of coastal zone management plans to preserve, protect, and enhance natural coastal resources and the wildlife using coastal habitats.	• PNNL considers coastal resources and the fish and wildlife that use the associated habitats when evaluating proposed actions.	2.6.1
The ESA provides for the protection of threatened and endangered plant and animal species.	• No endangered or threatened species were observed during biological field surveys of the PNNL-Richland campus. • PNNL evaluates potential impacts to federally listed species and their designated critical habitats for all proposed research or development actions. • Consultations with regulatory agencies (USFWS, National Marine Fisheries Service [NMFS]) were completed, as required, whenever proposed actions had the potential to affect ESA-listed resources.	2.6.1
The *Forest Service Organic Administration Act of 1897* (FSOAA) provides for the protection and administration of U.S. Forest Service lands.	• Authorizations under the FSOAA were acquired for off-site research studies, as applicable.	2.6.1
The *Magnuson–Stevens Fishery Conservation and Management Act of 1976* (MSFCMA) governs marine fisheries management.	• PNNL evaluates potential impacts to essential fish habitat from all proposed research or development actions. Consultations with the NMFS were completed, as required, whenever proposed actions had the potential to affect essential fish habitat resources.	2.6.1
The *Marine Mammal Protection Act of 1972* (MMPA) provides for the protection of all marine mammals.	• PNNL evaluates potential impacts to federally protected marine mammal species and their habitats for all proposed research or development actions.	2.6.1
The *Migratory Bird Treaty Act of 1918* (MBTA) makes it illegal to take, capture, or kill migratory birds or their feathers, nests, or eggs.	• The USFWS Special Purpose – miscellaneous permit allows for the relocation or take of five total migratory bird nests between the Richland and Sequim campus. No nests were relocated or taken in 2024 and required reporting was completed. • PNNL also evaluates potential impacts to migratory birds for all proposed R&D activities. • Migratory birds are routinely observed at the lands encompassing the PNNL-Richland and PNNL-Sequim campuses. • PNNL biologists resolved 19 inquiries concerning migratory birds.	2.6.1

Statute/Regulation	Compliance Activities	Report Section(s)
The *National Environmental Policy Act of 1969* (NEPA) requires the formulation of an environmental impact statement, environmental assessment, or categorical exclusion for federal projects that have the potential to affect the quality of the human environment.	• 1,697 NEPA reviews for newly proposed and funded research activities and 57 NEPA reviews for facility modification permits were conducted. • DOE-PNSO approved two new project-specific categorical exclusions in 2024 and reissued four generic categorical exclusions. • DOE-PNSO published a Notification of Intent to conduct an environmental assessment for aquatic research in Sequim Bay and the Strait of Juan de Fuca in August 2024 and published a final environmental assessment in February 2025 (DOE/EA-2271).	2.2.7, 7.1
The *National Park Service Organic Act of 1916* provides for the management of national parks and monuments.	• Scientific Research and Collecting Permits and Special Use Permits were acquired for off-site studies, as applicable.	2.6.1
The *National Wildlife Refuge System Administration Act of 1966* provides administrative and management directives for refuges under the jurisdiction of the USFWS.	• Special Use Permits were acquired for off-site research studies, as needed.	2.6.1
The *Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990* prevents the spread of nonindigenous aquatic nuisance species to non-infested waters.	• An aquatic invasive plant and animal species interception program has been developed and implemented by PNNL.	2.6.1.1, 2.6.2.1
The *Rivers and Harbors Appropriation Act of 1899* (RHA) prohibits obstruction or alteration of navigable waters.	• RHA Section 10 permits were obtained for off-site research studies as applicable.	2.6.1
Executive Order 11988, *Floodplain Management* (42 FR 26951), requires federal agencies to evaluate the potential effects of any actions within a floodplain.	• Compliance was achieved through the biological resource review process at PNNL.	2.6.1
Executive Order 11990, *Protection of Wetlands* (42 FR 26961), requires federal agencies to minimize the loss or degradation of wetlands and to preserve and enhance their natural and beneficial values.	• Compliance was achieved through the biological resource review process at PNNL.	2.6.1

Table 5. Status of Washington State Environmental Laws and Regulations Applicable to PNNL, 2024

Statute/Regulation	Compliance Activities	Report Section(s)
The *Hazardous Waste Management Act of 1976* provides for safe planning, regulation, control, and management of hazardous waste.	• PNNL manages hazardous wastes in a safe and responsible manner. Inventories and storage methods are regulated, and reports are submitted as required.	2.2
The *Shoreline Management Act of 1971* establishes guidelines for shoreline use, environmental protection, and public access.	• Shoreline Substantial Development Permits or Exemptions were acquired for off-site research studies as applicable.	2.6.1
The *Washington Clean Air Act* implements and supplements the federal CAA, overseeing state air quality.	• PNNL operated under permits issued by the WDOH, Washington State Department of Ecology, BCAA, and ORCAA. • No events were reported for emissions of regulated substances or substances of concern to the outside air.	2.12
The *Washington Pesticide Application Act* provides for the control of pesticide application and use to protect public health and welfare.	• Pesticide use and applications were accomplished by licensed staff at PNNL or certified commercial applicators in compliance with regulations.	2.2.6
The *Washington Pesticide Control Act* establishes guidelines for proper use and control of pesticides.	• Pesticide use and applications were accomplished by licensed staff at PNNL or certified commercial applicators in compliance with regulations.	2.2.6
The *Washington State Environmental Policy Act* (SEPA) requires the identification and analysis of the environmental impacts of state and local decisions, giving agencies the authority to deny a proposal when adverse environmental impacts are identified.	• PNNL environmental compliance representatives and staff review research and support activities and complete SEPA checklists as required.	2.2.7
Washington Administrative Code (WAC) 246–290, “Group A Public Water Supplies,” establishes drinking water State Action Levels and monitoring requirements for five PFAS chemicals in Washington State.	• In 2024, testing and analysis of the PNNL-Sequim campus groundwater well for PFAS chemicals was completed, and all results were nondetectable. No PFAS monitoring was required for the water supply at the PNNL-Richland campus as the City of Richland is responsible for monitoring for PFAS in drinking water.	2.5.3, 2.5.4

2.2 Environmental Restoration and Waste Management

This section describes PNNL activities conducted to protect the environment through proper management of waste.

2.2.1 Emergency Planning and Community Right-to-Know Act of 1986

***Emergency Planning and Community Right-to-Know Act of 1986* (EPCRA; 42 U.S.C. § 11001 *et seq.*)**	
The *Emergency Planning and Community Right-to-Know Act of 1986* (EPCRA; 42 U.S.C. § 11001 *et seq.*) requires each state to establish an emergency response commission and local emergency planning committees and develop a process for gathering and distributing information about hazardous chemicals present in local facilities. These local planning committees develop emergency plans for local planning districts. Facilities that produce, use, release, or store toxic or hazardous substances in quantities above threshold levels must submit information about the chemicals to local emergency planning committees. EPCRA has four major provisions: 1. Emergency planning 2. Emergency release notification 3. Hazardous chemical inventory reporting 4. Toxic chemical release inventory reporting. Each provision requires reporting when thresholds are exceeded (Table 6).	Compliance Activities • Tier 2 reporting for PNNL-Sequim and PNNL-Richland campuses • Evaluating inventories to determine whether or not Toxic Release Inventory reporting for PNNL-Sequim and PNNL-Richland campuses is required.

PNNL EPCRA reporting for the PNNL-Richland campus combines the quantities of chemicals in the Hanford 300 Area facilities that PNNL occupies and those present in on-campus facilities. EPCRA reports for the PNNL-Sequim campus are submitted separately from those for the PNNL-Richland campus because the PNNL-Sequim campus is in a different county (Clallam).

On February 22, 2024, the annual Tier-Two inventory report for the PNNL-Richland campus was submitted to the Washington State Emergency Response Commission via the SecureAccessWA website. The completed Tier-Two form then was transmitted via email to the Benton County Emergency Management and the Richland Fire Department. Under the governing regulations, R&D chemicals are exempt from reporting. The report includes facility operations chemical inventories located at PNNL-occupied 300 Area Hanford facilities and facilities on the PNNL-Richland campus. This report identified that lead-acid batteries, diesel fuel, and the urea content of fertilizer products stored at PNNL exceeded the reporting threshold.

Using the same process, the annual Tier-Two inventory report for the PNNL-Sequim campus was submitted to the Washington State Emergency Response Commission on February 22, 2024. The completed Tier-Two form was emailed to Clallam County Emergency Management and Clallam County Fire District 3. As in previous years, this report identifies diesel fuel as the only material that exceeds the reporting threshold at the PNNL-Sequim campus.

Neither the PNNL-Richland campus nor the PNNL-Sequim campus were required to submit a Toxic Release Inventory Report in 2024 for the previous CY 2023 reporting period. Table 7 provides an overview of PNNL reporting under EPCRA for CY 2024.

Table 6. Provisions of the *Emergency Planning and Community Right-to-Know Act of 1986*

Section	CFR Section	Reporting Criteria	Due Date	Agencies Receiving Report
302	40 CFR Part 355: "Emergency Planning"	The presence of an extremely hazardous substance in a quantity equal to or greater than the threshold planning quantity at any one time.	Within 60 days of threshold planning quantity exceedance	SERC; LEPC
302	40 CFR Part 355: "Emergency Planning"	Change occurring at a facility that is relevant to emergency planning.	Within 30 days after the change has occurred	LEPC
304	40 CFR Part 355: "Emergency Release Notification"	Release of an extremely hazardous substance or a CERCLA hazardous substance in a quantity equal to or greater than the reportable quantity.	Initial notification: immediate (within 15 minutes of knowledge of reportable release). Written follow-up within 14 days of the release.	SERC; LEPC
311	40 CFR Part 370: "Reporting Requirements – Material Safety Data Sheet Reporting"	The presence at any one time at a facility of an OSHA hazardous chemical in a quantity equal to or greater than 4,500 kg (10,000 lb.) or an extremely hazardous substance in a quantity equal to or greater than the threshold planning quantity or 230 kg (500 lb.), whichever is less.	Revised list of chemicals due within 3 months of a chemical exceeding a threshold	SERC; LEPC; local fire departments
312	40 CFR Part 370: "Reporting Requirements – Tier-Two Report"	The presence at any one time at a facility of an OSHA hazardous chemical in a quantity equal to or greater than 4,500 kg (10,000 lb.), or an extremely hazardous substance in a quantity equal to or greater than the threshold planning quantity or 230 kg (500 lb.), whichever is less.	Annually by March 1	SERC; LEPC; local fire departments
313	40 CFR Part 372: "Reporting Requirements – Toxic Release Inventory Report"	Manufacture, processing, or use at a facility of any listed Toxic Release Inventory chemical in excess of its threshold amount during a calendar year. Thresholds are 11,300 kg (25,000 lb.) for manufactured or processed chemicals or 4,500 kg (10,000 lb.) for chemicals otherwise used, except for persistent, bio-accumulative, toxic chemicals, which have thresholds of 45 kg (100 lb.) or less.	Annually by July 1, for the previous calendar year	EPA; SERC

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR = *Code of Federal Regulations*
EPA = U.S. Environmental Protection Agency
LEPC = Local Emergency Planning Committee
OSHA = Occupational Safety and Health Administration
SERC = State Emergency Response Commission

Table 7. *Emergency Planning and Community Right-to-Know Act of 1986* Compliance Reporting, 2024

Section	Description of Reporting	Reporting Status	Notes
302	Emergency planning notifications	Not required	No changes in previously reported inventories of sulfuric acid and no new extremely hazardous substances greater than thresholds.
304	Extremely hazardous substance release notification	Not required	No releases occurred.
311	Safety Data Sheet	Required	No changes in previously reported inventories.
312	Chemical inventory	Required	Tier-Two reports for the PNNL-Richland campus and PNNL-Sequim campus were submitted to the Washington State Department of Ecology, LEPC, and local fire departments in February 2024.
313	Toxic release inventory	Required	Evaluation of chemical inventories for both the PNNL-Richland and PNNL-Sequim campuses did not require reporting for the previous calendar year reporting cycle.

2.2.2 Comprehensive Environmental Response, Compensation, and Liability Act of 1980

CERCLA

CERCLA was promulgated to address response, compensation, and liability for past releases or potential releases of hazardous substances, pollutants, and contaminants to the environment. CERCLA was amended by the *Superfund Amendments and Reauthorization Act of 1986* (42 U.S.C. § 9601 *et seq.*), which made several important changes and additions, including clarification that federal facilities are subject to the same provisions of CERCLA as any nongovernmental entity. Executive Order 12580 of January 23, 1987, *Superfund Implementation* (52 FR 2923), directs that DOE, as the lead agency, must conduct CERCLA response actions (i.e., removal and remedial actions). Such actions would be subject to oversight by EPA and/or the Washington State Department of Ecology.

Two Hanford 300 Area operable units,[1] listed on the National Priorities List on November 3, 1989, are located near the PNNL-Richland campus.

A portion of the PNNL-Richland campus located north of Horn Rapids Road was investigated as part of the Hanford 300-FF-2 Operable Unit in the late 1990s. Site characterization efforts found vestiges of petroleum hydrocarbons, irrigation canals, and debris (windblown garbage, porcelain products, battery cores, cans, and glass). After a site evaluation, EPA issued a CERCLA Final Record of Decision (EPA and DOE-RL 2013) that concluded that PNNL-Richland campus areas north of Horn Rapids Road require no further remedial action under CERCLA.

No PNNL-Sequim campus facilities require action under CERCLA guidelines.

Compliance Activities

- None required

2.2.3 Washington State Dangerous Waste/Hazardous Substance Reportable Releases to the Environment

Washington State Dangerous Waste Regulations (WAC 173-303-145) require that spills or nonpermitted discharges of dangerous wastes or hazardous substances to the environment be

[1] Further details regarding Hanford Site CERCLA and CERCLA groundwater sampling program can be found at https://www.hanford.gov/page.cfm/environmentalsurveillance.

reported to the Washington State Department of Ecology. This requirement applies to discharges to soil, surface water, groundwater, or air when such discharges threaten human health or the environment, regardless of the quantity of dangerous waste or hazardous substance released.

During CY 2024, no spills or nonpermitted discharges that posed a threat to human health or the environment occurred on the PNNL-Richland campus or on the PNNL-Sequim campus. Minor spills were cleaned up immediately and disposed of in accordance with applicable requirements.

2.2.4 Resource Conservation and Recovery Act of 1976

RCRA of 1976

RCRA was enacted to protect human health and the environment through cradle-to-grave management of hazardous waste from its generation through treatment, storage, and disposal. The Washington State Department of Ecology has the authority to enforce RCRA requirements in the state under WAC 173-303, "Dangerous Waste Regulations." The PNNL-Richland campus, PNNL-Sequim campus, and PNNL facilities on the Hanford Site operate under the generator requirements of WAC 173-303. During CY 2024, PNNL facilities followed the generator requirements for waste management and shipped hazardous waste to off-site facilities for proper disposal. RCRA also includes requirements for the proper management of underground storage tanks. In CY 2024, Battelle administered two underground storage tanks that store diesel fuel for backup generators on the PNNL-Richland campus that are registered under the WAC-173-360A, Underground Storage Tank regulations—a 20,000-gallon tank and 600-gallon tank. The tanks are routinely monitored, and no problems have been observed. No underground tanks are used at the PNNL-Sequim campus. There were no regulatory inspections performed at the PNNL-Richland or PNNL-Sequim facilities during 2024.	Compliance Activities • Routine monitoring of Underground Storage Tanks • Compliant management of dangerous waste

2.2.5 Toxic Substances Control Act

***Toxic Substances Control Act* (TSCA; 15 U.S.C. § 2601 *et seq.*)**	
Requirements of the *Toxic Substances Control Act* (TSCA; 15 U.S.C. § 2601 *et seq.*) that apply to PNNL involve the regulation of PCBs and continued use of chemical substances that have been deemed by EPA to pose an unreasonable risk under certain conditions of use. Federal regulations for PCB use, storage, and disposal are provided in 40 CFR Part 761, "Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions." PNNL generates very small quantities of waste that is regulated by 40 CFR Part 761, and any of these wastes are stored and/or disposed of in accordance with this regulation. A PCB log and annual report were not required for either the PNNL-Richland campus or the PNNL-Sequim campus in 2024. In 2024, EPA issued new federal regulations provided in 40 CFR Part 751 for five chemical substances used at PNNL. Continued use of the five chemicals, which include methylene chloride, perchloroethylene, carbon tetrachloride, trichlorethylene, and N-methylpyrrolidone, require various methods of reducing human exposure limits to below the EPA determined exposure levels. PNNL began implementation of a workplace chemical protection program, development of an exposure control plan, and establishment of other protective measure as required by the new TSCA rules under 40 CFR Part 751. EPA continues to evaluate additional chemicals utilizing their risk evaluation process for existing chemicals under TSCA to determine additional chemicals that present an unreasonable risk to human health or the environment.	Compliance Activities • Began implementation of programmatic changes required by EPAs unreasonable risk determination for continued use of TSCA chemicals.

2.2.6 Federal Insecticide, Fungicide, and Rodenticide Act

The *Federal Insecticide, Fungicide, and Rodenticide Act* (7 U.S.C. § 136 *et seq.*) is administered by the EPA. Washington State Department of Agriculture rules implementing the requirements of this act include the *Washington Pesticide Control Act* (RCW 15.58), the *Washington Pesticide Application Act* (RCW 17.21), and rules related to general pesticide use codified in WAC 16-228, "General Pesticide Rules." In 2024, restricted use pesticides used at both the PNNL-Richland and PNNL-Sequim campuses were managed in accordance with these rules and applied either by PNNL staff with private-commercial applicator licenses or by a licensed commercial applicators.

2.2.7 National Environmental Policy Act of 1969

NEPA (42 U.S.C. § 4321 *et seq.*)

NEPA (42 U.S.C. § 4321 *et seq.*) was enacted to assure that potential environmental impacts, as well as technical factors and costs, are considered during federal agency decision-making. For the first time since 1978, in July 2020, the Council on Environmental Quality (CEQ) comprehensively updated its regulations for federal agencies to implement NEPA (85 FR 43304; CEQ 2020). DOE is in the process of updating its implementing procedures to match changes in CEQ regulations. The goal of the update was to facilitate more efficient, effective, and timely NEPA reviews. The regulations were amended in May 2022 and updated to restore provisions that had been in effect prior to the 2020 update (87 FR 23453). The Fiscal Responsibility Act of 2023, signed into law in June 2023, made amendments to NEPA. CEQ finalized revised NEPA regulations on July 1, 2024. PNNL's NEPA Compliance Program supports its compliance with NEPA and SEPA (Revised Code of Washington [RCW] 43.21C, as amended). Program activities include preparing generic and project-specific categorical exclusions, environmental assessments, and Washington SEPA checklists. NEPA reviews of PNNL activities are conducted by PNSO. NEPA compliance is verified through assessments conducted by PNNL and PNSO.	Compliance Activities • Conducted 1,697 NEPA reviews for newly proposed and funded research activities and 57 NEPA reviews of facility modification permits. • DOE-PNSO approved two new project-specific categorical exclusions in 2024 and reissued four generic categorical exclusions. • DOE-PNSO published a Notification of Intent to conduct an environmental assessment for aquatic research in Sequim Bay and the Strait of Juan de Fuca in August 2024 and published a final environmental assessment in February 2025 (DOE/EA-2271).

PNNL environmental compliance representatives and NEPA experts conducted 1,697 NEPA reviews for newly proposed and funded research activities during CY 2024 for research and support activities. Additionally, 57 facility modification permits were reviewed for NEPA compliance. The number of NEPA reviews conducted annually for new projects within the Electronic Prep and Risk system has increased over the past ten years (Figure 8). NEPA experts review projects in Electronic Prep and Risk to verify that potential project environmental impacts were adequately considered, and NEPA (and as appropriate, SEPA) coverage was correctly applied.

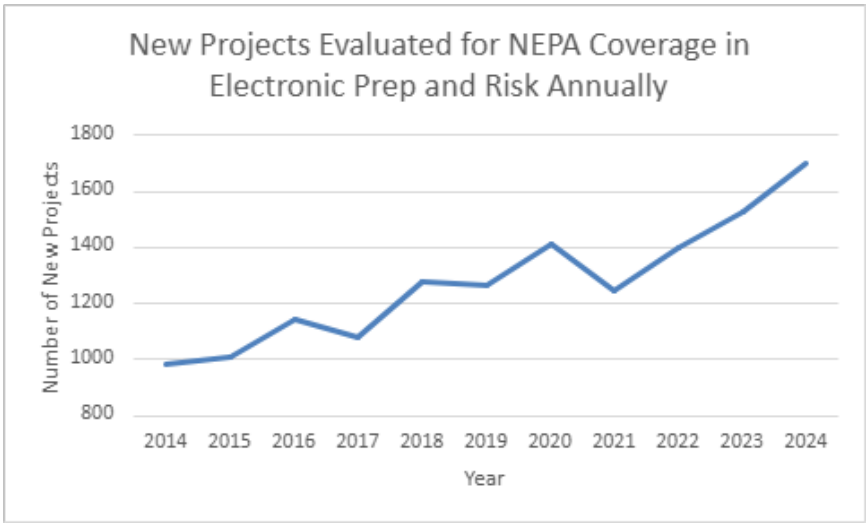


Figure 8. NEPA Reviews for New Projects in the Electronic Prep and Risk System Conducted Annually at PNNL from CY 2014–2024.

In all cases, activities were adequately addressed in previously approved NEPA documentation, including generic categorical exclusions, environmental assessments, environmental impact statements, and supplement analyses.

Categorical exclusions represent an effective and necessary means of addressing activities that 1) clearly fit within a class of actions that DOE has determined do not individually or cumulatively have a significant effect on the environment, 2) do not have extraordinary circumstances that may affect the environment, and 3) are not connected to other actions that may have potentially significant impacts. A single determination for a generic categorical exclusion is allowed for recurring activities undertaken during a specified period of time.

There were four modified PNSO-approved generic categorical exclusions in 2024. Twenty generic categorical exclusions have been approved by PNSO to cover PNNL research and operations activities to date. Generic categorical exclusions are reevaluated every 5 years by PNSO. When projects clearly are within the definition of a categorical exclusion, but a generic categorical exclusion is not applicable, a new project- or activity-specific categorical exclusion is prepared. Two project-specific categorical exclusions were published in CY 2024. A list of all PNSO-approved categorical exclusions is available at https://science.osti.gov/pnso/NEPA-Documents/Categorical-Exclusion-Determinations.

Environmental assessments are prepared for proposed actions that do not fit within the DOE categorical exclusions, and when the decision has been made not to prepare in environmental impact statement. DOE-PNSO published a Notification of Intent to conduct an environmental assessment for aquatic research in Sequim Bay and the Strait of Juan de Fuca in August 2024 and published a final environmental assessment in February 2025 (DOE/EA-2271). DOE-PNSO held public meetings virtually and in Sequim, Washington, and accepted public comments in October 2024.

Potential impacts to the environment from campus development at the PNNL-Richland and PNNL-Sequim campuses are evaluated in environmental assessments. A list of all PNSO-approved environmental assessments is available at https://science.osti.gov/pnso/NEPA-Documents/PNSO-EA-EIS.

The environmental assessment for PNNL-Richland campus development describes mitigation actions required to mitigate for the impacts of campus development to mature shrub steppe. In 2023, a utilities installation project cleared 19.0 ac (7.7 ha) of mature shrub steppe habitat. A contract has been established with Benton Conservation District to perform mitigation actions related to the utilities installation project. In 2024, 20.4 ac (8.3 ha) of mature shrub steppe habitat was cleared to support buildout of the National Security Complex. A contract is being established with the Benton Conservation District to perform mitigation actions related to the National Security Complex buildout. No mitigation actions were performed in 2024.

2.3 Radiation protection

PNNL is subject to radiation protection statutes and regulations that are designed to protect the health and safety of the workforce, the public, and the environment.

2.3.1 DOE Order 458.1, Radiation Protection of the Public and the Environment

During the reporting period of this annual site environmental report, PNNL was working under the requirements of DOE Order 458.1, Chg 4 (September 2020). Section 2.d (“As Low As

Reasonably Achievable [ALARA]"), Section 2.g ("Control and Management of Radionuclides from DOE Activities in Liquid Discharges"), and Section 2.k ("Release and Clearance of Property") of DOE Order 458.1 were incorporated into PNNL's contract with PNSO in July 2011 and were fully implemented on September 1, 2012. PNNL's contract was revised in March 2021 to replace DOE Order 458.1, Chg 3, with DOE Order 458.1, Chg 4.

Section 2.d of DOE Order 458.1 requires each contractor to establish an environmental ALARA process to control and manage radiological activities so that doses to the public and releases to the environment are kept ALARA (Figure 9). The ALARA process must be applied to the design or modification of facilities and to the conduct of radiological work activities.

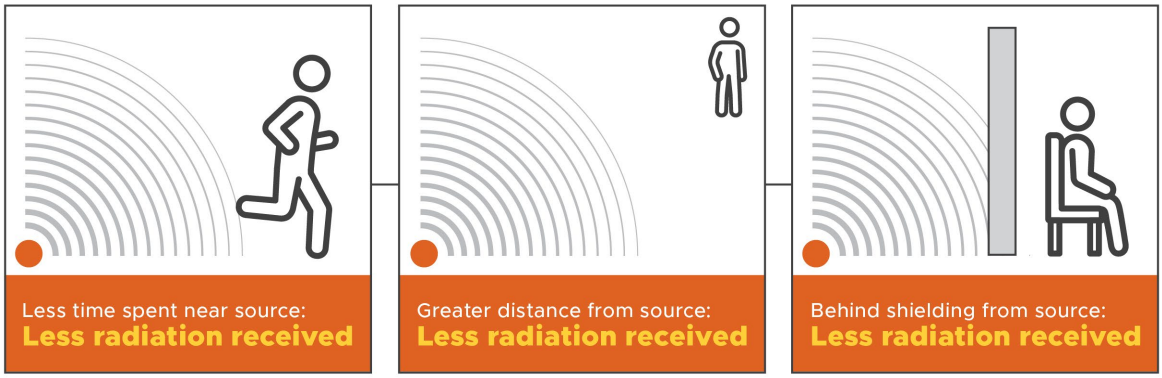


Figure 9. Elements of the As Low As Reasonably Achievable (ALARA) Principle

Section 2.g of DOE Order 458.1 requires each contractor to establish and implement procedures and practices related to control and management of radionuclides from DOE activities in liquid discharges. A description of how PNNL complies with the liquid discharge requirements in Section 2.g of DOE Order 458.1 is found in Section 5.1 of this report.

Section 2.k of DOE Order 458.1 provides the requirements with which each contractor must comply when releasing property that potentially contains residual radioactivity. Dose constraints for the public are established based on the type of property (i.e., personal property and real property). Requirements for releasing property based on process knowledge, radiological surveys, or a combination of both are provided. The process of obtaining preapproved release limits and activity-specific release limits for releasing property is also described in the Order. The public is required to be notified annually of property released from contractor facilities.

PNNL radiation protection procedures implement Sections 2.d and 2.k of DOE Order 458.1. Procedures include guidance on the environmental ALARA program, use of process knowledge and historical knowledge when releasing property, preparation and approval of requests for authorized limits, and preparation of an annual site environmental report. A description of PNNL programs that implement these sections of the Order is found in Section 4.0 of this report.

No property with detectable residual radioactivity above guideline limits was released in 2024.

2.3.2 DOE Order 435.1, Radioactive Waste Management

The purpose of DOE Order 435.1 is to establish requirements for assuring that DOE radioactive waste is managed in a manner that protects workers, public health and safety, and the environment. The Order takes a cradle-to-grave approach to managing waste and includes

requirements for waste generation, storage, treatment, disposal, and post-closure monitoring of facilities.

Radioactive waste shall be managed such that the requirements of other DOE Orders, standards, and regulations are met, including the following:

- 10 CFR Part 835, “Occupational Radiation Protection”
- DOE Order 440.1B, Chg 4 (Admin Chg), *Worker Protection Program for DOE (Including the National Nuclear Security Administration) Federal Employees*
- DOE Order 458.1, Chg 4 (Ltd Chg), *Radiation Protection of the Public and the Environment*.

DOE Order 435.1 establishes requirements for the management of high-level waste, transuranic waste, and low-level waste. It also pertains to mixed waste (i.e., high-level waste, transuranic waste, or low-level waste that also contain chemically hazardous constituents).

PNNL’s Radioactive Waste Management Basis (Ellefson 2023) identifies the hazards associated with radioactive waste management at PNNL along with their potential impacts. Controls for protection of the public, workers, and environment also are presented. Controls are implemented through internal PNNL workflows and waste management procedures.

2.3.3 Atomic Energy Act of 1954

***Atomic Energy Act of 1954* (42 U.S.C. § 2011 *et seq.*)**	
The *Atomic Energy Act of 1954* (42 U.S.C. § 2011 *et seq.*) was passed to assure the proper management of radioactive materials. Through the act, DOE regulates the control of radioactive materials under its authority, including the treatment, storage, and disposal of low-level radioactive waste from its operations and establishes radiation protection standards for itself and its contractors. Accordingly, DOE promulgated a series of regulations (e.g., 10 CFR Part 820, 10 CFR Part 830, and 10 CFR Part 835) and directives (e.g., DOE Order 435.1 and DOE Order 458.1) to protect public health and the environment from potential risks associated with radioactive materials. PNNL complies with the *Atomic Energy Act (of 1954)* through its Radiation Protection Management and Operation Program and Radioactive Waste Management Basis.	Compliance Activities • PNNL complies with worker and public health dose limits • PNNL manages radiological operations to manage risk from radioactive material in sources or waste, manage risk from handling and processes, and manage risk during transport and final disposition

2.4 Air Quality and Protection

Federal and state regulations that apply to air quality at the PNNL-Richland campus and PNNL-Sequim campus, and the permits necessary to maintain compliance, are discussed in this section.

2.4.1 Clean Air Act

Clean Air Act (42 U.S.C. § 7401 *et seq.*)	
The CAA (42 U.S.C. § 7401 *et seq.*) is administered by the EPA. It regulates air emissions from stationary and mobile sources, both criteria and hazardous air pollutants. It authorized the EPA to establish National Ambient Air Quality Standards for the protection of public health and welfare. Establishment of these pollutant standards was combined with state implementation plans to facilitate attainment of the standards. The *Washington Clean Air Act* (RCW 70A.15), which implements and supplements the federal law, has been revised periodically to keep pace with changes at the federal level. The Washington State Department of Ecology is responsible for developing most statewide air-quality rules and enforces Title 40 of the *Code of Federal Regulations* (CFR) Part 52 (40 CFR Part 52), 40 CFR Part 60, 40 CFR Part 61, 40 CFR Part 63, 40 CFR Part 68, 40 CFR Part 82, and 40 CFR Part 98, as well as the state requirements in WAC 173-400, "General Regulations for Air Pollution Sources;" WAC 173-441, "Reporting of Emissions of Greenhouse Gases;" WAC 173-443, "Hydrofluorocarbons (HFCs) and Other Fluorinated Greenhouse Gases," WAC 173-460, "Controls for New Sources of Toxic Air Pollutants;" and WAC 173-480, "Ambient Air Quality Standards and Emission Limits For Radionuclides." The BCAA implements and enforces most federal and state requirements on the PNNL-Richland campus through BCAA Regulation 1 (BCAA 2021). Requirements applicable to the PNNL-Richland campus include Article 4, "General Standards for Particulate Matter;" Article 5, "Outdoor Burning;" Article 8, "Asbestos;" Article 9, "Source Registration;" and Article 10, "Fees and Charges." The ORCAA implements and enforces most federal and state requirements at the PNNL-Sequim campus through ORCAA Regulations (ORCAA 2024). Requirements applicable to the PNNL-Sequim campus include Regulation 4, "Registration;" Regulation 6, "Required Permits and Notifications;" Regulation 7, "Prohibitions;" and Regulation 8, "Performance Standards."	Compliance Activities • Visible emission surveys of boilers and engines • Preventative maintenance of boilers & engines (e.g., visual checks of combustion; inspection of air supply systems, fuel supply systems, burners, filters) • Boiler tune-ups by manufacture trained technician • Monitor emergency generator fuel usage and hours of operation to ensure permit conditions are met and total emissions do not exceed WAC 173-460 acceptable source impact levels. • Review pilot-scale and field R&D projects to ensure emissions meet permit conditions or are exempt from permitting • Triennial Greenhouse Gas Applicability Assessment • Semi-annual and annual reporting to state and local regulatory agencies • Management and sampling of radioactive materials in air effluent

2.4.2 Radioactive Emissions

Federal regulations in 40 CFR Part 61, Subpart H, require the measurement and reporting of radionuclides emitted from DOE facilities and the resulting maximum public dose from those emissions. These regulations impose a standard of 10 mrem/yr (0.1 mSv/yr) effective dose equivalent (EDE), which is not to be exceeded. Washington State adopted the 40 CFR Part 61, Subpart H, standard in its regulations (WAC 246-247), "Radiation Protection – Air Emissions," that require the calculation and reporting of the EDE to the maximum exposed individual (MEI) from point-source emissions and from radon and fugitive source emissions. While the WAC 246-247 receptor location considers whether an individual resides or abides at the evaluated location, an additional assessment is performed for the location that has the maximum off-site nuclide air concentrations, whether or not the reside/abide criterion is met (WAC 173-480).

On the PNNL-Richland campus, the Physical Sciences Facility (PSF) has the potential to emit radionuclides. PSF[2] radioactive emission point sources at the PNNL-Richland campus are actively ventilated stacks that use electrically powered exhausters and from which emissions are discharged under controlled conditions. PNNL sources are major, minor, and fugitive emissions units. In addition, several sitewide radioactive air permits, commonly called Potential Impact Category 5 (PIC-5) permits (Barnett 2018), were used to assign dose from very low potential emissions sources associated with campus-wide operations. The low-level radioactive sources permitted under PIC-5 include emissions for instrument and operational checks, nondispersible radioactive materials, volumetrically released radioactive materials, and certain facility restoration activities.

Details regarding ambient air, stack emissions monitoring, and PIC-5 permit programs for the PNNL-Richland campus and PNNL-Sequim campus are reported annually. Richland data for 2024 are available in the *PNNL-Richland Campus Radionuclide Air Emissions Report for Calendar Year 2024* (Snyder, Bisping, et al. 2025). The PNNL-Sequim campus has one sitewide minor fugitive emission unit that has the potential to emit radionuclides. Radioactive air emissions results for Sequim are available in the *PNNL-Sequim Campus Radionuclide Air Emissions Report for Calendar Year 2024* (Hay et al. 2025). During CY 2024, both the PNNL-Richland and PNNL-Sequim campuses maintained compliance with state and federal regulations and with issued air emissions permits. Radioactive air emissions were more than 100,000 times lower than the regulatory standard of 10 mrem/yr (0.1 mSv/yr) EDE for the period at each facility.

2.4.3 Air Permits

PNNL has several permits that control airborne emissions from facilities within the PNNL-Richland campus boundary. Permits for radioactive air emissions are issued by the WDOH as a Notice of Construction and are incorporated into the Radioactive Air Emissions License (RAEL). For the PNNL-Richland campus, WDOH issued RAEL-005, which was last renewed on January 1, 2021; the renewal cycle for a WDOH RAEL is every five years. Permits for nonradiological air emissions at the PNNL-Richland campus are issued by the BCAA as an Order of Approval; they can cover particulate, volatile organic compound, and toxic air pollutant emissions. Current Orders of Approval issued by the BCAA to the PNNL-Richland campus are listed below:

- PNNL Site – William R. Wiley Environmental Molecular Sciences Laboratory (EMSL), PSF Complex, Energy Sciences Center, Life Sciences Laboratory 2 Halogenated Solvent Degreaser Operations, Grid Storage Launchpad (Order of Approval No. 2019-0005, Rev. 2)
- Life Sciences Laboratory 2 Building Operations (Order of Approval No. 2007-0006, Rev. 1)
- Richland North Building Operations (Order of Approval No. 2012-0017)
- Richland North Research (Order of Approval No. 2012-0016).

The PNNL-Sequim campus has two air permits for airborne emissions: RAEL-014 issued effective on January 1, 2023, by the WDOH and a nonradiological regulatory order issued by the ORCAA (Order of Approval 13NOI968).

[2] As a group of research buildings, the PSF is expected to accommodate emerging research over time.

2.4.4 Hydrofluorocarbon Phasedown

AIM Act of 2020 (42 U.S.C. § 7675 *et seq.*)	
The AIM Act of 2020 (42 U.S.C. § 7675 *et seq.*) seeks to reduce HFC consumption and production to 15% of a 2011–2013 baseline by 2036. PNNL uses HFCs primarily as refrigerants in chillers and other refrigeration appliances. Cleaning solvents that may contain HFCs also are used at PNNL. Refrigerants and products containing HFCs will be replaced with EPA-approved substitutes as they become available. Chemical products containing HFCs are currently tracked in the Chemical Management System. Refrigerants containing HFCs are currently tracked in the Compliance Suite Refrigeration Compliance Management Software™.	Compliance Activities • Semi-annual refrigerant inventories • Annual calibration of chiller leak detection system • Monitoring of refrigerant leaks • Annual reporting to WDOE

2.5 Water Quality and Protection

Federal, state and local regulations that apply to water quality at the PNNL-Richland campus and PNNL-Sequim campus are discussed in this section, which addresses wastewater, stormwater, drinking water, and emerging contaminant regulations and permitting processes.

2.5.1 Clean Water Act

CWA (33 U.S.C. § 1251 *et seq.*)	
The CWA (33 U.S.C. § 1251 *et seq.*) establishes the basic structure for regulating discharges of pollutants into the waters and wetlands of the United States, as well as quality standards for surface waters. The CWA was enacted in 1948 and was officially named the *Federal Water Pollution Control Act*. Substantially reorganized and expanded with amendments in 1972, it became commonly known as the CWA. Under the CWA, EPA has implemented pollution control programs, such as setting wastewater standards for industry and implementing water quality standards for all contaminants in surface waters. The CWA made it unlawful to discharge any pollutant from a point source into navigable waters unless a permit is obtained. EPA's NPDES permit program controls these point-source discharges. Point sources are discrete conveyances such as pipes or constructed ditches. Industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters. The EPA delegated responsibility for the Washington State NPDES permit program to the Washington State Department of Ecology in August 1989.	Compliance Activities • Continuous Flow monitoring • Monitoring for pH, and metals • Sewer Discharge Approval of each waste stream prior to discharge • Implementation of construction stormwater best management practices • Monthly reporting to state regulatory agency

The Washington State Department of Ecology has issued Permit No. WA0020419 to the City of Richland for discharges from its Publicly Owned Treatment Works to the Columbia River. To make sure it meets its NPDES permit conditions, the City of Richland issues industrial wastewater discharge permits to industrial users that discharge process wastewater to the City of Richland sanitary sewer system, as codified in Richland Municipal Code Chapter 17.30.

On the PNNL-Richland campus, the discharge of process wastewater to the City of Richland sanitary sewer system is governed by three City of Richland industrial wastewater discharge permits. Permit No. CR-IU001 regulates discharges from facilities on the PNNL-Richland campus and leased facilities, and requires monitoring at one discharge point, Outfall CS-001. Permit No. CR-IU005 regulates discharges from EMSL to Outfall 001. Permit No. CR-IU011

regulates process wastewater discharged from the PSF to Outfall PS-001. All waste streams regulated by these permits are reviewed by staff at PNNL and evaluated for compliance with the applicable permit prior to being discharged. PNNL files quarterly discharge monitoring reports to the City of Richland.

Process wastewater from PNNL-Sequim campus facilities is discharged to an on-site wastewater treatment system before being discharged to Sequim Bay under the authorization of Washington State Department of Ecology NPDES Permit No. WA0040649. The wastewater treatment system consists of particulate filters, ultraviolet lamps, and granulated activated carbon. All waste streams regulated by this permit are reviewed by staff at PNNL and evaluated for compliance prior to being discharged.

2.5.2 Stormwater Management

The CWA (33 U.S.C. § 1251 *et seq*.) also regulates the discharge of stormwater to the surface waters of the United States from point sources. Stormwater discharges from specific industries or industrial categories are governed by general permits or individual permits issued under the NPDES program. Stormwater discharges to the ground through certain types of engineered structures (e.g., dry wells, French drains) are regulated by the SDWA (42 U.S.C. § 300f *et seq*.) under the Underground Injection Control well program. The EPA has delegated responsibility for both of these stormwater programs to the Washington State Department of Ecology.

Stormwater on the PNNL-Richland campus is primarily managed via underground injection control wells and grassy swales. The underground injection control wells are registered with the Washington State Department of Ecology, as required by WAC 173-218, "Underground Injection Control Program." Best management practices, in accordance with the *Stormwater Management Manual for Eastern Washington* (Ecology 2024a) and the *Stormwater Management Manual for Western Washington* (Ecology 2024b), are used to minimize pollution in stormwater. These practices include using catch basins to remove solids, storing chemicals inside or under cover, when possible, to prevent contact with stormwater, routinely sweeping and cleaning parking lots, promptly notifying the appropriate facilities manager of spills, cleaning up spills, and conducting good housekeeping. In 2024, two Underground Injection Control Well Registrations were completed for new stormwater systems.

Stormwater at the PNNL-Sequim campus is managed via a stormwater drain system that includes grated catch basins for paved areas and parking lots. The catch basins provide basic treatment for solids removal. In addition, catch basins in the boat storage yard and in the wastewater treatment system area contain multimedia filtration systems for oil control. Stormwater from the beach area drains to outfalls located near the shoreline. Stormwater from the uplands area of the PNNL-Sequim campus drains to ground via an engineered infiltration trench and an infiltration pond, which is an engineered stormwater collection basin with an overflow trench.

Industrial stormwater discharges from the PNNL-Richland campus and PNNL-Sequim campus are not subject to federal or state NPDES stormwater regulations. However, stormwater management practices that promote water drainage and reduce runoff as outlined under EISA (42 U.S.C. § 17001) Section 438 are considered and implemented as part of PNNL best practices. Registration of underground injection control wells for stormwater has been completed, as required by the SDWA and WAC 173-218.

In late 2024, PNNL began construction on a new storage facility at the PNNL-Sequim Campus. Because the project disturbed an area greater than 1 acre and stormwater had the potential to be discharged to a surface water (Sequim Bay), PNNL obtained permit No. WAR314056 under the Washington State Department of Ecology's Construction Stormwater General Permit. PNNL files monthly discharge monitoring reports.

2.5.3 Safe Drinking Water Act of 1974

SDWA (42 U.S.C. § 300f *et seq.*)

The SDWA (42 U.S.C. § 300f *et seq.*) is the main federal law that assures the quality of drinking water in the United States. Under the SDWA, the EPA establishes primary and secondary standards for drinking water quality and oversees the states, municipalities, and water suppliers who implement those standards. The SDWA was originally passed by Congress to protect public health by regulating the nation's public drinking water supply. The law was amended in 1986 and 1996 and requires many actions to protect drinking water and its sources—rivers, lakes, reservoirs, springs, and groundwater wells. The SDWA focuses on all waters actually or potentially designated for use as drinking water, whether from aboveground or underground sources. The SDWA authorizes the EPA to establish minimum standards to protect tap water and requires all owners or operators of public water systems to comply with these standards. The WDOH has been approved to implement these rules for EPA under WAC 246-290 "Group A Public Water Supplies," which also addresses compliance with water quality and implementation of secondary standards. Under the SDWA, EPA also established minimum standards for state programs to protect underground sources of drinking water from endangerment by underground injection of fluids. The PNNL-Richland campus receives all drinking water from the City of Richland drinking water supply, and the city is responsible for meeting water quality standards under the SDWA. Water for PNNL-Sequim campus facilities is provided exclusively from an on-site well. PNNL is considered the water purveyor and is responsible for all monitoring and sampling of the drinking water system. All drinking water parameters sampled met compliance requirements.	Compliance Activities • In 2024, two Underground Injection Control Well Registrations were completed for new stormwater systems • Drinking water samples were collected for the PNNL-Sequim Campus water system as required by the WDOH and there were no compliance issues • In 2024, initial lead service line inventories were completed for the PNNL-Sequim Campus, and no lead piping was identified • PFAS sampling of the PNNL-Sequim Campus water system was required under Washington State regulations and all results were nondetectable.

2.5.4 Emerging Contaminants

PFAS are a family of chemicals that are emerging contaminants-of-concern because of their potential adverse health effects and widespread contamination at sites across the nation. PFAS chemicals are used to manufacture stain-resistant, water-resistant, and nonstick products, as well as some cleaning products and engineered coatings, and certain types of firefighting foam. In 2021, DOE established a policy (Turk 2021) for addressing these emerging contaminants, and in 2022, the *Per- and Polyfluoroalkyl Substances (PFAS) Strategic Roadmap: DOE Commitments to Action 2022-2025* was issued (DOE 2022d). In 2021, Washington State passed legislation to monitor certain PFAS chemicals in drinking water and established state action levels for these PFAS. Under WAC 246-290, effective January 2023, all public water systems in the state are required to perform sampling for five specific PFAS chemicals and in 2024, the EPA announced new national drinking water standards for six PFAS chemicals.

In 2024, PFAS samples were collected from the PNNL-Sequim Campus drinking water well to meet the state requirements and all results were nondetectable. Initial sampling under the new EPA rule and application of the new drinking water standards will not become effective until 2026.

In 2022, an initial assessment of PNNL properties and activities was conducted to determine if the potential for PFAS contamination exists (DOE 2022b). The assessment identified that there may be some chemicals, products, or pieces of equipment being used at PNNL that contain PFAS, but there are no active fire suppression systems that contain aqueous film forming foam or other PFAS chemicals. During this initial assessment, one decommissioned fire suppression system that contained PFAS chemicals was identified. The aqueous film forming foam and the system and piping were removed and disposed of in 2014 and 2022, respectively. In 2023, a below-grade emergency overflow tank that was previously connected to this system was tested, and residual liquid in the tank was found to have detectible levels of PFAS. Removal of the tank was initiated, and residual liquid in the tank was removed and properly disposed of. Soils surrounding the tank were tested and found to contain low concentrations of PFAS chemicals. In 2024, additional soil samples were collected to develop a depth profile and evaluate if the soil would have an impact to groundwater approximately 45-feet below ground surface. Evaluation showed the contaminates in the soil would not impact the groundwater. No other PNNL activities or properties were identified to have potential PFAS contamination.

2.6 Other Environmental Statutes and Executive Orders

The *Pacific Northwest Site Office Cultural and Biological Resources Management Plan* (CBRMP; DOE-PNSO 2021a) provides guidance related to protecting and managing biological and cultural resources on the PNNL-Richland campus in accordance with applicable laws and regulations. The CBRMP was developed as a requirement of DOE Policy 141.1, “Department of Energy Management of Cultural Resources,” to provide for the protection and management of cultural and biological resources, identify impacts of unauthorized public use on prehistoric sites, identify actions that will protect sensitive sites, and provide details of annual monitoring activities to identify potential impacts. The CBRMP is implemented by application of PNNL’s internal cultural and biological resource protection procedures, which are updated regularly to reflect relevant changes in applicable laws and regulations and compliance methods.

PNNL staff members conduct field research for which environmental permits are required, often at locations throughout the Pacific Northwest and elsewhere in the United States other than the PNNL-Richland or PNNL-Sequim campuses. The Environmental Research Permitting (ERP) program was established in 2016 to centralize the acquisition of permits and authorizations in compliance with laws and regulations applicable to PNNL research projects. The ERP program also maintains an online, internal PNNL database for environmental permits (the Environmental Permitting Information Center) and tracks reporting requirements on behalf of research projects.

The following sections describe the laws and regulations applicable to 1) management of biological and cultural resources on the PNNL-Richland campus and 2) environmental permits required to protect biological and cultural resources that may be affected by research projects conducted on the PNNL-Richland campus, PNNL-Sequim campus, and other research locations.

2.6.1 Biological Resources and Environmental Permitting

Several federal and state laws, Executive Orders, regulations, and related memoranda contain requirements for 1) managing biological resources on the PNNL-Richland campus and PNNL-Sequim campus and 2) acquiring the environmental permits or authorizations required to allow research activities and protect biological resources that may be affected by research projects conducted on the PNNL-Richland campus, PNNL-Sequim campus, and other research locations. This section and Table 8 summarize the requirements and catalog PNNL's compliance activities related to biological resources and environmental permitting in 2024. Figure 10 shows the average number of authorizations (permits and biological no effects determinations and/or consultations) in effect for research projects at any given time for years 2017 through 2024 and, within that, the number of new authorizations obtained. Both the numbers of active and newly obtained authorizations have generally increased over the past eight years, though numbers dipped during the COVID-19 pandemic.

Table 8. Environmental Research Permits/Authorizations Obtained in 2024 for PNNL Research Activities

Issuer	Authorization Type	Regulatory Driver	Number
Alaska Department of Fish and Game	Fish Habitat Permit	AFA	1
Benton County	Park Use Permit	NA	2
Benton County	Shoreline Substantial Development Permit Exemption	SMA	2
Bureau of Land Management	Casual Use Determination	FLPMA	1
Chesapeake Bay National Estuarine Research Reserve	Research Approval	NA	1
City of Port Angeles	Shoreline Substantial Development Permit Exemption	SMA	1
City of Richland	Research Approval	NA	2
Clallam County	Shoreline Substantial Development Permit or Exemption	SMA	6
Confederated Tribes and Bands of the Yakama Nation	Closed Area Work Permit	NA	10
Hanford Mission Integration Solutions	Hanford Site Evaluation	NA	2
Igiugig Native Corporation	Research Approval	NA	1
Linn County	Parks Permit	NA	1
Louisiana Department of Wildlife and Fisheries	Scientific Collection Permit	LAC	1
Louisiana Department of Wildlife and Fisheries	Special Use Permit	LAC	2
Michigan State University	Research Approval	NA	1
Mississippi State University	Research Approval	NA	1
National Marine Fisheries Service	Formal Consultation	ESA, MSFCMA	1
National Marine Fisheries Service	Informal Consultation	ESA, MSFCMA	3
National Marine Fisheries Service	Marine Mammal Protection Act Take Permit	MMPA	2
National Marine Fisheries Service	Section 10 Take Permit	ESA	1
National Marine Fisheries Service	Take Authorization under a Biological Opinion	ESA	5
National Park Service	Scientific Research and Collecting Permit	CFR	2

Issuer	Authorization Type	Regulatory Driver	Number
North Carolina Department of Environmental Quality	Development Permit Waiver	SMA	1
North Carolina Wildlife Resources Commission	Research Approval	NA	1
National Telecommunications and Information Administration	Automatic Identification Systems License	CFR	1
Ohio Department of Natural Resources	Research Permit	OAC	1
Oregon Department of Fish and Wildlife	Scientific Taking Permit - Fish	OAR	4
Oregon Department of State Lands	No State Permit Verification	OAR	1
Oregon Department of State Lands	Short Term Access Agreement	OAR	1
Oregon State Parks	Research Approval	NA	1
Oregon Travel Information Council	Research Approval	NA	1
PNNL for DOE-PNSO	No effects Determination	ESA, MMPA, MSFCMA	13
Pomona College	Research Approval	NA	1
Private Landowner	Access Approval	NA	5
Qawalangin Tribe of Unalaska	Research Approval	NA	1
San Diego Habitat Conservancy	Research Approval	NA	1
Skamania County	Shoreline Substantial Development Permit Exemption	SMA	1
University of Colorado – Niwot Ridge LTER	Research Approval	NA	1
University of Georgia	Research Approval	NA	1
University of North Carolina Wilmington	Research Approval	NA	1
U.S. Army Corps of Engineers	Research Approval	NA	5
U.S. Army Corps of Engineers	Massachusetts General Permit 14 – Scientific Measurement Devices	CWA	1
U.S. Army Corps of Engineers	Nationwide Permit 3 - Maintenance	CWA	2
U.S. Army Corps of Engineers	Nationwide Permit 5 – Scientific Measurement Devices	CWA	4
U.S. Coast Guard	Local Notice to Mariners	CFR	2
U.S. Coast Guard	Private Aids to Navigation Permit	CFR	2
U.S. Department of Agriculture	Research Approval	NA	3
U.S. Department of Agriculture – Animal and Plant Health Inspection Service	Plant Protection and Quarantine – Controlled Import Permit to Import Restricted or Not Authorized Plan Material	PPA	1
U.S. Department of Agriculture – Animal and Plant Health Inspection Service	Plant Protection and Quarantine – Permit to Move Live Plant Pests, Biocontrol Organisms, Federal Noxious Weeds, Soil, and Bees – Importation	PPA	4
U.S. Department of Agriculture – Animal and Plant Health Inspection Service	Plant Protection and Quarantine – Permit to Move Live Plant Pests, Biocontrol Organisms, Federal Noxious Weeds, Soil, and Bees – Interstate Movement	PPA	5
U.S. Department of Agriculture – Animal and Plant Health Inspection Service	Plant Protection and Quarantine – Permit to Receive Soil	PPA	2
U.S. Department of Agriculture – Veterinary Services	Permit for Import and Transport of Controlled Materials, Organisms, and Vectors	CFR	2
U.S. Department of Energy – Bonneville Power Administration	No effects Determination	ESA, MMPA, MSFCMA	1
U.S. Fish and Wildlife Service	Formal Consultation (Biological Opinion)	ESA	1
U.S. Fish and Wildlife Service	Informal Consultation	ESA	2

Issuer	Authorization Type	Regulatory Driver	Number
U.S. Fish and Wildlife Service	Special Use Permit	NWRSAA, CFR	1
U.S. Forest Service	Nominal Effects Letter	FSOAA	1
U.S. Forest Service	Research Approval	FSOAA	2
U.S. Forest Service	Special Use Permit	FSOAA	2
Utah Department of Natural Resources	Right of Entry	UAC	1
Virginia Institute of Marine Science	Research Permit	NA	1
Washington Department of Ecology	Ecology Permit	WAC	1
Washington Department of Fish and Wildlife	Fish Transport Permit	WAC	10
Washington Department of Fish and Wildlife	Hydraulic Project Approval	WAC	4
Washington Department of Fish and Wildlife	Right of Entry/Temporary Use Permit	WAC	5
Washington Department of Fish and Wildlife	Scientific Collection Permit	WAC	2
Washington Department of Natural Resources	Aquatic Lands Lease	WAC	3
Washington Department of Natural Resources	Aquatic Lands Right of Entry License	WAC	3
Washington State Parks	Scientific Research Permit	WAC	1
Washington State University	Access Approval	NA	2
Total Environmental Research Permits/Authorizations			**162**

AFA = *American Fisheries Act of 1998*
CFR = Code of Federal Regulations
CWA = Clean Water Act
ESA = *Endangered Species Act of 1973*
FLPMA = *Federal Land Policy and Management Act of 1976*
FSOAA = *Forest Service Organic Administration Act of 1897*
LAC = Louisiana Administrative Code
MMPA = *Marine Mammal Protection Act of 1972*
MSFCMA = *Magnuson–Stevens Fishery Conservation and Management Act*
NA = not applicable
NOAA = National Oceanic and Atmospheric Administration
NWRSAA = *National Wildlife Refuge System Administration Act of 1966*
OAC = Ohio Administrative Code
OAR = Oregon Administrative Rules
PPA = *Plant Protection Act*
SMA = *Shoreline Management Act of 1971*
UAC = Utah Administrative Code
WAC = Washington Administrative Code

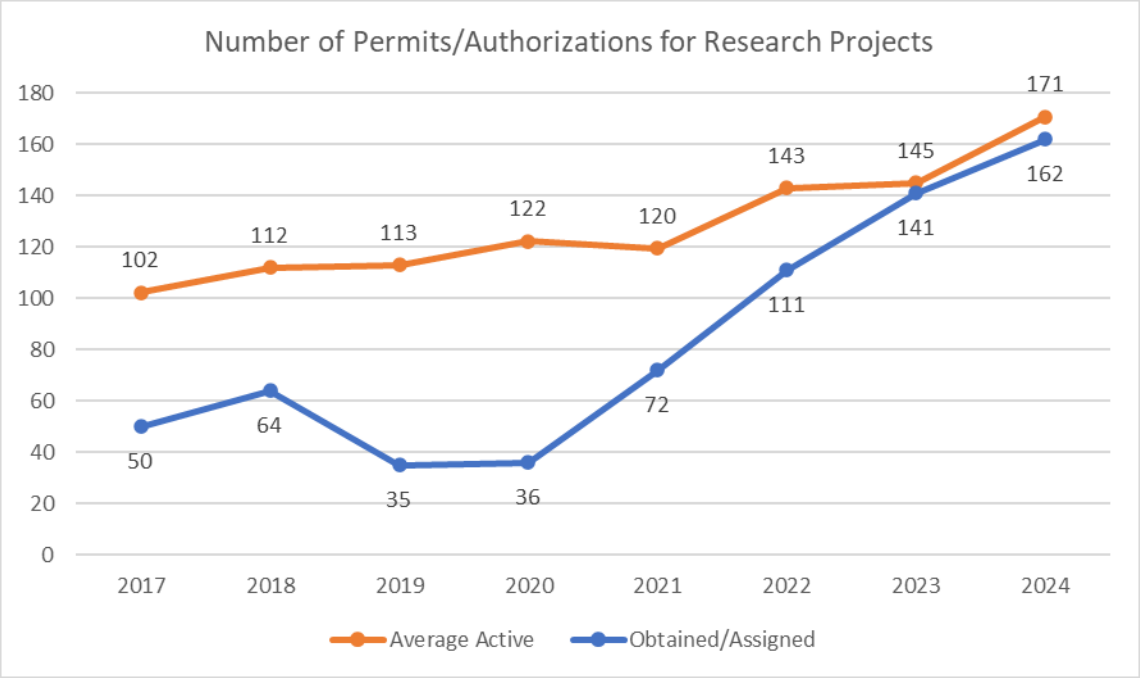


Figure 10. Number of Permits/Authorizations Obtained and Used for Research Projects

2.6.1.1 Federal Statutes and Regulations

The ESA (16 U.S.C. § 1531 *et seq.*) contains requirements for the designation and protection of wildlife, fish, plant, and invertebrate species that are in danger of becoming extinct because of natural or manmade factors and the conservation of habitats upon which they depend. Section 7(a)(2) of the ESA requires federal agencies to evaluate actions that they perform, fund, or permit to determine whether they would affect any species listed as endangered or threatened or affect designated critical habitat. Consultation with the USFWS and/or the NMFS is required if the action may affect listed species or critical habitat. The biological resource review process and consultation with USFWS and/or NMFS are the primary means by which PNNL determines whether any listed species or critical habitat may be affected by a proposed action.

The MBTA (16 U.S.C. § 703 *et seq.*) makes it illegal to take, capture, or kill any migratory bird, or to take any part, nest, or egg of any such birds. The MBTA prohibits incidental take and applies enforcement discretion (86 FR 54642). PNNL projects that have a potential to affect avian species listed under the MBTA use the PNNL biological resource review process, as described in the CBRMP (DOE-PNSO 2021a) and implemented by PNNL's internal biological resource protection procedures to protect migratory birds regardless of intent. PNNL assisted PNSO in the acquisition of a Special Purpose Miscellaneous permit from the USFWS Migratory Bird Permit Office to allow the relocation or take of up to five migratory bird nests for human health and safety as well as to ensure the continuation of important research. Nest destruction is only authorized in emergency situations and nests cannot be relocated. In 2024, PNNL biologists resolved 19 inquiries concerning migratory birds on the PNNL-Richland campus and PNNL-Sequim campus and installed deterrents in areas of habitual nesting to avoid potential impacts on active bird nests. No inquiries resulted in the relocation or take of a migratory bird nest.

The *Bald and Golden Eagle Protection Act of 1940* (16 U.S.C. § 688 *et seq.*) prohibits anyone without a permit from disturbing, wounding, killing, harassing, or taking bald eagles (*Haliaeetus leucocephalus*) or golden eagles (*Aquila chrysaetos*), alive or dead, including their parts, nests, or eggs. The act also applies to impacts made around previously used nest sites, if upon an eagle's return, normal breeding, feeding, or sheltering habits are influenced negatively. In 2024, PNNL biologists conducted occupancy monitoring of known bald eagle nests within the Sequim campus as required by the short-term eagle incidental take permit from the USFWS that allows disturbance of up to three bald eagle nests incidental to PNNL-Sequim campus construction and maintenance activities. All monitoring activities were completed as required, and no nest take resulted from PNNL-Sequim activities. The PNNL biological resource review process provides assurance that all other proposed research or development actions will not adversely affect bald or golden eagles. Mitigation, if needed for other PNNL activities, includes performing work according to the spatial and timing restrictions established for seasonal use locations away from the DOE-Sequim campus, such as nest sites and communal night roosts in applicable jurisdictional management plans for the species.

The MSFCMA (16 U.S.C. § 1801 *et seq.*) is the primary law governing marine fisheries management in the United States. It provides a national program for the conservation and management of U.S. fishery resources to prevent overfishing, rebuild overfished stocks, assure conservation, and facilitate long-term protection of essential fish habitats (waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity). Under Section 305(b)(2) of the MSFCMA, federal agencies must consult with the NMFS about any action that might adversely affect essential fish habitat. The PNNL biological resource review process and consultation with NMFS are the primary means by which PNNL determines whether any essential fish habitat may be affected by a proposed action.

The MMPA (16 U.S.C. § 1361 *et seq.*) provides a program for the protection of all marine mammals based on some species or stocks being in danger of extinction or depletion due to human activities. The purpose of the MMPA is to assure actions that may affect marine mammal species or stocks do not cause them to fall below their optimum sustainable population levels. The biological resource review process is the primary means by which PNNL determines whether marine mammal species may be affected by a proposed action.

The RHA (33 U.S.C. § 403 *et seq.*) is the oldest federal environmental law in the United States. Section 10 of the act prohibits the creation of any obstruction, excavation, or fill within a navigable waterway without a permit, including but not limited to the building of any wharfs, piers, jetties, or other structures. The CWA (33 U.S.C. § 1251 *et seq.*) regulates the discharge of dredged or fill material into waters of the United States. Authorization for issuing permits under both RHA Section 10 and CWA Section 404 is delegated to the U.S. Army Corps of Engineers (USACE), within the Department of the Army. One of several permit types may be issued depending on the type of use and the project's impacts on navigable waters. The USACE has established a system of Nationwide Permits to streamline permitting certain activities known to have minimal impacts. Nationwide Permits are often used for PNNL research projects. PNNL achieves compliance with these regulations through its ERP program.

The *Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990* (16 U.S.C. § 4701 *et seq.*) provides for the development and execution of environmentally sound control methods that prevent the unintentional introduction and dispersal of nonindigenous aquatic nuisance species into waters of the United States. PNNL has developed and implements an aquatic invasive plant and animal species interception program to comply with this Act. This program is detailed in Section 2.6.2.1 of this report.

Executive Order 11990 of May 24, 1977, “Protection of Wetlands” (42 FR 26961), requires federal agencies to minimize the destruction, loss, or degradation of wetlands on federal lands and to preserve and enhance the natural and beneficial values of wetlands on federal lands. It states that federal agencies should avoid undertaking or assisting in new construction located in wetlands unless the agency finds 1) that there is no practicable alternative to such construction and 2) that the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use. Compliance with Executive Order 11990, as well as the wetland provisions of the CWA (see Section 2.5.1 of this report), is achieved through the biological resource review process at PNNL.

Executive Order 11988 of May 24, 1977, “Floodplain Management” (42 FR 26951), requires federal agencies to evaluate the potential effects of any actions within a floodplain to minimize any direct or indirect impacts on the floodplain’s natural and beneficial values. Potential floodplain impacts are considered through the biological resource review process at PNNL.

Executive Order 13112 of February 3, 1999,“Invasive Species” (64 FR 6183) and its amendment Executive Order 13751 of December 5, 2016, “Safeguarding the Nation from the Impacts of Invasive Species” (81 FR 88609), established a National Invasive Species Council to oversee implementation of the executive order and require federal agencies to identify actions that may affect the status of invasive species; prevent introduction of invasive species; detect, respond to, monitor, and control populations of invasive species; provide for restoration of native species and habitats in ecosystems that have been invaded; and conduct research and public outreach to control and prevent the introduction of invasive species. See Section 2.6.2.2 of this report for a description of the PNNL noxious weed control program.

Executive Order 13186 of January 10, 2001, “Responsibilities of Federal Agencies to Protect Migratory Birds” (66 FR 3853), requires agencies to avoid or minimize the adverse impact of their actions on migratory birds and to assure that environmental analyses under NEPA evaluate the effects of proposed federal actions on such species. A Memorandum of Understanding between DOE and USFWS regarding implementation of Executive Order 11386, identifies specific areas in which enhanced collaboration between DOE and USFWS will substantially contribute to the conservation and management of migratory birds and their habitats (DOE and USFWS 2013). Compliance with the order and memorandum of understanding is assured by PNNL’s biological resource review process, as described in the CBRMP (DOE-PNSO 2021a), and implemented by PNNL’s internal biological resource protection procedures.

The Coastal Zone Management Act of 1972 (16 U.S.C. § 1451 *et seq.*) includes establishment of a National Coastal Zone Management Program administered by the National Oceanic and Atmospheric Administration (NOAA) Office of Ocean and Coastal Resource Management. Most coastal and Great Lakes states have a federally approved coastal zone management program (CMP) to preserve, protect, develop, and, where possible, restore or enhance valuable natural coastal resources such as wetlands, floodplains, estuaries, beaches, dunes, barrier islands, and coral reefs, as well as the fish and wildlife using those habitats. Federally funded research performed by PNNL that may affect natural resources of the coastal zone must be consistent with the policies of the applicable coastal state’s federally approved CMP. The *Coastal Zone Act Reauthorization Amendments of 1990* include Section 6217, which calls upon states that have a federally approved CMP to develop coastal nonpoint pollution control programs to improve, safeguard, and restore the quality of coastal waters. Section 6217 is administered jointly by the EPA and NOAA. PNNL maintains compliance with the federal consistency provisions and Section 6217 of the Coastal Zone Management Act through its ERP program.

The U.S. Coast Guard (USCG) administers 33 CFR Part 66, *Navigation and Navigable Waters*, "Private Aids to Navigation." For the safe navigation of watercraft, installation of a fixed structure or floating object in any navigable water of the United States requires review by the USCG to determine whether a private aid to navigation permit is necessary. Each USCG district also publishes a *Local Notice to Mariners* weekly, which provides information about the location of structures to facilitate navigational safety in marine or riverine environments. Permits and *Local Notices to Mariners* allow research projects to be carried out in navigable waters without posing undue hazards to watercraft. PNNL maintains compliance with these regulations through its ERP program.

The *Forest Service Organic Administration Act of 1897* (formally titled the *Sundry Civil Appropriations Act of 1897* but commonly called the *Forest Service Organic Act*) specified the purpose for establishing forest reserves and their administration and protection. The U.S. Forest Service, within the U.S. Department of Agriculture, administers the use of national forests, including for scientific research, under 36 CFR Part 251. Uses such as scientific research and specimen collection are deemed "special uses" and require a permit. PNNL maintains compliance with these regulations through its ERP program.

The *National Park Service Organic Act of 1916* established the National Park Service to oversee management of national parks and monuments. The National Park Service, within the U.S. Department of the Interior, administers the use of such lands under Chapter 1 of 36 CFR, which governs parks, forests, and public property. A Scientific Research and Collecting Permit is required for activities pertaining to natural resources that involve fieldwork, specimen collection, or that may potentially disturb resources or visitors. PNNL maintains compliance with these regulations through its ERP program.

The *National Wildlife Refuge System Administration Act of 1966* formally established the National Wildlife Refuge System and provided administration and management directives under the jurisdiction of the USFWS. The USFWS, in accordance with 50 CFR, issues permits for uses, including scientific research, deemed compatible with the purposes of specific refuge areas. PNNL maintains compliance with these regulations through its ERP program.

2.6.1.2 State Statutes and Regulations

PNNL conducts research at locations throughout the United States and must comply with applicable state and local statutes, regulations, and directives at those sites. Washington and Oregon are the principal states in which PNNL conducts research, although work also was undertaken in several other states in 2024. Applicable rulings under which work was conducted are summarized in the following paragraphs.

The Washington State *Shoreline Management Act of 1971* (RCW 90.58, as amended) establishes policy for shoreline use and environmental protection along shorelines that include rivers and streams with a mean annual flow greater than 0.6 m^3/s (21 ft^3/s), which includes the Columbia River in Benton and Franklin Counties. The shoreline jurisdiction extends 61 m (200 ft) landward of these waters and includes associated wetlands, floodways, and up to 61 m (200 ft) of floodway-contiguous floodplains. The act requires that shoreline uses be consistent with the control of pollution and protection of natural resources, including the land, vegetation, wildlife, water, and aquatic life from adverse effects. County Shoreline Master Programs (Ecology 2021) implement the policies of the Washington State *Shoreline Management Act of 1971* and establish a shoreline-specific combined comprehensive plan, zoning ordinance, and

development permit system. PNNL maintains compliance with the act by meeting the provisions of County Shoreline Master Plans through PNNL's ERP program.

Several chapters and sections of the WAC govern activities that affect fish and wildlife or their habitat, aquatic lands, and excavation activities in Washington State. WAC 220-200-150 requires a Scientific Collection Permit from the WDFW for the collection of fish, shellfish, wildlife, or nests of birds for research purposes, as well as a Fish Transport Permit for transporting fish or the viable eggs/gametes of fish into or through Washington. WAC 220-660 requires a Hydraulic Project Approval from the WDFW for construction or projects that will use, divert, obstruct, or change the natural flow or bed of any waters in the state (see RCW 77.55). WAC 332-30 governs the use of state-owned aquatic lands and outlines necessary use authorizations from the Washington State Department of Natural Resources. WAC 296-155-655 requires that utility companies or landowners be contacted prior to excavation activities, resulting in the issuance of an Excavation Permit. PNNL maintains compliance with these regulations through its ERP program.

PNNL regularly conducts research activities in Oregon and must comply with state regulations involving fish and wildlife or their habitat, and aquatic lands as governed by the Oregon Administrative Rules (OARs). OAR 635-007 and OAR 635-043 direct the administration of Scientific Taking Permits for fish and for wildlife, respectively, under the jurisdiction of the Oregon Department of Fish and Wildlife. OAR 141-082 governs the use of state-owned submerged land, and OAR 141-089 governs removal/fill activities within waters of the state under the jurisdiction of the Oregon Department of State Lands. PNNL maintains compliance with these regulations for research activities through its ERP program.

Research conducted in Alaska is done under permits issued by the Alaska Department of Fish and Game as required by the Alaska State Anadromous Fish Act (AS 16.05.871).

Scientific collections and research conducted in Louisiana are authorized by permits issued through the Louisiana Department of Wildlife and Fisheries under the Louisiana Administrative Code (LAC, Title 76, Part I).

For research conducted in Ohio on natural areas and preserves, a permit issued by the Ohio Department of Natural Resources is required under the Ohio Administrative Code (OAC, Rule 1501:17-3-02).

Research conducted in Utah is done under permits issued by the Forestry, Fire, and State Lands Division of the Utah Department of Natural Resources under the Utah Administrative Code (UAC, R652).

2.6.2 PNNL Programs

Programs and activities performed to assure compliance with the preceding biological resource and environmental statutes and drivers are discussed in this section.

PNSO prepared the CBRMP (DOE-PNSO 2021a) in response to the direction and guidance provided in DOE Policy 141.1, "Department of Energy Management of Cultural Resources," related to protecting and managing cultural and biological resources. The plan provides direction regarding the requirements for annual surveys and monitoring for species of concern, review of project activities for environmental impacts, and identification and control of invasive

species. The CBRMP is implemented by application of PNNL's internal cultural and biological resource protection procedures.

As stipulated in the CBRMP (DOE-PNSO 2021a), projects involving soil or vegetation disturbance, tagging and tracking of fish, placement of research equipment and sensors in the environment, and myriad other outdoor research activities are routinely evaluated to determine their potential to affect biological resources prior to implementation. A sum of 119 biological resource reviews were completed for PNNL projects in CY 2024 as compared to just 88 the previous year, with most reviews conducted for off-site activities (Figure 11).

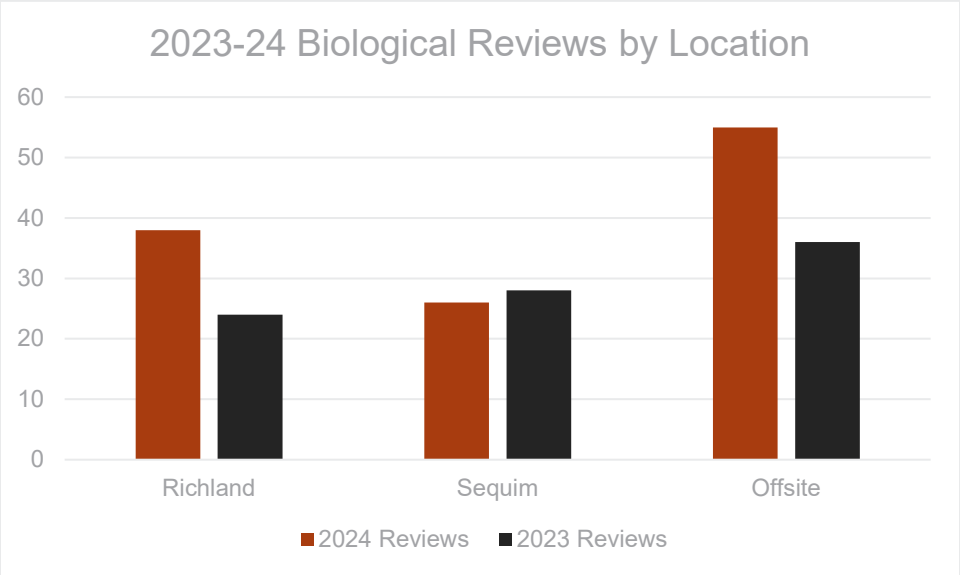


Figure 11. Biological Reviews by Location During 2023–2024

Potential project impacts were evaluated for plant or animal species protected under the ESA, species proposed or candidates for such protection, and species of concern; species listed by the state of Washington and elsewhere as threatened, endangered, sensitive, candidate, or monitor; State priority habitats where the action is proposed; marine mammals protected by the MMPA; commercial fish and their essential habitats protected under the *Magnuson-Stevens Fishery Conservation and Management Act*; and bird species protected under the *Migratory Bird Treaty Act* and *Bald and Golden Eagle Protection Act.* Federal- and state-listed species on the PNNL-Richland campus and PNNL-Sequim campus are listed in Table 1 and Table 2, respectively. No projects violated related federal or state laws, regulations, or conservation priority guidance.

Staff ecologists performed pedestrian surveys of vegetation resources found at the PNNL-Sequim campus in 2024 and recorded 27 plant species previously unobserved on the campus. Staff ecologists performed pedestrian and visual reconnaissance surveys of biological resources found on the undeveloped portions of the PNNL-Richland campus in 2023, except for the riparian zone adjacent to the Columbia River, with the most recent survey occurring from May through August 2018. The primary objective of the field surveys was to determine the occurrence of the plant and animal species and habitats of concern for project-specific biological resource reviews. Lists of plant and animal species identified on the undeveloped portions of the PNNL-Richland campus from 2009 to 2023, and at the PNNL-Sequim campus from 2006 to

2024, and their status are provided in Appendix A and Appendix B, Table A.1 through Table B.3, respectively.

2.6.2.1 Aquatic Invasive Species Interception

Several nonnative invasive aquatic species identified by the WDFW (2001) are of concern for boaters in Washington State, including staff at PNNL operating research watercraft, and are addressed by PNNL's Aquatic Invasive Species Interception Program. These include some "Prohibited Level 1 Species" and "Prohibited Level 3 Species" listed by the state of Washington (WAC 220-640-030 and WAC 220-640-050, respectively). Prohibited Level 1 and Level 3 species are considered to pose an invasive risk that is either a high (Level 1) with a priority for an expedited response or moderate to high (Level 3) with a coordinated, species-specific response (RCW 77.135.030). Prohibited Level 1 species include zebra mussels (*Dreissena polymorpha*) and quagga mussels (*D. rostriformis bugensis*). Prohibited Level 3 species include New Zealand mud snail (*Potamopyrgus antipodarum*) and all other Dreissenid mussel species. PNNL's Aquatic Invasive Species Interception Program also includes several invasive or potentially invasive tunicate species (e.g., club tunicate [*Styela clava*]), identified by WDFW (Pleus et al. 2008), and aquatic plant species such as Eurasian water milfoil (*Myriophyllum spicatum*), a Class B noxious weed (WAC 16-750-011). Class B noxious weeds are species designated for control where they are not yet widespread, to prevent new infestations (WNWCB 2025).

PNNL's Aquatic Invasive Species Interception Program prevents the conveyance and dispersal of the species listed above. Water bodies are researched beforehand during the PNNL biological resource review process to determine if there are known invasive species present and if there are any specific state requirements and control programs. In addition, the boat manifest details invasive species known to exist in the body of water where the launch is planned. Watercraft, equipment, and trailers recovered from infested water bodies are either self-inspected or inspected at state-sponsored check stations, decontaminated, and quarantined according to protocols specific to the type or types of infestation: aquatic weed, tunicate, and/or New Zealand mud snail and Dreissenid mussel (Elwell and Phillips 2016). The boat operator is responsible for meeting PNNL invasive species-specific requirements, completing a PNNL Watercraft and Trailer Self-Inspection Form, where applicable, and submitting the inspection form to the boat custodian. Boat custodians notify subsequent boat operators of watercraft condition and status relative to completion of decontamination and quarantine requirements prior to launch.

2.6.2.2 Noxious Weed Control

Several nonnative plant species listed in the state noxious weed list "Class B" or "Class C" noxious weeds (as classified by the state of Washington, WAC 16-750-011 and WAC 16-750-015, respectively) have been identified on the PNNL-Richland campus (Larson and Downs 2009; Thompson et al. 2024; see Appendix A, Table A.1). Class B noxious weeds are species designated for control where they are not yet widespread to prevent new infestations (WNWCB 2025). On the PNNL-Richland campus, Class B species include the following:

- Broadleaf (perennial) pepperweed (*Lepidium latifolium*)
- Burning-bush (kochia) (*Bassia* [*Kochia] scoparia*)
- Cotton (Scotch) thistle (*Onopordum acanthium*)
- Diffuse knapweed (*Centaurea diffusa*)

- Puncturevine (*Tribulus terrestris*)
- Rush skeletonweed (*Chondrilla juncea*)
- Russian knapweed (*Rhaponticum [Acroptilon] repens*)
- Yellow starthistle (*Centaurea solstitialis*).

Rush skeletonweed occurs throughout areas of natural vegetation on the PNNL-Richland campus and is most prevalent in previously disturbed areas or along road edges. It spreads by seed and by root, forming dense stands if left unchecked. Diffuse knapweed occurs sporadically throughout areas of natural vegetation and reproduces primarily by seed. Russian knapweed reproduces by seed and roots; it can form dense stands where water is adequate. Yellow starthistle (Figure 12) is an annual or biennial plant that reproduces by seed; scattered, relatively small patches occur throughout undeveloped areas of the site. Cotton thistle was first identified on the PNNL-Richland campus in 2016. It reproduces by seed. Broadleaf pepperweed, a perennial that spreads by seed and root, occurs in seasonally moist areas (e.g., low areas or near the river). Burning-bush and puncturevine are annual plants typically found along road edges.

Figure 12. Yellow Starthistle (*Centaurea solstitialis*) in Bloom

Class C noxious weeds are already widespread, and control is determined on a case-by-case basis at the county level (WNWCB 2025). These species are not typically targeted for control on the PNNL-Richland campus. Known Class C species on the PNNL-Richland campus are as follows:

- Baby's breath (*Gypsophila paniculata*)
- Field bindweed (*Convolvulus arvensis*)
- Longspine sandbur (*Cenchrus longispinus*)
- Common groundsel (*Senecio vulgaris*)
- Common St. Johnswort (*Hypericum perforatum*)
- Creeping (Canada) thistle (*Cirsium arvense*)
- Heart-podded hoarycress (*Lepidium draba*)
- Himalayan blackberry (*Rubus bifrons*)
- Reed canarygrass (*Phalaris arundinacea*)
- Russian olive (*Elaeagnus angustifolia*)
- Tree of heaven (*Ailanthus altissima*).

PNNL has carried out a noxious weed control program on the PNNL-Richland campus since 2010. Certified Facilities and Operations staff, in coordination with staff ecologists, use hand-spraying methods (spot application of herbicide to individual weeds within a surveyed/traversed area) to control populations of Class B noxious weeds in upland areas of natural vegetation. The hand-spraying method (see Figure 13) facilitates avoidance of nontarget (i.e., native)

species. The herbicide Milestone™ is generally used (along with water conditioner, drift control agent, surfactant, and blue visibility dye). In addition, hand-pulling or chopping is used opportunistically on species for which mechanical control is effective (e.g., annual or biennial plants with limited occurrence such as yellow starthistle and cotton thistle).

Areas treated in 2024 are shown in Figure 14. In 2024, the primary weed species targeted for herbicide applications were rush skeletonweed and Russian knapweed. Herbicide applications were conducted over 4 days in April 2024.

Figure 13. Field Crew Applying Targeted Herbicides at the PNNL-Richland Campus

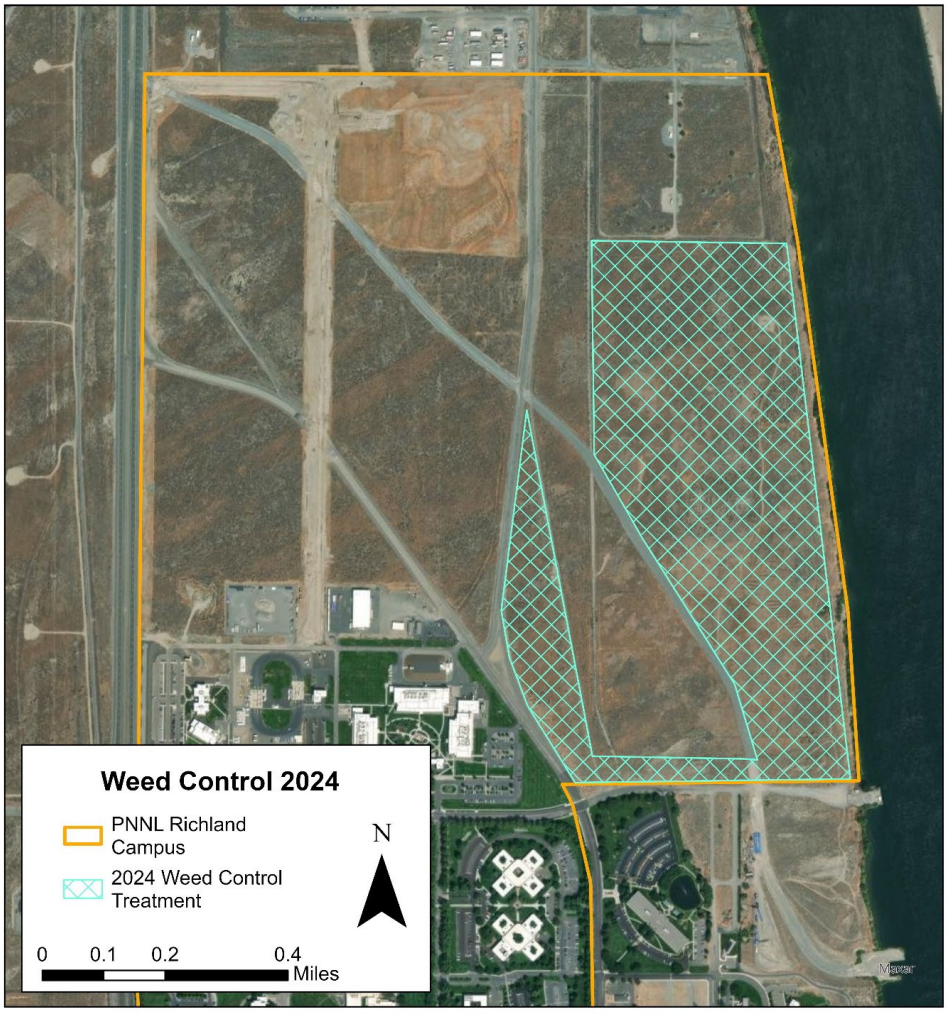


Figure 14. Areas Treated for Noxious Weeds on the PNNL-Richland Campus in 2024

2.6.3 Cultural Resources

NHPA (54 U.S.C. § 300101 *et seq.*)	
The NHPA requires federal agencies to consider the effects of their project on any district, site, building, structure, or object that may be eligible for inclusion in the National Register of Historic Places to avoid, minimize, or mitigate these impacts. Program activities include conducting cultural resources reviews for proposed Facilities and Infrastructure Operations and research projects, and conditions monitoring of Historic Properties under the jurisdiction or control of DOE. NHPA reviews of PNNL activities are conducted by PNNL on behalf of PNSO which acts in the role of Lead Federal Agency.	Compliance Activities • Conducted 116 cultural resources reviews for newly proposed and funded Facilities and Infrastructure Operations and research activities. • Conducted site conditions monitoring of archaeological resources at the PNNL Sequim and Richland campuses. • Conducted conditions monitoring of Historic Built Environment resources at the PNNL-Richland campus.

2.6.3.1 Project Review

The PNNL cultural resources program supported 116 projects by performing compliance reviews. A breakdown of reviews by location is shown in Figure 15. Of the 116 reviews completed, 26 (22%) were conducted for projects at the PNNL-Richland campus, 27 (23%) were conducted for projects at the PNNL-Sequim campus, 7 (6%) were conducted for projects on the Hanford Site, and 56 (48%) were conducted for projects deployed at off-site locations across 23 states. Of the 72 cultural reviews conducted, 31 (26%) were completed in accordance with provisions of memoranda of agreement and/or Programmatic Agreements for the PNNL-Richland or PNNL-Sequim campuses (DOE-PNSO 2018, DOE-PNSO 2021b).

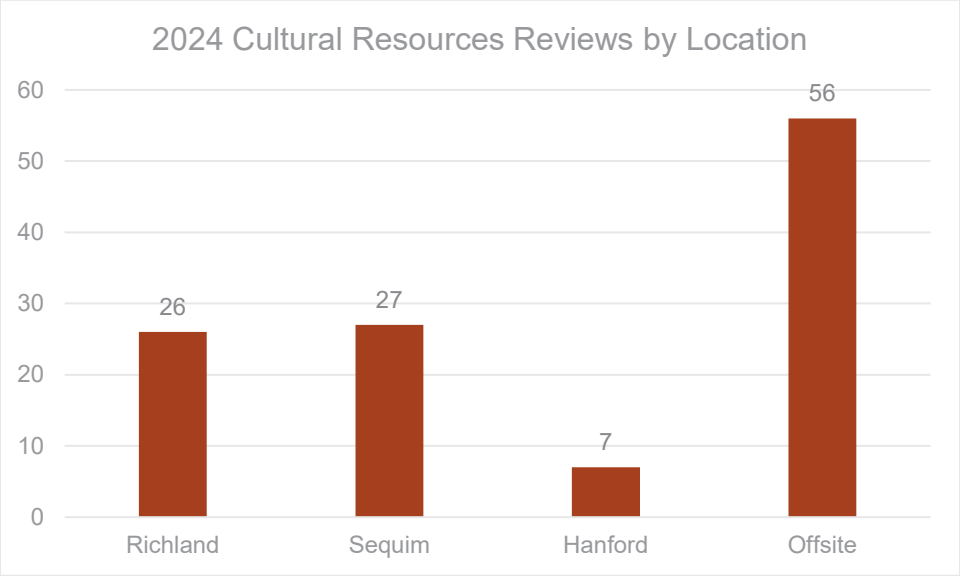


Figure 15. Number of Cultural Reviews by Location

The PNNL cultural resources program assists PNSO with tribal consultation in accordance with NHPA, the Native American Graves Protection and Repatriation Act of 1990, and DOE-O 144.1. PNSO consults with the Confederated Tribes of the Colville Reservation, Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes and Bands of the Yakama Nation, the

Nez Perce, and the Wanapum Band for undertakings on the PNNL-Richland campus. For undertakings on the PNNL-Sequim campus, PNSO consults with the Hoh Indian Tribe, Jamestown S'Klallam Tribe, Lower Elwha Klallam Tribe, the Lummi Nation, Makah Indian Tribe of the Makah Indian Reservation, Port Gamble S'Klallam Tribe, and the Quileute Nation. Cultural resource reviews conducted under the NHPA require consultation with the State Historic Preservation Officer for the state in which the project will take place. In 2024, cultural reviews were conducted for projects in 23 states.

2.6.3.2 Conditions Monitoring

Archaeological and historic resources at the PNNL-Richland and PNNL-Sequim campuses have the potential to be impacted by both natural and human caused disturbances. Annual conditions monitoring is conducted by PNNL cultural resources program to document evidence of any such disturbances and make management recommendations to minimize, rectify, or avoid impacts. Conditions monitoring is conducted in partial fulfillment of DOE-PNSO's responsibilities under the *Archaeological Resources Protection Act* (ARPA) and NHPA.

Results from annual conditions monitoring conducted on the PNNL-Richland campus in November 2024 and on the PNNL-Sequim campus in August 2024 are shown in Table 9. Monitoring was conducted by the PNNL cultural resources staff and Tribal cultural resources staff. Monitoring personnel inspected all relevant resources to assess conditions and document potential changes to the site caused by human or natural impacts. In addition, information was collected and added to file records to update the current documentation for the sites.

Table 9. Results from Annual Conditions Monitoring Activities on the PNNL-Richland and PNNL-Sequim Campuses in 2024

Campus	Site/Resource	Resource Type	Adverse Impacts
Richland	45BN28/104	Archaeology	No
Richland	45BN105	Archaeology	No
Richland	45BN1426	Archaeology	No
Richland	AUD	Architecture	No
Richland	EDL	Architecture	No
Richland	LSL2	Architecture	No
Richland	MATH	Architecture	No
Richland	ROB	Architecture	No
Richland	PSL	Architecture	No
Sequim	45CA227	Archaeology	No
Sequim	45CA278	Archaeology	No

None of the annual condition monitoring activities identified impacts that would diminish the historic or archaeological significance of any observed resources. In general, sensitive archaeological remains appear to be free from unauthorized access, looting, or damage from

human activities. Evidence of some nominal disturbances from erosion or animal activities were observed for resources at both the PNNL-Richland and PNNL-Sequim campuses. Monitoring of historic architectural resources at the PNNL-Richland campus identified wear, disrepair, or damage to some architectural elements. These areas will continue to be monitored and, if they are found to diminish the historic character or integrity of the historic architectural resources, corrective actions may be developed. Annual conditions monitoring of archaeological and historic resources at the PNNL-Richland and PNNL-Sequim campuses will continue to be performed to make sure these non-renewable resources are protected.

2.7 Other Major Issues and Accomplishments

DOE Order 232.2A and The Energy Independence and Security Act of 2007 activities in FY 2024 are discussed in this section.

2.7.1 DOE Order 232.2A, Occurrence Reporting and Processing of Operations Information

DOE Order 232.2A requires reporting of incidents that could adversely affect the public or workers, the environment, or the mission that occur at DOE sites and/or during DOE operations. Significant releases of radiological or hazardous substances above established regulatory limits requiring regulatory agency notification (Section 2.12) and receipt of formal or informal regulator correspondence alleging violations (Section 2.2) must be reported to DOE through the reporting system. PNNL reports all incidents to DOE as required.

2.7.2 Energy Independence and Security Act of 2007

EISA (42 U.S.C. § 17001)

The EISA (42 U.S.C. § 17001) was enacted "… to move the United States toward greater energy independence and security." It promotes the production of clean, renewable fuels, R&D of biofuels, improved vehicle technology, energy savings through improved standards including those for appliances and lighting, improved energy savings in buildings and industry, reduction of stormwater runoff, water conservation and protection, development and extension of new technologies (including solar, geothermal, marine and hydrokinetic, and energy storage), carbon capture and sequestration research, and energy transportation and infrastructure provisions.	Compliance Activities • In FY 2024, PNNL completed required evaluation in two buildings that are subject to EISA Section 432 continuous (4-year cycle) comprehensive energy and water requirements. • Whole-building metering for electricity, natural gas, and water are installed in DOE-owned buildings, enabling facility system analyses. Stormwater management practices are implemented to promote water drainage and reduce runoff (see Section 2.5.2 of this report). • PNNL total electricity supply exceeds the requirement that renewable electric energy should account for not less than 7.5% of total electric consumption. PNNL's purchases the majority of the electricity from the City of Richland, which has a similar resource mix as the BPA. Based on the BPA 2021, 2022, and 2023 fuel mix reports, the average of BPA-supplied electricity is approximately 94% renewable, including power sources from hydroelectric, wind, and nuclear (PNNL 2024).

2.8 Natural Resources and Conservation Programs and Projects

Opportunities to deploy nature-based solutions, promote habitat connectivity, and preserve and restore ecosystem function are limited by the small size of both the PNNL-Richland and PNNL-Sequim campuses coupled with their juxtaposition (along major waterways) in the landscape. Use of previously disturbed or degraded habitats for both development and research are encouraged, and long-term development is planned at the landscape level to the extent practicable. At the PNNL-Richland campus, loss of mature shrub steppe habitats is minimized through compensatory mitigation that enables more strategic investments to promote habitat connectivity nearby. Both federal (i.e., USFWS, NMFS, etc.) and state (i.e., WDNR, WDFW, etc.) regulatory agencies are consulted for actions that have the potential to affect natural resources in order to preserve ecosystem functions.

2.9 Remediation

In FY 2024 PNNL did not carry out remediation tasks.

2.10 Site Resilience

The DOE-Battelle prime contract for management and operation of PNNL (DOE-PNSO 2024) continues to require the implementation of applicable environmental management system (EMS) requirements, including associated performance goals, objectives, and systems.

Section 3.4 highlights PNNL's FY 2024 accomplishments and continuous improvement opportunities related to DOE's energy resiliency and efficiency goals.

2.11 Continuous Release Reporting

A continuous release is a hazardous release exceeding reporting thresholds under CERCLA regulations (40 CFR 302.8) that is "continuous" and "stable in quantity and rate" for which reduced reporting requirements apply. There were no continuous releases on the PNNL-Richland campus or the PNNL-Sequim campus in 2024.

2.12 Unplanned Releases

No environmentally significant releases occurred at PNNL in 2024.

2.13 Summary of Permits

Table 10 summarizes air, liquid, and hazardous waste permits for the PNNL-Richland and PNNL-Sequim campuses during CY 2024. Project-specific permits also are acquired but are not reflected in the table because they are usually of limited term and scope.

Table 10 PNNL Air, Liquid, and Hazardous Waste Permits, 2024

Issuer	Permit #	Location(s) Regulated	Activity(ies) Regulated	Expiration Date[a]
Air Emissions				
Washington State Department of Health	FF-01[b]	PNNL-occupied locations on the Hanford Site	Radioactive air emissions	10/20/2027
Washington State Department of Health	RAEL-005	PNNL-Richland campus	Radioactive air emissions	1/1/2026
Washington State Department of Health	RAEL-014	PNNL-Sequim campus	Radioactive air emissions	1/1/2028
Washington State Department of Ecology	00-05-006, Renewal 3	PNNL-occupied locations on the Hanford Site	Radioactive and nonradioactive air emissions	8/1/2024
Benton Clean Air Agency	Order 2019-0005, Rev. 2	PNNL Site – EMSL, Physical Sciences Facility Complex, Energy Sciences Center, Life Sciences Laboratory II Halogenated Solvent Degreaser, Grid Storage Launchpad	Nonradioactive air emissions	None
Benton Clean Air Agency	Order 2012-0017	PNNL-Richland Campus – Building Operations	Nonradioactive air emissions	None
Benton Clean Air Agency	Order 2012-0016	PNNL-Richland Campus – R&D Pilot-Scale Processes and Field Experiments	Nonradioactive air emissions	None
Benton Clean Air Agency	Order 2007-0006, Rev. 1	Life Sciences Laboratory II – Building Operations	Nonradioactive air emissions	None
Washington State Department of Ecology	Order 02NWP-001	300 Area Standby Generators (Radiochemical Processing Laboratory & 331 Buildings)	Nonradioactive air emissions	None
Washington State Department of Ecology	Order 97NM-138	200/300 Area Boilers (331, 325, & 318 Buildings)	Nonradioactive air emissions	None
Olympic Region Clean Air Agency	Order of Approval 13NOI968	PNNL-Sequim Campus Standby Generators	Nonradioactive air emissions	None
Liquid Effluents[c]				
City of Richland	CR-IU001	PNNL-Richland campus	Liquid effluent discharges to city sewer	8/15/2025
City of Richland	CR-IU005	W.R. Wiley Environmental and Molecular Sciences Laboratory	Liquid effluent discharges to city sewer	1/15/2027
City of Richland	CR-IU011	Physical Sciences Facility (buildings north of Horn Rapids Road)	Liquid effluent discharges to city sewer	12/15/2028
Washington State Department of Ecology	WA0040649[l]	PNNL-Sequim campus	Treated liquid effluent discharges to Sequim Bay	11/30/2022
Washington State Department of Ecology	WAR314056	PNNL Sequim Campus Storage Facility	Construction stormwater potentially leaving construction site	12/31/2025

(a) Expired permits generally remain in force while renewal applications are processed by the issuing agency.
(b) Permit is issued to DOE-Richland Operations Office (DOE-RL) and/or its contractor(s). PNNL is obligated to comply with this permit through an operating agreement between the DOE-RL and PNSO.
(c) PNNL also conducts activities in leased facilities that have wastewater permits issued to the owner. These permits are not listed here, but compliance-related impacts from PNNL activities are included in this report.

3.0 ENVIRONMENTAL MANAGEMENT SYSTEM

PNNL has a mature, robust EMS integrated into PNNL's Integrated Safety Management Program to assure that staff are aware of project scope, risks/hazards, and controls available to address functions, processes, and procedures used to plan and perform work safely. The outcome of the integration is the accomplishment of PNNL missions while protecting the worker, the public, and the environment.

The EMS performs regulatory analysis, implements and monitors compliance with permits, and develops laboratory systems to assist staff in conducting research and operational activities that comply with regulatory and contractual requirements, as well as recognized standards.

The EMS oversees the following program areas within PNNL:

- Biological resource management
- Chemical air emissions
- Controlled substances management
- Cultural resource management
- Drinking water
- Environmental research permitting
- EPCRA reporting
- FIFRA
- Liquid effluents
- NEPA/SEPA compliance
- Pollution prevention
- Radioactive air emissions
- Sample management
- Start-clean, Stay-clean
- TSCA
- Underground storage tanks
- Waste management.

A key element of the EMS is deployment of environmental subject matter experts to work with research and facility management to help implement environmental requirements and solve environmental management problems.

The benefits of implementing a well-performing EMS include enabling upfront planning to incorporate energy resiliency and efficiency, and pollution prevention opportunities, early identification of environmental requirements to avoid project delays, high-level integration with existing programs to improve efficiency, reduced operational costs, and enhanced public recognition as a "good neighbor."

3.1 Environmental Protection Programs, including Training and Community Outreach and Performance Measurement

See Section 4.0 for radiological monitoring, and see Section 5.0 for non-radiological monitoring.

3.2 Site Planning Progress

PNNL developed the FY 2025 Site Sustainability Plan (PNNL 2024) in accordance with the DOE FY 2025 Site Sustainability Plan Instructions issued in August 2024. Since then, PNNL has refreshed its strategy in alignment with DOE's current priorities, placing greater emphasis on energy resiliency and efficiency. In FY 2024, PNNL continued to strive for excellence in meeting DOE's energy resiliency and efficiency goals. Key achievements and efforts to advance DOE's goals are emphasized in Sections 3.2.1 through 3.2.4.

Table 11 summarizes PNNL's performance status, planned actions, and contribution toward DOE's goals in energy management, water management, high performance buildings, and acquisition and procurement.

Table 11. PNNL FY 2024 Energy Resiliency and Efficiency Goals and Planned Actions

Prior DOE Goal	Current Performance Status	Planned Actions & Contribution
Energy Management		
Reduce energy intensity (Btu per gross square foot [gsf]) in goal subject buildings by 50% by the end of FY 2030.	A 7.4% decrease versus last year due to reverting to standard (pre-Covid) filters to reduce equipment wear and tear, retuning the fresh air intake to approximately five air changes per hour for office buildings, and resuming nighttime and weekend heating, ventilating, and air conditioning setbacks for offices spaces.	PNNL will continue implementing electrification projects and cost-effective energy conservation measures.
Water Management		
Reduce potable water use intensity (WUI) (gal/gsf).	52% reduction in WUI from FY 2007 baseline; the WUI remains the same compared to FY 2023.	PNNL will continue to reduce potable WUI.
Reduce non-potable freshwater consumption (gal) for industrial, landscaping, and agricultural (ILA).	35% increase in ILA usage from FY 2011 baseline; 15% increase compared to FY 2023.	The increase in use is largely due to a new building coming online and the repair of a mainline leak. New buildings will continue to impact ILA usage. PNNL will continue to design landscape with minimal ILA usage, where appropriate.

Prior DOE Goal	Current Performance Status	Planned Actions & Contribution
High Performance Buildings		
Increase the number of owned buildings that are compliant with the Guiding Principles for Sustainable Federal Buildings.	Completed the documentation for the Grid Storage Launchpad (GSL) building in FY 2024 in accordance with the 2020 Guiding Principles for Sustainable Federal Buildings (Guiding Principles).	All new construction of DOE-owned buildings greater than 25,000 gsf will meet the Guiding Principles. PNNL will also look for opportunities to use best practices from the Guiding Principles for buildings under 25,000 gsf and implement, where practical.
Acquisition & Procurement		
Promote responsible and energy efficient acquisition and procurement to the maximum extent practicable, ensuring responsible and energy efficient clauses are included as appropriate.	100% of eligible contracts contain the responsible and energy efficient acquisition clause.	Continue being proactive with responsible and energy efficient acquisition.

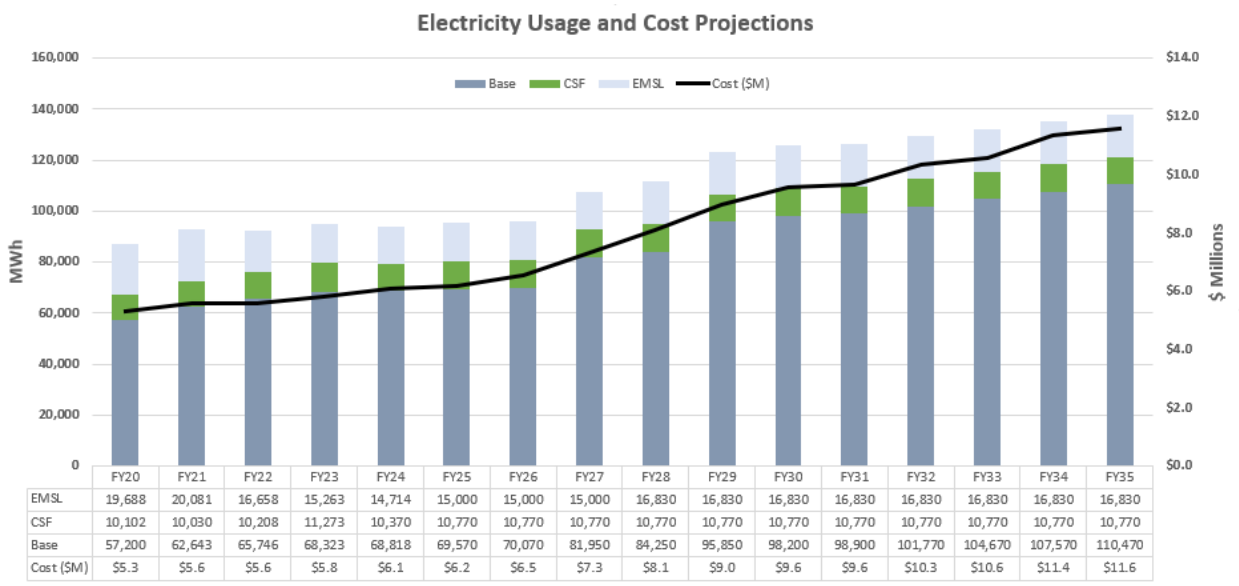
3.2.1 Reducing Energy Use

Leveraging the DOE Federal Energy Management Program 50001 Ready Energy Management System framework, PNNL has significantly improved its capabilities in identifying, monitoring, tracking, and enhancing energy conservation measures. Recognition from DOE's 50001 Ready program for the third consecutive year in early 2025 underscores the effectiveness of the EMSs at the PNNL-Richland and PNNL-Sequim campuses.

In fiscal year (FY) 2024, Pacific Northwest National Laboratory's (PNNL's) energy intensity decreased by 7.4% from the prior year, with a usage of 173.9 thousand British thermal units (kBtu)/gross square foot (gsf).

The primary contributor to the decrease in energy use is the rollback of facility controls to pre-pandemic levels. This includes reverting to standard filters to reduce equipment wear and tear, returning the fresh air intake to approximately five air changes per hour for office buildings, and resuming nighttime and weekend heating, ventilating, and air conditioning setbacks for office spaces. Additionally, the PNNL-Richland campus also experienced milder summer and winter weather compared to last year.

Figure 16 shows the total electricity use in megawatt-hour (MWh), including the actual electricity use in the High-Energy Mission-Specific Facility, and associated costs from FY 2020 through FY 2024 as well as the projection through FY 2035. The projection was determined based on planned energy conservation, and new building construction.



	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35
EMSL	19,688	20,081	16,658	15,263	14,714	15,000	15,000	15,000	16,830	16,830	16,830	16,830	16,830	16,830	16,830	16,830
CSF	10,102	10,030	10,208	11,273	10,370	10,770	10,770	10,770	10,770	10,770	10,770	10,770	10,770	10,770	10,770	10,770
Base	57,200	62,643	65,746	68,323	68,818	69,570	70,070	81,950	84,250	95,850	98,200	98,900	101,770	104,670	107,570	110,470
Cost ($M)	$5.3	$5.6	$5.6	$5.8	$6.1	$6.2	$6.5	$7.3	$8.1	$9.0	$9.6	$9.6	$10.3	$10.6	$11.4	$11.6

Figure 16. Electricity Usage and Cost Projections

3.2.2 Water Management

3.2.2.1 Potable Water

In FY 2024, the PNNL-Richland campus potable WUI remained the same as in FY 2023. The current WUI, 33.59 gallons per gross square foot (gal/gsf), is 52% less than the FY 2007 baseline WUI of 70.1 gal/gsf.

3.2.2.2 Industrial, Landscaping, and Agricultural Water

In FY 2024, approximately 98% of PNNL-Richland campus ILA water was supplied from the Columbia River, either through a PNNL river irrigation pumping plant or from the City of Richland's river irrigation pumping plant. The remaining irrigation is provided by potable water.

PNNL's FY 2024 total ILA water usage of 239.5 million gallons is about 35% higher than the FY 2011 baseline and 15% higher than the FY 2023 usage of 207.8 million gallons. This is primarily due to an earlier watering season in FY 2024 as well as the addition of the new GSL building and its associated landscaping. The repair of a mainline leak in late FY 2023 also allowed a full season of watering in FY 2024.

PNNL implements best practices in managing ILA water, such as using soil moisture measurements and other soil analysis data for irrigation setting and reviewing and adjusting irrigation water settings/schedule settings, as needed.

3.2.3 Transition to Energy Efficient Campus

Throughout FY 2024, PNNL has advanced toward its objective of energy-efficient campus. Notably, Another high-performance building, the GSL, was completed on the PNNL-Richland campus. This building is approximately 93,000 gsf and is part of PNNL's first district energy system using the Heat Transfer Building (HTB) and heat transfer water as primary sources for

building heating and cooling. An electric boiler has been incorporated for backup heating. The GSL also meets the 2020 Guiding Principles for Sustainable Federal Buildings requirements.

Also on the PNNL-Richland campus, PNNL also completed one deep energy retrofit project in the Testing and Analysis Laboratory where PNNL replaced oversized natural-gas-fired boilers in the building formerly known as the Battelle Inhalation Laboratory with air source heat pumps and electric boilers for backup. The new system is expected to achieve an energy use intensity reduction of approximately 76%, which is well above the 40% reduction requirement.

3.2.4 Resilient Operation

Resilience planning is an iterative and continuous process. During FY 2022, PNNL completed two key resilience planning processes—resiliency planning using the Technical Resilience Navigator tool and the Vulnerability Assessment and Resilience Plan, which identified PNNL top risks and provided the blueprint to mitigate those risks and strengthen resilient operations.

Central to this plan was implementation of energy district energy systems as one of the solutions to elevate resilient operations. In FY 2023, PNNL began operation of its first district energy system. The Energy Science Center features an energy reducing design that captures and uses waste heat from EMSL supercomputer and research equipment via the creation of the HTB. In the spring of 2024, this system was expanded with connections to the Grid Storage Launchpad (GSL) building. When optimized, this district energy system is expected to reduce PNNL's carbon footprint by approximately 3.2 million pounds of CO_2 equivalent per year. This is approximately 4% of PNNL's total Scope 1 and 2 emissions.

3.3 Environmental Operating Experience

Continuous improvement in environmental operations is a goal of PNNL. During CY 2024, a PNNL ambient air sampling station required relocation, and, during its assessment, a second station was recommended for relocation. Construction of new office space is underway at the north end of the PNNL-Richland campus, requiring an ambient air particulate monitoring station located in the vicinity to be moved from within the new construction footprint. Radiological atmospheric release modeling was done to determine appropriate relocation to maintain adequate nominal emissions monitoring. During this computational modeling, it was observed that, because of updates in meteorological conditions and effluent source reconfigurations, one other ambient air monitoring station should be moved to a better nominal location. Stations PNL-2 and PNL-3 both were relocated in 2024 (see section 4.5.1).

3.4 Accomplishments, Awards, and Recognition

In FY 2024, PNNL received several awards and recognitions that underline its commitment to achieving excellence in energy resiliency and efficiency:

- The Energy Sciences Center/HTB project won the Federal Energy Management Program Federal Energy and Water Management Award.
- The 2024 Electronic Product Environmental Assessment Tool (EPEAT) Purchaser Award from the Global Electronics Council.
- 50001 Ready Energy Management System.

4.0 ENVIRONMENTAL RADIOLOGICAL PROTECTION PROGRAM & DOSE ASSESSMENT

This section describes the environmental monitoring programs for radiological constituents and the associated estimated dose assessments for the PNNL-Richland and PNNL-Sequim campuses. Reported doses are calculated rather than measured, so they represent potential or estimated doses.

4.1 Radiological Discharges and Doses

PNNL liquid and air discharge activities are described in this section.

4.1.1 Radiological Liquid Discharges and Doses

PNNL prohibits the discharge of liquid waste streams that contain radiological material to sanitary sewer systems, groundwater, or surface water. Wastewater in PNNL facilities is expected to be free of radioactive materials but may have the potential for contamination in the event of a failure of an engineered barrier or administrative control. In facilities in which wastewater generated in radiologically controlled areas has the potential to become contaminated, it is discharged to retention tanks. After each retention tank is filled, it is isolated, and its contents are analyzed for radiological components. The results of the analyses are compared to screening limits in WAC 246-221-190, "Disposal by Release into Sanitary Sewerage Systems." If the analytical results indicate that the concentrations of radiological components in the wastewater are below the WAC screening limit, the wastewater is released to the City of Richland's sanitary sewer system. If the analytical results indicate that the concentrations of radiological components in the wastewater are above the WAC screening limit, the wastewater is transported to a waste treatment facility. These wastes may be transferred to a permitted waste treatment facility that is authorized to receive radiological material. Further evaluation is then performed to determine the source of the radiological component in the discharge.

If a waste stream is identified as containing very low levels of radioactive material, a request to authorize the discharge of this waste stream to the sewer system would be submitted to the City of Richland. The City of Richland can authorize the discharge of individual waste streams that contain very low levels of radiological material to the sewer system, as appropriate. As described in Section 4.1.2, there is currently only one authorized discharge of a liquid waste stream potentially containing radiological material to the City of Richland sanitary sewer.

4.1.2 Annual Report for DOE Order 458.1

This report has been prepared in accordance with DOE Order 458.1 (DOE CRD 458.1, Section [2][g][8][a][7]), which requires that the contractor prepare and provide a report that describes and summarizes discharges of liquids potentially containing radionuclides from DOE activities into nonfederally owned sanitary sewers. PNNL has one waste stream that has the potential for containing radionuclides that is approved for discharge to the City of Richland's sanitary sewer system. This waste stream is associated with fume hood washdown operations in the PSF.

On November 2, 2010, the City of Richland authorized the release of "… very low levels of volumetrically released radioactive material." These volumetrically released radioactive materials can be handled without concern for measurable contamination and without radiological postings or labeling pursuant to 10 CFR Part 835.

The total amount of radioactive material used in each fume hood is very small. Each washdown is estimated to be 190 L (50 gal). The worst-case concentration of radioactivity in each washdown is estimated to be 7.1×10^{-7} pCi/L. In 2024, the fume hoods were washed down an estimated total of 28 times. The screening criteria, as referenced in the City of Richland's Industrial Wastewater Discharge Permit CR-IU011 for PSF, are based on WAC 246-221-190, Appendix A, Table III. The screening limits for each washdown are 20 pCi/L for gross alpha activity and 100 pCi/L for beta/gamma activity. If all activity in each washdown is conservatively presumed to be alpha activity, the concentration of radioactive material is more than a million times less than these WAC screening limits. This affirms that the washdowns are negligible in terms of the screening limits for discharge to the City of Richland's sewer systems.

4.1.3 Radiological Air Discharges and Doses

The federal regulatory standard for a maximum dose to any member of the public is 10 mrem/yr (0.1 mSv/yr) EDE. The standard is set forth in 40 CFR Part 61, Subpart H, and applies to radionuclide air emissions other than radon from DOE facilities.

Washington State has adopted the federal dose standard of 10 mrem/yr (0.1 mSv/yr) EDE in WAC 246-247-040(1). In addition to the maximum dose attributable to radionuclides emitted from point sources, WAC 246-247-060(6) requires that the dose to the MEI include doses attributable to fugitive emissions, radon, and nonroutine events.

Radionuclide air emissions are routinely sampled and tracked at the PNNL-Richland campus and routinely tracked at the PNNL-Sequim campus. Regulatory compliance reporting and monitoring results are reported in an annual air emission report for each location (Hay et al. 2025, Snyder, Bisping, Klein, et al. 2025). CY 2024 data are summarized in the following sections.

4.1.3.1 Contributions from PNNL-Richland Campus

Operations are registered with the state of Washington under RAEL-005. For CY 2024, the PNNL-Richland campus MEI location was 0.65 km (0.40 mi) south-southeast of PSF relative to the 3410 Building. Table 12 lists the relative contributions of each nuclide to the MEI dose. There were no unplanned releases from the PNNL-Richland campus in CY 2024.

Table 12. PNNL-Richland Campus Emissions and Dose Contributions by Radionuclide, 2024

Radionuclide[a]	Releases (Ci)	Campus MEI Dose (mrem EDE)	Percent of EDE
Gross α[b]	1.0×10^{-7}	4.1×10^{-6}	32%
Gross β[c]	1.3×10^{-6}	5.2×10^{-6}	41%
Hydrogen-3 (tritium)	1.2×10^{-4}	1.6×10^{-8}	<1%
Manganese-54	3.7×10^{-10}	1.9×10^{-10}	<1%
Iron-55	9.6×10^{-8}	9.8×10^{-10}	<1%
Cobalt-60	1.2×10^{-8}	3.2×10^{-8}	<1%
Zinc-65	1.3×10^{-10}	1.8×10^{-10}	<1%
Rubidium-83	5.0×10^{-9}	9.9×10^{-10}	<1%
Yttrium-88	6.0×10^{-10}	3.3×10^{-10}	<1%
Xenon-131m	2.0×10^{-4}	1.3×10^{-9}	<1%
Xenon-133	2.0×10^{-4}	4.8×10^{-9}	<1%
Xenon-133m	4.1×10^{-10}	6.9×10^{-15}	<1%
Cesium-137	2.9×10^{-10}	3.8×10^{-9}	<1%
Cerium-141	9.0×10^{-8}	4.7×10^{-10}	<1%
Lead-210	4.7×10^{-10}	7.7×10^{-9}	<1%
Radon-222	2.2×10^{-7}	4.1×10^{-10}	<1%
Thorium-232	3.0×10^{-12}	3.4×10^{-10}	<1%
Uranium-233/234	1.1×10^{-7}	3.9×10^{-7}	3%
Uranium-235	1.7×10^{-11}	1.9×10^{-10}	<1%
Plutonium-238	1.2×10^{-8}	4.3×10^{-7}	3%
Plutonium-239/240	6.2×10^{-9}	2.4×10^{-7}	2%
Americium-241	9.4×10^{-9}	3.3×10^{-7}	3%
Americium-243	6.2×10^{-11}	2.1×10^{-9}	<1%
Curium-243/244	8.7×10^{-9}	2.2×10^{-7}	2%
All other nuclides	3.9×10^{-8}	4.5×10^{-10}	<1%
PIC-5 emissions – VRRM	NA	9.4×10^{-7}[d]	7%
PIC-5 emissions – NDRM	NA	6.6×10^{-8}[d]	1%
PIC-5 emissions – Facilities Restoration	NA	8.4×10^{-7}[d]	7%
PIC-5 emissions – SIOC[d]	NA	0	0%
Total[e]	**5.2×10^{-4} Ci**	**1.3×10^{-5} mrem EDE**	**100%**

(a) Release information available in Snyder, Bisping, Klein, et al. (2025).
(b) Gross alpha from PSF emission unit sampling assumed to be Pu-239 for dose modeling.
(c) Gross beta from PSF emission unit sampling assumed to be Cs-137 for dose modeling.
(d) The PIC-5 emission doses are assigned based on permit value. The SIOC emission sources were not implemented in 2024. The SIOC PIC-5 permit has been alternatively referred to as the LLS PIC-5 permit.
(e) Totals may not add up to value indicated due to rounding.
NA = not applicable.
To convert Ci to GBq, multiply Ci by 37. To convert mrem to mSv, multiply mrem by 0.01.

Emissions were determined from both sampling and, for nonsampled emissions, using the method described in 40 CFR Part 61, Appendix D. The CAP88-PC Version 4.1.1 code was used for estimating dose. The MEI annual dose of 1.3×10^{-5} mrem (1.3×10^{-7} mSv) effective dose[3] is more than 100,000 times smaller than the 10 mrem/yr WAC 246-247 compliance standard. This dose is many orders of magnitude below the average annual individual background dose of 310 mrem (3.1 mSv) from natural terrestrial and cosmic radiation and inhalation of naturally occurring radon (NCRP 2009).

[3] The EDE and effective dose units can be considered equivalent for the purposes of this report and reflect the units calculated by the software used.

The regional collective dose from the PNNL-Richland campus air emissions in CY 2024 also was estimated using CAP88-PC Version 4.1.1. Estimates of population exposure to radionuclide air emissions consider site-specific meteorology and population distributions. The population consists of approximately 605,000 people residing within an 80 km (50 mi) radius of the PNNL-Richland campus (Rose et al. 2023). Pathways evaluated for population exposure include inhalation, air submersion, ground shine, and consumption of food. The CY 2024 total collective dose from radionuclide air emissions estimated from nuclides that originated from the PNNL-Richland campus was 1.3×10^{-4} person-rem (1.3×10^{-6} person-Sv).

4.1.3.2 Contributions from PNNL-Sequim Campus

PNNL-Sequim campus operations for the sitewide minor, fugitive, nonpoint source emission unit is registered with the state of Washington under RAEL-014. For CY 2024, the PNNL-Sequim campus MEI location was 0.23 km (0.14 mi) west of a central PNNL-Sequim campus emission location. This emission location is central to all operations areas at the PNNL-Sequim campus (Figure 3). Radiological operations at the PNNL-Sequim campus emit very low levels of radioactive materials. Table 13 lists the relative contributions to the MEI dose. The 40 CFR Part 61, Appendix D method was used to determine the routine emissions from the PNNL-Sequim campus in CY 2024, which are summarized as gross alpha and gross beta emissions. There were no unplanned emissions or radon emissions from the site during the year. The COMPLY Code (a computerized screening tool for evaluating radiation exposure from atmospheric releases of radionuclides) Version 1.7.1 (Level 4) was used for estimating dose (EPA 1989).

Table 13. PNNL-Sequim Campus Emissions and Dose Contributions, 2024 (Hay et al. 2025)

Radionuclide	Releases[(a)] (Ci)	Dose to MEI (mrem EDE)	Percent of EDE
Gross Alpha (as americium-241)	3.9×10^{-16}	7.0×10^{-13}	97.6%
Gross Beta (as cesium-137)	2.4×10^{-16}	1.7×10^{-14}	2.4%
Total	**6.3×10^{-16}**	**7.2×10^{-13}**	**100%**

[(a)] Emissions based on 40 CFR Part 61, Appendix D methods.

To convert Ci to GBq, multiply Ci by 37; to convert from mrem to mSv, multiply mrem by 0.01.

The dose to the PNNL-Sequim campus MEI was 7.2×10^{-13} mrem (7.2×10^{-15} mSv) EDE. This dose is many orders of magnitude below the average annual individual background dose from natural terrestrial and cosmic radiation and inhalation of naturally occurring radon of 310 mrem (3.1 mSv) (NCRP 2009).

Collective dose was determined for the estimated 2.94 million people who live within 80 km (50 mi) of the PNNL-Sequim campus; about 456,000 of them reside in Canada (Rose et al. 2023). Victoria, British Columbia, is the only major Canadian city within 80 km (50 mi) and is more than 32 km (20 mi) away. The maximum collective dose was determined assuming the total CY 2024 PNNL-Sequim campus curies released were dispersed in the single direction that results in the maximum collective dose. This direction was determined to be toward the west, which only contains U.S. populations. The MEI dose was multiplied by a population-weighted air concentration for a collective dose of 2.0×10^{-12} person-rem (2.0×10^{-14} person-Sv). If the release were dispersed only to the maximum Canadian sector (north-northwest), the maximum estimated Canadian collective dose would be 3.7×10^{-13} person-rem (3.7×10^{-15} person-Sv).

4.1.4 Public Dose Summary

The total public dose includes air, water, and other contributions from facility operations. DOE limits the all-pathway public dose limit to 100 mrem/yr (1,000 μSv/yr) in DOE Order 458.1 (DOE CRD 458.1, Section 2.b.1). Components of the total public dose can include contributions from the radiological air emissions pathway, which is limited to 10 mrem/yr (100 μSv/yr) under 40 CFR Part 61, Subpart H. Radiological liquid effluents for community water systems are limited to 4 mrem/yr (40 μSv/yr) beta/gamma under 40 CFR 141.26. Other dose pathways may be addressed through environmental surveillance activities (e.g., ambient air monitoring, environmental dosimetry, biota [such as native plant and wildlife] surveys, and farm product surveys [such as local milk, produce, and meat]) (DOE 2022a). The 100 mrem (1,000 μSv/yr) public dose limit is about one-third of the typical background exposure of 310 mrem/yr (3,100 μSv/yr) (NCRP 2009).

In 2024, the radiological public dose was assigned only from the air pathway (i.e., resulting from permitted operations on the PNNL-Richland campus and the PNNL-Sequim campus). The radiological dose summary to the public by pathway and total is provided in Table 14.

Table 14. Radiological Dose Summary for PNNL Locations, 2024

Dose Source	PNNL-Richland Campus		PNNL-Sequim Campus	
	MEI Dose (mrem/yr)	Collective Dose (person-rem/yr)	MEI Dose (mrem/yr)	Collective Dose (person-rem/yr)
Air Pathway	1.3×10^{-5}	1.3×10^{-4}	7.2×10^{-13}	2.0×10^{-12}
Water Pathway	0	0	0	0
Other Pathway	0	NA	NA	NA
Total Dose	**1.3×10^{-5}**	**1.3×10^{-4}**	**7.2×10^{-13}**	**2.0×10^{-12}**
All-Pathways Dose Limit	100	NA	100	NA
Natural Background Radiation	310	$1.9 \times 10^{+5}$	310	$9.1 \times 10^{+5}$

NA = not applicable
To convert Ci to GBq, multiply Ci by 37. To convert mrem to mSv, multiply mrem by 0.01.

4.2 Clearance of Property Containing Residual Radioactive Material

Principal requirements for the release of DOE property having residual radioactivity are set forth in DOE Order 458.1, Chg 4, *Radiation Protection of the Public and the Environment*. These requirements are designed to assure the following:

- Property is evaluated, radiologically characterized and, where appropriate, decontaminated before it is released.
- The level of residual radioactivity in property to be released is as near background levels as is reasonably practicable, as determined using DOE's ALARA process requirements, and it meets DOE-authorized limits.
- All property releases are certified, verified, documented, and reported; public participation needs are addressed; and processes are in place to appropriately maintain records.

Property as defined in DOE Order 458.1 consists of real property (i.e., land and structures), personal property, and materials and equipment. PNNL has two paths for releasing property

to the public: (1) preapproved surface contamination limits for releasing property potentially contaminated on the surface and (2) preapproved volumetric release limits for small-volume research samples. A summary of the two release paths is provided in the following sections. No property with detectable residual radioactivity above DOE-authorized limits was released from PNNL during CY 2024.

4.2.1 Property Potentially Contaminated on the Surface

PNNL uses the previously approved surface activity limits (Table 15) derived from guidance in DOE Order 458.1 when releasing property potentially contaminated on the surface.

Table 15. Preapproved Surface Activity Guideline Limits

Radionuclides	Allowable Total Residual Surface Contamination Limits (dpm/100 cm^2)		
	Removable	Total Average	Total Maximum
Uranium-natural, uranium-235, uranium-238, and associated decay products	1,000	5,000	15,000
Transuranic elements,[a] radium-226, radium-228, thorium-230, thorium-228, protactinium-231, actinium-227, iodine-125, iodine-129	20	100	300
Natural thorium, thorium-232, strontium-90, radium-223,radium-224, uranium-232, iodine-126, iodine-131, iodine-133	200	1,000	3,000
Beta/gamma-emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except strontium-90 and others noted above	1,000	5,000	15,000
Select hard-to-detect radionuclides (carbon-14, iron-55,nickel-59, nickel-63, selenium-79, technetium-99, palladium-107, and europium-155)	10,000	50,000	150,000
Tritium organic compounds, surfaces contaminated with tritium gas, tritiated water vapor, and metal tritide aerosols	10,000	NA	NA

[a] All transuranic elements except plutonium-241, which is treated as a beta/gamma-emitter.
dpm = disintegrations per minute
NA = not applicable

As part of research activities conducted in PNNL facilities, PNNL releases hundreds of items of personal property annually for excess to the general public, including office equipment, office furniture, labware, and research equipment. The PNNL Radiation Protection organization has a documented process for releasing items based on process knowledge, radiological surveys, or a combination of both. No property with detectable residual radioactivity above the preapproved surface activity guidelines was released from PNNL during CY 2024.

4.2.2 Property Potentially Contaminated in Volume

PNNL uses preapproved volumetric release limits when releasing small-volume research samples and wastewater potentially contaminated in volume (Table 16). DOE approved these release limits in response to an authorized limits request submitted by PNNL in 2000 and 2007 (DOE-RL 2001; DOE-PNSO 2007). During CY 2024, PNNL released liquid research samples with a total volume on the order of 19 L (5 gal), using the preapproved release limits in Table 16. Generally, the liquid samples were not released to the public but were handled without radiological controls in PNNL facilities. When disposed of, the samples were treated as radioactive waste.

Table 16. Preapproved Volumetric Release Limits

Radionuclide Groups	Volumetric Release Limit (pCi/mL)
Transuranic elements, iodine-125, iodine-129, radium-226, actinium-227, radium-228, thorium-228, thorium-230, protactinium-231, polonium-208, polonium-209, polonium-210	1
Natural thorium, thorium-232	3
Strontium-90, iodine-126, iodine-131, iodine-133, radium-223, radium-224, uranium-232	9
Natural uranium, uranium-233, uranium-235, uranium-238	30
Beta/gamma-emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except strontium-90 and others noted in the rows above	45
Tritium	450

4.3 Addressing Radiation Protection of Biota in ASERs

DOE Order 458.1 directs that DOE sites establish procedures and practices to protect biota, while DOE-STD-1153-2019, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2019), provides a graded approach for evaluating the doses to biota. PNNL has adopted dose rate limits of 1 rad/d (10 mGy/d) for aquatic animals and terrestrial plants and 0.1 rad/d (1 mGy/d) for riparian and terrestrial animals (Figure 17 shows example of a native species) for the demonstration of the protection of biota (DOE 2020, DOE Order 458.1). These limits are applied similarly at the PNNL-Richland campus and the PNNL-Sequim campus.

Figure 17. Canada Goose (Branta canadensis) on the PNNL-Richland Campus

4.3.1 Radiation Protection of Biota – PNNL-Richland Campus

Environmental media pathways were evaluated for the PNNL-Richland campus following the data quality objectives (DQOs) process in support of radiological emissions monitoring (Snyder et al. 2024a). Potential media exposure pathways, such as air, soil, water, and food, were considered in conjunction with both gaseous and particulate radioactive contamination of the air pathway. The DQO process determined that only the air pathway necessitates monitoring because there are no radiological emissions via liquid pathways or directly to contaminated land areas. It also determined that the extremely small amounts of emissions would be impossible to differentiate from background levels in nearby locations, such as the Columbia River, and from food sources. While these measures are used primarily to demonstrate protection of the public, they also adequately demonstrate protection of biota. Therefore, biota monitoring for radionuclides both near and far from the PNNL-Richland campus is not conducted.

Routine operations were conducted on the PNNL-Richland campus during CY 2024—there were no unplanned radiological emissions. The resultant absorbed dose (external and internal) rates were less than the DOE criteria of 1 rad/d (10 mGy/d) for both aquatic animals and

terrestrial plants, and less than 0.1 rad/d (1 mGy/d) for both riparian animals and terrestrial animals (Table 17). The dose rates are based on the PNNL-reported total particulate radionuclide emissions for CY 2024 (Snyder, Bisping, Klein, et al. 2025). Calculations are based on conservative assumptions that all the particulate radioactive material is concentrated into either 2,500 m^3 (8.8×10^4 ft^3) of contaminated water, equivalent to the volume of an Olympic swimming pool, or 50 m^2 (538 ft^2) of contaminated soil or sediment, with a soil density of 224 kg/m^2 (14 lb/ft^2) to a depth of 15 cm (6 in.), equivalent to a representative garden area (Napier 2006). For comparison, an average of 5.04×10^3 m^3/s (1.78×10^5 ft^3/s) of Columbia River water flows below Priest Rapids Dam (USGS 2024) and past the PNNL-Richland campus on a daily basis, and the PNNL-Richland campus occupies approximately 3.1×10^6 m^2 (3.3×10^7 ft^2) of area.

Table 17. Absorbed Biota Dose Rates for the PNNL-Richland Campus, 2024

	Particulate Emissions[a] (Bq/yr)	Terrestrial Animal to Contaminated Soil[b] (mGy/d)	Terrestrial Plant to Contaminated Soil[b] (mGy/d)	Aquatic Animals to Contaminated Water[c] (mGy/d)	Riparian Animal to Contaminated Sediment[b] (mGy/d)
Totals	4.5×10^6	6.3×10^{-3}	9.5×10^{-4}	4.8×10^{-2}	5.3×10^{-3}
Dose Limit mGy/d	-	1	10	10	1

[a] Total particulate emissions determined from Snyder, Bisping, Klein, et al. (2025).
[b] The terrestrial animals may include deer, bee, earthworm, and rat. The terrestrial plants may include pine tree and wild grass. The riparian animals may include duck and frog. The contaminated soil area is 50 m^2 (538 ft^2) to a depth of 15 cm (6 in.) (Napier 2006).
[c] The aquatic animals may include trout, bass, salmon, and steelhead. The contaminated water volume is 2,500 m^3 (8.8×10^4 ft^3).

Conversion factors: 1 Ci = 3.7×10^{10} Bq; 1 Gy = 100 rad.

Doses to terrestrial plants and terrestrial animals are assumed to be from contaminated soil, while doses to aquatic animals are assumed to be from contaminated water and doses to riparian animals are assumed to be from contaminated sediment. The dose coefficients were determined using RESRAD-BIOTA V1.8 Level 2 (ANL 2016). The resulting water and soil concentrations are very conservative and are used for basic screening and calculating the contrast to adopted biota dose rate limits.

4.3.2 Radiation Protection of Biota – PNNL-Sequim Campus

Environmental media pathways were evaluated during the development of PNNL-Sequim campus DQOs in support of radiological emissions monitoring. Potential media exposure pathways, such as air, soil, water, and food, were considered in conjunction with potential releases of radioactive contamination to the air pathway.

The DQO process determined that, because of the low probability of potential air emissions and the absence of radiological emissions via liquid pathways or directly to land areas, no environmental sampling would be required. Because emission levels at the PNNL-Sequim campus are very low, it would be impossible to differentiate actual emissions from background levels in nearby locations such as Sequim Bay and those from food sources (Snyder et al. 2019). Reported emissions from the PNNL-Sequim campus are conservatively estimated because neither environmental surveillance nor stack sampling are required. These conservatively estimated emissions are also adequate to demonstrate protection of the

public and of biota; therefore, biota monitoring for radionuclides, both near to and far from the PNNL-Sequim campus, is not conducted.

Routine operations were conducted at PNNL-Sequim campus facilities during CY 2024—there were no unplanned radiological emissions. The resultant absorbed dose (external and internal) rates were less than the DOE criteria of 1 rad/d (10 mGy/d) for both aquatic animals and terrestrial plants, and 0.1 rad/d (1 mGy/d) for both riparian and terrestrial animals (Table 18).

Table 18. Absorbed Biota Dose Rates for the PNNL-Sequim Campus, 2024

	Particulate Emissions[a] (Bq/yr)	Terrestrial Animal to Contaminated Soil[b] (mGy/d)	Terrestrial Plant to Contaminated Soil[b] (mGy/d)	Aquatic Animals to Contaminated Water[c] (mGy/d)	Riparian Animal to Contaminated Sediment[b] (mGy/d)
Totals	2.3×10^{-5}	1.7×10^{-12}	1.3×10^{-12}	1.5×10^{-10}	9.4×10^{-126}
Dose Limit mGy/d	–	1	10	10	1

[a] Total particulate emissions determined from Hay et al. (2025).
[b] The terrestrial animals may include deer, bee, earthworm, and rat. The terrestrial plants may include pine tree and wild grass. The riparian animals may include duck and frog. The contaminated soil area is 50 m^2 (538 ft^2) to a depth of 15 cm (6 in.) (Napier 2006).
[c] The aquatic animals may include crab, shrimp, and saltwater fish. The contaminated water volume is 2,500 m^3 (8.8×10^4 ft^3).

Conversion factors: 1 Ci = 3.7×10^{10} Bq; 1 Gy = 100 rad

These conservative dose rates are well below dose rate limits, which are based on the PNNL-reported total particulate radionuclide emissions for CY 2024 (Hay et al. 2025). Conservative assumptions are that the particulate radioactive material is concentrated into either 2,500 m^3 (8.8×10^4 ft^3) of contaminated water, equivalent to the volume of an Olympic swimming pool, or 50 m^2 (538 ft^2) of contaminated soil or sediment, with a soil density of 224 kg/m^2 (14 lb/ft^2) to a depth of 15 cm (6 in.), equivalent to a representative garden area (Napier 2006). For comparison, Sequim Bay contains an approximate 1.32×10^8 m^3 (4.66×10^9 ft^3) of seawater with continuous tidal flow past Travis Spit, and the PNNL-Sequim campus developed land occupies approximately 3×10^4 m^2 (3.2×10^5 ft^2) of area.

Doses to terrestrial plants and terrestrial animals are assumed to be from contaminated soil, while doses to aquatic animals are assumed to be from contaminated water and doses to riparian animals are assumed to be from contaminated sediment. The dose coefficients were determined using RESRAD-BIOTA V1.8 Level 2. The resulting water and soil concentrations are very conservative and are used for basic screening and calculating the contrast to adopted biota dose rate limits.

4.4 Unplanned Radiological Releases

No radiological releases to the environment exceeded permitted limits at the PNNL-Richland campus or PNNL-Sequim campus in 2024. There were no unplanned releases reported at either the PNNL-Richland campus or PNNL-Sequim campus via air effluent in 2024 (Snyder, Bisping, Klein, et al. 2025), nor were there any unplanned release events via liquid effluents or to soil.

4.5 Environmental Radiological Monitoring

The DOE Handbook, *Environmental Radiological Effluent Monitoring and Environmental Surveillance*, provides information about basic program implementation requirements and activities (DOE-HDBK-1216-2015; DOE 2022a). In addition, the WDOH may require an operator of any emission unit to conduct ambient air monitoring or other testing, as necessary, to demonstrate compliance with the WAC 246-247 standard; such requirements for a program would be included in the operator's license. This section summarizes environmental radiological monitoring activities conducted by PNNL for both the PNNL-Richland campus and PNNL-Sequim campus.

4.5.1 Environmental Radiological Monitoring – PNNL-Richland Campus

A particulate air-sampling (environmental surveillance) network was established in 2010 to monitor radioactive particulates in ambient air near the PNNL-Richland campus as stipulated by WDOH in RAEL-005. As a result of changes in DOE-permitted operations in 2012, the air-sampling network was reevaluated (Barnett et al. 2012b). In 2017, the PNNL-Richland campus boundary was expanded by 35 ha (85.6 ac) to the north, necessitating that the particulate air-sampling network again be evaluated (Snyder et al. 2017). Starting in 2023, the north area of the campus began to undergo development and Snyder et al. (2024) documents the impacts to and the optimization of the ambient air surveillance network stations. The current PNNL-Richland campus particulate air-sampling network consists of four campus samplers (PNL-1, PNL-2, PNL-3, and PNL-4), one background sampler (PNL-5), and co-located ambient external dose monitors. Air surveillance station locations for the PNNL-Richland campus are shown in Figure 18. To accommodate the future development of the Richland campus, PNL-2 was relocated in November 2024. In an effort to improve the sampling of emission unit effluent in the ambient environment, PNL-3 was relocated in August 2024 (Figure 19).

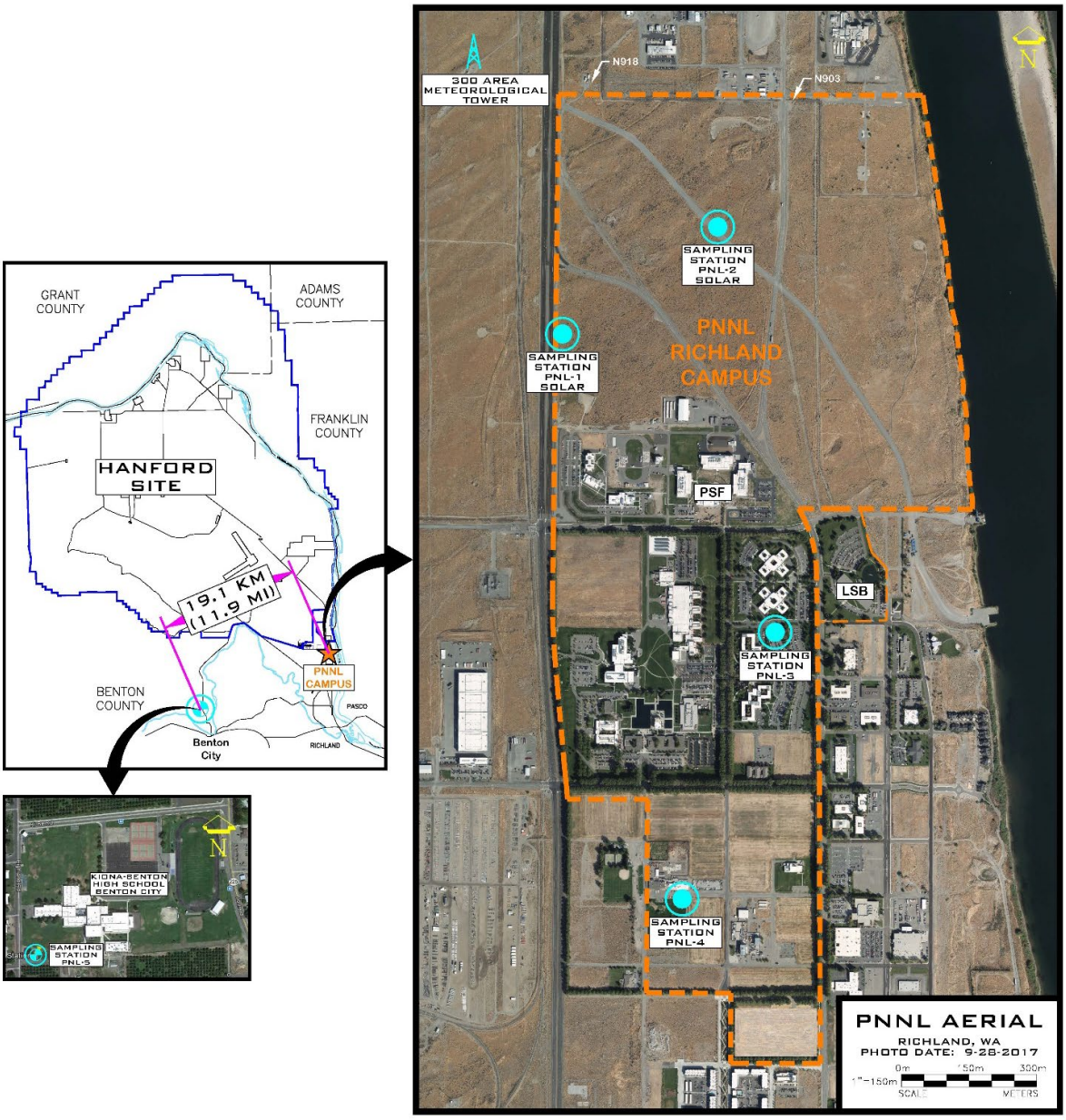


Figure 18. Air Surveillance Station Locations for the PNNL-Richland Campus Prior to CY 2024 PNL-2 and PNL-3 Station Moves

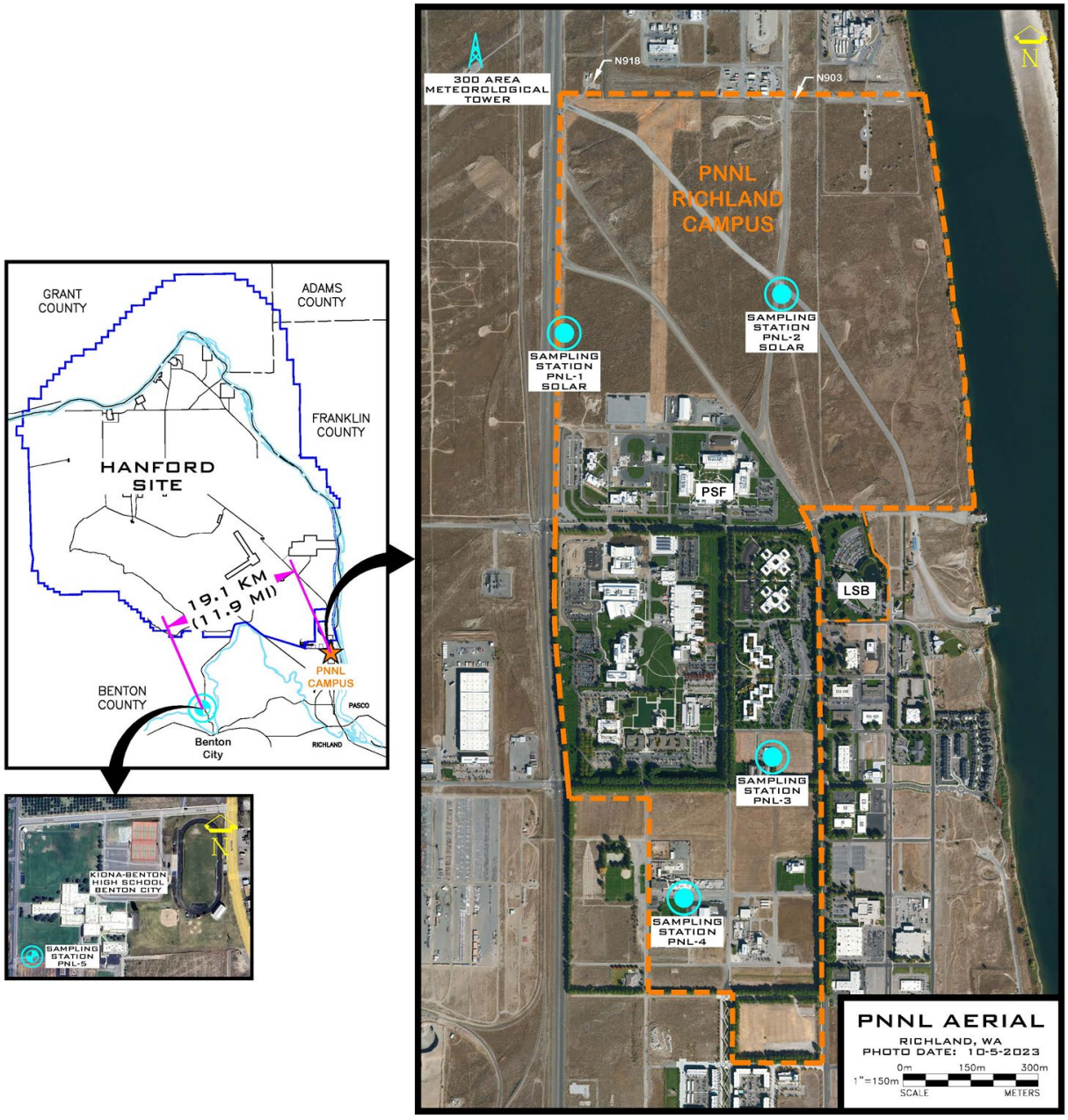


Figure 19. Air Surveillance Station Locations for the PNNL-Richland Campus After CY 2024 PNL-2 and PNL-3 Station Moves

4.5.1.1 Environmental Air Surveillance – PNNL-Richland Campus

During CY 2024, air samples were collected at all sampling stations and included sampling and analysis for airborne particulate radionuclides. Two-week particulate air samples are routinely analyzed for gross alpha and beta activity. These gross analyses would indicate potential unexpected increases in emissions. Semiannually, filters are composited for specific radionuclide analysis. There were no significant impacts to the annual composite results or network station operational frequency for CY 2024. The required composite analyses include

cobalt-60, uranium-233/234,[4] plutonium-238 and plutonium-239/240, americium-241 and americium-243, and curium-243/244.[5] See Snyder, Bisping, Klein, et al. (2025) for additional details regarding environmental air surveillance in CY 2024.

No PNNL activities resulted in increased ambient air concentrations at the air-sampling locations in CY 2024 (Table 19). The gross alpha and beta results were comparable to background levels. These nuclide-specific results were less than the 40 CFR Part 61, Appendix E, Table 2 values, and there was no indication of elevated levels of monitored particulate radionuclides near the PNNL-Richland campus. The lack of overall detectable concentrations supports the results of stack effluent monitoring and demonstrates that emissions from the PNNL-Richland campus are low and have minimal potential for dose to members of the public.

Table 19. Summary of 2024 Air-Sampling Results for the PNNL-Richland Campus (Snyder, Bisping, Klein, et al. 2025)

Nuclide	Location[a]	No. of Samples Analyzed	No. of Detections	Value ± Error (pCi/m^3)[b]		
Gross Alpha	PNL-1	26	22	7.6×10^{-4}	±	2.5×10^{-3}
	PNL-2	26	22	7.4×10^{-4}	±	2.4×10^{-3}
	PNL-3	23	18	7.7×10^{-4}	±	2.2×10^{-3}
	PNL-4	26	19	6.7×10^{-4}	±	2.1×10^{-3}
	PNL-5	26	21	6.6×10^{-4}	±	2.1×10^{-3}
Gross Beta	PNL-1	26	26	1.6×10^{-2}	±	8.0×10^{-3}
	PNL-2	26	26	1.5×10^{-2}	±	7.8×10^{-3}
	PNL-3	23	23	1.5×10^{-2}	±	6.8×10^{-3}
	PNL-4	26	26	1.4×10^{-2}	±	6.8×10^{-3}
	PNL-5	26	26	1.4×10^{-2}	±	7.0×10^{-3}
Co-60[c]	PNL-1	2	0	-6.2×10^{-5}	±	1.3×10^{-4}
	PNL-2	2	0	2.9×10^{-7}	±	1.4×10^{-4}
	PNL-3	2	0	-3.0×10^{-5}	±	1.1×10^{-4}
	PNL-4	2	0	-5.8×10^{-5}	±	1.3×10^{-4}
	PNL-5	2	1	8.9×10^{-5}	±	1.7×10^{-4}
Cs-137[c]	PNL-1	2	0	-1.9×10^{-5}	±	1.2×10^{-4}
	PNL-2	2	0	1.6×10^{-5}	±	8.3×10^{-5}
	PNL-3	2	0	3.0×10^{-5}	±	1.5×10^{-4}
	PNL-4	2	0	-5.5×10^{-5}	±	1.3×10^{-4}
	PNL-5	2	0	3.0×10^{-5}	±	1.2×10^{-4}
U-233/234[c]	PNL-1	2	1	5.0×10^{-5}	±	5.6×10^{-5}
	PNL-2	2	2	6.8×10^{-5}	±	5.7×10^{-5}
	PNL-3	2	1	5.0×10^{-5}	±	7.1×10^{-5}
	PNL-4	2	1	4.5×10^{-5}	±	4.4×10^{-5}
	PNL-5	2	2	5.7×10^{-5}	±	4.6×10^{-5}

[4] Only uranium-233 is required, but it is reported as uranium-233/234 because the naturally occurring uranium-234 emission peak overlaps with uranium-233.
[5] Only curium-244 is required, but it is reported as curium-243/244 because the curium-243 emission peak overlaps with curium-244.

Nuclide	Location[a]	No. of Samples Analyzed	No. of Detections	Value ± Error (pCi/m^3)[b]
Pu-238[c]	PNL-1	2	0	$3.4 \times 10^{-6} \pm 1.2 \times 10^{-5}$
	PNL-2	2	0	$8.6 \times 10^{-6} \pm 1.3 \times 10^{-5}$
	PNL-3	2	0	$1.6 \times 10^{-6} \pm 1.4 \times 10^{-5}$
	PNL-4	2	0	$5.9 \times 10^{-6} \pm 1.3 \times 10^{-5}$
	PNL-5	2	0	$4.2 \times 10^{-6} \pm 1.2 \times 10^{-5}$
Pu-239/240[c]	PNL-1	2	0	$4.8 \times 10^{-6} \pm 1.8 \times 10^{-5}$
	PNL-2	2	0	$2.3 \times 10^{-6} \pm 1.3 \times 10^{-5}$
	PNL-3	2	0	$-2.2 \times 10^{-6} \pm 1.8 \times 10^{-5}$
	PNL-4	2	0	$4.4 \times 10^{-6} \pm 1.4 \times 10^{-5}$
	PNL-5	2	0	$1.2 \times 10^{-6} \pm 1.2 \times 10^{-5}$
Am-241[c]	PNL-1	2	0	$9.7 \times 10^{-7} \pm 1.2 \times 10^{-5}$
	PNL-2	2	0	$7.1 \times 10^{-6} \pm 1.5 \times 10^{-5}$
	PNL-3	2	0	$-5.6 \times 10^{-6} \pm 2.4 \times 10^{-5}$
	PNL-4	2	0	$5.0 \times 10^{-6} \pm 1.3 \times 10^{-5}$
	PNL-5	2	0	$2.1 \times 10^{-6} \pm 1.2 \times 10^{-5}$
Am-243[c]	PNL-1	2	0	$-4.4 \times 10^{-6} \pm 2.2 \times 10^{-5}$
	PNL-2	2	0	$8.5 \times 10^{-6} \pm 2.1 \times 10^{-5}$
	PNL-3	2	0	$4.5 \times 10^{-6} \pm 2.1 \times 10^{-5}$
	PNL-4	2	0	$4.7 \times 10^{-6} \pm 1.8 \times 10^{-5}$
	PNL-5	2	0	$7.8 \times 10^{-6} \pm 1.8 \times 10^{-5}$
Cm-243/244[c]	PNL-1	2	0	$1.9 \times 10^{-6} \pm 1.0 \times 10^{-5}$
	PNL-2	2	0	$2.9 \times 10^{-6} \pm 1.8 \times 10^{-5}$
	PNL-3	2	0	$1.6 \times 10^{-6} \pm 8.6 \times 10^{-6}$
	PNL-4	2	0	$-1.6 \times 10^{-6} \pm 1.3 \times 10^{-5}$
	PNL-5	2	0	$-2.8 \times 10^{-6} \pm 1.4 \times 10^{-5}$

To convert pCi/m^3 to Bq/m^3, multiply pCi/m^3 by 0.037.

[a] Refer to Figure 18 for PNL-1, PNL-2, PNL-3, PNL-4, and PNL-5 locations; Figure 19 displays the locations after PNL-2 and PNL-3 were relocated in 2024. These stations were temporarily out of service during relocation for one biweekly sampling period (PNL-2) and three sampling periods (PNL-3).

[b] Value is the average of samples collected throughout the year, with no background (PNL-5) results subtracted.

[c] Semiannual composite analyses.

4.5.1.2 Ambient External Dose Monitoring – PNNL-Richland Campus

Ambient levels of external dose from gamma, beta, and X-ray sources were monitored quarterly at the five particulate air monitoring stations during 2024. The external dose monitoring program establishes baseline ambient external dose levels at the perimeter particulate sampling stations and the background (PNL-5) station. No current PNNL-Richland campus radioactive air emissions include significant quantities of external dose contributors, nor had PNNL transported high external dose sources on campus roads in 2024.

Ambient external dose monitoring is done with aluminum oxide dosimeters read by optically stimulated luminescence, using the Landauer[6] InLight® System. The system has a 5 mrem

[6] Landauer, 2 Science Rd, Glenwood, Illinois 60425-1586. Accessed at https://www.landauer.com.

(50 µSv) minimum detection level with two sigma uncertainty of 12% for each measurement period. Additional QA information regarding dosimeters is found in Section 7.3.

Optically stimulated luminescence dosimeter (OSLD) results for the 2024 monitoring periods are presented in Appendix C. After adjusting for control dosimeter results, daily and hourly reported results were determined and used to evaluate dose rates by the number of days monitored each quarter. Daily average dose rates and total 2024 annual background are provided in Figure 20. Hourly average dose rates are provided in Table 20, with no uncertainties indicated. Background values at PNL-5 are not subtracted from the PNL-1 through PNL-4 values in the figure and table data.

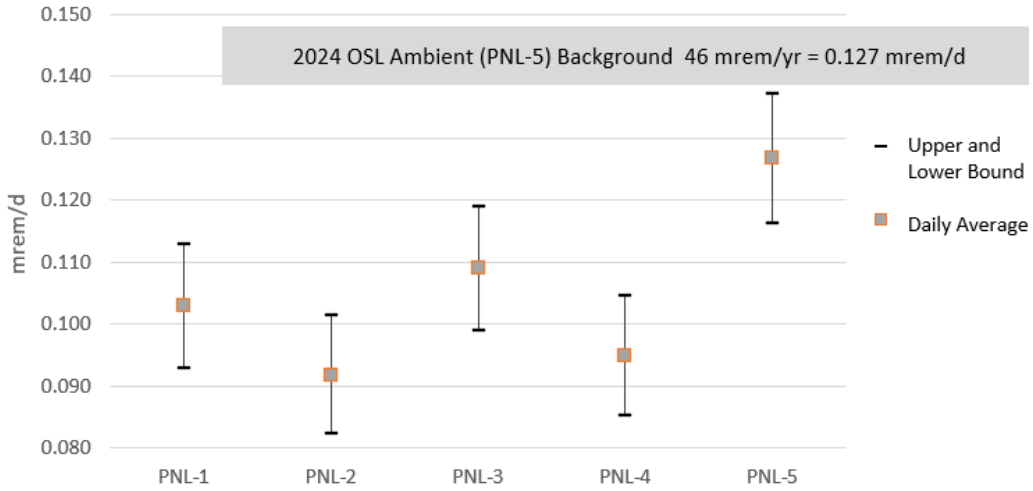


Figure 20. Average Daily Ambient External Dose Rates in 2024 for the PNNL-Richland Campus

Table 20. Average Hourly Ambient External Dose Rates in 2024 for the PNNL-Richland Campus (µrem/hr)

2024 Quarter	PNL-1	PNL-2	PNL-3	PNL-4	PNL-5[(a)]
First (Q1)	5.0	1.5	3.5	2.5	4.5
Second (Q2)	2.1	4.7	4.3	3.8	4.7
Third (Q3)	4.5	4.0	4.0	3.5	6.0
Fourth (Q4)	5.6	5.2	6.5	6.1	6.1
Average annual (µrem/hr)	**4.3**	**3.8**	**4.6**	**4.0**	**5.3**

(a) PNL-5 is the background station. No background values were subtracted from PNNL-Richland campus perimeter stations (PNL-1 through PNL-4) results.
To convert µrem/hr to µSv/hr, multiply mrem by 0.01.

CY 2024 annual dose rates at each campus monitoring location are within or below the PNL-5 background (46.2 ± 3.8 mrem/yr [462 ± 38 µSv/yr] with normalized 91-day quarters). The 2024 normalized results at all stations would be expected to range from 42.4–50.1 mrem/yr (424–501 µSv/yr), based on PNL-5 background measurements. For this seventh year of ambient external dose monitoring, the PNNL-Richland campus measurements remained similar to previous regional average background levels from 2017–2023 (29–40 mrem [290–400 µSv]).

In addition to the boundary and background station ambient external dose monitoring discussed above, the PNNL Radiation Protection organization performs external dose rate surveys and direct contamination surveys of the ground within 6 m (20 ft) of PNNL buildings that contain radiological areas. For CY 2024, survey results were at background levels (< 20 µrem/hr [<0.2 µSv/hr]) in areas that could be occupied by the public. For roof areas not accessible by the public, similar measurements were made, and all were found to be at background levels.

4.5.2 Environmental Radiological Monitoring – PNNL-Sequim Campus

Emissions at the PNNL-Sequim campus (see Figure 21) are low, the radionuclide inventory is relatively small, and radiological impact estimates are well below regulatory limits, even when highly over-estimated assumptions are applied (Snyder et al. 2019; Barnett et al. 2012a). The emissions at the PNNL-Sequim campus have historically met requirements for dose limit compliance based on estimates derived using the COMPLY Code (EPA 1989). COMPLY is applicable to sites that have low levels of releases (i.e., releases that result in an MEI dose below the minor emissions unit limit of 0.1 mrem/yr [1 µSv/yr]) (Snyder et al. 2019; Barnett et al. 2012a). The PNNL-Sequim campus incorporated environmental dosimeters into their program in June 2024. OSLD results for the 2024 monitoring periods are presented in Appendix C. At this time, there are no data available for particulate radionuclide air sampling for baseline background monitoring.

Figure 21 Bird's-eye View of MSL at PNNL-Sequim

The PNNL Radiation Protection organization performs external dose rate surveys at MSL-1 and MSL-5 exterior door locations, as well as direct contamination surveys of the ground within 6 m (20 ft) of these building perimeters. For CY 2024, survey results were at background levels (<20 µR/hr [approximately <0.2 µSv/hr]) in areas that could be occupied by the public. For roof areas not accessible by the public, similar measurements were made, and all were found to be at background levels.

4.5.3 Future Radiological Monitoring

The PNNL-Sequim campus RAEL-014 was renewed with an effective date of January 1, 2023. The RAEL-014 single PNNL-Sequim campus sitewide minor, fugitive, nonpoint source emission unit has no specific building units. A reevaluation of the PNNL-Sequim campus for environmental surveillance began in 2018 and concluded in CY 2019. While operations under the RAEL-014, Renewal 1, do not require emission unit sampling, monitoring, or ambient surveillance, the revised DQO (Snyder et al. 2019) recommended baseline radioactive air background surveillance be performed because no baseline radioactive air background data

are available for the PNNL-Sequim campus or surrounding area. Determinations of site radiation background for ambient external environmental dose and for particulate gross alpha and beta in air were recommended. DQO results further recommended the sampling be performed at an on-site location; on-site sampling is acceptable because of the historical and continued minimal radiological operations at the PNNL-Sequim campus (Snyder et al. 2019). Implementation planning of baseline radioactive air particulates background surveillance at the PNNL-Sequim campus will coincide with future land decisions.

5.0 ENVIRONMENTAL NONRADIOLOGICAL PROGRAM INFORMATION

The Effluent, Waste, and Transportation Programs Group (EWTPG) within the PNNL Environmental Protection and Regulatory Programs Division establishes or provides reference to already established discharge limits for toxic and radiological effluents to air and water. Specific effluent management services include establishing monitoring and sampling programs to characterize effluents from PNNL facilities, including those at the PNNL-Sequim campus, verifying compliance with effluent standards and controls, assisting facility operations, and monitoring compliance with air and wastewater permits.

EWTPG provides the interface between regulatory agencies and PNNL to prepare and submit required environmental permitting documentation, and reports spills and releases to regulatory agencies. A detailed description of the responsibilities assigned to the group and interactions with other PNNL organizations is provided in the internal *Pacific Northwest National Laboratory Effluent Management Quality Assurance Plan* (Barnett 2024). The ALARA principle is applied to effluent activities to minimize potential effects of emissions on the public and the environment.

5.1 Liquid Effluent Monitoring

Wastewater from the PNNL-Richland campus is discharged directly to the City of Richland's Publicly Owned Treatment Works. Wastewater discharges are regulated by the City of Richland under three industrial wastewater discharge permits (see Table 10). Waste streams regulated by these permits are reviewed by staff at PNNL and evaluated relative to compliance with the applicable permit prior to their discharge. Sampling, monitoring, and reporting of the wastewater discharges to the City of Richland's sewer system are done as required in accordance with the permits.

Process wastewater from the PNNL-Sequim campus is discharged to an on-site treatment plant and then directly discharged to Sequim Bay under the authorization of Washington State Department of Ecology NPDES Permit No. WA0040649. This permit identifies effluent limitations and monitoring requirements for this facility. Monitoring data required by the NPDES permit for 2024 are listed in Table 21. All parameters met the NPDES permit effluent limitations. There were no regulated discharges from Outfall 007 during this time period.

Table 21 PNNL-Sequim Campus NPDES Monitoring Results for Outfall 008, 2024[a]

Parameter	Total Samples	Quantity Found Below Method Reporting Limit	Method Reporting Limit[b]	Maximum Value
Maximum flow (gpd)	NA	NA	NA	38,200
Antimony (µg/L)	1	1	80	<80
Arsenic (µg/L)	1	0	1.9	1.9
Beryllium (µg/L)	1	1	0.40	<0.40
Cadmium (µg/L)	1	1	40	<40
Chromium (µg/L)	1	1	0.80	<0.80
Copper (µg/L)	12	12	10	<10
Lead (µg/L)	12	12	40	<40
Mercury (µg/L)	1	1	0.00050	<0.00050
Nickel (µg/L)	1	1	3.0	<3.0
Selenium (µg/L)	1	1	8.0	<8.0
Silver (µg/L)	1	1	40	<40
Thallium (µg/L)	1	1	100	<100
Zinc (µg/L)	12	12	35	<35
pH[c]	12	12	NA	7.60

[a] There were no regulated discharges from Outfall 007 during this time period.
[b] The highest Method Reporting Limit reported for all months is listed.
[c] The current permit specifies pH limits of 6−9 standard units.
gpd = gallons per day
NA = not applicable
µg/L = micrograms per liter

5.2 Air Effluent

While PNNL is not a large source of nonradiological air emissions, past and present emissions include greenhouse gases (e.g., tons of carbon dioxide-equivalent emissions), ozone-depleting substances (primarily refrigerants), hazardous air pollutants, and criteria air pollutants. The air effluent program does not monitor any stacks for nonradiological constituents, and compliance is assured by complying with regulatory standards for equipment and permit conditions. Complying typically involves activities such as using clean fuels and monitoring fuel use, adhering to required operating hours for boilers and diesel engines, and following maintenance and operating requirements. Permit applications contain emission estimates based on vendor data (e.g., emission rate/hour), so monitoring of run time or fuel use is an acceptable method of determining permit compliance. In addition, reviews of research and facility construction and renovation projects are conducted to maintain compliance with all applicable requirements.

6.0 GROUNDWATER PROTECTION PROGRAM

PNNL-Richland and PNNL-Sequim campuses do not currently have any Washington State Department of Ecology requirements to monitor groundwater. PNNL is not required to have a Groundwater Protection Program.

7.0 QUALITY ASSURANCE

The PNNL QA Program is based on the requirements defined in DOE Order 414.1D, *Quality Assurance*, and 10 CFR Part 830, *Energy/Nuclear Safety Management*, Subpart A, "Quality Assurance Requirements." PNNL has chosen to implement the following American Society of Mechanical Engineers (ASME) consensus standards in a graded approach:

- ASME NQA-1-2000, *Quality Assurance Requirements for Nuclear Facility Applications*, Part I, "Requirements for Quality Assurance Programs for Nuclear Facilities" (ASME 2001)
- ASME NQA-1-2000, Part II, Subpart 2.7, "Quality Assurance Requirements for Computer Software for Nuclear Facility Applications," including problem reporting and corrective actions (ASME 2001)
- ASME NQA-1-2000, Part IV, Subpart 4.2, "Guidance on Graded Application of Quality Assurance (QA) for Nuclear-Related Research and Development" (ASME 2001).

An internal PNNL document, *Quality Assurance Program Description/Quality Management M&O Program Description*, describes the Laboratory-level QA program that applies to all work performed by PNNL. Laboratory-level procedures for implementing the QA requirements described in the standards identified above are deployed through PNNL's web-based "How Do I…?" (HDI) system, a standards-based informational system for managing and deploying requirements and procedures to staff at PNNL.

To demonstrate compliance with the requirements, it is essential to implement a robust QA program capable of passing external audits. The basic components of a QA program depicted in Figure 22 may include various quality supporting documents, procedures, training, and assessments (Barnett 2011).

Figure 22. Components Basic to a Comprehensive QA Program

7.1 Environmental Monitoring Program

Environmental sampling and monitoring were performed under PNNL's Environmental Management Program. These activities included sampling of water, wastewater, radiological air emissions, ambient air, and environmental dosimeters. Sampling is conducted by the EWTPG (formerly, the Effluent Management [EM] Group) or its delegates under the *Pacific Northwest National Laboratory Effluent Management Quality Assurance Plan*, EM-QA-01 (Barnett 2024).

The EM Quality Assurance Plan (QAP) has been developed to demonstrate how the EWTPG is meeting QA requirements specified in environmental regulations and permits; assist EM staff in identifying applicable requirements and procedures (i.e., workflows, work controls, or process lifecycles) that are delivered through the HDI standards-based management system; and to document the integration of quality into EM processes and activities. For further information about the quality requirements mentioned in this section, refer to the documents listed in Table 22.

Table 22. PNNL Effluent Management QA Requirements Documents

Document Titles
Effluent Management Quality Assurance Plan (EM-QA-01)
Quality Requirements for Air Chemical Emissions Management
Quality Requirements for Facility Effluent Management Planning
Quality Requirements for Industrial Wastewater Discharge Permit Sampling and Monitoring for the PNNL Campus (CR-IU001), Environmental Molecular Sciences Laboratory (CR-IU005), Physical Sciences Facility (CR-IU011), and 300 Area (CR-IU010)
Quality Requirements for PNNL Sequim Campus Sampling and Monitoring to National Pollutant Discharge Elimination System Permit WA0040649
Quality Requirements for Radioactive Air Emissions Sampling and Monitoring
Quality Requirements for Radioactive Air Environmental Surveillance Monitoring
Quality Requirements for Environmental Dose Assessment

The EM QAP addresses the requirements in DOE Order 414.1D and the guidance in EPA QA/R-5 (EPA 2001). The EM QAP is written in the same format as the DOE Order 414.1D, so that identical requirement sections align. Sections 1–10 of the document discuss each of the 10 criteria in the DOE Order and the applicable EM procedures and processes to meet the criteria.

The related quality requirements documents were approved by the PNNL QA organization that monitors compliance. Work performed through contracts or statements of work, including sample analyses, must meet the U.S. governmental agencies, state, and local regulations, as well as other technical and guidance regulations specified by the PNNL program or the project-specific procedure. Potential suppliers of items and services that could have an impact on quality (e.g., analytical services, calibration services, reference standard material providers) were closely evaluated before contracts were awarded.

PNNL's Contracts and Acquisitions Department directly supports and follows DOE's socioeconomic objectives. Acquisition Quality Support Services (AQSS), as an integral part of Contracts, provides staff to support acquisition activities. This service model appoints matrixed AQSS professionals to provide independent oversight while making sure that internal and external requirements are met.

Radiological environmental air monitoring activities were determined using the DQO process described in *EPA Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA 2006) for operations on the PNNL-Richland campus (Snyder et al. 2024) and PNNL-Sequim campus (Snyder et al. 2019). The DQO process provides a standard working tool for project managers and planners to develop DQOs for determining the type, quantity, and quality of data needed to reach defensible decisions or make credible estimates. Snyder et al. (2024) determined and documented the environmental sampling and monitoring requirements necessary to comply with applicable regulations at the PNNL-Richland campus. As determined in the DQO process for the PNNL-Richland campus, PNNL has established an environmental surveillance program that samples particulate radionuclides in ambient air at strategic locations. The Environmental Management Plan (EMP; Snyder, Barnett, Bisping, et al. 2025) with its attachments—*Sampling and Analysis Plan, Data Management Plan, and Dose Assessment Guidance*—documents the environmental radioactive air monitoring program.

PNNL-Richland Campus radioactive air emissions are permitted under RAEL-005, which was issued by the WDOH. PNNL-owned facilities in the 300 Area also are subject to the Hanford Site Air Operating Permit. Regulatory standards/bodies include NESHAP (40 CFR Part 61, Subpart H and WAC 246-247), WAC 173-480, and Facility Use Agreements. Radiological air emissions are monitored by several different means, including the analysis of air filters; calculations of potential releases that are based on radioactive inventory using 40 CFR Part 61, Appendix D, calculations; and using the recorded releases documented in the PNNL Radioactive Gas Inventory database.

Environmental air surveillance and ambient external dose surveillance were performed at the five particulate air monitoring stations (see Figure 23) associated with the PNNL-Richland campus. The environmental air surveillance meets the requirements of the RAEL-005. The program also collects baseline ambient external dose levels at the perimeter and background sampling stations (Appendix C); the PNNL-Richland campus currently has no significant quantities of external dose contributors. Dose monitoring is done using aluminum oxide dosimeters read by optically stimulated luminescence.

Potential PNNL-Sequim campus radioactive air emissions are permitted under the current RAEL and compliance is demonstrated through calculated emission rates using 40 CFR Part 61, Appendix D, calculations. The renewed PNNL-Sequim campus license (RAEL-014, Renewal 2) approved in September 2022 went into effect on January 1, 2023, and is renewed every 5 years. This RAEL provides a permit for PNNL-Sequim campus radioactive air emissions as a single sitewide emission unit. The PNNL-Sequim campus DQO (Snyder et al. 2019) notes radioactive air emissions from operations at the campus do not require emission unit sampling or monitoring, or ambient surveillance under the RAEL-014, Renewal 1 nor Renewal 2. Snyder et al. (2019) recommended that baseline radioactive air background surveillance be performed using on-site ambient external dosimetry and installing sampling station(s) for particulate gross alpha and gross beta in air. Sampling is acceptable at on-site locations because of the historical and continued minimal radiological operations at the PNNL-Sequim campus. Ambient external dosimetry began at the PNNL-Sequim campus in June 2024; however, establishing on-site air samplers has been delayed until final land transfer decisions occur. (Note: Final land transfer took place in the spring of 2025 and will be addressed in the FY2025 ASER).

Figure 23. Staff Member Maintaining an Air Sampling Station

Wastewater sampling and monitoring at the PNNL-Richland campus are performed to meet requirements in permits issued by the City of Richland for discharges to the sewer. At the PNNL-Sequim campus, water and wastewater sampling and monitoring are performed to comply with NPDES and Group A Drinking Water permits. QA requirements for these activities have been integrated into the EM QAP (Barnett 2024) and related QA documents (see Table 22), and include specific requirements such as sampling locations, quality objective criteria, analytical methods, and detection limits.

In lieu of monitoring, chemical air emissions are managed by complying with PNNL's air permits. Permits for nonradiological air emissions are issued by the BCAA for the PNNL-Richland campus and the ORCAA for the PNNL-Sequim campus. Applicable regulatory statutes include the CAA and NEPA. PNNL limits its chemical air emissions primarily by limiting the hours of operation, using ultralow sulfur diesel fuel when operating on diesel, and operating and maintaining PNNL combustion units (e.g., backup generators, boilers, water heaters) as described in the notice of construction application and in accordance with the manufacturer's emission-related instructions. All research projects or Facilities and Infrastructure Operations activities that potentially could generate nonradiological air emissions are subject to air emissions reviews to identify compliance actions and administrative controls necessary to assure compliance with existing air permits.

7.2 Sample Collection Quality Assurance

Samples are collected by PNNL personnel trained to conduct environmental sampling according to approved and documented procedures. These procedures are based on standards, regulatory requirements, and guidance produced by NESHAP, EPA, WAC, WDOH, and the American National Standards Institute/Health Physics Society (ANSI/HPS). Sampling protocols include use of appropriate sampling methods and equipment, a defined sampling frequency, specified sampling locations, and procedures for sample handling (which may include storage, packaging, and shipping) to maintain sample integrity. Chain-of-custody processes are used to track the transfer of samples from the point of collection to the analytical laboratory. Requests for sample analysis are also a means of sample tracking and provide specific instructions for completing analyses of specific samples. QA program requirements in terms of sample receipt, handling, control, and identification of samples are integrated into the statement of work for subcontracted analytical laboratories.

Typically, samples are collected then analyzed in a laboratory. However, some water and wastewater samples are required to be analyzed in the field at the time of sample collection because of short holding time limits. These analyses (e.g., pH, temperature, and conductivity) are completed by staff at both the PNNL-Richland and PNNL-Sequim campuses using portable calibrated equipment (e.g., pH probe), approved standards, and controlled procedures based on EPA-approved methods or methods specified by the applicable regulatory agency.

7.3 Quality Assurance Analytical Results

Analyses are performed according to a statement of work or contract that describes the activities necessary to assure that the analytical results are of high and verifiable quality. These activities include calibration and performance testing of analytical methods and equipment; implementing a QA program; maintaining analytical and support equipment and facilities; handling, protecting, and analyzing samples; checking data traceability, validity, and quality; recording all analytical data; participating in the analysis of performance evaluation programs; and communicating and reporting to the EWTPG. Each analytical data package is validated prior to using and reporting the data. Data packages include the analytical results of quality control (QC) samples/analysis, which help determine the adequacy of the entire analysis. These QA requirements, which are disseminated to subcontractors, may include the analyses of laboratory method blanks to evaluate sources of contamination, laboratory duplicates to evaluate method precision, laboratory control samples/blank spike samples, and sometimes matrix spikes and/or surrogates to assess accuracy. A description of these QC terms is provided in Table 23. For cases where identified quality issues result in invalid data, the issues are documented, and corrective actions are taken.

The following laboratories conducted the analyses of environmental samples (i.e., stack air emissions, ambient air, water, wastewater, and environmental dosimeters) from the PNNL-Richland campus and PNNL-Sequim campus during 2024:

- Radiological air emission filter samples were analyzed by PNNL's Analytical Support Operations (ASO) laboratory located on the Hanford Site in the 325RPL Building.
- Ambient air filter samples were analyzed for radioactivity by General Engineering Laboratories (GEL), LLC, Charleston, South Carolina.
- Environmental dosimeters were read using optically stimulated luminescence technology by Landauer,® Glenwood, Illinois.

Table 23. Quality Control Terms

QC Type	Description
Laboratory method blank	Control sample containing no analyte of interest; used to monitor for bias or contamination introduced during processing and analysis in the laboratory.
Duplicate	Field Duplicate: An additional sample collected as closely as possible to the same time and location, to measure sources of error from field sampling activities when compared to laboratory duplicate precision results. (PNNL does not sample field duplicates.) Laboratory Duplicate: An additional aliquot or split sample from the same sample that is analyzed by the laboratory to measure analytical precision.
Matrix spike or surrogate samples	An aliquot of actual sample spiked with a known concentration of target analytes and processed in the same manner as the sample; used to determine the extent to which matrix bias or interferences affect the results when compared to a blank spike result. Instead of target analytes, surrogate analytes can be used. The surrogates are similar compounds that behave analytically like the target analyte in the specific analytical process.
Blank spike or reagent spike samples	A known concentration of target analytes added to the sample matrix prior to analysis. Blank or reagent spike samples are used to determine the accuracy associated with measuring a specific analyte by a specific method.
Laboratory control samples	A certified reference material or a prepared sample (created from an analyte-free sample matrix spiked with a known amount of analyte), which is carried through the preparation and analysis procedures to measure possible sources of preparation and measurement error.

Water and wastewater samples were analyzed by the following organizations:

- Eurofins Environment Testing Seattle, Tacoma, Washington
- ALS Environmental, Kelso, Washington
- Benton-Franklin Health District Laboratory, Kennewick, Washington
- Spectra Laboratories, Poulsbo, Washington.

Information about each laboratory is summarized below.

The ASO laboratory analyzed all airborne filter samples for radioactivity according to criteria in their statements of work and contracts. Analytical activities included use of daily calibration and verification QC samples (e.g., blanks, spiked samples, and sample duplicate pairs) and precision and accuracy targets that require the analysis method to meet quality performance limits. A blank and an instrument control sample were measured against known standards for each batch of routine samples analyzed for alpha and beta activity. In addition, a spiked sample and a blank were included with each batch of composite analysis samples and were analyzed for specific isotopes in addition to alpha and beta activity to assure QC. ASO's QAP, ASO-QAP-001, Rev. 12 (PNNL 2023), is guided by the Hanford Analytical Services Quality Assurance Requirements Document (HASQARD), which direct the facility staff and management to maintain a high level of analytical testing rigor, giving special attention to radiological safety and environmental protection. ASO performs assessments that address analytical instrument maintenance, checking data traceability and validity, undergoing independent DOE performance testing, and communicating results to the client. Any corrective actions are addressed by the ASO quality engineer and laboratory management.

Landauer provided dosimetry services for ambient air external dose monitoring at the PNNL-Richland and PNNL-Sequim campuses. Services included providing an aluminum oxide dosimeter in a waterproof pouch at the frequency requested by PNNL, reading the exposed dosimeter using optically stimulated luminescence technology, and providing dose results for the deployment period. Landauer provided two control dosimeters per shipment: the first to

measure exposure during field deployment/retrieval activities and the second to measure exposure during shipment to and from the vendor. Control or background values were not subtracted from the PNNL-Richland campus value in Landauer-reported results, but these values are subtracted when dosimeter results are evaluated for reporting. The environmental dosimeter external dose reporting information is expected to follow the ANSI/HPS Standard N13.37-2014, Environmental Dosimetry—Criteria for System Design and Implementation (HPS 2019).

GEL analyzed all particulate air filters for radioactivity according to criteria in their statement of work. The analytical activities included use of calibration and verification QC samples (e.g., blanks, spiked samples, and sample duplicate pairs) with precision and accuracy targets that require that the analysis method meets quality performance QC limits. A blank sample was analyzed for each analytical batch analyzed for alpha and beta activity. In addition, each analytical batch reporting composite result included a blank, a duplicate, and a laboratory control sample. The integrity and validity of analytical test results are maintained by GEL through the implementation of an internal QC program, while meeting the requirements of 40 CFR Part 61 and the U.S. Department of Defense (DoD)/DOE Consolidated Quality Systems Manual 5.4 for Environmental Laboratories (DoD and DOE 2021).

ALS Environmental, Eurofins Environment Testing Seattle, Benton-Franklin Health District Laboratory, and Spectra Laboratories analyzed all water and wastewater samples from the PNNL-Richland and PNNL-Sequim campuses during 2024. All analytical laboratories are accredited by the Washington State Department of Ecology for the analysis of water and wastewater samples. To receive accreditation, a laboratory must implement a QAP, perform periodic proficiency testing, and undergo periodic inspection by the Washington State Department of Ecology to assure that it is operating within regulatory and QA requirements. Each time a laboratory is selected to perform analyses for PNNL, the PNNL AQSS Group evaluates whether the laboratory is accredited. ALS Environmental and Eurofins Environment Testing Seattle are also accredited by the National Environmental Laboratory Accreditation Conference Institute, which requires adherence to a uniform and robust laboratory program that has been implemented consistently nationwide. All wastewater and drinking water analyses are performed using approved CWA or SDWA methods specified by EPA in “Guidelines Establishing Test Procedures for the Analysis of Pollutants” (40 CFR Part 136) and “National Primary Drinking Water Regulations” (40 CFR Part 141). QA/QC requirements in the contract with PNNL for wastewater analyses include the measurement or assessment of sample accuracy, precision, reliability, representativeness, completeness, and comparability. Measurements are reviewed for each analytical data package to verify that the data are valid. Analytical methods, method detection limits, holding times, sample containers, and sample preservation laboratory activities must meet regulatory requirements and are verified for each sample collected.

7.4 Data Management and Calculations

QA is integrated into data management processes and calculations through the EM QAP and related QA documents, the EMP Data Management Plan, and staff procedures; parameters for dose calculations are documented as a component of the EMP. Software QA processes are used to verify the accuracy of databases used for analytical results.

Procedures identify the process for developing, testing, maintaining, and using spreadsheets to perform calculations that support or relate to a regulatory compliance, permit, or safety requirement; procedures also contain the basis for parameters and methods used in estimating

environmental releases, as well as checklists used to verify and validate analytical results. The processes for managing data and calculations were followed during 2024.

7.5 Interlaboratory Performance Programs

The semiannual Mixed-Analyte Performance Evaluation Program (MAPEP) is a performance testing program managed by the Radiological and Environmental Sciences Laboratory (RESL) at Idaho National Laboratory. RESL is a government-owned and -operated DOE laboratory facility that provides unbiased technical DOE oversight to assure the quality and stability of analytical chemistry, radiation calibrations, and measurements. As a laboratory accredited by ISO/IEC (International Organization for Standardization/International Electrotechnical Commission) 17043 (2010), RESL complies with the requirements of DOE Order 414.1D, *Quality Assurance*; ISO 9001:2015, *Quality Management Systems – Requirements;* and ISO/IEC 17025:2017, *General Requirements for the Competence of Testing and Calibration Laboratories*. Each year, the MAPEP provides samples of environmental media for assessing air filters, water, soil, and vegetation, which contain specific amounts of one or more radionuclides unknown to the participating laboratory. After analysis, the results are evaluated against a stated reference value and acceptance range. For 2024, two studies—MAPEP-50 and MAPEP-51—were issued to participating laboratories; results are provided below.

GEL participated in both MAPEP-50 and MAPEP-51 performance evaluation studies, as well as Multimedia Radiochemistry Proficiency Testing (MRAD)-40 and MRAD-41 studies in 2024. MRAD is provided by ERA-Waters Corporation, which is also accredited to ISO 9001:2015 and ISO/IEC 17025:2017. For MAPEP-50, radiological filter results for gross beta, select gamma, and alpha spectroscopy results were all acceptable; however, the gross alpha filter result was unacceptable with GEL issuing a Corrective Action Report. For MAPEP-51, radiological filter results for gross alpha, gross beta, select gamma, and alpha spectroscopy results were acceptable or acceptable with warning (Am-241 and Cs-137 only). For MRAD-40, radiological filter results for gross alpha, select gamma, and select alpha spectroscopy sample results were all acceptable; however, the gross beta filter result was unacceptable with GEL issuing a Correction Action Report. For MRAD-41, radiological filter results for gross alpha, gross beta, select gamma, and select alpha spectroscopy sample results were all acceptable. The DOE Consolidated Audit Program Accreditation Body contractual auditing organization American Association for Laboratory Accreditation performed the analyte performance assessment per the requirements of the program for 2024. GEL maintained laboratory accreditation, which provides added confidence in the data reported by the laboratory. The latest certification, Certificate Number 2567.01, was authorized in June 2023, and expires in June 2025. GEL also maintained Laboratory Accreditation through the State of Washington for 2024 (Certificate Number: C780-23, which expired November 25, 2024).

In 2024, the ASO 325RPL at PNNL participated in MAPEP-50 and MAPEP-51 testing studies. Table 24 shows the analytes of interest for reporting purposes, as well as ASO's proficiency performance for the corresponding constituents. For MAPEP-50, radiological results for air filters were acceptable; however, the gross alpha and Sr-90 results were unacceptable with ASO issuing a Corrective Action Report. For MAPEP-51, radiological results for air filters were acceptable; however, Am-241 result was unacceptable and Pu-239/240 and Sr-90 results were acceptable with warning flags. It should be noted that ASO's internal requirement is to have one acceptable result for the year, which is why there are certain instances of nonreporting. Any instance of a nonacceptable result or consecutive nonreporting is captured in a corrective action/occurrence report.

In addition to participating in performance testing, it should be noted that, on a periodic basis, the ASO laboratory is audited relative to requirements of the HASQARD (DOE-RL 2014) to remain on the Hanford Evaluated Suppliers List; the most recent audit was performed in October 2021. ASO was also audited by PNNL's internal audit program using the HASQARD standard in November 2022.

The requirements for interlaboratory performance do not apply to dosimetry.

Participation in interlaboratory performance programs for the analysis of water and wastewater samples is not required pursuant to permits issued under the SDWA or CWA.ALS Environmental is an accredited laboratory (WAC 173-50) certified by the Washington State Department of Ecology. The laboratory's certification (Accreditation ID: C544-24a) was updated July 9, 2024, and expires July 8, 2025, at which time the scope of their accreditation will be reevaluated. ALS also was accredited by Perry Johnson Laboratory Accreditation, Inc., as being certified to the ISO/IEC 17025:2017 standard, the DoD Environmental Laboratory Accreditation Program for ISO/IEC 17025:2017, and the DoD Quality Systems Manual Version 5.4; this accreditation expires June 30, 2026. Eurofins Environment Testing Seattle is also certified by the Washington State Department of Ecology. Their laboratory certification (Accreditation ID C788-24c) was updated on July 14, 2024, and expires on July 13, 2025. Spectra Labs and the Benton-Franklin Health District Laboratory are also accredited by the Washington State Department of Ecology to WAC 173-50 and WAC 246-290 criteria. These accreditations are renewed annually. Spectra Labs accreditation (Accreditation ID: C594-24a) was revised September 28, 2024, and expires September 27, 2025, and the Benton-Franklin Health District accreditation (Accreditation ID: H408-24a) was revised August 24, 2024, and expires August 23, 2025.

Table 24. Participating Laboratory MAPEP Performance and Analytes Summaries

Analytes of Interest (Hanford and PNNL)[a]	ASO						GEL					
	MAPEP-51 (Nov 2024)	MAPEP-50 (May 2024)	MAPEP-49 (Aug 2023)	MAPEP-48 (Mar 2023)	MAPEP-47 (Aug 2022)	MAPEP-46 (Mar 2022)	MAPEP-51 (Nov 2024)	MAPEP-50 (May 2024)	MAPEP-49 (Aug 2023)	MAPEP-48 (Mar 2023)	MAPEP-47 (Aug 2022)	MAPEP-46 (Mar 2022)
Gross Alpha	A	N	NRPR	A	NRPR	A	A	N	N	A	A	A
Gross Beta	A	A	NRPR	A	NRPR	A	A	A	A	A	A	A
Am-241	N	NRPR	A	A	NR	NR	W	A	A	A	A	A
Co-60	A	A	N	A	NRPR	A	A	A	A	A	A	A
Cs-137	A	A	A	A	NRPR	A	W	A	A	A	A	A
Pu-238	A	NRPR	N	N	A	NR	A	A	ND	A	A	A
Pu-239/240	W	NRPR	A	A	A	NR	A	A	A	A	A	A
Sr-90	W	N	A	NR	A	NRPR	A	A	A	A	A	A
U-233/234	A	NR	NR	A	A	N	A	A	A	A	A	A

A = Acceptable; N = Not Acceptable; W = Acceptable with Warning; NR = Not Reported; ND = Not Detected; NRPR = Not Reported Previously Reported

[a] MAPEP does not include analytes of interest Al-26, Am-243, Cm-243/244, Pu-241, and Th-229 for Proficiency Testing.

Note: ASO also reports select MAPEP filter analytes that are not target Hanford/PNNL analytes of interest: Co-57, Mn-54, U-234, U-238, and Zinc-65.

References

10 CFR Part 820. “Procedural Rules for DOE Nuclear Activities.” *Code of Federal Regulations*, U.S. Department of Energy, Washington, DC.

10 CFR Part 830. “Nuclear Safety Management.” *Code of Federal Regulations*, U.S. Department of Energy, Washington, DC.

10 CFR Part 830, Subpart A. “Quality Assurance Requirements.” *Code of Federal Regulations,* U.S. Department of Energy, Washington, DC

10 CFR Part 835. “Occupational Radiation Protection.” *Code of Federal Regulations*, U.S. Department of Energy, Washington, DC.

10 CFR Part 1021, Appendix D. “Classes of Actions that Normally Require EISs.” *Code of Federal Regulations*, U.S. Department of Energy, Washington, DC.

33 CFR Part 66. “Private Aids to Navigation.” *Code of Federal Regulations*, U.S. Coast Guard, Washington, DC.

36 CFR. “Parks, Forests, and Public Property.” *Code of Federal Regulations*. U.S. Forest Service. Washington, DC.

36 CFR Part 251. “Land Uses.” *Code of Federal Regulations*, U.S. Forest Service. Washington, DC.

40 CFR Part 52. “Approval and Promulgation of Implementation Plans.” *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, DC.

40 CFR Part 60. “Standards of Performance for New Stationary Sources.” *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, DC.

40 CFR Part 61. “Protection of the Environment/National Emission Standards for Hazardous Air Pollutants (NESHAP).” *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, DC.

40 CFR Part 61, Appendix D. “Methods for Estimating Radionuclide Emissions.” *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, DC.

40 CFR Part 61, Appendix E. “Compliance Procedures Methods for Determining Compliance with Subpart I.” *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, DC.

40 CFR Part 61, Subpart H. “National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities.” C*ode of Federal Regulations*, U.S. Environmental Protection Agency, Washington, DC.

40 CFR Part 63. “National Emissions Standards for Hazardous Air Pollutants for Source Categories.” *Code of Federal Regulations,* U.S. Environmental Protection Agency, Washington, DC.

40 CFR Part 68. “Chemical Accident Prevention Provisions.” *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, DC.

40 CFR Part 82. “Protection of Stratospheric Ozone.” *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, DC.

40 CFR Part 98. “Mandatory Greenhouse Gas Reporting.” *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, DC.

40 CFR Part 136. “Guidelines Establishing Test Procedures for the Analysis of Pollutants.” *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, DC.

40 CFR Part 141. “National Primary Drinking Water Regulations.” *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, DC.

40 CFR Part 141.26. “Monitoring frequency and compliance requirements for radionuclides in community water systems.” *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, DC.

40 CFR Part 302.8. “Continuous Releases.” *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, DC.

40 CFR Part 355. “Emergency Planning and Notification.” *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, DC.

40 CFR Part 370. “Hazardous Chemical Reporting: Community Right-To-Know.” *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, DC.

40 CFR Part 372. “Toxic Chemical Release Reporting: Community Right-To-Know.” *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, DC.

40 CFR Part 751. “Regulation of Certain Chemical Substances and Mixtures Under Section 6 of The Toxic Substances Control Act.” *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, DC.

40 CFR Part 761. “Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions.” *Code of Federal Regulations*, U.S. Environmental Protection Agency, Washington, DC.

50 CFR. “Wildlife and Fisheries.” *Code of Federal Regulations,* U.S. Fish and Wildlife Service and National Marine Fisheries Service, Washington, DC.

50 CFR 226.212. “Critical habitat for 15 Distinct Population Segments (DPSs) of Salmon and Steelhead (*Oncorhynchus* spp.) in Washington, Oregon and Idaho.” *Code of Federal Regulations*, U.S. Fish and Wildlife Service and National Marine Fisheries Service, Washington, DC.

42 FR 26951. May 25, 1977. Executive Order 11988 of May 24, 1977: “Floodplain Management.” *Federal Register*, Office of the President, Washington, DC.

42 FR 26961. May 25, 1977. Executive Order 11990 of May 24, 1977: “Protection of Wetlands.” *Federal Register*, Office of the President, Washington, DC.

52 FR 2923. January 29, 1987. Executive Order 12580 of January 23, 1987: “Superfund Implementation.” *Federal Register*, Office of the President, Washington, DC.

64 FR 6183. February 8, 1999. Executive Order 13112 of February 3, 1999: “Invasive Species.” *Federal Register*, Office of the President, Washington, DC.

66 FR 3853. January 17, 2001. Executive Order 13186 of January 10, 2001: “Responsibilities of Federal Agencies to Protect Migratory Birds.” *Federal Register*, Office of the President, Washington, DC.

70 FR 52630. September 2, 2005. “Endangered and Threatened Species; Designation of Critical Habitat for 12 Evolutionarily Significant Units of West Coast Salmon and Steelhead in Washington, Oregon, and Idaho; Final Rule.” *Federal Register*, National Oceanic and Atmospheric Administration, Washington, DC.

75 FR 63898. October 18, 2010. “Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for Bull Trout in the Coterminous United States.” Final Rule, *Federal Register*, Fish and Wildlife Service, Washington, DC.

79 FR 68042. November 13, 2014. “Endangered and Threatened Species; Designation of Critical Habitat for the Puget Sound/Georgia Basin Distinct Population Segments of Yelloweye Rockfish, Canary Rockfish and Bocaccio.” Final Rule, *Federal Register*, National Marine Fisheries Service, Washington, DC.

81 FR 88609. December 8, 2016. Executive Order 13751 of December 5, 2016: “Safeguarding the Nation from the Impacts of Invasive Species.” *Federal Register*, Office of the President, Washington, DC.

85 FR 43304. July 16, 2020. “Update to the Regulations Implementing the Procedural Provisions of the National Environmental Policy Act.” Final Rule, *Federal Register*, Council on Environmental Quality, Washington, DC.

86 FR 54642. October 4, 2021. Regulations Governing Take of Migratory Birds; Revocation of Provisions. U.S. Fish and Wildlife Service, Washington, DC.

87 FR 23453. May 20, 2022. “National Environmental Policy Act Implementing Regulations Revisions.” Final Rule, *Federal Register*, Council on Environmental Quality, Washington, DC.

Ackerman R, KC Reid, JD Gallison, and ME Roe. 1985. *Archaeology of Heceta Island: A Survey of 16 Timber Harvest Units in the Tongass National Forest, Southern Alaska.* Center for Northwest Archaeology, Washington State University, Pullman, WA.

American Innovation and Manufacturing (AIM) Act. Section 103 of HR 133 Consolidated Appropriations Act of 2021. Accessed July 18, 2025, at https://www.epa.gov/climate-hfcs-reduction/aim-act.

ANL. 2016. “RESRAD-BIOTA Version History.” Argonne National Laboratory, Lemont, IL. Accessed July 9, 2025, at https://resrad.evs.anl.gov/codes/resrad-biota/history.cfm.

Archaeological Resources Protection Act of 1979 (ARPA). 16 U.S.C. § 470. Accessed June 2, 2025, at https://www.govinfo.gov/content/pkg/USCODE-2013-title16/html/USCODE-2013-title16-chap1B.htm.

AS 16.05.871. 2023 “Alaska State Anadromous Fish Act.” *Alaska Statutes*, Juneau, AK.

ASME (American Society of Mechanical Engineers). 2001. *Quality Assurance Requirements for Nuclear Facility Applications*. ASME NQA-1-2000, New York, NY.

Atomic Energy Act of 1954. Chapter 724, 60 Stat. 755, 42 U.S.C. § 2011 *et seq*. Accessed June 30, 2025, at https://www.gpo.gov/fdsys/pkg/USCODE-2015-title42/pdf/USCODE-2015-title42-chap23-divsnA.pdf.

Bald and Golden Eagle Protection Act. Public Law 87-884, as amended, 16 U.S.C. § 688 *et seq*. Accessed July 18, 2025, at https://www.fws.gov/birds/policies-and-regulations/laws-legislations/bald-and-golden-eagle-protection-act.php.

Barnett JM. 2011. *Concepts for Environmental Radioactive Air Sampling and Monitoring*. In: EO Ekundayo, ed., Environmental Monitoring, ISBN 979-953-307-295-0. Rejeka, Croatia: InTech; 263-282. DOI: 10.5772/28533. Accessed June 15, 2025, at http://www.intechopen.com/books/environmental-monitoring/concepts-for-environmental-radioactive-air-sampling-and-monitoring.

Barnett JM. 2018. *Pacific Northwest National Laboratory Potential Impact Categories for Radiological Air Emission Monitoring.* PNNL-19904, Revision 5, Pacific Northwest National Laboratory, Richland, WA. Accessed June 30, 2025, at https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-19904Rev.5.pdf.

Barnett JM. 2024. *Pacific Northwest National Laboratory Effluent Management Quality Assurance Plan*. EM-QA-01, Revision 12,Pacific Northwest National Laboratory, Richland, WA.

Barnett JM, KM Meier, SF Snyder, EJ Antonio, BG Fritz, and TM Poston. 2012a. *Data Quality Objectives Supporting Radiological Air Emissions Monitoring for the Marine Sciences Laboratory, Sequim Site.* PNNL-22111, Pacific Northwest National Laboratory, Richland, WA. Accessed June 30, 2025, at http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-22111.pdf.

Barnett JM, KM Meier, SF Snyder, BG Fritz, TM Poston, and EJ Antonio. 2012b. *Data Quality Objectives Supporting Radiological Air Emissions Monitoring for the PNNL Site.* PNNL-19427, Revision 1, Pacific Northwest National Laboratory, Richland, WA. Accessed June 30, 2025, at http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-19427rev1.pdf.

Battelle-Northwest. 1967. “Architect Selected for Sequim.” *Staff Bulletin*, Volume IV, Number 2, May 22, 1967. Richland, WA.

BCAA (Benton Clean Air Agency). 2021. “Regulation 1 of the Benton Clean Air Agency.” Kennewick, WA. Accessed July 1, 2025, at https://bentoncleanair.org/air-quality/regulation-fees.

Brownell D. 2018. *A Glimpse of Sxʷčkʷíyəŋ, A S’Klallam Village at Washington Harbor*. Blyn, WA.

Cannon A. 1991. *The Economic Prehistory of Namu*. Archaeology Press, Simon Fraser University, Burnaby, BC.

CEQ (Council on Environmental Quality). 2020. *Guiding Principles for Sustainable Federal Buildings and Associated Instructions*. Washington, DC. Accessed June 30, 2025, at https://www.sustainability.gov/pdfs/guiding_principles_for_sustainable_federal_buildings.pdf.

Clallam County. 2018. "Shoreline Master Program (SMP) Maps, Exhibit A: Draft Clallam County Shoreline Environmental Designation Maps, 03 Sequim Bay North, Gibson & Travis Spit Vicinity." Accessed July 18, 2025, at https://www.clallamcountywa.gov/DocumentCenter/View/5805/03-Sequim-Bay-North-Gibson-and-Travis-Spit-Vicinity-PDF.

Clean Air Act. Public Law 88-206, as amended, 42 U.S.C. § 7401 *et seq*. Accessed June 30, 2025, at https://www.epa.gov/laws-regulations/summary-clean-air-act.

Clean Water Act. Public Law 95-217, as amended, 33 U.S.C. § 1251 *et seq*. Accessed June 30, 2025, at https://www.epa.gov/laws-regulations/summary-clean-water-act.

Coastal Zone Management Act of 1972. Public Law 89-454, Title III, as amended, 16 U.S.C. § 1451 *et seq*.

Coastal Zone Act Reauthorization Amendments of 1990. Public Law 101-508, Title VI, Subtitle C § 6201 *et seq*., 104 Stat. 1388–299.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). Public Law 96-510, as amended, 42 U.S.C. § 9601 *et seq*. Accessed June 30, 2022, at https://www.gpo.gov/fdsys/pkg/USCODE-2015-title42/pdf/USCODE-2015-title42-chap103.pdf.

Croes D. 1989. "Prehistoric Ethnicity on the Northwest Coast of North America: An Evaluation of Style in Basketry and Lithics." *Journal of Anthropological Archaeology* 8:101–130.

DoD and DOE (U.S. Department of Defense and U.S. Department of Energy). 2021. *DoD/DOE ConsolidatedQuality Systems Manual for Environmental Laboratories*. DoD Quality Systems Manual Version 5.4, Washington, DC. Accessed July, 2, 2025, at https://www.denix.osd.mil/edqw/denix-files/sites/43/2021/10/QSM-Version-5.4-FINAL.pdf.

DOE (U.S. Department of Energy). 2019. *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*. DOE-STD-1153-2019, U.S. Department of Energy, Washington, DC. Accessed June 30, 2025, at https://www.standards.doe.gov/standards-documents/1100/1153-astd-2019/@@images/file.

DOE (U.S. Department of Energy). 2022a. *Environmental Radiological Effluent Monitoring and Environmental Surveillance*. DOE-HDBK-1216-2015 Chg Notice 1 (Reaffirmed 2022), U.S. Department of Energy, Washington, DC. Accessed July 9, 2025, at https://www.standards.doe.gov/standards-documents/1200/1216-hdbk-2015-cn1-2022-reaff-2022.

DOE (U.S. Department of Energy). 2022b. *Initial Assessment of Per- and Polyfluoroalkyl Substances at Department of Energy Sites*. U.S. Department of Energy, Washington, DC. Accessed June 6, 2024, at https://www.energy.gov/sites/default/files/2022-11/DOE%20Initial%20PFAS%20Assessment%20-508.pdf.

DOE (U.S. Department of Energy). 2022d. *PFAS Strategic Roadmap: DOE Commitments to Action 2022-2025*. U.S. Department of Energy, Washington, DC. Accessed June 6, 2025, at https://www.energy.gov/sites/default/files/2022-08/DOE%20PFAS%20Roadmap%20August%202022.pdf.

DOE (U.S. Department of Energy). 2025. "Met and Climate Data Summary Products." Richland, WA. Accessed July 8, 2025, at http://www.hanford.gov/page.cfm/MetandClimateDataSummary.

DOE and USFWS (U.S. Department of Energy and U.S. Fish and Wildlife Service). 2013. Memorandum of Understanding between the United States Department of Energy and the United States Fish and Wildlife Service Regarding Implementation of Executive Order 13186, "Responsibilities of Federal Agencies to Protect Migratory Birds." Washington, DC. Accessed June 30, 2025, at http://energy.gov/sites/prod/files/2013/10/f3/Final%20DOE-FWS%20Migratory%20Bird%20MOU.pdf.

DOE/EA-2271. 2025. *Pacific Northwest National Laboratory Aquatic Research Activities in Sequim Bay and the Strait of Juan de Fuca*. Final Environmental Assessment. U.S. Department of Energy Pacific

Northwest Site Office. Accessed July 3, 2025, at https://science.osti.gov/-/media/ssp/pdf/nepa-documents/ea-eis/pnso/2025/FONSI-and-Environmental-Assessment-for-PNNL-Aquatic-Research-Activities-in-Sequim-Bay-and-the-Strait.pdf

DOE Order 144.1, Admin Chg 1. 2009. *Department of Energy American Indian Tribal Government Interactions and Policy*. U.S. Department of Energy, Washington, DC. Accessed July 2, 2025, at https://www.energy.gov/sites/prod/files/DOE%20O%20144.1.pdf.

DOE Order 231.1B, Admin Chg 1. 2012. *Environment, Safety and Health Reporting*. U.S. Department of Energy, Washington, DC. Accessed June 30, 2025, at https://www.directives.doe.gov/directives-documents/200-series/0231.1-BOrder-b-admchg1/@@download/file.

DOE Order 232.2A Chg 1 (MinChg). 2019. *Occurrence Reporting and Processing of Operations Information*. U.S. Department of Energy, Washington, DC. Accessed June 30, 2025, at https://www.directives.doe.gov/directives-documents/200-series/0232.2-BOrder-a-chg1-minchg.

DOE Order 414.1D Admin Chg 2 (LtdChg). 2020. *Quality Assurance*. U.S. Department of Energy, Washington, DC. Accessed June 30, 2025, at https://www.directives.doe.gov/directives-documents/400-series/0414.1-BOrder-d-chg2-ltdchg.

DOE Order 435.1, Chg 2 (AdminChg). 2021. *Radioactive Waste Management.* U.S. Department of Energy, Washington, DC. Accessed July 2, 2025, at https://www.directives.doe.gov/directives-documents/400-series/0435.1-BOrder-chg2-AdminChg.

DOE Order 440.1B, Chg 4. 2022. *Worker Protection Program for DOE (Including the National Nuclear Security Administration) Federal Employees – Change Chart*. U.S. Department of Energy, Washington, DC. Accessed July 18, 2025, at https://www.directives.doe.gov/related-items/doe-o-440.1b-chg4-admchg-change-chart.

DOE Order 458.1 Chg 4 (LtdChg). 2020. *Radiation Protection of the Public and the Environment.* U.S. Department of Energy, Office of Health, Safety and Security, Washington, DC. Accessed July 9, 2025, at https://www.directives.doe.gov/directives-documents/400-series/0458.1-border-chg4-ltdchg.

DOE-PNSO (U.S. Department of Energy Pacific Northwest Site Office). 2007. Memorandum from RM Kilbury to M Kluse, dated June 18, 2007, regarding "Approval of Application for Authorized Limits for the Release of Small Volume Laboratory Liquid Samples from Radiological Control." Richland, WA.

DOE-PNSO (U.S. Department of Energy Pacific Northwest Site Office). 2018. "Memorandum of Agreement Between the U.S. Department of Energy Pacific Northwest Site Office, The Washington State Historic Preservation Officer, the Confederated Tribes and Bands of the Yakama Nation, the Confederated Tribes of the Umatilla Indian Reservation, the Nez Perce Tribe, and the Wanapum Band, Regarding the Adverse Effect of the Pacific Northwest National Laboratory Richland Campus Future Development on the Yakama Nation Traditional Cultural Property, the Wanapum Band Traditional Cultural Property, and the Preservation Designated Area (45BN1426)." Richland, WA.

DOE-PNSO (U.S. Department of Energy Pacific Northwest Site Office). 2021a. *Pacific Northwest Site Office Cultural and Biological Resources Management Plan*. PNSO-PLAN-09, Revision 4. Richland, WA.

DOE-PNSO (U.S. Department of Energy Pacific Northwest Site Office). 2021b "Memorandum of Agreement Among the U.S. Department of Energy Pacific Northwest Site Office, the Washington State Historic Preservation Officer, and The Jamestown S'Klallam Tribe, Regarding the Adverse Effect of the Pacific Northwest National Laboratory Sequim Campus Future Development." Richland, WA.

DOE-PNSO (U.S. Department of Energy Pacific Northwest Site Office). 2022. *Pacific Northwest National Laboratory-Sequim Campus Future Development*. DOE/EA-2130, Environmental Assessment, Richland, WA. Accessed June 4, 2025, at https://science.osti.gov/-/media/ssp/pdf/nepa-documents/ea-eis/pnso/2023/Final_Signed_PNNL_Sequim_Campus_Future_Development_EA_and_FONSI_12-27-2022.pdf.

DOE-PNSO (U.S. Department of Energy Pacific Northwest Site Office). 2024. "DOE-Battelle Prime Contract for the Management and Operation of Pacific Northwest National Laboratory, DE-AC05-76RL01830." Richland, WA. Accessed June 18, 2024, at http://doeprimecontract.pnnl.gov/.

DOE Policy 141.1. 2011. "Department of Energy Management of Cultural Resources." U.S. Department of Energy, Washington, DC. Accessed June 30, 2025, at https://www.directives.doe.gov/directives-documents/100-series/0141.1-APolicy/@@images/file.

DOE-RL (U.S. Department of Energy Richland Operations Office). 2001. Memorandum from JK Erickson to LJ Powell, dated February 21, 2001, regarding "Approval of Application for Authorized Limits for the Release of Small Volume Laboratory Liquid Samples from Radiological Control." Richland, WA.

DOE-RL (U.S. Department of Energy Richland Operations Office). 2002. *Standardized Stratigraphic Nomenclature for the Post-Ringold-Formation Sediments Within the Central Pasco Basin*. DOE/RL-2002-39, Revision 0, Richland, WA. Accessed June 30, 2025, at https://pdw.hanford.gov/document/0081471H.

DOE-RL (U.S. Department of Energy Richland Operations Office). 2014. Hanford Analytical Services Quality Assurance Requirements Document. DOE/RL-96-68, Revision 4, Richland, WA.

DOE-RL (U.S. Department of Energy Richland Operations Office). 2020. *Hanford Site Groundwater Monitoring Report for 2019*. DOE/RL-2019-66, Revision 0, Richland, WA. Accessed June 30, 2025, at https://www.hanford.gov/files.cfm/DOE-RL-2019-66_R0_Clean.pdf.

Duncan JP, ed. 2007. *Hanford Site National Environmental Policy Act (NEPA) Characterization*. PNL-6415, Revision 18. Pacific Northwest National Laboratory, Richland, WA. Accessed June 30, 2025, at http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-6415Rev18.pdf.

Ecology (Washington State Department of Ecology). 2021. "Shoreline Master Programs." Olympia, WA. Accessed July 18, 2025, at https://ecology.wa.gov/Water-Shorelines/Shoreline-coastal-management/Shoreline-coastal-planning/Shoreline-Master-Programs.

Ecology (Washington State Department of Ecology). 2024a. *Stormwater Management Manual for Eastern Washington*. Olympia, WA. Accessed July 2, 2025, at https://fortress.wa.gov/ecy/ezshare/wq/SWMMs/2024SWMMEW/2024_SWMMEW.htm.

Ecology (Washington State Department of Ecology). 2024b. *Stormwater Management Manual for Western Washington*. Olympia, WA. Accessed July 2, 2025, at https://fortress.wa.gov/ecy/ezshare/wq/SWMMs/2024SWMMWW/2024_SWMMWW.htm.

Ecology, EPA, and DOE (Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy). 1989. *Hanford Federal Facility Agreement and Consent Order*. Document No. 89-10, as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, WA. Accessed June 30, 2025, at http://www.hanford.gov/?page=81.

Ellefson MD. 2023. *Radioactive Waste Management Basis, Revision 7*. Pacific Northwest National Laboratory, Richland, WA.

Elwell LC and S Phillips, editors. 2016. Uniform Minimum Protocols and Standards for Watercraft Inspection and Decontamination Programs for Dreissenid Mussels in the Western United States (UMPS III). Pacific States Marine Fisheries Commission, Portland, OR. Accessed July 18, 2025, at https://invasivemusselcollaborative.net/wp-content/uploads/2018/11/UMPS-III-7-14-2016.pdf.

Emergency Planning and Community Right-to-Know Act of 1986. Public Law 99-499, as amended, 42 U.S.C. 11001 *et seq*. Accessed June 30, 2025, at http://www.gpo.gov/fdsys/pkg/USCODE-2010-title42/html/USCODE-2010-title42-chap116.htm.

Endangered Species Act of 1973 (ESA). Public Law 100-478, as amended, 16 U.S.C. § 1531 *et seq*. Accessed June 30, 2025, at https://www.gpo.gov/fdsys/pkg/USCODE-2015-title16/pdf/USCODE-2015-title16-chap35.pdf.

Energy Act of 2020. U.S. Department of Energy, Washington, DC. Accessed June 30, 2025, at https://www.directives.doe.gov/ipt_members_area/doe-o-436-1-departmental-sustainability-ipt/background-documents/energy-act-of-2020.

Energy Independence and Security Act of 2007 (EISA). Public Law 110-140, 121 Stat. 1492, 42 U.S.C. § 17001.

Energy Northwest. 2011. "Site Characteristics." Chapter 2 in *Columbia Generating Station Final Safety Analysis Report.* Amendment 61, Richland, WA. Accessed June 30, 2025, at https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML12011A153.

EPA (U.S. Environmental Protection Agency). 1989. *User's Guide for the COMPLY Code*. EPA 520/1-89-003, Revision 2, (Applicable to COMPLY v1.7.1 [2017]) Office of Radiation and Indoor Air, Washington, DC. Accessed May 21, 2024, https://www.epa.gov/radiation/users-guide-comply-code-revision-2.

EPA (U.S. Environmental Protection Agency). 2001. *EPA Requirements for Quality Assurance Project Plans*. EPA QA/R-5, EPA/240/B-01/003, Washington, DC. Accessed June 30, 2025, at https://www.epa.gov/sites/production/files/2016-06/documents/r5-final_0.pdf.

EPA (U.S. Environmental Protection Agency). 2006. *Guidance on Systematic Planning Using the Data Quality Objective Process (EPA QA/G-4)*. EPA/240/B-06/001, Office of Environmental Information, Washington, DC. Accessed June 30, 2025, at https://www.epa.gov/quality/guidance-systematic-planning-using-data-quality-objectives-process-epa-qag-4.

EPA (U.S. Environmental Protection Agency). 2024. "Ecoregions of North America." Accessed July 30, 2025, at https://www.epa.gov/eco-research/ecoregions-north-america.

EPA and DOE-RL (U.S. Environmental Protection Agency and U.S. Department of Energy Richland Operations Office). 2013. *Hanford Site 300 Area Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1*. Accessed June 30, 2025, at https://pdw.hanford.gov/document/0087180?.

Fagan BM. 2001. *Ancient North America: The Archaeology of a Continent*. Thames & Hudson, New York, New York.

Federal Facility Compliance Act of 1992. Public Law 102-386, as amended, 106 Stat. 1505 *et seq*., 42 U.S.C. 6939c and 6961. Accessed June 30, 2025, at http://www.labtrain.noaa.gov/ppguide/ffpp_55.htm.

Federal Insecticide, Fungicide, and Rodenticide Act. 1975. Public Law 94-51, as amended, 7 U.S.C. § 136 *et seq*. Accessed June 30, 2025, at https://www.gpo.gov/fdsys/pkg/USCODE-2014-title7/pdf/USCODE-2014-title7-chap6-subchapII.pdf.

Federal Water Pollution Control Act. 1948. Public Law 92-500, 86 Stat. 816 *et seq*., 33 U.S.C. § 1251 *et seq*. (Also see *Clean Water Act*.)

FEMA (Federal Emergency Management Administration). 1984. "Flood Insurance Rate Map, City of Richland, WA, Benton County, Community-Panel Number 5355330010E, March 1, 1984." Washington, DC. Accessed June 30, 2022, at https://msc.fema.gov/portal.

First War Powers Act of 1941. 55 Stat. 838, Ch. 593, 50 U.S.C. App. 601 *et seq*.

Forest Service Organic Administration Act of 1897. 16 U.S.C. § § 473-478, 479-482, and 551, as amended.

Freedman VL, RD Mackley, SR Waichler, JA Horner, TW Moon, DR Newcomer, DJ DeSmet, KA Lindsey, and JJ Porcello. 2010. *Hydrogeologic Evaluation of a Ground-Source Cooling System at the BSF/CSF on the Battelle Campus: Final Report*. PNNL-18463, Pacific Northwest National Laboratory, Richland, WA. Accessed June 30, 2025, at http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-18463final.pdf.

Galm JR, GD Hartmann, RA Masten, and GO Stephenson. 1981. *A Cultural Resources Overview of the Bonneville Power Administration's Mid-Columbia Project, Central Washington*. Eastern Washington University, Cheney, WA.

Hay TR, SF Snyder, and JM Barnett. 2025. *PNNL-Sequim Campus Radionuclide Air Emissions Report for Calendar Year 2024*. PNNL-22342-13, Pacific Northwest National Laboratory, Richland, WA. Accessed July 18, 2025, at https://science.osti.gov/-/media/pnso/pdf/resources/2024/25PNSO0214-TMMpdf--PNNL-Sequim-Campus-Radionuclide-Air-Emissions-Report-for-Calendar-Year-2024.pdf.

Hazardous Waste Management Act of 1976. RCW 70.105, as amended. *Revised Code of Washington*, Olympia, WA. Accessed June 30, 2025, at http://apps.leg.wa.gov/rcw/default.aspx?cite=70.105.

Hodges CM, C Miss, and J Shea. 2003. *Cultural resources survey for the Desert Claim Wind Power Project, Kittitas County, Washington*. Seattle, WA: Northwest Archaeological Associates. Report on file at the Department of Archaeology and Historic Preservation, Olympia, WA.

HPS (Health Physics Society). 2019. *Environmental Dosimetry – Criteria for System Design and Implementation.* ANSI/HPS N13.37-2014 (R2019), Herndon, VA.

ISO 9001:2015. 2015. *Quality Management Systems – Requirements.* International Organization for Standardization, Geneva, Switzerland.

ISO/IEC 17025:2017. 2017. *General Requirements for the Competence of Testing and Calibration Laboratories.* International Organization for Standardization/International Electrotechnical Commission, Geneva, Switzerland.

ISO/IEC 17043:2010. 2010. *Conformity Assessment – General Requirements for Proficiency Testing.* International Organization for Standardization/International Electrotechnical Commission, Geneva, Switzerland.

LAC, Title 76, Part I. 2024. "Wildlife and Fisheries." *Louisiana Administrative Code*, Baton Rouge, LA.

Larson KB and JL Downs. 2009. *2009 Baseline Ecological Survey: Pacific Northwest National Laboratory Site*. PNNL-18939, Pacific Northwest National Laboratory, Richland, WA.

Lindsey KA. 1995. Miocene- to Pliocene-Aged Suprabasalt Sediments of the Hanford Site, South-Central Washington. BHI-00184, Bechtel Hanford, Inc., Richland, WA.

Linsley RK, JB Franzini, DL Freyberg, and G Tchobanoglous. 1992. *Water Resources Engineering*. McGraw-Hill Publishing Company, New York, NY.

Magnuson–Stevens Fishery Conservation and Management Act. 1976. 90 Stat. 331, as amended, 16 U.S.C. § 1801 *et seq*. Accessed June 30, 2025, at https://www.fisheries.noaa.gov/resource/document/magnuson-stevens-fishery-conservation-and-management-act.

Marceau TE, DW Harvey, DC Stapp, SD Cannon, CA Conway, DH DeFord, BJ Freer, MS Gerber, JK Keeting, CF Noonan, and G Weisskopf. 2002. *History of the Plutonium Production Facilities at the Hanford Site Historic District 1943–1990*. DOE-RL-97-1047, U.S. Department of Energy, Richland Operations Office, Richland, WA. Accessed June 30, 2025, at https://pdw.hanford.gov/document/0081396H?.

Mendez JL, D W Harvey, SC Simmons, KM Mendez, and EP Kennedy. 2018. Cultural Resources Review for the Pacific Northwest National Laboratory (PNNL) Richland Campus Future Development, Richland, Benton County, Washington (2016-PNSO-003). Pacific Northwest National Laboratory, Richland, WA.

Marine Mammal Protection Act of 1972. 86 Stat. 1027, as amended, 16 U.S.C. § 1361 *et seq*. Accessed July 1, 2025, at USCODE-2017-title16-chap31-subchapI-sec1361.pdf.

Migratory Bird Treaty Act of 1918. 40 Stat. 755, as amended, 16 U.S.C. § 703 *et seq*. Accessed June 30, 2025, at http://www.fws.gov/laws/lawsdigest/migtrea.html.

Morgan V. 1996. *Results of Cultural Resources Survey and Testing for the Washington State Department of Transportation's Planned SR 101 Sequim Bypass Project, Clallam County, Washington, NADB#1344078*. Archaeological and Historical Services, Eastern Washington University, Cheney, WA.

Napier B. 2006. *Alternative Conceptual Models for Assessing Food Chain Pathways in Biosphere Models*. NUREG/CR-6910, U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, Washington, DC. Accessed June 30, 2025, at https://www.nrc.gov/docs/ML0622/ML062210427.pdf.

National Environmental Policy Act of 1969 (NEPA). Public Law 91-190, as amended, 42 U.S.C. § 4321 *et seq*. Accessed July 9, 2025, at https://www.govinfo.gov/content/pkg/COMPS-10352/pdf/COMPS-10352.pdf.

National Historic Preservation Act of 1966 (NHPA). Public Law 89-665, as amended, 54 U.S.C. § 300101 *et seq*. Accessed July 9, 2025, at https://www.achp.gov/sites/default/files/2018-06/nhpa.pdf.

National Park Service Organic Act. 16 U.S.C. § 1, 2, 3, and 4. Accessed June 30, 2025, at https://www.nps.gov/grba/learn/management/organic-act-of-1916.htm.

National Wildlife Refuge System Administration Act of 1966. 16 U.S.C § 668dd-668ee. Accessed July 21, 2025, at USCODE-2017-title16-chap5A-subchapIII-sec668dd.pdf (govinfo.gov).

NCRP (National Council on Radiation Protection and Measurements). 2009. *Ionizing Radiation Exposure of the Population of the United States*. NCRP Report 160, Bethesda, MD.

Newcomer DR. 2007. *Groundwater Monitoring at the 1100-EM-1 Operable Unit*. PNNL-16528, Pacific Northwest National Laboratory, Richland, WA. Accessed June 30, 2025, at http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-16528.pdf.

Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990. Public Law 101-646, as amended, 16 U.S.C. § 4701 et seq.

OAC (Ohio Administrative Code). 2024. Preservation of property; exceptions. Rule 1501:17-3-02. Accessed June 13, 2025, at https://codes.ohio.gov/ohio-administrative-code/rule-1501:17-3-02. Columbus, OH.

OAR 141-082. "Rules Governing the Management of, and Issuing of Leases, Licenses and Registrations for Structures on, and Uses of State-Owned Submerged and Submersible Land." *Oregon Administrative Rules*, Salem, OR.

OAR 141-089. "Administrative Rules Governing the Issuance and Enforcement of General Authorizations within the Waters of this State." *Oregon Administrative Rules*, Salem, OR.

OAR 635-007. "Fish Management and Hatchery Operations." *Oregon Administrative Rules*, Salem, OR.

OAR 635-043. "Miscellaneous Permits and Records." *Oregon Administrative Rules*, Salem, OR.

ORCAA (Olympic Region Clean Air Agency). 2024. *Regulations of the Olympic Region Clean Air Agency, Clallam, Grays Harbor, Jefferson, Mason, Pacific, and Thurston Counties*. Olympia, WA. Accessed April 18, 2025, at https://www.orcaa.org/about/air-quality-regulations.

Petersen MD, MP Moschetti, PM Powers, CS Mueller, KM Haller, AD Frankel, Y Zeng, S Rezaeian, SC Harmsen, OS Boyd, N Field, R Chen, KS Rukstales, N Luco, RL Wheeler, RA Williams, and AH Olsen. 2015. "The 2014 United States National Seismic Hazard Model." *Earthquake Spectra* 31 (S!): S1-S30. https://doi.org/10.1193/120814EQS210M.

Pleus A, L LeClair, J Schultz, and G Lambert. 2008. *2007-09 Tunicate Management Plan*. Washington State Department of Fish and Wildlife Aquatic Invasive Species Unit. In coordination with the Tunicate Response Advisory Committee, Olympia, WA. Accessed June 30, 2025, at https://wdfw.wa.gov/sites/default/files/publications/00806/wdfw00806.pdf.

PNNL (Pacific Northwest National Laboratory). 2023. *Analytical Support Operations (ASO) Quality Assurance Plan*. ASO-QAP-001, Revision 12, Richland, WA.

PNNL (Pacific Northwest National Laboratory). 2024. *Pacific Northwest National Laboratory FY 2025 Site Sustainability Plan*. Richland, WA.

Poston TM, JP Duncan, and RL Dirkes. 2011. *Hanford Site Environmental Report for Calendar Year 2010*. PNNL-20548, Pacific Northwest National Laboratory, Richland, WA. Accessed June 30, 2025, at http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-20548.pdf.

RCW 77.55, as amended. "Construction Projects in State Waters." *Revised Code of Washington,* Olympia, WA.

RCW 77.135.030. "Invasive Species. Classification of species—Rules. " *Revised Code of Washington,* Olympia, WA.

Reidel SP, KA Lindsey, and KR Fecht. 1992. *Field Trip Guide to the Hanford Site*. WHC-MR-0391, Westinghouse Hanford Company, Richland, WA. Accessed June30, 2025, at http://pbadupws.nrc.gov/docs/ML0901/ML090120386.pdf.

Renaud LY, and NK Perrin. 2023. *Section 106 Review for the Proposed PNNL Sequim Future Campus Expansion, Clallam County, Washington (2019-PNSO-050)*. Pacific Northwest National Laboratory, Richland, Washington.

Resource Conservation and Recovery Act of 1976 (RCRA). Public Law 94-580, as amended, 42 U.S.C. § 6901 *et seq*. and 42 U.S.C. § 6927(c) *et seq*. Accessed June 30, 2025, at https://www.epa.gov/laws-regulations/summary-resource-conservation-and-recovery-act.

Richland Municipal Code 17.30. Title 17, *Sewers*, Chapter 30, "Richland Pretreatment Act." Last updated June 4, 2019, Richland, WA. Accessed June 30, 2025, at http://www.codepublishing.com/WA/Richland/html/Richland17/Richland1730.html.

Rivers and Harbors Appropriation Act of 1899. Ch. 425, 30 Stat. 1121 et seq., 33 U.S.C. § 403 et seq.

Rose SA, JD Tagestad, and SF Snyder. 2023. *Pacific Northwest National Laboratory Regional Populations – 2020 Census, Richland Campus and Sequim Campus*. PNNL-25305, Rev. 1, Pacific Northwest National Laboratory, Richland, WA.

Russell J. 1971. *Jimmy Come Lately – History of Clallam County*. Clallam County Historical Society, Port Angeles, WA.

Safe Drinking Water Act of 1974. Public Law 93-523, as amended, 42 U.S.C. § 300f *et seq*. Accessed June 30, 2025, at http://www.gpo.gov/fdsys/pkg/USCODE-2013-title42/pdf/USCODE-2013-title42-chap6A-subchapXII.pdf.

Schalk RF. 1988. *The Evolution and Diversification of Native Land Use Systems on the Olympic Peninsula.* Institute for Environmental Studies, University of Washington, Seattle, WA.

Schasse HW and RL Logan. 1998. *Geologic Map of the Sequim 7.5-Minute Quadrangle, Clallam County, Washington*. Open File Report 98-7, Washington Department of Natural Resources, Olympia, WA.

Schroeder WD and C Landreau. 2012. *Archaeological Survey and Inventory of A CRP 601/Road Safety Program Road Project (Phase III), Franklin County, Washington*. Report on file with the Washington State Department of Archaeology and Historic Preservation, Olympia, WA.

Sharpe J. 1999. *Pre-Hanford Agricultural History: 1900–1943*. BHI-01326, Revision 0, Bechtel Hanford, Inc., Richland, WA.

Shoreline Management Act of 1971. RCW 90.58, as amended. *Revised Code of Washington,* Olympia, WA. Accessed June 30, 2025, at http://app.leg.wa.gov/rcw/default.aspx?cite=90.58.

Smith HI. 1910. "The Archaeology of the Yakima Valley." *Anthropological Papers of the American Museum of Natural History VI (1).* American Museum of Natural History, New York, NY.

Snyder SF, JM Barnett, LE Bisping, and LN Dinh. 2025. *Environmental Radiological Air Monitoring Plan, PNNL Operations in Washington*. PNNL-20919, Revision 2, Pacific Northwest National Laboratory, Richland, WA.

Snyder SF, JM Barnett, KM Meier, and LE Bisping. 2019. *Data Quality Objectives Supporting Radiological Air Emissions Monitoring for the Marine Sciences Laboratory, Sequim Site*. PNNL-22111, Revision 1, Pacific Northwest National Laboratory, Richland, WA.

Snyder SF, LE Bisping, TR Hay, JM Barnett, LN Dinh, and MC Klein. 2024. *Data Quality Objectives Supporting Radiological Air Emissions Monitoring for the PNNL-Richland Campus.* PNNL-19427, Revision 3, Pacific Northwest National Laboratory, Richland, WA. Accessed May 24, 2025, at https://doi.org/10.2172/2326089.

Snyder SF, LE Bisping, ME Klein, LN Dinh, and JM Barnett. 2025. *PNNL-Richland Campus Radionuclide Air Emissions Report for Calendar Year 2024*. PNNL-20436-15, Pacific Northwest National Laboratory, Richland, WA. https://science.osti.gov/pnso/Resources.

Snyder SF, DGL Moleta, KM Meier, and JM Barnett. 2017. *Data Quality Objectives Supporting Radiological Air Emissions Monitoring for the PNNL-Richland Campus.* PNNL-19427, Revision 2, Pacific Northwest National Laboratory, Richland, WA. Accessed May 24, 2025, at https://doi.org/10.2172/1415711.

State Environmental Policy Act (SEPA). RCW 43.21C, as amended. *Revised Code of Washington*, Olympia, WA. Accessed July 21, 2025, at http://app.leg.wa.gov/RCW/default.aspx?cite=43.21C.

Superfund Amendments and Reauthorization Act of 1986. Public Law 99-499, as amended, 42 U.S.C. § 9601 et seq.

Suttles W and B Lane. 1990a. "Central Coast Salish." In *Handbook of North American Indians: Northwest Coast*. Volume 7, Smithsonian Institution, Washington, DC.

Suttles W and B Lane. 1990b. "Southern Coast Salish." In *Handbook of North American Indians: Northwest Coast*. Volume 7, Smithsonian Institution, Washington, DC.

Thomas BE, LA Goodman, and TD Olsen. 1999. Hydrogeologic Assessment of the Sequim-Dungeness Area, Clallam County, Washington. Water Resources Investigation Report 99-4048, U.S. Geological Survey, Tacoma, WA. Accessed June 30, 2025, at https://pubs.er.usgs.gov/publication/wri994048.

Thompson SW, SF Snyder, CA Duberstein, ES Norris, JM Barnett, JL Blake, AT Pitman, C Counts, J Haigh, KM Mendez, KD Hand, J Su-Coker, RA Del Mar, LE Bisping, TW Moon, EA Raney, CJ Duchsherer, RS Wiegman, SR Horn, L Dinh, JA Stephens, and C Ramos. 2024. *Pacific Northwest National Laboratory Annual Site Environmental Report for Calendar Year 2023*. PNNL-36464, Pacific Northwest National Laboratory, Richland, WA. Accessed May 28, 2025, at https://www.pnnl.gov/pnnl-environmental-policy-and-annual-site-environmental-reports.

Thorne PD, MA Chamness, FA Spane, Jr., VR Vermeul, and WD Webber. 1993. *Three-Dimensional Conceptual Model for the Hanford Site Unconfined Aquifer System, FY 93 Status Report*. PNL-8971, Pacific Northwest Laboratory, Richland, WA.

Toxic Substances Control Act. 1976. Public Law 94-469, as amended, 15 U.S.C. § 2601 *et seq*. Accessed June 30, 2025, at https://www.gpo.gov/fdsys/pkg/USCODE-2014-title15/pdf/USCODE-2014-title15-chap53.pdf.

Turk D. 2021. September 16, 2021, Memorandum from DOE Deputy Secretary, David Turk, Addressing Per- and Polyfluoroalkyl Substances at the Department of Energy, Washington, DC. Accessed June 17, 2025, at https://www.energy.gov/ehss/articles/exec-2021-004118-distribution-memo-s2-turk-addressing-and-polyfluoroalkyl-substances.

UAC R652. 2022. "Natural Resources, Forestry, Fire and State Lands." *Utah Administrative Code*, Salt Lake City, UT.

USCB (U.S. Census Bureau). 2022. American Community Survey 5-year Estimates Subject Table, Sequim City and Clallam County, Washington. Washington, DC. Accessed May 25, 2025, at https://data.census.gov/cedsci/table?q=United%20States.

USFWS (U.S. Fish and Wildlife Service). 2022. "Endangered Species: Glossary." Washington, DC. Accessed June 16, 2025, at https://digitalmedia.fws.gov/digital/collection/document/id/1798/.

USGS (U.S. Geological Survey). 2024. "National Water Information System: USGS 12472800 Columbia River Below Priest Rapids Dam, WA." Washington, DC. Accessed June 30, 2025, at https://waterdata.usgs.gov/nwis/uv?site_no=12472800.

WAC 16-228. 2019. "General Pesticide Rules." *Washington Administrative Code*, Olympia, WA.

WAC 16-750-011. 2023. "State Noxious Weed List—Class B Noxious Weeds." *Washington Administrative Code*, Olympia, WA.

WAC 16-750-015. 2023. "State Noxious Weed List—Class C Noxious Weeds." *Washington Administrative Code*, Olympia, WA.

WAC 173-50. 2010. “Accreditation of Environmental Laboratories.” *Washington Administrative Code*, Olympia, WA.

WAC 173-218. 2008. “Underground Injection Control Program.” *Washington Administrative Code*, Olympia, WA.

WAC 173-303. 2020. “Dangerous Waste Regulations.” *Washington Administrative Code*, Olympia, WA.

WAC 173-303-145. 2019. “Dangerous Waste Regulations—Spills and Discharges into the Environment.” *Washington Administrative Code*, Olympia, WA.

WAC 173-400. 2021. “General Regulations for Air Pollution Sources.” *Washington Administrative Code*, Olympia, WA.

WAC 173-441. 2016. “Reporting of Emissions of Greenhouse Gases.” *Washington Administrative Code*, Olympia, WA.

WAC 173-443. 2024. “Hydrofluorocarbons (HFCs) and Other Fluorinated Greenhouse Gases.” *Washington Administrative Code*, Olympia, WA.

WAC 173-460. 2019. “Controls for New Sources of Toxic Air Pollutants.” *Washington Administrative Code*, Olympia, WA.

WAC 173-480. 2007. “Ambient Air Quality Standards and Emission Limits for Radionuclides.” *Washington Administrative Code*, Olympia, WA.

WAC 220-200-150. 2019. “Scientific Collection Permits.” *Washington Administrative Code*, Olympia, WA.

WAC 220-640-030. 2019. “Prohibited Level 1 Species.” *Washington Administrative Code*, Olympia, WA.

WAC 220-640-050. 2019. “Prohibited Level 3 Species.” *Washington Administrative Code*, Olympia, WA.

WAC 220-660. 2021. “Hydraulic Code Rules.” *Washington Administrative Code*, Olympia, WA.

WAC 246-221-190. 2003. “Disposal by Release into Sanitary Sewerage Systems.” *Washington Administrative Code*, Olympia, WA.

WAC 246-247. 2024. “Radiation Protection—Air Emissions.” *Washington Administrative Code*, Olympia, WA.

WAC 246-290. 2019. “Group A Public Water Supplies.” *Washington Administrative Code*, Olympia, WA.

WAC 296-155-655. 2021. “Safety Standards for Construction Work, Part N – Excavation, Trenching, and Shoring.” *Washington Administrative Code*, Olympia, WA.

WAC 332-30. 2015. “Aquatic Land Management.” *Washington Administrative Code*, Olympia, WA.

Washington Clean Air Act. RCW 70A.15, as amended. *Revised Code of Washington*. Olympia, WA. Accessed June 30, 2025, at https://app.leg.wa.gov/RCW/default.aspx?cite=70A.15&full=true.

Washington Pesticide Application Act. RCW 17.21, as amended. *Revised Code of Washington.* Olympia, WA. Accessed June 30, 2025, at http://apps.leg.wa.gov/rcw/default.aspx?cite=17.21.

Washington Pesticide Control Act. RCW 15.58, as amended. *Revised Code of Washington.* Olympia, WA. Accessed June 30, 2025, at http://apps.leg.wa.gov/rcw/default.aspx?cite=15.58.

WDFW (Washington Department of Fish and Wildlife). 2001. *Washington State Aquatic Nuisance Species Management Plan*. Olympia, WA. Accessed June 30, 2025, at https://wdfw.wa.gov/sites/default/files/publications/00105/wdfw00105.pdf.

WDFW (Washington Department of Fish and Wildlife). 2005. Volume I, Chapter 6, Washington’s Ecoregional Conservation Strategy, Washington's Comprehensive Wildlife Conservation Strategy, Accessed June 21, 2025, at https://wdfw.wa.gov/publications/00727#:~:text=Guiding%20principles%20for%20Washington's%20CWCS,local%20governments%2C%20and%20non%2Dgovernmental.

WDFW (Washington Department of Fish and Wildlife). 2023. *Priority Habitats and Species List*. Olympia, WA. Accessed June 30, 2025, at https://wdfw.wa.gov/publications/00165.

WDFW (Washington Department of Fish and Wildlife). 2024. “Threatened and Endangered Species.” Revised March 2024. Olympia, WA. Accessed May 20, 2024, at https://wdfw.wa.gov/sites/default/files/2024-03/wa-state-listed-and-candidate-species-list.pdf.

WDNR (Washington Department of Natural Resources). 2013. "Modeling a Magnitude 9.0 Earthquake on the Cascadia Subduction Zone off the Pacific Coast." Olympia, WA. Accessed June 30, 2025, at http://www.dnr.wa.gov/Publications/ger_seismic_scenario_cascadia.pdf.

WDNR (Washington Department of Natural Resources). 2021. "Natural Resources Geologic Information Portal Maps of Active Faults and Earthquakes, Liquefaction Susceptibility, Tsunami Hazard, Landslides, and Volcano Hazards." Olympia, WA. Accessed June 30, 2025, at https://geologyportal.dnr.wa.gov.

Williams BA, BN Bjornstad, R Schalla, and WD Webber. 2000. *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*. PNNL-12261, Pacific Northwest National Laboratory, Richland, WA. Accessed June 30, 2025, at http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-12261.PDF.

Williams BA, CF Brown, W Um, MJ Nimmons, RE Peterson, BN Bjornstad, DC Lanigan, RJ Serne, FA Spane, and ML Rockhold. 2007. *Limited Field Investigation Report for Uranium Contamination in the 300-FF-5 Operable Unit at the 300 Area, Hanford Site, Washington*. PNNL-16435, Pacific Northwest National Laboratory, Richland, WA. Accessed June 30, 2025, at http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-16435.pdf.

WNHP (Washington Natural Heritage Program). 2024. *2024 Washington Vascular Plant Species of Conservation Concern*. WNHP Report Number 2024-07, Olympia, WA. Accessed July 9, 2025, at https://www.dnr.wa.gov/publications/amp_nh_vascular_ets.pdf?zp5o7v1.

WNWCB (Washington Noxious Weed Control Board). 2025. “The 3 Classes of Noxious Weeds.” Olympia, WA. Accessed May 28, 2025, at https://www.nwcb.wa.gov/classes-of-noxious-weeds.

WOFM (Washington Office of Financial Management. 2024. 2024 Population Trends, Olympia, WA. Accessed July 1, 2025, at https://ofm.wa.gov/sites/default/files/public/dataresearch/pop/april1/ofm_april1_poptrends.pdf.

WSU (Washington State University). 2024. “AgWeatherNet Data for Sequim, Clallam County, Washington.” Data downloaded from https://weather.wsu.edu/?p=127751.

Appendix A – Plant and Animal Species Found on Undeveloped Upland and Riparian Areas of the PNNL-Richland Campus

Table A.1. Plant Species Observed on the Undeveloped Upland Portions of the PNNL-Richland Campus

Species Name[a]	Common Name[a]	State Status	Federal Status	Noxious Weed Class [2025][b]
Achillea millefolium	Common yarrow			
Achnatherum hymenoides	Indian ricegrass			
Agoseris glauca	Pale agoseris			
Agoseris grandiflora	Large-flowered agoseris			
Agoseris heterophylla	Annual agoseris			
Agropyron cristatum	Crested wheatgrass			
Ailanthus altissima	Tree of heaven			C
Allium schoenoprasum	Chives			
Amaranthus albus	White pigweed			
Ambrosia acanthicarpa	Bur ragweed			
Amsinckia lycopsoides	Tarweed fiddleneck			
Amsinckia tessellata	Tessellate fiddleneck			
Aphyllon corymbosum	Flat-topped broomrape			
Artemisia campestris	Pacific sagewort			
Artemisia dracunculus	Tarragon			
Artemisia ludoviciana	Prairie sage			
Artemisia tridentata	Big sagebrush			
Asclepias speciosa	Showy milkweed			
Asparagus officinalis	Garden asparagus			
Astragalus caricinus	Buckwheat milkvetch			
Avena sativa	Cultivated oats			
Balsamorhiza careyana	Carey's balsamroot			
Bassia scoparia	Burning-bush			B
Bromus tectorum	Cheatgrass			
Calochortus macrocarpus	Sagebrush mariposa lily			
Camissonia parvula	Small desert primrose			
Capsella bursa-pastoris	Shepherd's purse			
Carex douglasii	Douglas's sedge			
Cenchrus longispinus	Bur-grass			C
Centaurea diffusa	Diffuse knapweed			B
Centaurea solstitialis	Yellow starthistle			B
Cerastium fontanum	Common mouse-ear			
Chaenactis douglasii	Hoary false yarrow			
Chamaesyce serpyllifolia	Thymeleaf sandmat			
Chenopodium album	White goosefoot			
Chenopodium leptophyllum	Slimleaf goosefoot			
Chondrilla juncea	Skeletonweed			B

Species Name[a]	Common Name[a]	State Status	Federal Status	Noxious Weed Class [2025][b]
Chorispora tenella	Chorispora			
Chrysothamnus viscidiflorus	Green rabbitbrush			
Cichorium intybus	Chicory			
Cirsium arvense	Canada thistle			C
Clematis ligusticifolia	Western clematis			
Comandra umbellate	Bastard toadflax			
Convolvulus arvensis	Bindweed			C
Conyza canadensis	Canadian horseweed			
Coreopsis tinctoria	Columbia coreopsis			
Crepis atribarba	Slender hawksbeard			
Cryptantha flaccida	Weak-stemmed cryptantha			
Cryptantha fendleri	Fendler's cryptantha			
Cryptantha pterocarya	Winged cryptantha			
Cymopterus terebinthinus	Turpentine spring parsley			
Cynodon dactylon	Cynodon			
Dalea ornata	Western prairie-clover			
Delphinium nuttallianum	Upland larkspur			
Descurainia pinnata	Western tansymustard			
Descurainia sophia	Flixweed			
Dieteria canescens	Hoary-aster			
Draba nemorosa	Woodland draba			
Draba verna	Spring Whitlow-grass			
Elaeagnus angustifolia	Russian olive			C
Eleocharis sp.	Spike-rush			
Elymus elymoides	Bottlebrush squirreltail			
Elymus lanceolatus	Thickspike wheatgrass			
Elymus violaceus	Alaska wheatgrass			
Epilobium brachycarpum	Tall annual willow-herb			
Equisetum sp.	Horsetail			
Ericameria nauseosa	Common rabbitbrush			
Erigeron filifolius	Thread-leaf fleabane			
Eriogonum niveum	Snow buckwheat			
Eriogonum vimineum	Broom buckwheat			
Erodium cicutarium	Redstem stork's bill			
Erysimum asperum	Wallflower			
Euphorbia glyptosperma	Ribseed sandmat			
Euphorbia serpillifolia	Thymeleaf spurge			
Fallopia convolvulus	Climbing bindweed			
Fritillaria pudica	Yellow bell			
Galium aparine	Cleavers			
Gaillardia aristata	Blanket-flower			
Gilia minutiflora	Small-flowered gilia			
Gilia sinuata	Rosy gilia			
Gratiola neglecta	Common American hedge-hyssop			
Grayia spinosa	Hopsage			
Greeneocharis circumscissa	Matted cryptantha			

Species Name[a]	Common Name[a]	State Status	Federal Status	Noxious Weed Class [2025][b]
Grindelia hirsutula	Hairy gumweed			
Gypsophila paniculata	Baby's-breath			C
Hesperostipa comata	Needle-and-thread			
Holosteum umbellatum	Jagged chickweed			
Hordeum jubatum	Foxtail barley			
Hymenopappus filifolius	Hymenopappus			
Hypericum perforatum	Common St. John's-wort			C
Iris missouriensis	Rocky mountain			
Juniperus scopulorum	Rocky Mountain juniper			
Koeleria macrantha	Junegrass			
Lactuca serriola	Prickly lettuce			
Ladeania lanceolata	Lance-leaf scurf-pea			
Lagophylla rammosissima	Hareleaf			
Lamium amplexicaule	Common dead-nettle			
Layia glandulosa	Tidytips			
Lepidium draba	Heart-podded hoarycress			C
Lepidium densiflorum	Common pepperweed			
Lepidium latifolium	Broadleaf pepperweed			B
Lepidium perfoliatum	Clasping pepperweed			
Leymus cinereus	Great Basin wildrye			
Linanthus pungens	Granite prickly-phlox			
Logfia gallica	Daggerleaf cottonrose			
Lomatium macrocarpum	Bigseed biscuitroot			
Malus pumila	Cultivated apple			
Malva neglecta	Common mallow			
Marrubium vulgare	Horehound			
Medicago lupulina	Black medick			
Medicago sativa	Alfalfa			
Melilotus officianalis	Common yellow sweet-clover			
Mentha arvensis	Mint			
Mentzelia albicaulis	Small-flowered mentzelia			
Microsteris gracilis	Microsteris			
Morus alba	White mulberry			
Narcissus pseudonarcissus	Common daffodil			
Oenothera pallida	Pale evening primrose			
Onopordum acanthium	Cotton thistle			B
Opuntia polyacantha	Starvation pricklypear			
Parthenocissus vitacea	Virginia creeper			
Phacelia hastata	Silverleaf phacelia			
Phacelia linearis	Thread-leaf phacelia			
Phlox longifolia	Longleaf phlox			
Plantago lanceolata	English plantain			
Plantago patigonica	Indian-wheat			
Plectritis macrocera	Longhorn plectritis			
Poa bulbosa	Bulbous bluegrass			
Poa pratensis	Kentucky bluegrass			

Species Name[a]	Common Name[a]	State Status	Federal Status	Noxious Weed Class [2025][b]
Poa secunda	Sandberg's bluegrass			
Polemonium micranthum	Annual Jacob's ladder			
Polygonum aviculare	Doorweed			
Prunus virginiana	Chokecherry			
Pseudognaphalium stramineum	Cottonbatting plant			
Pseudoroegneria spicata	Bluebunch wheatgrass			
Purshia tridentata	Bitterbrush			
Rhaponticum repens	Hardheads (Russian knapweed)			B
Ribes aureum	Golden currant			
Robinia pseudoacacia	Black locust			
Rosa woodsii	Rose			
Rubus bifrons	Himalayan blackberry			C
Rumex salicifolius	Willow dock			
Rumex venosus	Veiny dock			
Salix exigua	Coyote willow			
Salsola tragus	Russian thistle			
Senecio vulgaris	Common groundsel			C
Setaria pumila	Foxtail			
Sisymbrium altissimum	Tall tumblemustard			
Sisymbrium loeselii	Loesel tumblemustard			
Solidago lepida	Western Canada goldenrod			
Solanum dulcamara	Climbing nightshade			
Solanum triflorum	Cut-leaved nightshade			
Sonchus arvensis	Sow-thistle			
Sphaeralcea munroana	Munro's globemallow			
Sporobolus cryptandrus	Sand dropseed			
Stephanomeria paniculata	Stiff-branched wirelettuce			
Taraxacum officinale	Common dandelion			
Toxicoscordion venenosum	Meadow death-camas			
Thinopyrum intermedium	Intermediate wheatgrass			
Tragopogon dubius	Yellow salsify			
Tribulus terrestris	Puncturevine			B
Trifolium repens	White clover			
Triteleia grandiflora	Large-flowered triteleia			
Ulmus pumila	Siberian elm			
Ulmus americana	American elm			
Verbascum thapsus	Common mullein			
Verbena bracteata	Bracted verbena			
Veronica arvensis	Common speedwell			
Veronica peregrina	Purslane speedwell			
Vulpia microstachys	Small fescue			
Vulpia octoflora	Six-weeks fescue			

[a] Nomenclature according to Hitchcock, CL and A Cronquist. 2018. *Flora of the Pacific Northwest: An Illustrated Manual, 2nd Edition*. Edited by DE Giblin, BS Legler, PF Zika, and RG Olmstead. University of Washington Press, Seattle, WA. 936pp.

[b] Noxious Weed Class: B = Prevent spread and contain or reduce existing populations; C = Weeds widespread, control methods available but not normally required.

Table A.2. Bird Species Observed on the Undeveloped Upland Portions of the PNNL-Richland Campus

Species Name	Common Name	State Status[2024]	Federal Status
Agelaius phoeniceus	Red-winged blackbird		
Artemisiospiza nevadensis	Sagebrush sparrow	Candidate	
Anas platyrhynchos	Mallard		
Asio flammeus	Short-eared owl		
Branta canadensis	Canada goose		
Buteo jamaicensis	Red-tailed hawk		
Buteo swainsoni	Swainson's hawk		
Callipepla californica	California quail		
Carpodacus mexicanus	House finch		
Carduelis tristis	American goldfinch		
Charadrius vociferus	Killdeer		
Chordeiles minor	Common nighthawk		
Chondestes grammacus	Lark sparrow		
Circus cyaneus	Northern harrier		
Colaptes auratus	Northern flicker		
Columbus livia	Rock pigeon		
Corvus brachyrhynchos	American crow		
Corvus corax	Common raven		
Eremophila alpestris	Horned lark		
Euphagus cyanocephalus	Brewer's blackbird		
Haliaeetus leucocephalus	Bald eagle		
Hirundo pyrrhonota	Cliff swallow		
Hirundo rustica	Barn swallow		
Icterus bullockii	Bullock's oriole		
Lanius ludovicianus	Loggerhead shrike	Candidate	
Numenius americanus	Long-billed curlew		
Pandion haliaetus	Osprey		
Passer domesticus	House sparrow		
Phasianus colchicus	Ring-necked pheasant		
Pica	Black-billed magpie		
Riparia	Bank swallow		
Sayornis saya	Say's phoebe		
Sturnella neglecta	Western meadowlark		
Sturnus vulgaris	European starling		
Tachycineta thalassina	Violet-green swallow		
Turdus migratorius	American robin		
Tyrannus tyrannus	Eastern kingbird		
Tyrannus verticalis	Western kingbird		
Zenaida macroura	Mourning dove		
Zonotrichia leucophrys	White-crowned sparrow		

Table A.3. Mammal Species Observed on the Undeveloped Upland Portions of the PNNL-Richland Campus

Species Name	Common Name	State Status (2024)	Federal Status
Canis latrans	Coyote		
Castor canadensis	Beaver		
Cervus elaphus	Elk		
Erithizon dorsatum	Porcupine		
Lepus californicus	Black-tailed jackrabbit	Candidate	
Odocoileus hemionus	Mule deer		
Perognathus parvus	Great Basin pocket mouse		
Sylvilagus nutalli	Mountain cottontail		
Taxidea taxus	Badger		
Thomomys talpoides	Northern pocket gopher		

Table A.4. Plant Species Observed in the Riparian Area of the PNNL-Richland Campus

Species Name[(a)]	Common Name[(a)]	State Status	Federal Status	Noxious Weed Class [2025][(b)]
Achillea millefolium	Common yarrow			
Achnatherum hymenoides	Indian ricegrass			
Agropyron cristatum	Crested wheatgrass			
Ailanthus altissima	Tree of heaven			C
Allium schoenoprasum	Chives			
Ambrosia acanthicarpa	Bur ragweed			
Amsinckia lycopsoides	Tarweed fiddleneck			
Apocynum cannabinum	Clasping-leaved dogbane			
Artemisia campestris	Pacific sagewort			
Artemisia dracunculus	Tarragon			
Artemisia ludoviciana	Prairie sage			
Artemisia tridentata	Big sagebrush			
Asclepias speciosa	Showy milkweed			
Asparagus officinalis	Garden asparagus			
Bromus tectorum	Cheatgrass			
Centaurea diffusa	Diffuse knapweed			B
Chondrilla juncea	Skeletonweed			B
Chrysothamnus viscidiflorus	Green rabbitbrush			
Cirsium arvense	Creeping thistle			C
Clematis ligusticifolia	Western clematis			
Convolvulus arvensis	Bind weed			C
Conyza canadensis	Canadian horseweed			
Coreopsis tinctoria	Columbia coreopsis			
Descurainia pinnata	Western tansymustard			
Descurainia sophia	Flixweed			
Dieteria canescens	Hoary-aster			
Eleocharis palustris	Common spike-rush			
Elymus lanceolatus	Thickspike wheatgrass			
Equisetum sp.	Horsetail			

Species Name[a]	Common Name[a]	State Status	Federal Status	Noxious Weed Class [2025][b]
Ericameria nauseosa	Rubber rabbitbrush			
Eriogonum niveum	Snow buckwheat			
Eriogonum sp.	Buckwheat			
Euphorbia glyptosperma	Ribseed sandmat			
Euphorbia serpillifolia	Thymeleaf sandmat			
Gaillardia aristata	Blanket-flower			
Galium sp.	Bedstraw			
Hesperostipa comata	Needle-and-thread			
Holosteum umbellatum	Jagged chickweed			
Hypericum perforatum	Common St. John's-wort			C
Iris missouriensis	Rocky Mountain iris			
Lactuca serriola	Prickly lettuce			
Ladeania lanceolata	Lance-leaf scurf-pea			
Lepidium densiflorum	Common pepperweed			
Lepidium draba	Heart-podded hoarycress			C
Lepidium perfoliatum	Clasping pepperweed			
Leymus cinereus	Great Basin wildrye			
Logfia gallica	Daggerleaf cottonrose			
Acmispon americanus	Spanish-clover			
Lupinus sericeus	Silky lupine			
Medicago sativa	Alfalfa			
Melilotus officinalis	Common yellow sweet clover			
Mentha piperita	Mint			
Morus alba	White mulberry			
Oenothera pallida	Pale evening primrose			
Parthenocissus vitacea	Virginia creeper			
Phalaris arundinacea	Reed canarygrass			C
Plantago lanceolata	English plantain			
Plantago patigonica	Indian-wheat			
Poa bulbosa	Bulbous bluegrass			
Poa compressa	Canada bluegrass			
Poa secunda	Sandberg's bluegrass			
Prunus virginiana	Chokecherry			
Purshia tridentata	Antelope-brush			
Rhaponticum repens	Hardheads (Russian knapweed)			B
Rhus glabra	Smooth sumac			
Ribes aureum	Golden currant			
Robinia pseudoacacia	Black locust			
Rosa woodsii	Rose			
Rubus bifrons	Himalayan blackberry			C
Rumex crispus	Curly dock			
Rumex patienta	Patience dock			
Rumex salicifolius	Willow dock			
Rumex venosus	Veiny dock			
Salix exigua	Coyote willow			
Salsola tragus	Russian thistle			

Species Name[a]	Common Name[a]	State Status	Federal Status	Noxious Weed Class [2025][b]
Sisymbrium altissimum	Tall tumblemustard			
Solidago lepida	Western Canada goldenrod			
Solanum dulcamara	Climbing nightshade			
Sphaeralcea munroana	Munro's globemallow			
Sporobolus cryptandrus	Sand dropseed			
Stephanomeria paniculata	Stiff-branched wirelettuce			
Taraxacum officinale	Common dandelion			
Tragopogon dubius	Yellow salsify			
Ulmus americana	American elm			
Verbascum thapsus	Common mullein			
Vicia cracca	Bird vetch			
Xanthium strumarium	Common cocklebur			

[a] Nomenclature according to Hitchcock, CL and A Cronquist. 2018. *Flora of the Pacific Northwest: An Illustrated Manual, 2nd Edition*. Edited by DE Giblin, BS Legler, PF Zika, and RG Olmstead. University of Washington Press, Seattle, WA. 936pp.

[b] Noxious Weed Class B = Prevent spread and contain or reduce existing populations;
Noxious Weed Class C = Weeds widespread, control methods available but not normally required.

Field surveys in the riparian zone have not been conducted since 2018.

Table A.5. Bird Species Observed in the Riparian Area of the PNNL-Richland Campus

Species Name	Common Name	State Status	Federal Status
Actitis macularius	Spotted sandpiper		
Agelaius phoeniceus	Red-winged blackbird		
Anas platyrhynchos	Mallard		
Ardea herodias	Great blue heron		
Branta canadensis	Canada goose		
Bubo virginianus	Great-horned owl		
Calidris bairdii	Baird's sandpiper		
Calidris mauri	Western sandpiper		
Callipepla californica	California quail		
Ardea alba	Great egret		
Columba livia	Rock pigeon		
Corvus corax	Common raven		
Icterus bullockii	Bullock's oriole		
Larus californicus	California gull		
Megaceryle alcyon	Belted kingfisher		
Melospiza lincolnii	Lincoln's sparrow		
Melospiza melodia	Song sparrow		
Mergus merganser	Common merganser		
Nycticorax nycticorax	Black-crowned night heron		
Pandion halaetus	Osprey		
Pelecanus erythrorhynchos	American white pelican	Sensitive	
Phalacrocorax auritus	Double-crested cormorant		
Pica	Black-billed magpie		
Riparia	Bank swallow		
Sturnus vulgaris	European starling		

Species Name	Common Name	State Status	Federal Status
Tyrannus	Eastern kingbird		
Tyrannus verticalis	Western kingbird		
Turdus migratorius	American robin		
Zenaida macroura	Mourning dove		
Field surveys in the riparian zone have not been conducted since 2018.			

Table A.6. Mammal Species Observed in the Riparian Area of the PNNL-Richland Campus

Species Name	Common Name	State Status	Federal Status
Canis latrans	Coyote		
Castor canadensis	American beaver		
Erithizon dorsatum	Porcupine		
Odocoileus hemionus	Mule deer		
Sciurus niger	Eastern fox squirrel		
Field surveys in the riparian zone have not been conducted since 2018.			

Appendix B – Plant and Animal Species Observed On and In the Vicinity of the PNNL-Sequim Campus

Biological resource surveys were last conducted in CY 2024 at the PNNL-Sequim campus.

Table B.1. Plant Species Observed on PNNL-Sequim Campus Lands, 2006–2019, 2024

Species Name[a]	Common Name[a]	State Status	Federal Status	Noxious Weed Class[b]
Abies grandis	Grand fir			
Abronia latifolia	Yellow sand verbena			
Acer circinatum	Vine maple			
Acer glabrum	Rocky Mountain maple			
Acer macrophyllum	Bigleaf maple			
Achillea millefolium	Common yarrow			
Agropyron repens	Quackgrass			
Alnus rubra	Red alder			
Ambrosia chamissonis	Silver bursage			
Amelanchier alnifolia	Saskatoon serviceberry			
Anaphalis margaritacea	Pearly-everlasting			
Anthriscus caucalis	Bur-chevil			
Arbutus menziesii	Madrone			
Arctostaphylos uva-ursi	Kinnikinnick			
Artemisia suksdorfii	Suksdorf's sagebrush			
Athyrium filix-femina	Lady fern			
Atriplex patula	Spear orache			
Avena sp.	Oat			
Bellis perennis	Daisy			
Berberis aquifolium	Shining Oregon-grape			
Berberis nervosa	Dull Oregon-grape			
Brassica rapa	Field mustard			
Cakile edentula	American searocket			
Cakile maritima	Sea rocket			
Calystegia soldanella	Beach morning-glory			
Capsella bursa-pastoris	Shepherd's-purse			
Carex sp.	Sedge			
Castilleja hispida	Harsh Indian-paintbrush			
Cerastium arvense	Field chickweed			C
Chamaenerion angustifolium	Fireweed			
Chenopodium album	White goosefoot			
Chenopodium leptophyllum	Narrowleaf goosefoot			
Cirsium arvense	Creeping thistle			
Cirsium remotifolium	Pacific fringed thistle	Endangered	Sensitive	
Cirsium vulgare	Bull thistle			
Claytonia perfoliata	Miner's lettuce			
Collinsia parviflora	Small-flowered blue-eyed Mary			
Collinsia verna	Blue-eyed Mary			
Conium maculatum	Poison-hemlock			B

Species Name[a]	Common Name[a]	State Status	Federal Status	Noxious Weed Class[b]
Convolvulus arvensis	Small bindweed			
Cornus stolonifera	Red-osier dogwood			
Corylus cornuta var. californica	Beaked hazelnut			
Crataegus douglasii	Douglas's hawthorne			
Crataegus monogyna	1-seed hawthorn			
Crepis capillaris	Smooth hawksbeard			C
Crepis monticola	Mountain hawksbeard			
Cuscuta pacifica	Pacific salt marsh dodder			
Cytisus scoparius	Scot's broom			B
Dactylis glomerata	Orchard-grass			
Danthonia intermedia	Timber oatgrass			
Delphinium sp.	Larkspur			
Deschampsia caespitosa	Tufted hairgrass			
Dicentra formosa	Pacific bleeding heart			
Dipsacus fullonum	Wild teasel			
Dipsacus sylvestris	Teasel			C
Distichlis spicata	Saltgrass			
Draba verna	Whitlow-grass			
Elymus glaucus	Blue wildrye			
Elymus mollis	American dunegrass			
Epilobium ciliatum	Common willow-herb			
Epilobium minutum	Small-flowered willow-herb			
Equisetum arvense	Common horsetail			
Equisetum hyemale	Common scouring-rush			
Erodium cicutarium	Redstem stork's bill			
Eschscholzia californica	Poppy			
Fragaria virginiana	Mountain strawberry			
Fritillaria affinis	Checker lily			
Galium aparine	Stickywilly			
Galium triflorum	Sweetscented bedstraw			
Gaultheria shallon	Salal			
Geranium molle	Dovefoot geranium			
Glehnia leiocarpa	Glehnia			
Grindelia integrifolia	Puget Sound gumweed			
Hedera helix	English ivy			
Heracleum maximum	Common cow-parsnip			
Hieraceum sp.	Hawkweed			
Holcus lanatus	Common velvet grass			
Holodiscus discolor	Oceanspray			
Hordeum brachyanterum	Meadow barley			
Hypericum scouleri	Western St. John's-wort			
Hypochaeris radicata	Hairy cat's ear			C
Ilex aquifolium	Holly			M
Juncus sp.	Rush			
Lactuca muralis	Wall lettuce			
Lamium purpureum	Purple dead-nettle			

Species Name[a]	Common Name[a]	State Status	Federal Status	Noxious Weed Class[b]
Lathyrus japonicus	Sea peavine			
Lathyrus polyphyllus	Leafy peavine			
Lepidium densiflorum	Common pepperweed			
Leptosiphon bicolor	True babystars			
Leucanthemum vulgare	Oxeye-daisy			C
Lilium columbianum	Columbia tiger lilly			
Linnaea borealis	Twinflower			
Lomatium nudicaule	Bare-stemmed biscuitroot			
Lonicera ciliosa	Orange honeysuckle			
Lonicera hispidula	California honeysuckle			
Lupinus sp.	Lupine			
Lysichiton americanus	Skunk cabbage			
Lysimachia latifolia	Western starflower			
Maianthemum dilatatum	False lily-of-the-valley			
Maianthemum racemosum ssp. amplexicaule	Large false Solomon's seal			
Malus fusca	Oregon crabapple			
Matricaria discoidea	Pineapple weed			
Medicago lupulina	Black medick			
Mycelis muralis	Mycelis			
Myosotis laxa	Small-flowered forget-me-not			
Oemleria cerasiformis	Indian plum			
Osmorhiza berteroi	Sweet-cicely			
Osmorhiza chilensis	Mountain sweet cicely			
Petasites frigidus	Sweet coltsfoot			
Phalaris arundinacea	Reed canary grass			
Physocarpus capitatus	Pacific ninebark			
Plantago lanceolata	English plantain			
Plantago major	Common plantain			
Plantago maritima	Sea tongue			
Plectritis congesta	Sea blush			
Poa annua	Annual meadow grass			
Poa bulbosa	Bulbous bluegrass			
Polygonum paronychia	Black knotweed			
Polyodium clycyrrhiza	Licorice fern			
Polystichum munitum	Western swordfern			
Populus trichocarpa	Black cottonwood			
Potentilla anserina	Cinquefoil			
Prunella vulgaris	Self-heal			
Prunus emarginata	Bitter cherry			
Prunus laurocerasus	Cherry laurel			
Pseudotsuga menziesii	Douglas fir			
Pteridium aquilinum	Bracken fern			
Ranunculus repens	Creeping buttercup			
Ranunculus uncinatus	Little buttercup			
Ribes divaricatum	Straggly gooseberry			
Ribes sanguineum	Redflower currant			

Species Name[a]	Common Name[a]	State Status	Federal Status	Noxious Weed Class[b]
Rosa gymnocarpa	Little wild rose			
Rosa nutkana	Nootka rose			
Rubus armeniacus	Himalayan blackberry			C
Rubus leucodermis	Blackcap			
Rubus nutkanus	Thimbleberry			
Rubus spectabilis	Salmonberry			
Rubus ursinus	Pacific blackberry			
Rumex acetosella	Sheep sorrel			
Rumex crispus	Curly dock			
Rumex occidentalis	Western dock			
Salicornia depressa	Low glasswort			
Salix lasiandra	Pacific willow			
Salix scouleriana	Scouler's willow			
Salix sitchensis	Sitka willow			
Sambucus nigra	Blue elderberry			
Sambucus racemosa	Red elderberry			
Sanicula crassicaulis	Pacific sanicle			
Senecio jacobaea	Common ragwort			
Senecio sylvaticus	Wood groundsel			
Senecio vulgaris	Old-man-in-the-spring			
Sonchus asper	Prickly sow-thistle			
Spiraea douglasii	Spirea			
Stellaria media	Common chickweed			
Struthiopteris spicant	Hard fern			
Symphoricarpos albus	Common snowberry			
Taraxacum officinale	Common dandelion			
Taxus brevifolia	Pacific yew			
Tellima grandiflora	Fringecup			
Thuja plicata	Western red cedar			
Tolmiea menziesii	Youth-on-age			
Tragopogon dubius	Yellow salsify			
Trifolium dubium	Suckling clover			
Trifolium pratense	Red clover			
Trifolium repens	White clover			
Triglochin maritima	Seaside arrow-grass			
Triphysaria pusilla	Dwarf owl-clover			
Tsuga heterophylla	Western hemlock			
Urtica dioica	Stinging nettle			
Valeriana locusta	Cornsalad			
Vicia americana	American vetch			
Vicia cracca	Bird vetch			
Vicia nigricans	Giant vetch			
Vicia sativa	Common vetch			

[a] Nomenclature according to Hitchcock, CL and A Cronquist. 2018. *Flora of the Pacific Northwest: An Illustrated Manual, 2nd Edition*. Edited by DE Giblin, BS Legler, PF Zika, and RG Olmstead. University of Washington Press, Seattle, WA. 936pp.

[b] Noxious Weed Class: B = Prevent spread and contain or reduce existing populations; C = Weeds widespread, control methods available but not normally required; M = Monitor list.

Table B.2. Bird Species Observed on and in the Vicinity of the PNNL-Sequim Campus Lands

Species Name	Common Name	State Status	Federal Status
Accipiter cooperii	Cooper's hawk		
Agelaius phoeniceus	Red-winged blackbird		
Accipiter striatus	Sharp-shinned hawk		
Aechmophorus occidentalis	Western grebe	Candidate	
Agelaius phoeniceus	Red-winged blackbird		
Anas platyrhynchos	Mallard		
Anthus rubescens	American pipit		
Ardea herodias	Great blue heron		
Aythya marila	Greater scaup		
Branta bernicla	Brant		
Branta canadensis	Canada goose		
Bubo virginianus	Great-horned owl		
Bucephala albeola	Bufflehead		
Bucephala clangula	Common goldeneye		
Buteo jamaicensis	Red-tailed hawk		
Calidris alpina	Dunlin		
Callipepla californica	California quail		
Calypte anna	Anna's hummingbird		
Cardellina pusilla	Wilson's warbler		
Cathartes aura	Turkey vulture		
Catharus ustulatus	Swainson's thrush		
Catharus guttatus	Hermit thrush		
Cepphus columba	Pigeon guillemot		
Cerorhinca monocerata	Rhinoceros auklet		
Certhia americana	Brown creeper		
Charadrius vociferus	Killdeer		
Circus hudsoneus	Northern harrier		
Cistothorus palustris	Marsh wren		
Coccothraustes vespertinus	Evening grosbeak		
Clangula hyemalis	Long-tailed duck		
Colaptes auratus	Northern flicker		
Columba livia	Rock dove (pigeon)		
Contopus cooperi	Olive-sided flycatcher		
Corvus brachyrhynchos	American crow		
Corvus corax	Common raven		
Cyanocitta stelleri	Steller's jay		
Dryobates pubescens	Downy woodpecker		
Dryobates villosus	Hairy woodpecker		
Empidonax difficilis	Pacific-slope flycatcher		
Empidonax hammondii	Hammond's flycatcher		
Euphagus cyanocephalus	Brewer's blackbird		
Falco peregrinus	Peregrine falcon		
Haematopus bachmani	Black oystercatcher		
Haemorhous mexicanus	House finch		
Haliaeetus leucocephalus	Bald eagle		

Species Name	Common Name	State Status	Federal Status
Hirundo rustica	Barn swallow		
Histrionicus histrionicus	Harlequin duck		
Hydroprogne caspia	Caspian tern		
Ixoreus naevius	Varied thrush		
Junco hyemalis	Dark-eyed junco		
Larus glaucescens	Glaucus-winged gull		
Larus glaucescens x L. occidentalis	Olympic gull		
Larus occidentalis	Western gull		
Leiothlypis celata	Orange-crowned warbler		
Lophodytes cucullatus	Hooded merganser		
Megaceryle alcyon	Belted kingfisher		
Melanitta deglandi	White-winged scoter		
Melospiza lincolnii	Lincoln's sparrow		
Melospiza melodia	Song sparrow		
Mergus merganser	Common merganser		
Mergus serrator	Red-breasted merganser		
Molothrus ater	Brown-headed cowbird		
Passerculus sandwichensis	Savannah sparrow		
Passerella iliaca	Fox sparrow		
Patagioenas fasciata	Band-tailed pigeon		
Petrochelidon pyrrhonota	Cliff swallow		
Phalacrocorax auritus	Double-crested cormorant		
Phalacrocorax pelagicus	Pelagic cormorant		
Phalacrocorax penicillatus	Brant's cormorant		
Pheucticus melanocephalus	Black-headed grosbeak		
Pipilo maculatus	Spotted towhee		
Piranga ludoviciana	Western tanager		
Podiceps nigricollis	Eared grebe		
Podilymbus podiceps	Pied-billed grebe		
Poecile atricapillus	Black-capped chickadee		
Poecile rufescens	Chestnut-backed chickadee		
Progne subis	Purple martin		
Psaltriparus minimus	Bushtit		
Regulus calendula	Ruby-crowned kinglet		
Regulus satrapa	Golden-crowned kinglet		
Selasphorus rufus	Rufous hummingbird		
Setophaga coronata	Yellow-rumped warbler		
Setophaga petechia	Yellow warbler		
Setophaga townsendi	Townsend's warbler		
Sitta canadensis	Red-breasted nuthatch		
Sphyrapicus ruber	Red-breasted sapsucker		
Spinus pinus	Pine siskin		
Spinus tristis	American goldfinch		
Stelgidopteryx serripennis	Northern rough-winged swallow		
Sterna caspia	Caspian tern		
Strix varia	Barred owl		
Sturnus vulgaris	European starling		

Species Name	Common Name	State Status	Federal Status
Tachycineta bicolor	Tree swallow		
Tachycineta thalassina	Violet-green swallow		
Thryomanes bewickii	Bewick's wren		
Troglodytes pacificus	Pacific wren		
Turdus migratorius	American robin		
Zenaida macroura	Mourning dove		
Zonotrichia leucophrys	White-crowned sparrow		

Table B.3. Other Vertebrate Species Observed on PNNL-Sequim Campus Lands

Species Name	Common Name	State Status	Federal Status
Anaxyrus boreas	Western toad		
Canis latrans	Coyote		
Odocoileus hemionus	Black-tailed deer		
Rana aurora	Northern red-legged frog		
Sorex sp.	Shrew		
Tamiasciurus douglasii	Douglas squirrel		
Taricha granulosa	Rough-skinned newt		

Appendix C – Ambient External Dose Surveillance Results

Ambient levels of external dose from beta, gamma, and X-ray sources are monitored on a quarterly basis at the five particulate air monitoring stations associated with the PNNL-Richland campus. Ambient external dose surveillance began in June 2024 at the PNNL-Sequim campus. Two onsite stations, one shoreline (SEQ-1) and one upland (SEQ-2), were established at Sequim. Annual results for the PNNL-Sequim campus will be presented next year when a full calendar year of data has been collected.

The Richland environmental dosimeters co-located at PNL-2 and PNL-3 stations were subject to planned maintenance activities in CY 2024 in order to relocate the sampling stations. The PNL-2 dosimeter reading for the fourth quarter and the PNL-3 dosimeter reading for the third quarter are not representative of their single sample location. The dosimeters were temporarily placed in storage and redeployed when the PNL-2 and PNL-3 sampling stations were reestablished and returned to normal operations (see Figure 18). No dosimeter change-outs were completed mid-quarter.

The program establishes baseline ambient external dose levels at four PNNL-Richland campus stations and at the background (PNL-5) station and two PNNL-Sequim campus locations. Definitions for the ambient air external dose sampling are in Table C.1; dose surveillance results are in Table C.2; and normalized quarterly external dose results are in Table C.3.

Table C.1. Definitions for Ambient Air External Dose Sampling Data

Column Heading	Data Type/Format	Content
Location ID	Text	Location of monitoring station: **PNNL-Richland campus** monitoring stations – PNL-1, PNL-2, PNL-3, PNL-4. Background Location – PNL-5 PNL-T – to measure exposure during field deployment/retrieval PNL-Control – to measure exposure during shipment to and from vendor (value is NOT subtracted from the monitoring station data shown in Table C.2) **PNNL-Sequim campus** monitoring stations – SEQ-1, SEQ-2 SEQ-T – to measure exposure during field deployment/retrieval SEQ-Control – to measure exposure during shipment to and from vendor (value is NOT subtracted from the monitoring station data shown in Table C.2
Field Sample ID	Number (######)	Unique identifier assigned to a sample (typically six-digit number but characters allowed).
Parameter Name	Text	Code assigned to analytical parameter: Optically Stimulated Luminescence Dosimeter-Gross Exposure (OSLD-GE).
Start Date	Date (DD-MMM-YYYY)	Date when dosimeter sampling started.
Sample Date	Date (DD-MMM-YYYY)	Date when dosimeter sampling ended.
Quarter	Text (Q#)	Calendar quarter when the dosimeter was deployed.
Result	Integer number	Gross dose (no control value subtracted) result as reported by the vendor.
Units	Text	Units associated with the value reported in the Result field, millirem (mrem).

Table C.2. Ambient External Dose Surveillance 2024

Location ID	Field Sample ID	Parameter Name	Start Date	Sample Date	Quarter	Result (mrem)
PNNL-Richland campus						
PNL-1	240029	OSLD-GE	12/27/2023	03/20/2024	Q1	30
PNL-2	240030	OSLD-GE	12/27/2023	03/20/2024	Q1	23
PNL-3	240031	OSLD-GE	12/27/2023	03/20/2024	Q1	27
PNL-4	240032	OSLD-GE	12/27/2023	03/20/2024	Q1	25
PNL-5	240033	OSLD-GE	12/27/2023	03/20/2024	Q1	29
PNL-T	240035	OSLD-GE	12/27/2023	03/20/2024	Q1	18
PNL-CONTROL	240034	OSLD-GE	12/27/2023	03/20/2024	Q1	20
PNL-1	240057	OSLD-GE	03/20/2024	06/26/2024	Q2	22
PNL-2	240058	OSLD-GE	03/20/2024	06/26/2024	Q2	28
PNL-3	240059	OSLD-GE	03/20/2024	06/26/2024	Q2	27
PNL-4	240060	OSLD-GE	03/20/2024	06/26/2024	Q2	26
PNL-5	240061	OSLD-GE	03/20/2024	06/26/2024	Q2	28
PNL-T	240063	OSLD-GE	03/20/2024	06/26/2024	Q2	18
PNL-CONTROL	240062	OSLD-GE	03/20/2024	06/26/2024	Q2	17
PNL-1	240064	OSLD-GE	06/26/2024	09/18/2024	Q3	22
PNL-2	240065	OSLD-GE	06/26/2024	09/18/2024	Q3	21
PNL-3[(a)]	240066	OSLD-GE	06/26/2024	09/18/2024	Q3	21
PNL-4	240067	OSLD-GE	06/26/2024	09/18/2024	Q3	20
PNL-5	240068	OSLD-GE	06/26/2024	09/18/2024	Q3	25
PNL-T	240070	OSLD-GE	06/26/2024	09/18/2024	Q3	12
PNL-CONTROL	240069	OSLD-GE	06/26/2024	09/18/2024	Q3	13
PNL-1	240071	OSLD-GE	09/18/2024	12/23/2024	Q4	25
PNL-2[(b)]	240072	OSLD-GE	09/18/2024	12/23/2024	Q4	24
PNL-3	240073	OSLD-GE	09/18/2024	12/23/2024	Q4	27
PNL-4	240074	OSLD-GE	09/18/2024	12/23/2024	Q4	26
PNL-5	240075	OSLD-GE	09/18/2024	12/23/2024	Q4	26
PNL-T	240077	OSLD-GE	09/18/2024	12/23/2024	Q4	14
PNL-CONTROL	240076	OSLD-GE	09/18/2024	12/23/2024	Q4	12
PNNL-Sequim campus						
SEQ-1	240252	OSLD-GE	06/21/2024	09/19/2024	Q3	19
SEQ-2	240253	OSLD-GE	06/21/2024	09/19/2024	Q3	16
SEQ-T	240255	OSLD-GE	06/26/2024	09/19/2024	Q3	13
SEQ-CONTROL	240254	OSLD-GE	06/26/2024	09/19/2024	Q3	12
SEQ-1	240256	OSLD-GE	09/19/2024	12/19/2024	Q3	19
SEQ-2	240257	OSLD-GE	09/19/2024	12/19/2024	Q3	17
SEQ-T	240259	OSLD-GE	09/19/2024	12/19/2024	Q3	11
SEQ-CONTROL	240258	OSLD-GE	09/19/2024	12/19/2024	Q3	11

(a) PNL-3 dosimeter reading is not representative of a single sample location. PNL-3 was removed on 07/12/24 and placed in storage; dosimeter was redeployed on 08/21/24 at new PNL-3 location (see Figure 19).

(b) PNL-2 dosimeter reading is not representative of a single sample location. PNL-2 was removed on 11/13/24 and placed in storage; dosimeter was redeployed on 11/26/24 at new PNL-2 location (see Figure 19).

Table C.3. 2024 PNNL-Richland Campus Ambient External Dose Calculated for ANSI/HPS N13.37-2014 (HPS 2019) 91-d Normalized Quarters

2024 91-d Normalized Quarter Dose	PNL-1	PNL-2	PNL-3	PNL-4	PNL-5[(a)]
Normalized Q1 (mrem/Q)	10.83	3.25	7.58	5.42	9.75
Normalized Q2 (mrem/Q)	4.64	10.21	9.29	8.36	10.21
Normalized Q3 (mrem/Q)	9.75	8.67	8.67	7.58	13.00
Normalized Q4 (mrem/Q)	12.32	11.38	14.22	13.27	13.27
Total (mrem/yr)	**37.5**	**33.5**	**39.8**	**34.6**	**46.2**

[(a)] PNL-5 is the background station. No background values were subtracted from listed campus perimeter stations (PNL-1 through PNL-4) results.

Appendix D – Helpful Information

The information in this appendix is provided to assist readers in understanding this report. Included here is information about scientific notation, units of measurement, radioactivity units, radiological dose units, chemical and elemental nomenclature, and greater than or less than symbols. Definitions of technical terms are provided in Appendix E.

D.1 Scientific Notation

Scientific notation is used to express very large or very small numbers. For example, the number 1 billion can be written as 1,000,000,000 or, by using scientific or E notation, written as 1×10^9 or 1.0E+09. Translating from scientific notation to a more traditional number requires moving the decimal point either left or right from its current location. If the value given is 2.0×10^3 (or 2.0E+03), the decimal point should be moved three places to the right, so that the number would then read 2,000. If the value given is 2.0×10^{-5} (or 2.0E-05), the decimal point should be moved five places to the left, so that the result would be 0.00002.

D.2 Units of Measurement

The primary units of measurement used in this report follow the International System of Units and are metric, but U.S. standard measurements are also provided. Table D.1 summarizes and defines the terms and corresponding symbols (metric and non-metric). A conversion table is provided in Table D.2.

Table D.1. Names and Symbols for Units of Measure

Symbol	Name	Symbol	Name
Concentration		**Area**	
ppb	parts per billion	ha	hectare(s) (1×10^4 m^2)
ppm	parts per million	km^2	square kilometer(s)
ppmv	parts per million by volume	mi^2	square mile(s)
Length		ft^2	square foot (feet)
cm	centimeter(s) (1×10^{-2} m)	**Mass**	
ft	foot (feet)	g	gram(s)
in.	inch(es)	kg	kilogram(s) (1×10^3 g)
km	kilometer(s) (1×10^3 m)	mg	milligram(s) (1×10^{-3} g)
m	meter(s)	µg	microgram(s) (1×10^{-6} g)
mi	mile(s)	lb	pound(s)
mm	millimeter(s) (1×10^{-3} m)	**Time**	
µm	micrometer(s) (1×10^{-6} m)	d	day(s)
Rate		hr	hour(s)
cfs (or ft^3/sec)	cubic feet per second	min	minute(s)
cpm	counts per minute	sec	second(s)
gpm	gallon(s) per minute	yr	year(s)
mph	mile(s) per hour	**Volume**	
mR/hr	milliroentgen(s) per hour	cm^3	cubic centimeter(s)
mrem/d	millirem per day	ft^3	cubic foot (feet)
mrem/yr	millirem per year	gal	gallon(s)
µrem/hr	microrem per hour	L	liter(s)
Temperature		m^3	cubic meter(s)
°C	degrees Celsius	mL	milliliter(s) (1×10^{-3} L)
°F	degrees Fahrenheit	yd^3	cubic yard(s)

Table D.2. Conversion Table

Multiply	By	To Obtain	Multiply	By	To Obtain
cm	0.394	in.	in.	2.54	cm
m	3.28	ft	ft	0.305	m
km	0.621	mi	mi	1.61	km
kg	2.205	lb	lb	0.454	kg
L	0.2642	gal	gal	3.785	L
m^2	10.76	ft^2	ft^2	0.093	m^2
ha	2.47	acres	acre	0.405	ha
km^2	0.386	mi^2	mi^2	2.59	km^2
m^3	35.31	ft^3	ft^3	0.0283	m^3
m^3	1.308	yd^3	yd^3	0.7646	m^3
pCi	1,000	nCi	nCi	0.001	pCi
µCi/mL	10^9	pCi/L	pCi/L	10^{-9}	µCi/mL
Ci/m^3	10^{12}	pCi/m^3	pCi/m^3	10^{-12}	Ci/m^3
mCi/cm^3	10^{15}	pCi/m^3	pCi/m^3	10^{-15}	mCi/cm^3
nCi/m^2	1.0	mCi/km^2	mCi/km^2	1.0	nCi/m^2
Ci	3.7×10^{10}	Bq	Bq	2.7×10^{-11}	Ci
pCi	0.037	Bq	Bq	27	pCi
rad	0.01	Gy	Gy	100	rad
rem	0.01	Sv	Sv	100	rem
ppm	1,000	ppb	ppb	0.001	ppm
°C	(°C × 9/5) + 32	°F	°F	(°F -32) ÷ 9/5	°C
oz	28.349	g	g	0.035	oz
ton	0.9078	tonne	tonne	1.1	ton

D.3 Radioactivity Units

Much of this report deals with levels of radioactivity in various environmental media. Radioactivity in this report is usually discussed in units of curies (Ci), with conversions to becquerels (Bq), the International System of Units measure (Table D.3). The curie is the basic unit used to describe the amount of activity present, and activities are generally expressed in terms of curies per mass or volume (e.g., picocuries per liter). One curie is equivalent to 37 billion disintegrations per second or is a quantity of any radionuclide that decays at the rate of 37 billion disintegrations per second. One becquerel is equivalent to one disintegration per second. Nuclear disintegrations produce spontaneous emissions of alpha or beta particles, gamma radiation, or combinations of these. Figure D.1 includes selected conversions from curies to becquerels.

Table D.3. Names and Symbols for Units of Radioactivity

Symbol	Name	Symbol	Name
Ci	curie	Bq	becquerel
mCi	millicurie (1×10^{-3} Ci)	kBq	kilobecquerel (1×10^3 Bq)
µCi	microcurie (1×10^{-6} Ci)	mBq	millibecquerel (1×10^{-3} Bq)
nCi	nanocurie (1×10^{-9} Ci)	MBq	megabecquerel (1×10^6 Bq)
pCi	picocurie (1×10^{-12} Ci)	GBq	gigabecquerel (1×10^9 Bq)
fCi	femtocurie (1×10^{-15} Ci)	TBq	terabecquerel (1×10^{12} Bq)
aCi	attocurie (1×10^{-18} Ci)		

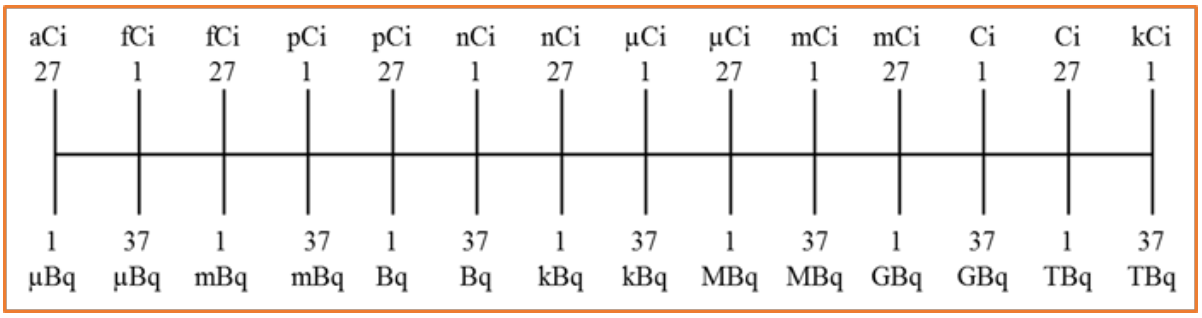


Figure D.1. Radioactivity Units, Curies to Becquerels

D.4 Radiological Dose Units

Radiological dose in this report is usually written in terms of EDE and reported numerically in units of millirem (mrem), with the metric units millisievert (mSv) or microsievert (µSv) following in parentheses or footnoted. The EDE and effective dose units can be considered equivalent for the purposes of this report and reflect the units calculated by the software used.

Millirem (millisievert) is a unit of measurement that relates a given amount of absorbed radiation energy to its biological effectiveness or risk (to humans). For perspective, a dose of 1 mrem (0.01 mSv) would have a biological effect roughly the same as that received from 1 day's exposure to natural background radiation. An acute (short-term) dose to the whole body of 100 rem (1 Sv) would likely cause temporary radiation sickness in some exposed individuals. An acute dose of over 500 rem (5 Sv) would soon result in death in approximately 50% of those exposed. Exposure to lower amounts of radiation (10 mrem [100 µSv] or less) produces no immediate observable effects, but long-term (delayed) effects are possible. The average person in the United States receives an annual dose from exposure to naturally produced radiation of approximately 300 mrem (3 mSv). Medical and dental x-rays and air travel add to this total. Figure D.2 includes selected conversions from rem to sievert.

Also used in this report is the term rad, with the corresponding International System of Units, gray (Gy), in parentheses or footnoted. The rad (gray) is a measure of the energy absorbed by any material, whereas a rem relates to both the amount of radiation energy absorbed by humans and its consequence. The gray can be converted to rad by multiplying by 100. The conversions in Figure D.2 can also be used to convert grays to rads, substituting Gy for Sv and substituting rad for rem in Figure D.2.

The names and symbols for units of radiation dose used in this report are listed in Table D.4.

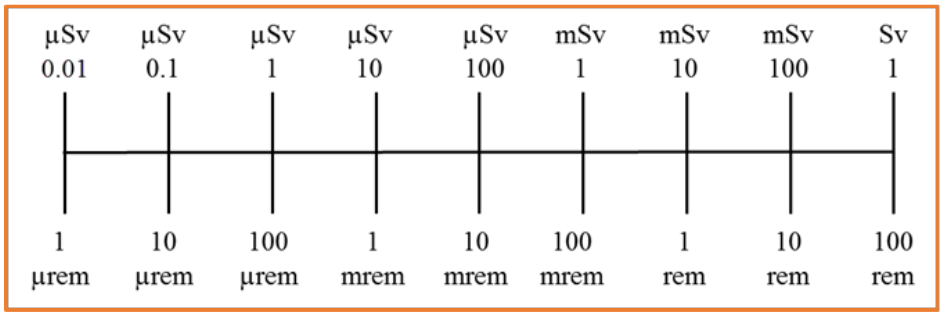


Figure D.2. Radiological Dose Units, Sieverts to Rem

Table D.4. Names and Symbols for Units of Radiation Dose or Exposure

Symbol	Name
mrad	millirad (1 × 10^{-3} rad)
mrem	millirem (1 × 10^{-3} rem)
µrem	microrem (1 × 10^{-6} rem)
Sv	sievert (= 100 rem)
mSv	millisievert (1 × 10^{-3} Sv)
µSv	microsievert (1 × 10^{-6} Sv)
Gy	gray (= 100 rad)
mGy	milligray (1 x 10^{-3} Gy)

Additional information about radiation and dose terminology can be found in Appendix E. A list of the radionuclides that may be discussed in this report, their symbols, and their half-lives are included in Table D.5.

Table D.5. Radionuclides and Their Half-Lives[(a)]

Symbol	Radionuclide	Half-Life	Symbol	Radionuclide	Half-Life
^{3}H	tritium	12.32 yr	^{140}Ba	barium-140	12.7527 d
^{7}Be	beryllium-7	53.22 d	^{152}Eu	europium-152	13.517 yr
^{14}C	carbon-14	5,700 yr	^{154}Eu	europium-154	8.601 yr
^{24}Na	sodium-24	14.997 h	^{155}Eu	europium-155	4.753 yr
^{40}K	potassium-40	1.248 × 10^{9} yr	^{177}Lu	lutetium-177	6.647 d
^{26}Al	aluminum-26	7.17 × 10^{5} yr	^{208}Po	polonium-208	2.898 yr
^{39}Ar	argon-39	269 yr	^{210}Pb	lead-210	22.20 yr
^{51}Cr	chromium-51	27.7025 d	^{212}Pb	lead-212	10.64 h
^{54}Mn	manganese-54	312.2 d	^{220}Rn	radon-220	55.6 sec
^{55}Fe	iron-55	2.744 yr	^{222}Rn	radon-222	3.8235 d
^{59}Fe	iron-59	44.495 d	^{226}Ra	radium-226	1600 yr
^{59}Ni	nickel-59	7.6 × 10^{4} yr	^{228}Ra	radium-228	5.75 yr
^{57}Co	cobalt-57	271.7 d	^{228}Th	thorium-228	1.9125 yr
^{60}Co	cobalt-60	5.275 yr	^{229}Th	thorium-229	7932 yr
^{63}Ni	nickel-63	101.2 yr	^{230}Th	thorium-230	7.54 × 10^{4} yr
^{65}Zn	zinc-65	243.9 d	^{232}Th	thorium-232	1.40 × 10^{10} yr
^{82}Br	bromine-82	35.282 h	U or uranium	natural uranium	~4.5 × 10^{9}[(b)] yr
^{83m}Kr	krypton-83m	1.83 h	^{232}U	uranium-232	68.9 yr
^{85}Kr	krypton-85	10.739 yr	^{233}U	uranium-233	1.592 × 10^{5} yr
^{89}Sr	strontium-89	50.563 d	^{234}U	uranium-234	2.455 × 10^{5} yr
^{90}Sr	strontium-90	28.9 yr	^{235}U	uranium-235	7.04 × 10^{8} yr
^{88}Y	yttrium-88	106.63 d	^{238}U	uranium-238	4.468 × 10^{9} yr
^{90}Y	yttrium-90	64.053 h	^{236}Np	neptunium-236	1.53 × 10^{5} yr
^{95}Zr	zirconium-95	64.032 d	^{237}Np	neptunium-237	2.144 × 10^{6} yr
^{99}Tc	technetium-99	2.111 × 10^{5} yr	^{238}Pu	plutonium-238	87.7 yr
^{103}Ru	ruthenium-103	39.247 d	^{239}Pu	plutonium-239	2.411 × 10^{4} yr
^{106}Ru	ruthenium-106	371.8 d	^{240}Pu	plutonium-240	6.561 × 10^{3} yr
^{109}Cd	cadmium-109	461.4 d	^{241}Pu	plutonium-241	14.329 yr
^{113}Sn	tin-113	115.09 d	^{242}Pu	plutonium-242	3.75 × 10^{5} yr

Symbol	Radionuclide	Half-Life	Symbol	Radionuclide	Half-Life
^{125}Sb	antimony-125	2.75856 yr	^{244}Pu	plutonium-244	8.0×10^7 yr
^{129}I	iodine-129	1.57×10^7 yr	^{241}Am	americium-241	432.6 yr
^{131}I	iodine-131	8.0252 d	^{243}Am	americium-243	7,364 yr
^{132}I	iodine-132	2.295 h	^{243}Cm	curium-243	29.1 yr
^{133}Xe	xenon-133	5.2475 d	^{244}Cm	curium-244	18.1 yr
^{134}Cs	cesium-134	2.0652 yr	^{245}Cm	curium-245	8,423 yr
^{137}Cs	cesium-137	30.08 yr	^{250}Cf	californium-250	13.08 yr
^{137m}Ba	barium-137m	2.552 min	^{252}Cf	californium-252	2.645 yr

(a) From NuDat 3.0 at https://www.nndc.bnl.gov/nudat3/
(b) Natural uranium is a mixture dominated by uranium-238.

Appendix E – Glossary

This glossary contains selected words and phrases used in this report that may not be familiar to readers. Words appearing in italic type within a definition also are defined in this glossary.

alpha particle – A positively charged particle composed of two protons and two neutrons ejected spontaneously from the nuclei of some *radionuclides* during radioactive decay. It has a low penetrating power and short range. The most energetic alpha particle will generally fail to penetrate the skin but is hazardous when introduced into the body.

aquifer – Underground sediment or rock that stores and/or transmits water.

background radiation – *Radiation* in the natural environment, including cosmic rays from space and *radiation* from naturally occurring radioactive elements in the air, in the earth, and in human bodies. It also includes *radiation* from global fallout from historical atmospheric nuclear weapons testing. In the United States, the average person receives approximately 300 *millirem* (3 mSv) of background radiation per year.

becquerel (Bq) – Unit of activity or amount of a radioactive substance (also *radioactivity*) equal to one nuclear transformation per second (1 Bq = 1 disintegration per second). Another unit of *radioactivity*, the *curie*, is related to the becquerel: 1 Ci = 3.7×10^{10} Bq.

beta particle – A negatively charged particle (essentially an electron) released from a nucleus during radioactive *decay*. At high enough intensities, some beta particles may cause skin burns and may be harmful if they enter the body. Beta particles are easily stopped by a thin sheet of metal or plastic.

Categorical Exclusion – A class of actions that DOE has determined are not likely to have significant environmental impacts under normal circumstances and for which an environmental assessment or environmental impact statement is not normally needed. These are listed at 10 CFR Part 1021, Appendix D.

collective dose – Sum of the total EDE for individuals composing a defined population. Collective dose units are *person-rem* or person-sievert.

composite sample – Sample formed by combining discrete samples taken at different times or from different locations.

confined aquifer – An *aquifer* bounded above and below by less permeable layers. *Groundwater* in the confined aquifer is under a pressure greater than atmospheric pressure.

curie (Ci) – A unit of *radioactivity* equal to 37 billion (3.7×10^{10}) nuclear transformations per second (*becquerels*).

decay – The decrease in the amount of any radioactive material (disintegration) with the passage of time. See *radioactivity*.

decay product – The atomic nucleus or nuclei that are left after radioactive transformation of a radioactive material. Decay products may be radioactive or nonradioactive (stable). They are informally referred to as daughter products or progeny. See *radioactivity*.

dispersion – Process whereby *effluents* or *emissions* are spread or mixed when they are transported by *groundwater*, surface water, or air.

dose rate – The rate at which a dose is delivered over time (e.g., *millirem* per hour [mrem/h]).

effective dose equivalent (EDE) – Dose unit qualifier to indicate whole body risk from ionizing radiation exposure. Calculated as the sum of critical human-tissue doses weighted for total health risk. Total health risk includes the risk of fatal and non-fatal cancers, severe hereditary effects, and lifespan.

effluent – Liquid material released from a facility.

effluent monitoring – Sampling or measuring specific liquid *effluent* streams for the presence of pollutants.

emission – Gaseous stream released from a facility.

essential fish habitat – Waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity.

exposure – The interaction of an organism with a physical agent (e.g., *radiation*) or a chemical agent (e.g., arsenic) of interest. Also used as a term for quantifying X- and *gamma-radiation* fields.

fission – The splitting or breaking apart of a nucleus into at least two other nuclei, accompanied by the release of a relatively large amount of energy.

gamma radiation – High-energy electromagnetic *radiation* (photons) originating in the nucleus of decaying *radionuclides*. Gamma radiation is substantially more penetrating than *alpha* or *beta emissions,* but comparatively the energy is not as readily absorbed.

grab sample – A short-duration sample (e.g., air, water, and soil) that is grabbed from the collection site.

gray (Gy) – Unit of absorbed dose in the International System of Units equal to the absorption of 1 joule per kilogram. The common unit of absorbed dose, the *rad*, is equal to 0.01 Gy.

groundwater – Subsurface water that is in the pores of sand and gravel or in the cracks of fractured rock.

high-level waste – Highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly from reprocessing and any solid material derived from such liquid waste that contains *fission* products and other *radioisotopes* in sufficient concentrations to require permanent isolation.

isotopes – *Nuclides* of the same chemical element with the same number of protons but a different number of neutrons.

low-level waste – Radioactive waste that is not high-level radioactive waste, spent nuclear fuel, *transuranic waste*, byproduct material, or naturally occurring radioactive material.

maximum exposed individual – A hypothetical member of the public residing near the PNNL-Richland campus or PNNL-Sequim campus who, by virtue of location and living habits, would reasonably receive the highest possible *radiation* dose from radioactive materials originating from the site.

method reporting limit – The lowest amount of analyte in a sample that can be quantitatively determined with the stated acceptable precision and accuracy under controlled laboratory conditions.

millirem – A unit of *radiation dose* that is equal to one one-thousandth (1/1000) of a *rem*.

minimum detectable activity – The smallest amount or concentration of a chemical or radioactive material that can be reliably detected in a sample.

mitigation – Prevention or reduction of expected *risks* to workers, the public, or the environment.

mixed waste – A U.S. Environmental Protection Agency or state-designated dangerous, extremely hazardous, or acutely hazardous waste that contains both a nonradioactive hazardous component and a radioactive component.

monitoring – As defined in DOE Order 458.1, Admin Chg 4, the collection and analysis of samples or measurements of liquid *effluent* and gaseous *emissions* for purposes of characterizing and quantifying contaminants, assessing *radiation exposure* to the public, and demonstrating compliance with regulatory standards.

nuclide – A particular combination of neutrons and protons. A *radionuclide* is a radioactive nuclide.

operable unit – A discrete area for which an incremental step can be taken toward comprehensively addressing site problems. The cleanup of a site can be divided into a number of operable units, depending on the complexity of the problems associated with the site.

outfall – End of a drain or pipe that carries wastewater or other *effluent* into a ditch, pond, river, or other water body.

person-rem or **person-sievert (person-Sv)** – Unit of *collective dose*.

1 person-rem = 0.01 person-Sv

plutonium – A heavy, radioactive, metallic element of several possible *isotopes*. One important *isotope* is plutonium-239, which is produced after a specific neutron reaction with uranium-238. Routine analysis cannot distinguish between the plutonium-239 and plutonium-240 *isotopes*; hence, the term plutonium-239/240 is used in this report to indicate the presence of one or both of these *isotopes* in the analytical results.

PNNL-Richland campus – Includes a mix of federal and private land and facility ownership north of Richland, Washington.

PNNL-Sequim campus – Consists of DOE-contracted facilities near Sequim, Washington. (Note: Final land transfer took place in the spring of 2025 and will be addressed in the FY2025 ASER).

quality assurance – Actions that provide confidence that an item or process meets or exceeds a user's requirements and expectations.

quality control – All actions necessary to control and verify that the features and characteristics of a material, process, product, or service meet specified requirements. Quality control is an element of *quality assurance*.

rad – The unit of absorbed dose.

1 rad = 0.01 gray (Gy)

radiation – The energy emitted in the form of photons or energetic *alpha* and *beta particles* subsequent to radioactive decay. For this report, radiation refers to ionizing types of radiation; not radio waves, microwaves, radiant light, or other types of non-ionizing radiation.

radioactivity – Property possessed by *radioisotopes* emitting *radiation* (such as *alpha* or *beta particles*, or high-energy photons) spontaneously in their *decay* process; also, the *radiation* emitted.

radionuclide – An atom that has a particular number of protons (Z), a particular number of neutrons (A), and a particular atomic weight (N = Z + A) that happens to emit *radiation*. Carbon-14 is a radionuclide but carbon-12, which is not radioactive, is referred to simply as a *nuclide*.

rem – The unit of EDE.

1 rem = 0.01 sievert (Sv)

remediation – Reduction (or cleanup) of known *risks* to the public and environment to an agreed-upon level.

risk – The probability that a detrimental health effect will occur.

shrub-steppe – A drought-resistant shrub and grassland ecosystem.

sievert (Sv) – The unit of EDE and its variants in the International System of Units. The common unit for EDE and its variants, the *rem*, is equal to 0.01 Sv.

surveillance – As defined in DOE Order 458.1, Admin Chg 4, the collection and analysis of samples of air, water, soil, foodstuffs, biota, and other media, and the measurement of external radiation for purposes of demonstrating compliance with applicable standards, assessing exposures to the public, and assessing effects, if any, on the local environment.

transuranic element – An element with an atomic number greater than 92 (92 is the atomic number of uranium).

transuranic waste – Waste containing more than 100 nanocuries (10^{-9} *curies*) per gram of alpha-emitting transuranic isotopes that have half-lives longer than 20 years.

tritium – The heaviest radioactive isotope of hydrogen (hydrogen-3); it has a 12.3-year half-life.

unconfined aquifer – An *aquifer* containing groundwater that is not confined above by relatively impermeable rocks. The pressure at the top of the unconfined aquifer is equal to that of the atmosphere. At the Hanford Site, the unconfined aquifer is the uppermost aquifer and is most susceptible to contamination from site operations.

vadose zone – Underground area from the ground surface to the top of the *water table* or *aquifer*.

volatile organic compounds – Lightweight organic compounds that vaporize easily; they are used in solvents and degreasing compounds as raw materials.

water table – The top of the *unconfined aquifer*.

Pacific Northwest National Laboratory

902 Battelle Boulevard
P.O. Box 999
Richland, WA 99354

1-888-375-PNNL (7665)

www.pnnl.gov