State Environmental Policy Act Draft Programmatic Environmental Impact Statement

For Green Hydrogen Energy Facilities in Washington State

Shorelands and Environmental Assistance Program

Washington State Department of Ecology

Olympia, Washington

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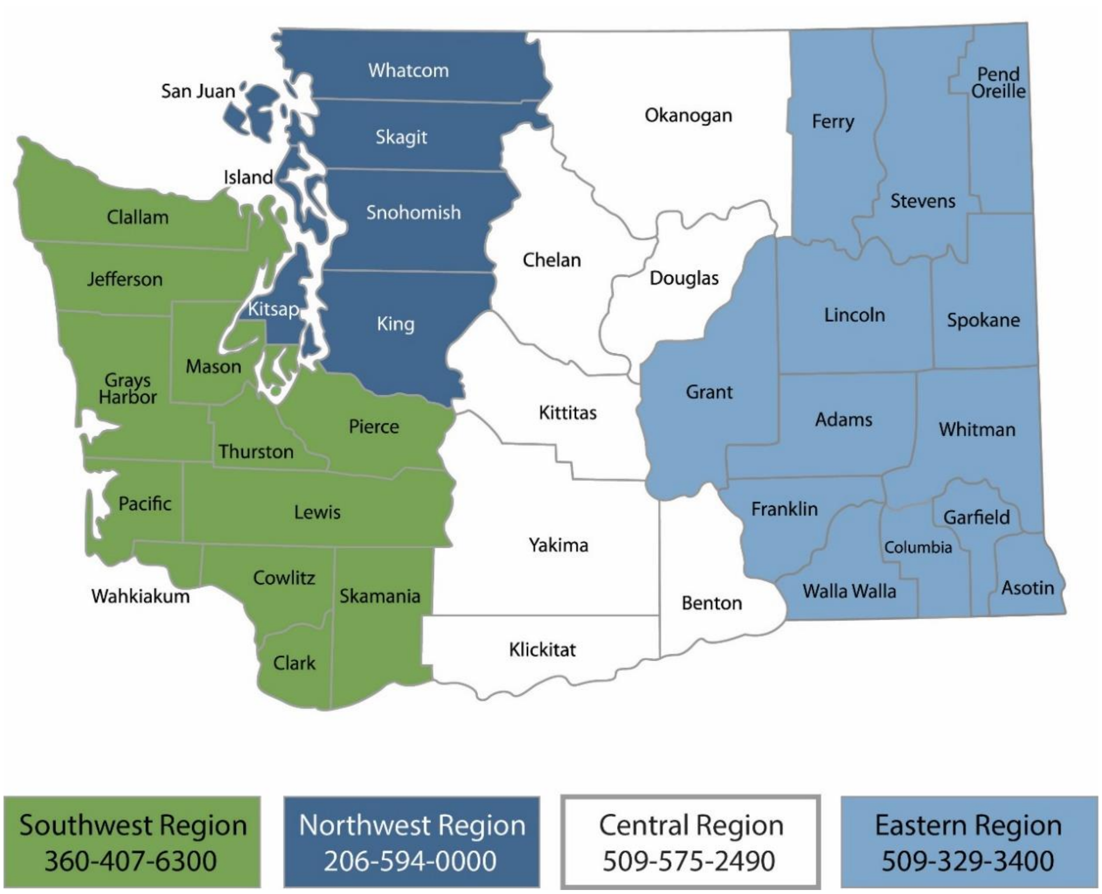
[1] https://climate.wa.gov/
[2] www.ecology.wa.gov/contact

Department of Ecology’s Regional Offices

Map of Counties Served



Region	Counties served	Mailing address	Phone
Southwest	Clallam, Clark, Cowlitz, Grays Harbor, Jefferson, Mason, Lewis, Pacific, Pierce, Skamania, Thurston, Wahkiakum	PO Box 47775 Olympia, WA 98504	360-407-6300
Northwest	Island, King, Kitsap, San Juan, Skagit, Snohomish, Whatcom	PO Box 330316 Shoreline, WA 98133	206-594-0000
Central	Benton, Chelan, Douglas, Kittitas, Klickitat, Okanogan, Yakima	1250 W Alder St Union Gap, WA 98903	509-575-2490
Eastern	Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman	4601 N Monroe Spokane, WA 99205	509-329-3400
Headquarters	Across Washington	PO Box 46700 Olympia, WA 98504	360-407-6000

Fact Sheet

Title

Programmatic Environmental Impact Statement on Green Hydrogen Energy Facilities in Washington State

Brief description of proposal

The Washington State Legislature directed the Washington State Department of Ecology (Ecology) to prepare a nonproject environmental review of green electrolytic and renewable hydrogen (green hydrogen) facilities in Washington by June 30, 2025. Revised Code of Washington (RCW) 43.21C.535[3] requires Ecology to assess and disclose the probable significant adverse environmental impacts and related mitigation measures for green hydrogen facilities. Ecology prepared this Draft Programmatic Environmental Impact Statement (PEIS) to evaluate potential impacts and mitigation at a broad level. This Draft PEIS was prepared in compliance with the Washington State Environmental Policy Act (SEPA).[4]

The intent of the PEIS is to:

- Support the state's clean energy transition while protecting the environment, Tribal rights and resources, and local communities.
- Identify the range of probable significant adverse environmental impacts green hydrogen facilities can pose.
- Identify general potential mitigation measures for impacts.
- Provide information for siting and design that may be used to help avoid or minimize adverse environmental impacts in future proposed projects.
- Provide information for lead agencies to consider when conducting environmental reviews for green hydrogen facilities.

The PEIS evaluated the following types of green hydrogen facilities as well as a No Action Alternative:

- **Green hydrogen production facilities:** A green hydrogen production facility would produce hydrogen using one of the following processes: electrolysis, steam-methane reforming, pyrolysis, or bio-gasification. The footprint of a facility would vary widely based on the technology used and production capacity. Production facilities would be in an area that is zoned for industrial land uses.
- **Green hydrogen production facilities with battery energy storage systems (BESSs):** This facility type would be the same as the green hydrogen production facility described above but would include a up to two co-located BESS to provide backup power.

[3] https://app.leg.wa.gov/RCW/default.aspx?cite=43.21C.535
[4] https://apps.leg.wa.gov/wac/default.aspx?cite=197-11

- **Green hydrogen storage facilities:** A green hydrogen storage facility could store hydrogen in gas or liquid form. This type of facility could be co-located at green hydrogen production facilities, a stand-alone facility, at transport terminals, or at an end-use location such as an industrial facility or fueling facility
- **No Action Alternative:** Agencies would continue to conduct environmental review and permitting for green hydrogen facilities under existing laws on a project-by-project basis without using this PEIS as a reference.

Location

The geographic scope for the green hydrogen PEIS includes areas throughout the state of Washington where green hydrogen facilities are likely to be developed based on proximity to transmission lines, proximity to freight highway routes, and industrial or industrial-use supporting zoning.

Proposed date of implementation

The Final PEIS will be issued by the legislatively mandated date of June 30, 2025.

Responsible official contact

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Required permits, licenses, and approvals

Numerous regulations, plans, and laws guided or influenced the development of this PEIS. Because this is a programmatic EIS for a nonproject action, and the specific nature of projects that would be proposed is not yet known, it is not possible to present a complete list of permits, licenses, and approvals that could be required for future facilities.

Implementation of the types of green hydrogen facilities evaluated in the PEIS would require compliance with regulations, rules, and plans at federal, Tribal, state, and local levels. For purposes of this PEIS, the term “laws and permits” includes any of the items listed below. Examples of those that could be associated with green hydrogen facilities include:

Federal

- Bald and Golden Eagle Protection Act
- Clean Water Act Section 404 Permit
- Coastal Zone Management Act Consistency
- Determination of No Hazard to Air Navigation Approval
- Endangered Species Act
- Fish and Wildlife Coordination Act
- Magnuson-Stevens Fishery Conservation and Management Act
- Migratory Bird Treaty Act
- Marine Mammal Protection Act
- National Environmental Policy Act
- National Historic Preservation Act, Section 106
- National Oceanic and Atmospheric Administration Radar Operations Center Approval
- Rivers and Harbors Act Permit Section 10
- U.S. Department of Defense Clearance for Radar Interference
- U.S. Department of Transportation Act of 1966 Section 4(f) Review

State

- Air quality permits
- Aquatic Use Authorization (Washington State Aquatic Lands Act)
- Archaeological Excavation and Removal Permit
- Clean Air Act Prevention of Significant Deterioration Permit
- Clean Water Act Section 402 National Pollutant Discharge Elimination System permits
- Clean Water Act Section 401 Water Quality Certification
- State Waste Discharge Permit
- State Refrigerant Management Program
- State Environmental Policy Act
- Surface Mining Reclamation Permit
- Washington Forest Practices Act
- Washington State Department of Labor and Industries electrical permits
- Washington State Department of Transportation permits (overweight/oversize, superload movement, special motor vehicle, access connection)
- Washington State Growth Management Act
- Washington State Hydraulic Project Approval
- Washington State Water Pollution Control Act
- Washington State Shoreline Management Act
- Water Right Permit
- Water Right Change or Transfer Authorization
- Washington State Department of Transportation utility accommodation permits and franchises

Local

- Air quality permits
- Blasting permits
- Construction permits (right-of-way, access, grading, building, mechanical, and electrical permits)
- Critical areas ordinances
- Floodplain development permits
- Shoreline permits
- Zoning ordinances and other land use requirements
- Utility connection permits
- Noise variance

Authors and principal contributors

This document has been prepared under the direction of Ecology. All chapters and appendices have been prepared for and approved by Ecology. Key authors and principal contributors to the PEIS analyses are listed below:

- Washington State Department of Commerce
- Washington State Department of Ecology
- Washington Department of Fish and Wildlife
- Washington State Department of Natural Resources
- Washington State Department of Archaeology and Historic Preservation
- Washington State Department of Transportation
- State of Washington Energy Facility Site Evaluation Council
- HDR Engineering, Inc.

Date of Draft PEIS issuance

12:00 p.m., January 7, 2025

Date comments are due

11:59 p.m., February 6, 2025

Public comment and hearings on the Draft PEIS

A 30-day public comment period is being conducted from 12:00 p.m., January 7, through 11:59 p.m., February 6, 2025. Comments should focus on the substance of the Draft PEIS and be as specific as possible. Comments on the Draft PEIS received during the comment period will be addressed in the Final PEIS, which is planned to be issued by June 30, 2025. Comments may be submitted in the following ways:

By mail:

Clean Energy Coordination
Department of Ecology
PO Box 47709
Olympia, WA 98504-7709

Online:

Complete a comment form[5]

Virtually at a public hearing:

January 23, 2025, starting at 9:00 a.m.;

January 28, 2025, starting at 12:30 p.m.;

and January 30, 2025, starting at 5:30 p.m.

Information and links to register at https://ecology.wa.gov/regulations-permits/sepa/clean-energy/programmatic-eis

Timing of additional environmental review

A Final PEIS will be completed by June 30, 2025. The PEIS considers potential impacts from general types of green hydrogen facilities; it is not site-specific or for a specific project. Implementation of the types of green hydrogen facilities evaluated in the PEIS would require additional, more detailed, project-level environmental review prior to implementation.

RCW 43.21C.538 requires SEPA lead agencies to consider the green hydrogen PEIS for any green hydrogen facilities. Agencies must use the information in the PEIS, along with other publicly available information and site-specific details, to support their evaluation of proposed actions, alternatives, environmental impacts, or mitigation for a proposed project. Potential impacts not addressed in the PEIS will need to be evaluated by the SEPA lead agency in the project-level environmental review.

Document availability

The Draft PEIS is posted on the following websites:

- SEPA Register website[6]
- Ecology's programmatic EIS website[7]

[5] https://ecology.wa.gov/regulations-permits/sepa/clean-energy/programmatic-eis
[6] https://apps.ecology.wa.gov/separ/Main/SEPA
[7] https://ecology.wa.gov/regulations-permits/sepa/clean-energy/programmatic-eis

This document is also available at the following locations:

Ecology Headquarters
300 Desmond Drive SE
Lacey, WA 98503

Ecology Central Region Office
1250 West Alder Street
Union Gap, WA 98903

Location of background materials

The PEIS and associated technical appendices developed specifically for this environmental review are available on Ecology's programmatic EIS website.[8]

Cost of copy of PEIS

To obtain a CD or printed copy of the Draft PEIS (for the cost of production), follow the instructions provided on the Ecology "Publications & Forms" webpage.[9]

[8] https://ecology.wa.gov/regulations-permits/sepa/clean-energy/programmatic-eis
[9] https://ecology.wa.gov/footer-pages/online-tools-publications/publications-forms

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January 2025 | Publication 24-06-028

DEPARTMENT OF ECOLOGY
State of Washington

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Acronyms and Abbreviations List

°C	degrees Celsius
°F	degrees Fahrenheit
AC	alternating current
AF	acre-foot/feet
BESS	battery energy storage system
BMP	best management practice
CESA	Compatible Energy Siting Assessment
CETA	Clean Energy Transformation Act
CFC	chlorofluorocarbon
CFR	Code of Federal Regulations
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
Commerce	Washington State Department of Commerce
DAHP	Washington State Department of Archaeology and Historic Preservation
dBA	A-weighted decibels
DC	direct current
DNR	Washington State Department of Natural Resources
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DS	Determination of Significance
Ecology	Washington State Department of Ecology
EDNA	environmental designation for noise abatement
EFH	Essential Fish Habitat
EFSEC	State of Washington Energy Facility Site Evaluation Council
EHS	environmental health and safety
EMS	emergency medical services
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency
ft^2	square feet
FTA	Federal Transit Administration
GHG	greenhouse gas
GMA	Growth Management Act
H_2	hydrogen
HAP	hazardous air pollutant
HAZMAT	hazardous materials
HFC	hydrofluorocarbon
I-	Interstate X

IBC	International Building Code
IFC	International Fire Code
kg	kilogram(s)
KOP	key observation point
kV	kilovolt(s)
kWh	kilowatt hour(s)
lbs	pounds
LCA	life-cycle assessment
MMBtu	metric million British thermal units
MMCF	million cubic feet
MMT	million metric tons
MT	metric tons
MTCA	Model Toxics Control Act
MW	megawatt(s)
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NFIP	National Flood Insurance Program
NFPA	National Fire Protection Association
NO_x	nitrogen oxides
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NREL	National Renewable Energy Laboratory
OHWM	ordinary high-water mark
OSHA	Occupational Safety and Health Administration
PCBs	polychlorinated biphenyls
PEIS	Programmatic Environmental Impact Statement
PEM	proton-exchange membrane
PFC	perfluorocarbon
PM10	particulate matter smaller than 10 microns in diameter
$PM_{2.5}$	particulate matter smaller than 2.5 microns in diameter
PNWH2	Pacific Northwest Hydrogen Hub
PPE	personal protective equipment
PUD	public utility district
RCW	Revised Code of Washington
RFFA	Reasonably Foreseeable Future Action
RNG	renewable natural gas
scf	standard cubic feet
SEPA	Washington State Environmental Policy Act
SF6	sulfur hexafluoride
SMP	Shoreline Management Plan
SMR	steam-methane reforming
SO_2	sulfur dioxide
SO_x	sulfur oxides
SPCC	spill prevention, control, and countermeasure

SWPPP	stormwater pollution prevention plan
TAP	toxic air pollutant
TCP	Traditional Cultural Property
TMDL	total maximum daily load
tpy	tons per year
UGA	Urban Growth Area
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	volatile organic compounds
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WRIA	Water Resource Inventory Area
WSDOT	Washington State Department of Transportation
WSRRI	Washington Shrubsteppe Restoration and Resiliency Initiative
WUI	wildland-urban interface

1 Introduction and Background

1.1 PEIS overview

This Washington State Environmental Policy Act (SEPA) Programmatic Environmental Impact Statement (PEIS) was prepared to evaluate green electrolytic and renewable hydrogen facilities (referred to as "green hydrogen facilities") in Washington state. A PEIS is a type of nonproject environmental review used for planning; it is not an evaluation of a specific project. This PEIS considers potential significant adverse environmental impacts at a broad level. It analyzes general types of facilities—but not individual projects—to identify probable significant adverse environmental impacts and possible ways to avoid, minimize, or mitigate those impacts.

The intent of this PEIS is to:

- Support the state's clean energy transition while protecting the environment, Tribal rights and resources, and local communities.
- Identify probable significant adverse environmental impacts green hydrogen facilities can pose.
- Identify general potential mitigation measures for impacts.
- Provide information for siting and design that may be used to help avoid or minimize adverse environmental impacts in future proposed projects.
- Provide information for lead agencies to consider when conducting environmental reviews for green hydrogen facilities.

This PEIS does not approve, authorize, limit, or exclude projects on a site-specific basis. Proposed green hydrogen facilities will need individual environmental review under SEPA and other applicable laws using project- and site-specific information as determined by the lead agency.

Environmental Review Terminology

Lead agency: Agency responsible for preparing an environmental review under state law.

State Environmental Policy Act (SEPA): Washington state law intended to ensure that environmental values are considered early and during decision-making actions by state and local agencies.

Programmatic Environmental Impact Statement (PEIS): Fact-based nonproject environmental review used for planning. It is not an evaluation of a specific project. A PEIS considers potentially significant adverse environmental impacts at a broad level as well as possible ways to avoid, minimize, or mitigate those impacts. Local, state, and federal agencies may use PEISs to help evaluate proposed actions, alternatives, environmental impacts, or mitigation for proposed projects.

1.2 Background and history

The Washington State Legislature directed the Washington Department of Ecology (Ecology) to prepare nonproject environmental reviews of utility-scale onshore wind energy facilities, utility-scale solar energy facilities, and green electrolytic and renewable hydrogen facilities in Washington by June 30, 2025 (Washington State Legislature 2023).[10] The reviews are being prepared pursuant to SEPA.

This Draft PEIS focuses on green hydrogen facilities.[11] Green hydrogen includes:

- Green electrolytic hydrogen[12] is hydrogen produced through electrolysis. It does not include hydrogen manufactured using steam reforming or any other conversion technology that produces hydrogen from a fossil fuel feedstock.
- Renewable hydrogen[13] is hydrogen produced using renewable resources both as the source for the hydrogen and the source for the energy input into the production process.

Other PEISs that focus on utility-scale wind and solar facilities are being developed separately and are not discussed further in this document. Information on the processes for all three PEISs is available on Ecology's webpage for clean energy PEISs.[14]

Ecology developed this PEIS to analyze potential impacts and mitigation at a broad level. The agency issued a Determination of Significance and opened an extended comment period on the scope of the PEIS on green hydrogen facilities in Washington on March 20, 2024. The PEIS was prepared under Revised Code of Washington (RCW) 43.21C.030(2)(c) pursuant to Chapter 197-11 Washington Administrative Code (WAC) procedures. The Determination of Significance and Scoping Notice for the PEIS initiated Ecology's environmental review process. Scoping helps determine the focus of the PEIS evaluation by seeking input from Tribes, agencies, members of the public, and interested parties on the contents of the PEIS. More information about the scoping process is available in Appendix A, *Scoping Summary Report*.

The Washington State Legislature enacted legislation[15] that set a series of limits on the emission of greenhouse gases (GHGs) within the state. Emissions of GHGs in Washington from human activities must be limited to achieve the following reductions:

- By 2020, reduce overall emissions of GHGs to 1990 levels, or 90.5 million metric tons (MMT)
- By 2030, reduce overall emissions of GHGs to 45% below 1990 levels, or 50 MMT

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[10] https://app.leg.wa.gov/RCW/default.aspx?cite=43.21C.535
[11] https://app.leg.wa.gov/RCW/default.aspx?cite=43.21C.535
[12] https://app.leg.wa.gov/RCW/default.aspx?cite=43.158.010
[13] https://app.leg.wa.gov/RCW/default.aspx?cite=43.158.010
[14] https://ecology.wa.gov/regulations-permits/sepa/clean-energy/programmatic-eis
[15] https://app.leg.wa.gov/rcw/default.aspx?cite=70A.45&full=true#:~:text=(iii)%20By%202040%2C%20reduce,five%20percent%20below%201990%20levels.

- By 2040, reduce overall emissions of GHGs to 70% below 1990 levels, or 27 MMT
- By 2050, reduce overall emissions of GHGs to 95% below 1990 levels, or 5 MMT, and achieve net-zero GHG emissions

The 2021 State Energy Strategy[16] provides a roadmap for meeting the state's GHG emission limits and identifies a path to a clean energy economy. Increased demand for electricity will come from electrifying passenger, truck, and freight vehicles and transitioning buildings and industry from use of fossil fuels for electricity to use of clean energy for electricity. Proposals for new clean energy facilities are expected that will address this increased demand for electricity.

In 2019, the Legislature passed the Clean Energy Transformation Act (CETA),[17] which requires all of Washington's electric utilities to meet 100% of their retail electric load using non-emitting and renewable resources by January 1, 2045. CETA requires electric utilities to eliminate coal-fired resources by December 31, 2025, and make all retail sales of electricity GHG-neutral by January 1, 2030.

1.3 Types of green hydrogen facilities evaluated (alternatives)

This PEIS evaluates different types of green hydrogen facilities that could be proposed in Washington. Ecology published a Scoping Document,[18] which included information on possible types of facilities that could be analyzed in the PEIS.

After consideration of comments received during scoping, Ecology identified three types of facilities and also the No Action Alternative to be evaluated in this PEIS. The facility types are as follows, and detailed descriptions are in Chapter 2:

- **Green hydrogen production facilities:** A green hydrogen production facility producing hydrogen using one of the following processes: electrolysis, steam-methane reforming, pyrolysis, or bio-gasification.
- **Green hydrogen production facilities with battery energy storage systems (BESSs):** This facility type would be a green hydrogen production facility with up to two co-located BESSs for backup power.
- **Green hydrogen storage facilities:** A green hydrogen storage facility storing hydrogen in gas or liquid form. This type of facility could be co-located at green hydrogen production facilities, a stand-alone facility, at transport terminals, or at an end-use location such as an industrial facility or fueling facility.

The PEIS did not evaluate the source used to create green hydrogen or the end uses. The source of electricity would vary depending on the project, and this would be evaluated during the

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[16] https://www.commerce.wa.gov/growing-the-economy/energy/2021-state-energy-strategy/
[17] https://lawfilesext.leg.wa.gov/biennium/2019-20/Pdf/Bills/Session%20Laws/Senate/5116-S2.SL.pdf
[18] https://apps.ecology.wa.gov/separ/Main/SEPA/Record.aspx?SEPANumber=202401209

project-level review. End uses of green hydrogen vary widely, such as refineries, industrial chemical processes, transportation, and powering the electrical grid or buildings. The sources and end uses would be evaluated during project-level reviews. The PEIS does not analyze new transmission pipelines for green hydrogen. New pipelines are likely to cover multiple jurisdictional areas with federal, state, and local permits and would be reviewed on a case-by-case basis.

It is important to note that this PEIS does not limit the types of facilities or technologies that could be proposed or built in Washington. The facilities evaluated in this PEIS are intended to capture the types of facilities and technologies most likely to be proposed based on current and best available information.

1.4 PEIS scope of analysis

Ecology considered the potential for impacts from these types of facilities, as well as comments received during scoping, to determine the scope of the Draft PEIS. The study focuses on probable significant adverse impacts, with some information provided on other impacts. This is reflected in the level of detail provided for resources in the sections in Chapter 4 and appendices, with more information provided for potential significant impacts.

RCW 43.21C.535 states that "the scope of a nonproject environmental review shall be limited to the probable, significant adverse environmental impacts in geographic areas that are suitable for the applicable clean energy type." Based on this and with consideration of comments received during scoping, the geographic scope of study for the PEIS is shown in Figure 1-1.

Areas included in the geographic scope of study for green hydrogen energy facilities were based on the assumptions listed below:

- For a green hydrogen production or storage facility:
    - 50 miles or less from freight highway routes
    - In an area zoned for industrial or industrial-supporting uses
- Additionally, for a green hydrogen production facility:
    - 25 miles or less from transmission lines of 55 kilovolts (kV) and above

Chapter 3 describes other factors considered for the geographic scope of study. It is important to note that the geographic scope of study does not show where a facility may or may not be sited; it is for impact analysis only. Facilities may be proposed within or outside of the geographic scope of study. Adjacent lands are used for various purposes and may be affected by green hydrogen facilities. Therefore, some resources have study areas for the analysis of impacts that may extend beyond the geographic scope of study.

Figure 1-1. Green Hydrogen Energy Facilities PEIS geographic scope of study

1.5 State Environmental Policy Act process

As the lead agency, Ecology prepared this PEIS in compliance with SEPA. The SEPA environmental review process provides a way to identify and assess the possible environmental effects of a proposal and how they could be avoided or mitigated. It helps decision-makers and the public understand how a proposed action could affect the natural and built environment.

The PEIS considers potential impacts from general types of green hydrogen facilities; it is not site-specific or for a specific project. It evaluates environmental impacts over a broad geography and the lifetime of facilities. The depth and detail of the impact analysis is general, focusing on major impacts in a qualitative manner. Mitigation is also identified at a high level.

SEPA analyses for specific green hydrogen project proposals would tier to this PEIS. Tiering means that a broad nonproject evaluation is later used during the evaluation of a specific project. Tiering can result in a more effective environmental analysis process for subsequent proposals (see Figure 1-2).

This PEIS identifies probable significant adverse environmental impacts and relevant mitigation applicable to green hydrogen development in general. The PEIS does not assess site-specific issues associated with any individual green hydrogen facility. Location-specific factors vary considerably from site to site. These include factors such as the soil type, groundwater availability, water types, habitat, vegetation, the presence of threatened or endangered species, and the presence of Tribal and cultural resources. The effects of location-specific and project-specific factors cannot be fully anticipated or addressed in a programmatic analysis. The PEIS identifies potential impacts to be considered early, and each proposed project is required to have its own SEPA environmental review as determined by the lead agency. During that process, site-specific information and project-specific effects will be evaluated.

A PEIS does not approve or deny a proposed facility. Federal, state, and local agencies may—and in some cases must, as explained below—use the information in the PEIS, along with other publicly available information and site-specific details, to inform project-level environmental reviews and permitting.

RCW 43.21C.535 requires SEPA lead agencies to consider this PEIS for applicable green hydrogen projects. Each agency would be responsible for determining which elements of the PEIS analysis are applicable to their evaluation of a proposed project and revising or supplementing the analysis to address project-specific elements and circumstances that were not evaluated in this PEIS.

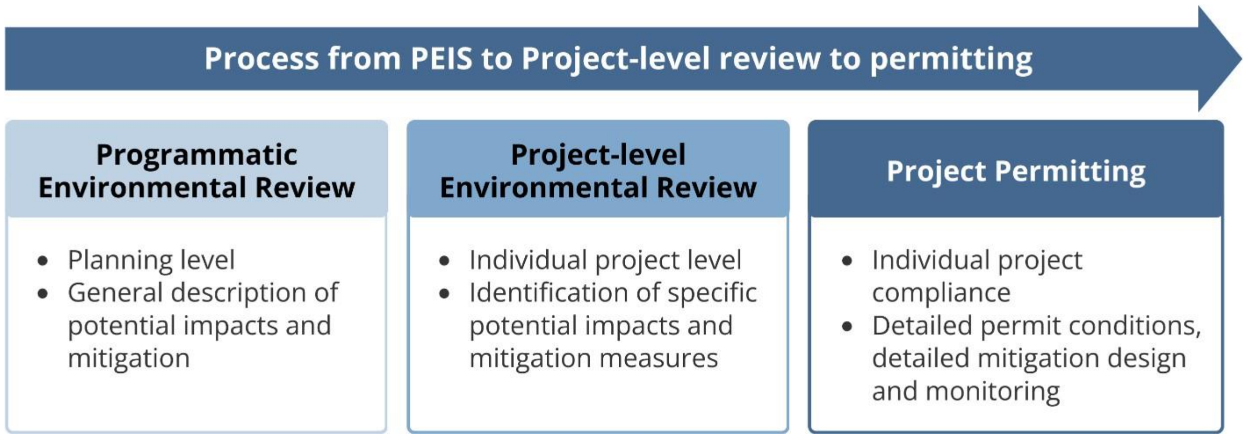

Figure 1-2. Planning, review, and permitting processes

In summary, this PEIS can help:

- Project developers avoid and minimize potential impacts as they work to site and develop their proposals and develop mitigation plans
- Local, state, and federal agencies conduct their environmental reviews and make permit decisions
- Provide information for the public and Tribes to use for future proposed projects

1.5.1 Using the PEIS for projects

Under SEPA, each individual green hydrogen energy project will need to have its own separate environmental review as determined by the lead agency. During that review process, site-specific information and project-specific effects will be evaluated. The information in the PEIS is intended to help a developer identify a suitable site, design a project, and submit a proposal that has considered potential environmental impacts. It can also help a developer design mitigation plans to reduce potentially significant impacts.

Developers can use the PEIS to:

1. Consider if a site or design could result in potential environmental impacts.
2. Make siting and design decisions that avoid or reduce impacts.
3. Help identify if impacts could be potentially significant and the type of information reviewing agencies will need for their evaluations.
4. Propose measures to mitigate potential significant impacts that can be incorporated into a mitigation plan.

If a lead reviewing agency finds that the plan reduces environmental impacts below levels deemed to be significant, they can issue a mitigated determination of significance. However, if significant impacts are probable, a lead reviewing agency will require an environmental impact statement for a proposed project.

1.6 PEIS organization

This PEIS is organized to provide information in three ways. The Summary provides brief, high-level information on key findings and probable significant adverse impacts. The PEIS chapters provide high-level information on the impact analysis and findings. The technical appendices contain detailed methods and technical documentation for the PEIS analysis. For sections of this PEIS that have a related resource technical appendix, the appendix is the official technical documentation for this PEIS. If there is conflicting information between the Summary, the PEIS chapters, or the technical appendices, the technical appendices are the controlling documents. The Draft PEIS is organized as follows:

- **Publication and Contact Information, Cover Letter, and Fact Sheet**
- **Draft PEIS:**
  - **Chapter 1: Introduction and Background** is contained in this chapter.
  - **Chapter 2: Green Hydrogen Facilities** describes the purpose and objectives of the PEIS, typical components and phases of green hydrogen facilities, and the alternatives considered for the PEIS.
  - **Chapter 3: Scope of Study** describes the geographic and temporal scope of study that was analyzed for the PEIS.
  - **Chapter 4: Affected Environment, Potential Impacts, and Mitigation** summarizes the current conditions in the study area and probable significant adverse impacts for each element of the environment examined in this PEIS. This chapter also identifies potential mitigation measures that could be implemented to reduce potential effects. References are provided to appropriate appendices for more details.
  - **Chapter 5: Cumulative Impacts** summarizes the evaluation of potential cumulative effects of the alternatives. Additional detail is provided in Appendix Q, *Cumulative Impacts*.
  - **Chapter 6: Consultation and Coordination** summarizes the PEIS scoping process; the roles of Ecology, other agencies, and Tribal governments in the development of the PEIS; and Ecology's coordination with Tribes, other agencies, the public, and interested parties.
  - **Chapter 7: Permits and Approvals** summarizes permits, licenses, and approvals that may be required for future proposed facilities.
  - **Chapter 8: List of Preparers and Contributors** identifies individuals from Ecology, other state agencies, Tribes, and consulting firms who participated in the evaluation.
  - **Chapter 9: Distribution List** identifies agencies, Tribes, organizations, and others who will receive this PEIS.
- **Technical appendices** include specific, detailed information relevant to the evaluation provided in this PEIS.

2 Green Hydrogen Facilities

2.1 Purpose and objectives

As directed by the Legislature, this PEIS evaluates potential impacts and mitigation for green hydrogen[19] energy facilities in Washington State. Green hydrogen includes:

- **Green electrolytic hydrogen[20]** is hydrogen produced through electrolysis. It does not include hydrogen manufactured using steam reforming or any other conversion technology that produces hydrogen from a fossil fuel feedstock. In this definition, water is the feedstock, while electricity is not a feedstock but is the input energy or process energy used in electrolysis of the water. Hydrogen produced through electrolysis will meet this definition regardless of whether the electricity is produced from renewable sources, fossil-fired generation, or any combination of these resources. The Clean Energy Transformation Act requires all electricity used in Washington to be GHG neutral by 2030 and 100% clean by 2045.
- **Renewable hydrogen[21]** is hydrogen produced using renewable resources both as the source for the hydrogen and the source for the energy input into the production process.

The PEIS evaluate the following types of green hydrogen facilities (alternatives), and a No Action Alternative:

- **Green hydrogen production facilities:** A green hydrogen production facility producing hydrogen using one of the following processes: electrolysis, steam-methane reforming, pyrolysis, or bio-gasification.
- **Green hydrogen production facilities with BESSs:** This facility type would be a green hydrogen production facility described with up to two co-located BESS for back-up power.
- **Green hydrogen storage facilities:** A green hydrogen storage facility storing hydrogen in gas or liquid form. This type of facility could be co-located at green hydrogen production facilities, a standalone facility, at transport terminals, or at an end-use location such as an industrial facility or fueling facility.

This PEIS is expected to be used by green hydrogen facility developers in developing specific projects. Project-level state environmental review would need to be completed for proposed projects and information from this PEIS would be considered by SEPA lead agencies.

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19 https://app.leg.wa.gov/RCW/default.aspx?cite=43.21C.535
20 https://app.leg.wa.gov/RCW/default.aspx?cite=43.158.010
21 https://app.leg.wa.gov/RCW/default.aspx?cite=43.158.010

2.2 General overview of hydrogen

Hydrogen is abundant on earth as an element but is almost always found as part of another compound, such as water or methane. It must be separated into pure hydrogen for use as energy. It can be stored and transported as a gas or liquid. Hydrogen as a fuel contains a high level of energy per unit of mass, more than natural gas or gasoline. The U.S Department of Energy (DOE)[22] and the National Renewable Energy Laboratory (NREL)[23] websites provide information on green hydrogen.

Hydrogen is nontoxic and is colorless and odorless. Under normal temperature and pressure, hydrogen is a gas that is lighter than air and spreads out rapidly. For example, hydrogen rises six times faster than natural gas at a speed of almost 45 miles per hour.

2.2.1 Hydrogen use

Currently, hydrogen is mainly used for petroleum refining and production of bulk chemicals, such as ammonia. The Washington State Department of Commerce (Commerce) conducted a study[24] to look at the potential for green hydrogen development in the state. It considered future scenarios and found that the following uses for green hydrogen development are likely in Washington:

- To create other materials such as sustainable aviation and marine fuels
- For industrial heat and as a feedstock in chemical production, including at refineries
- As a direct fuel source for vessels, aircraft, freight rail, and heavy-duty vehicles
- For energy storage and electricity generation

2.2.2 Current hydrogen production

The United States currently produces approximately 10 MMT of hydrogen annually. Most comes from a process called steam-methane reforming (SMR) where fossil fuels are used as the feedstock. Natural gas is processed to produce hydrogen and subsequently carbon dioxide is released into the atmosphere. The electricity used for process energy also has associated carbon emissions in most cases. This hydrogen is often called gray hydrogen. Nearly 70% of this hydrogen is used in the petroleum refining industry, and 20% goes into fertilizer production.[25]

2.2.3 Hydrogen storage

Hydrogen can be stored and moved as a gas or liquid. The liquid form must be kept at very low temperatures. As a liquid, hydrogen is stored at -423 degrees Fahrenheit (°F; or -253 degrees Celsius [°C]). Liquid hydrogen has different characteristics and different potential hazards than gaseous hydrogen, so different control measures are used to ensure safety. Detection sensors, safety procedures, and personal protective equipment are critical for both. Liquid hydrogen is

[22] https://www.hydrogen.energy.gov/
[23] https://www.nrel.gov/hydrogen/
[24] https://deptofcommerce.app.box.com/s/widfnmxbo8ijt3uozpoq91jzapu4dhae
[25] https://www.energy.gov/eere/fuelcells/hydrogen-production

denser than gaseous hydrogen and can be stored and transported in smaller containers than gas.

2.2.4 Hydrogen safety and risk

Appendix I, *Environmental Health and Safety Technical Appendix*, includes detailed information about potential impacts; an overview is provided here. Hydrogen has been used for many years as a fuel by the National Aeronautics and Space Administration as well as in industrial processes and at refineries.

Hydrogen gas is nontoxic and is colorless and odorless. Human senses cannot detect a hydrogen leak, so sensors are used. The U.S. Occupational Safety and Health Administration has not defined a permissible exposure limit for hydrogen. Hydrogen is unlikely to be confined near areas where people could work and cause risk of asphyxiation. When it is stored at very low temperatures as a liquid, severe freeze burns can occur if the liquid comes into contact with human skin.

Hydrogen has similar risks to other flammable fuels, such as natural gas and gasoline. It has a wide flammability range (4–74% in air). Hydrogen must be confined to be fire hazard. Facilities must be properly ventilated to reduce hydrogen gas accumulation in the event of a leak or spill. Equipment, safety valves, and industrial buildings can be designed to help hydrogen escape to the atmosphere if there is release. NREL states hydrogen can be explosive at concentrations of 18.3–59%. For comparison, gasoline has the potential for explosion at much lower concentrations (1.1–3.3%). There is very little likelihood that hydrogen will explode in open air, due to its tendency to rise quickly. This is the opposite of heavier gases such as propane or gasoline fumes, which hover near the ground, creating a greater danger for explosion. Liquid hydrogen containers are double-walled, vacuum-jacketed, super-insulated containers designed to vent hydrogen safely in gaseous form if a breach of either the outer or inner wall is detected.

As with other fuels, using proper materials and safety equipment and implementing engineering controls and safety procedures help reduce risks. The DOE has stated that "new model building codes and equipment and other technical standards will need to be developed."[26] The PEIS describes current requirements and where there are gaps.

There are requirements for the type of material used for processing equipment at these types of facilities. In an industrial use area, there are requirements for locating a facility, and since hydrogen is a combustible fuel gas, setbacks (minimum distances that say how far a storage tanks must be from materials and conditions called "exposure groups," would be required for compliance with Washington International Building Code (IBC) and International Fire Code (IFC) and local code, as adopted. Valves are required on processing equipment to release hydrogen at specified levels to prevent high levels of pressure building. Facilities must have emergency stop buttons to immediately cease operations. Other safety equipment includes hydrogen leak sensors, flame sensors, fire extinguishers and/or automatic fire suppression system, and alarm

[26] https://www.hydrogen.energy.gov/program-areas/codes-standards

systems. Safety, construction, operations, and training requirements for green hydrogen facilities are discussed and analyzed in this Draft PEIS.

2.2.5 Green hydrogen uses

This section provides information **Error! Reference source not found.**about the end uses of green hydrogen for awareness (see Figure 2-1). This PEIS does not analyze the many end uses for green hydrogen; the use of green hydrogen for a specific facility would be evaluated during project-level analysis.

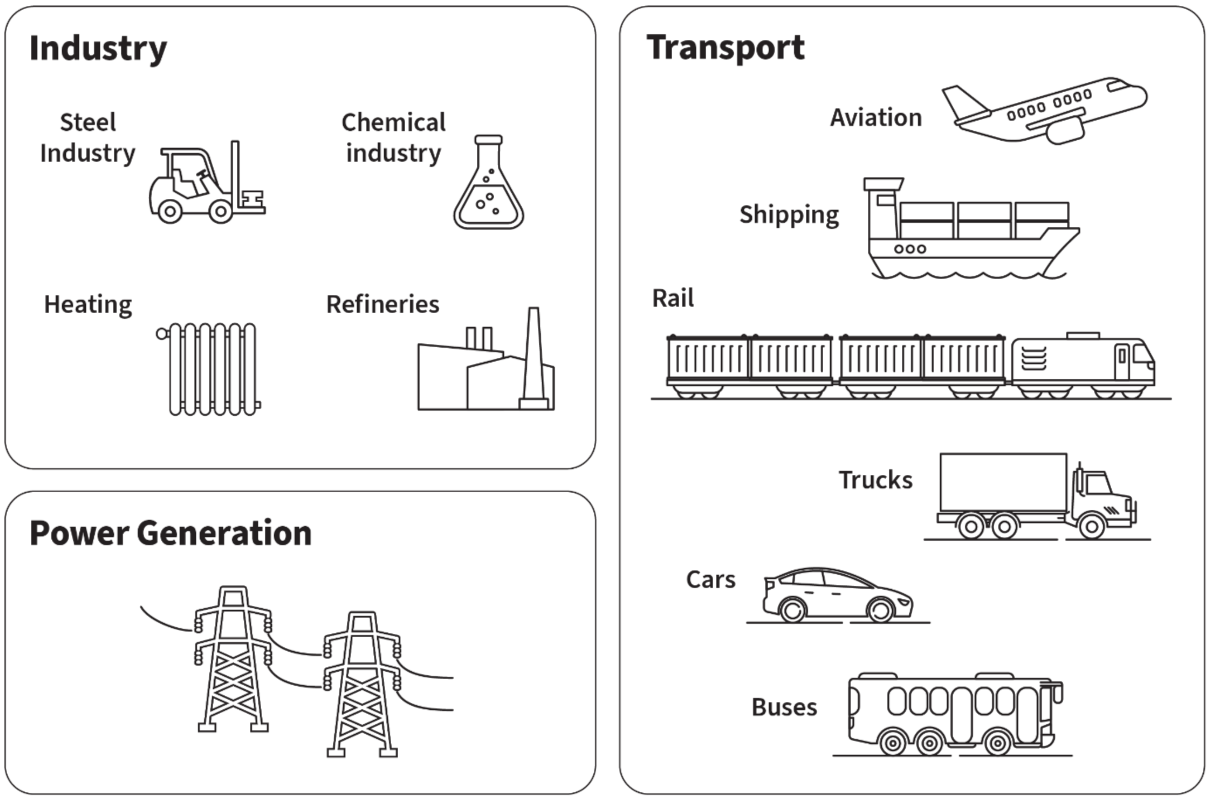

Figure 2-1. End uses of green hydrogen

2.2.5.1 Chemical and industrial operations

Hydrogen is used at petroleum refineries, for industrial chemical processes, and in iron and steel production. It is used to produce high-temperature heat that cannot easily be produced using electricity.

2.2.5.2 Create other products

Green hydrogen can be used as the energy source to produce other fuels such as alternative jet fuel or sustainable aviation fuel. It can be chemically converted to green ammonia and green methanol, which can be used as a fuel source that can be combusted or used in a fuel cell to generate electricity. Aircraft and large vessels may use these fuels in place of petroleum products. Green ammonia can also be used in production of fertilizer and other industrial products, such as feedstock for chemical production.

2.2.5.3 Fuel source for vessels, aircraft, freight rail, and heavy-duty vehicles

When hydrogen combines with oxygen in a fuel cell, it creates electricity and water through an electrochemical process. Hydrogen can be used as a fuel to substitute for existing conventional fuels such as gasoline, diesel, and aviation fuel. It can be used for fueling and powering aircraft, vessels, and vehicles. The Commerce 2023 report on the development of green hydrogen[27] and 2024 Transportation Electrification Strategy[28] predict that passenger and light-duty vehicles would not likely use this as a fuel because of the high costs of hydrogen compared to electric vehicles and a lack of hydrogen refueling stations.

2.2.5.4 Electricity and heat generation

Green hydrogen can be used in the following ways for power and heat generation:

- Burned to generate electricity for the electrical grid.
- As a way to store energy in gas or liquid form for future use.
- Hydrogen fuel cells can be used to store energy and generate electricity, similar to an electric battery. They can be used in place of gasoline, diesel, or natural gas for vehicles and machinery.
- In buildings for heat and power.

2.2.6 Transportation of green hydrogen

This information is provided for context. This PEIS does not analyze the transportation of green hydrogen between facilities; that evaluation would be done for each specific project. Green hydrogen can be transported from a production facility to a storage facility or an end user by truck, rail, or ship or pipeline. Figure 2-2 illustrates potential pathways. Any container used to transport hydrogen must meet federal and international design and safety standards. The U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration is responsible for regulating pipelines. Pipelines at green hydrogen production or storage facilities for on-site operations are evaluated in this PEIS.

Pipelines can move hydrogen gas over long-distances and at high-volumes. They could be hydrogen-only or blended with natural gas. Blending hydrogen in existing natural gas pipelines is limited by safety considerations because there is a broader range for possible ignition.[29] Hydrogen also has varying degrees of compatibility with different materials (such as plastics, stainless steel, or iron) used in the existing natural gas pipeline network and could cause these to degrade.

[27] https://deptofcommerce.app.box.com/s/widfnmxbo8ijt3uozpoq91jzapu4dhae
[28] Final_RMI-US-WA-Transportation-Electrification-Strategy_full-report_020224.pdf
[29] https://www.nrel.gov/docs/fy13osti/51995.pdf

Trucks could be used to move gas or liquid hydrogen. The gas form must be compressed, and the liquid form would be cooled to very low temperatures. Trucks that move gaseous hydrogen are called tube trailers (see Figure 2-3), where long cylinders are stacked on the trailer. Liquid hydrogen is transported in super-insulated, cryogenic (very low-temperature) tanker trucks.

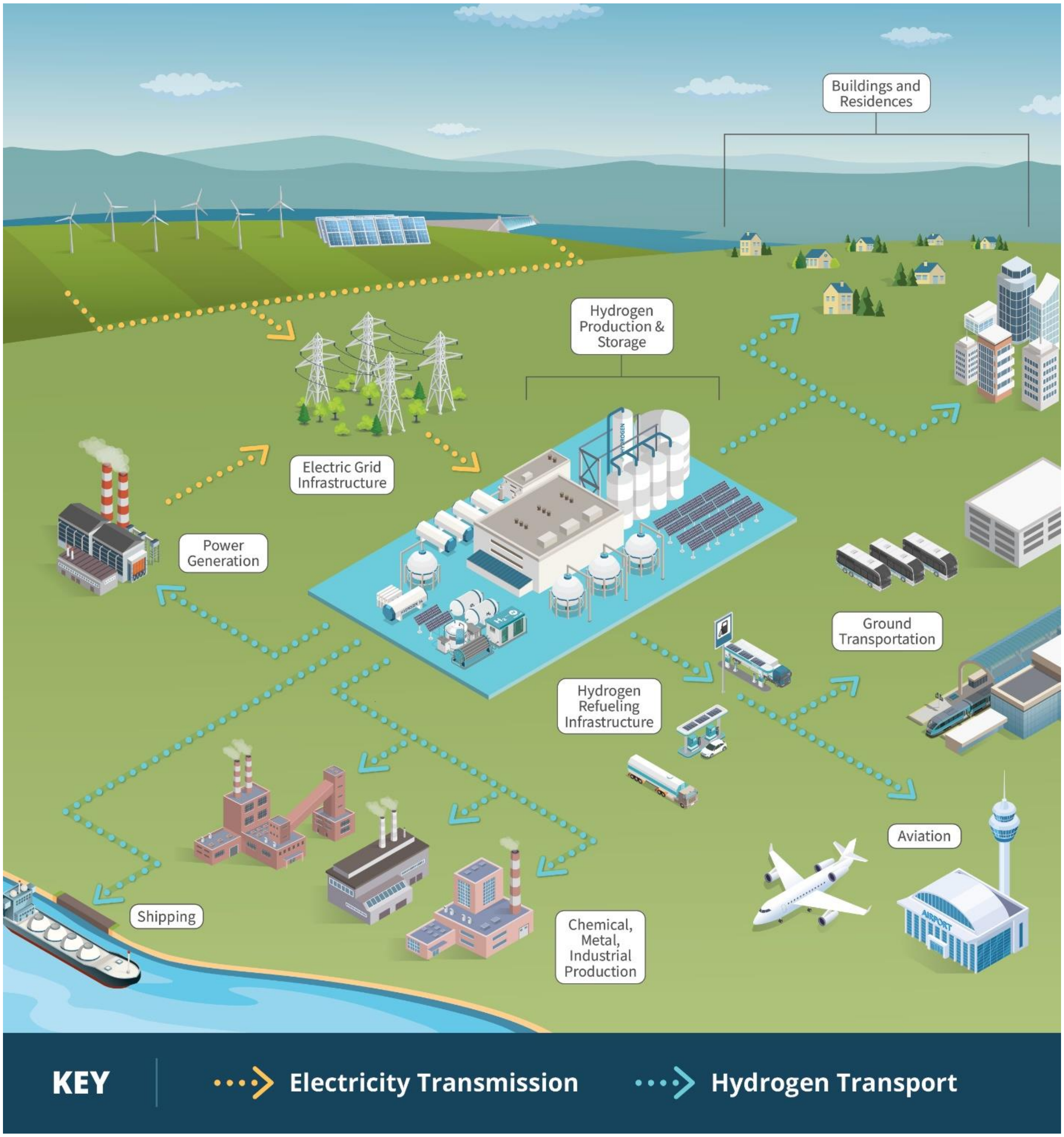

Figure 2-2. Typical inputs and outputs of a green hydrogen facility

Figure 2-3. Example of a tube trailer transporting gaseous hydrogen

Source: Hydrogen Tube Trailers | U.S. Department of Energy

2.3 Assumptions used for analysis

This section describes assumptions used for analysis of green hydrogen facilities, including size and scale, electrical power system, water needs, and buildings. The lifespan of a green hydrogen facility can range from 20 to 50 years.

2.3.1 Size and scale of facility components

The sizes and scale of a facility would vary. The PEIS uses a range from 1 acre to 10 acres, based on the size of similar industrial facilities. The footprints of the foundation pads and structures are estimated to be 30% of the site (0.30 acre for a 1-acre site and 3.0 acres for a 10-acre site). A co-located BESS would consist of up to two containers, each with a size of 60 feet by 8 feet by 10 feet. Figure 2-4 shows the relative scale of typical components of green hydrogen storage facilities and Figure 2-5 shows the relative scale of typical components of green hydrogen production facilities.

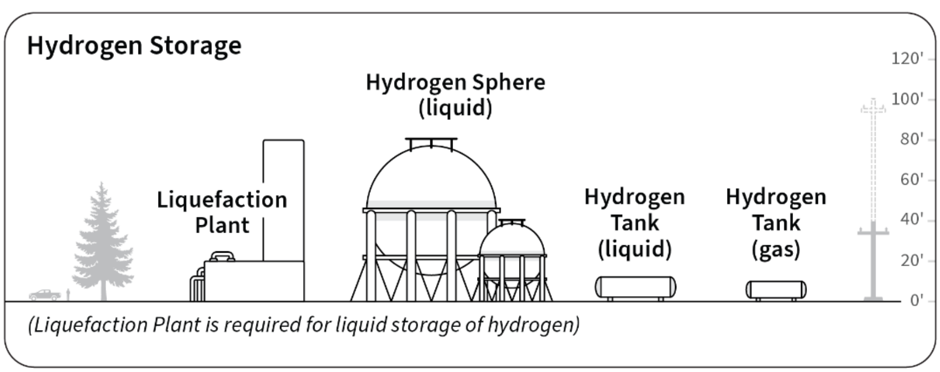

Figure 2-4. Relative scale of the typical components of green hydrogen storage facilities

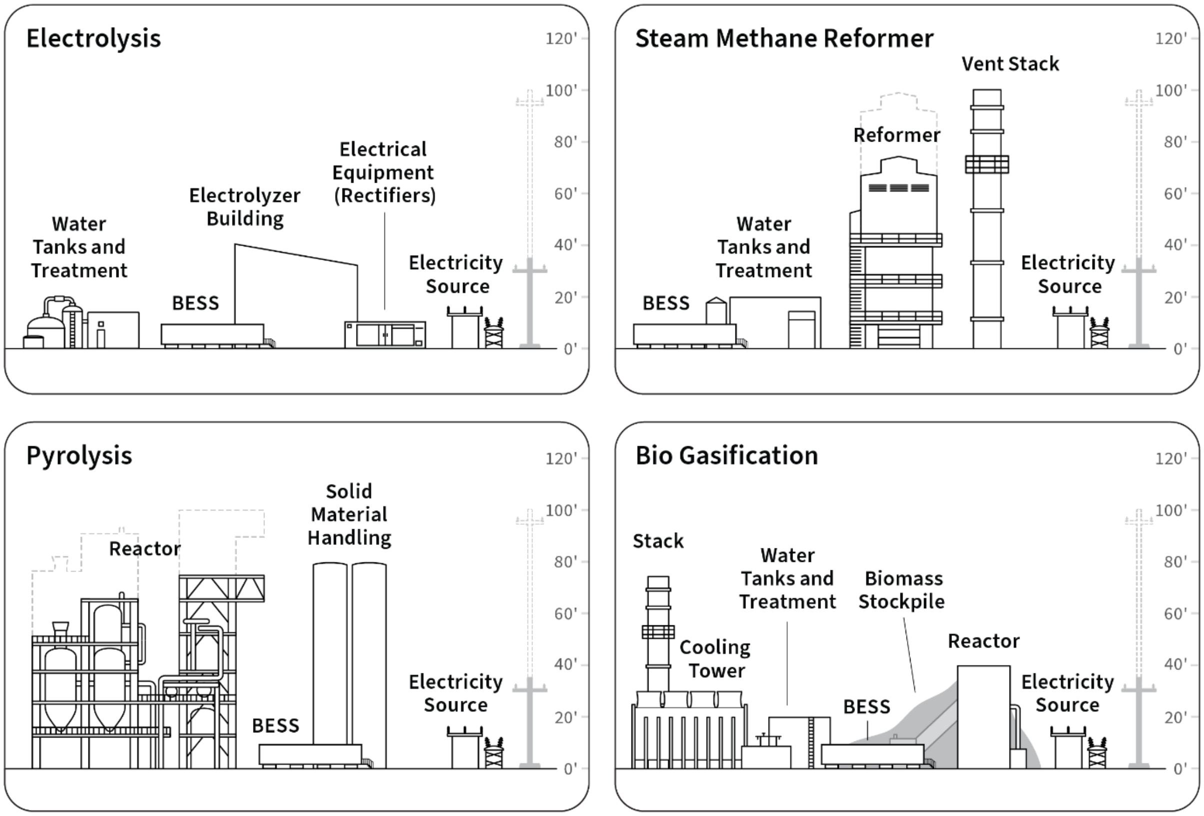

Figure 2-5. Relative scale of the typical components of green hydrogen production facilities

2.3.2 Electrical power system

All green hydrogen facilities would require some amount of electricity for construction, operation, and decommissioning. It is expected that the facility would connect to the local electric utility grid (electric grid) using distribution lines. These are analyzed in the PEIS as part of a facility. It is assumed that these lines would follow existing utility or road rights-of-way and would either replace or be co-located with existing transmission and distribution lines wherever possible. The utility-owned transmission lines, which carry power over long distances and at high voltage are not considered part of a facility and are not analyzed here.

More than 81% of potential sites within the study area are within 1 mile of existing 55 kV (or greater) transmission lines. The remaining sites are up to 8 miles from existing transmission lines. This is the range used for impact analysis.

Electrical components are expected to include a transformer, underground main service line, main switchgear and control, and distribution lines. Production facilities using electrolysis would also have rectifiers. Figure 2-6 shows electrical infrastructure components connecting to a transmission line.

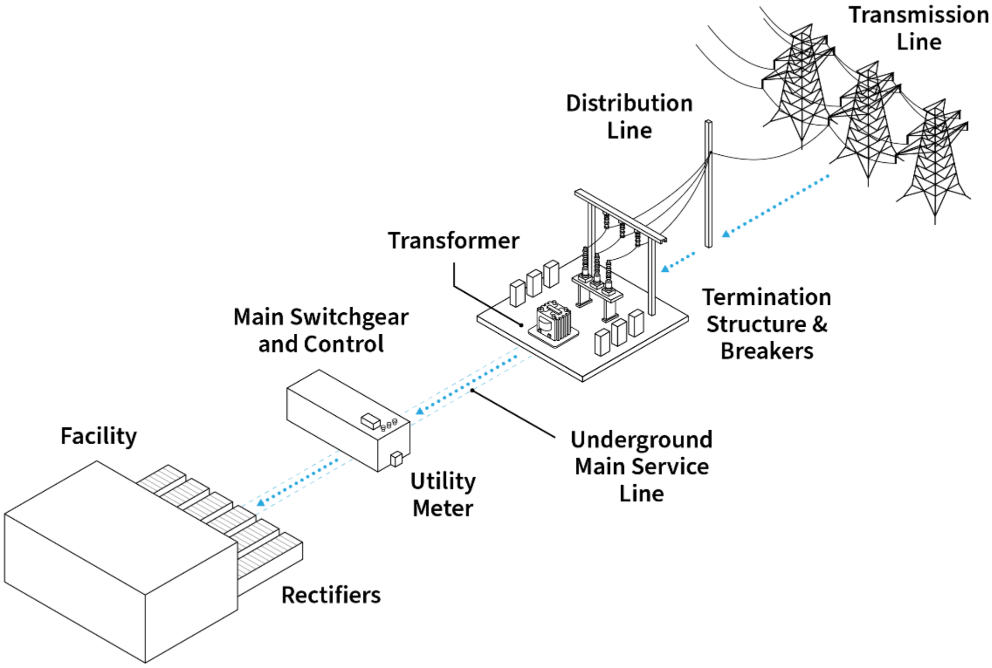

Figure 2-6. Production facility electrical infrastructure components

Each of the electrical infrastructure components is described below:

- **Rectifiers (for electrolysis production only):** Electricity from local utility grids is supplied as alternating current (AC). Electrolyzers typically operate using direct current (DC) power. Rectifiers are needed to convert this power and are usually pad-mounted as shown in Figure 2-7.
- **Main switchgear and control:** Switchgear provides electrical equipment protection, control, and isolation by interrupting electrical current when abnormal conditions are detected. This could be from overloads, short circuits, or electrical fault. These are located inside a structure with lighting and environmental controls. An interior view of the structure is shown in Figure 2-8.
- **Utility meter:** A device for measuring electricity usage.
- **Main service line:** These are cables that supply power between different parts of the same facility, often between switchboards and power distribution transformers. They may be located above ground or underground. The lengths would vary based on the distance between a site and existing electric grid infrastructure
- **Transformers:** These can be used to allow various levels of voltage to be supplied from a single main utility connection. These are typically mounted on concrete pads and fed with underground cables for power supply
- **Distribution line:** Overhead electrical lines that move power from a transmission line to a facility. Distribution lines are supported by poles/tower structures. The PEIS assumes that most would be less than 1 mile, although some could be up to 8 miles long. Overhead distribution lines include various types of equipment including conductors, poles, switches, and protective equipment (voltage regulators and transformers). It is

anticipated that distribution lines would follow existing utility or road rights-of-way and would either replace or be co-located with existing transmission and distribution lines.

- **Termination structures:** These devices are located at the end of a transmission line and are used to reduce distortion or power loss.
- **Breaker:** A safety device that automatically interrupts the current of an overloaded electrical circuit by shutting off.

Figure 2-7. Rectifiers

Source: Make your hydrogen production future proof | SMA Albesto

Figure 2-8. Indoor view of switchgear structure

Source: Fundamentals of Switchgear | Eaton

2.3.3 Buildings for operations and maintenance

All types of green hydrogen facilities would have buildings for operations and maintenance, and infrastructure for lighting, security, service access, parking areas, electrical, and water management. The buildings could be for control rooms, maintenance equipment, storage areas for facility tools and materials, motor control centers, instrument air compressors, utility connections, hydrogen transfer stations or facility pipeline connections, water treatment infrastructure, and small-scale storage tanks for fuel to support on-site equipment such as generators or vehicles. They must be constructed in compliance with state structural and electrical codes. Buildings would include safety equipment and systems and water, electrical, and telephone connections.

The facility may include small aboveground fuel tanks for generators to serve as backup power. The PEIS assumes that no pier or dock structures are part of the facilities evaluated.

For all types of facilities evaluated, smaller facilities may be remotely operated, while larger facilities may have one to three operations personnel on site 24 hours per day, 7 days per week. General maintenance for the facility would be completed by a facility's operations staff.

2.3.4 Off-site access roads

Washington State Department of Transportation (WSDOT) state routes that intersect with the PEIS geographic scope of study are expected to serve as first- and last-mile connections between green hydrogen facilities and workers, equipment, and other elements necessary for the facility. Off-site access roads may be needed to connect a facility to the existing state routes or surface streets. Most of the study area is located less than 10 miles from an interstate or state route (63% within 1 mile and 99% within 10 miles).

The PEIS assumes that off-site access roads would be two lanes (a total width of 24 feet) that support a medium-duty level traffic flow. Medium-duty level traffic can include cement trucks, tow-trucks, utility trucks, dump trucks, and trucks carrying building materials. Roads that support medium-duty traffic require a 12-inch depth of aggregate. It is estimated that a 1-mile off-site access road would require approximately 4,693 cubic yards of aggregate and a 10-mile off-site access road would require approximately 46,933 cubic yards of aggregate.

The road size and type needed would vary based on the facility location and expected use. The project developer would determine the length of off-site access road needed based on the distance between a selected site, existing road infrastructure, and coordination with state and local departments of transportation.

2.4 Development of green hydrogen facilities

This section describes the development of green hydrogen facilities, including site characterization, construction, operation, and decommissioning.

2.4.1 Site characterization

Project developers would conduct desktop analyses, feasibility and site studies during the site characterization with agreement from the landowner(s) as needed. During site characterization, generally very little modification of the site would occur. Work would include conducting surveys to gather data on ecological, cultural, Tribal, and historical resources. Surveys would need to follow appropriate regulatory requirements and procedures. If existing structures are on site, appropriate demolition considerations to undevelop a site would be made during site characterization. For purposes of this PEIS analysis, no demolition of existing buildings is proposed; construction estimates are based on new construction at a site that does not have existing structures.

Siting considerations typically include the availability of water, the geography of an area, and access to electric transmission lines and infrastructure. Considerations would also include zoning requirements and identification of sensitive areas. Since hydrogen is a combustible fuel gas, compliance with setbacks from adjacent structures would be required.

Activities that would involve minimal or no site disturbance include:

- Mapping surface hydrology assessment and floodplain
- Tribal, cultural, and historic resource studies
- Slope evaluation and soil stability studies
- Habitat mapping, including wetland identification
- Water type mapping, including identification of fish waters and water crossings
- Species identification (plants and wildlife)
- Due diligence assessment for lands with previous industrial uses
- Evaluation of seismic stability and potential storm event runoff
- Baseline air quality assessment
- Noise assessment/study
- Traffic study
- Routing study to evaluate feasibility of distribution line routes

Activities that could include substantial ground disturbance include:

- Grading for access roads
- Soil coring and geotechnical investigation

2.4.2 Construction

Construction of green hydrogen facilities would occur similarly to other industrial facilities. Site preparation would be followed by assembly, testing and startup, and then post-construction removal of temporary structures. The PEIS assumes that construction would be 1 to 3 years based on the size of the facility.

Equipment used during construction may include graders, rubber-tired bulldozers, tractors, loaders, backhoes, excavators, cranes, forklifts, generators, welders, cement and mortar mixers, pavers, rollers, pile-drivers, air compressors, and trucks.

2.4.2.1 Site preparation

Site preparation depends on the site, including size, shape, existing conditions, and accessibility. Site preparation could involve excavation, blasting, vegetation removal, and grading. Site access could include modifying existing roads or building new access roads (on site or to the site). On-site access road widths would vary based on the type of road, use, and room required for turning and emergency service. Blasting is not expected to be needed for construction of most facilities but may occur as part of site preparation activities, depending on subsurface conditions. It is expected that aggregate such as gravel or concrete would be brought to the site. Security fencing and road access gates would be installed, along with temporary work buildings and storage facilities for materials, tools, and equipment. Sites would install systems for water, wastewater, and electrical power. Site drainage would be developed for stormwater and flooding prevention. Intake and discharge pipes would be installed if needed. This would involve in-water work.

2.4.2.2 Building structures

Once the site is prepared, facility structures and other supporting components would be built. This includes the foundation, framework (including internal components and structural support), roofing, and siding. Materials such as steel and concrete are common construction materials for industrial buildings due to their strength and durability. Reinforced concrete is used for foundations, floor slabs, and structural elements. Steel is used for structural framing, roofing systems, and wall cladding. This work would also include installing electrical systems; plumbing; and heating, ventilation, and air conditioning systems.

2.4.2.3 Post-construction and startup

Once construction is complete, temporary buildings and material storage facilities would be removed. Disturbed areas would be revegetated. The facility would undergo testing and start-up of the various systems installed before operations can begin.

2.4.2.4 Construction estimates

The PEIS assumes the following for a 1-acre and a 10-acre facility footprint (Table 2-1):

- Green hydrogen production facilities are expected to be built on relatively flat areas, with slopes less than 15%.
- Grading would disturb the entire site, with an assumed depth of 1 foot.
- Excavation would occur for building foundations and equipment pads.
- Excavation and trenching would occur for utility installation and for any underground service lines.
- Aggregate material (e.g., cement, gravel) would be hauled to the site.

Table 2-1. Construction estimates for a 1-acre site and a 10-acre site

Construction assumption	1-acre site estimate	10-acre site estimate
Construction timeframe	1 year	3 years
Construction employees	10 individuals	100 individuals
Construction staging footprint	0.1 acre/ 10%	1 acre/ 10%
Worker trips (total one-way)	3,888	99,943
Vendor trips (total one-way)	1,179	37,573
Onsite truck trips (total one-way)	261	1,542

Construction assumption	1-acre site estimate	10-acre site estimate
Hauling trips (total one-way)	378	1,873
Grading	1,602 CY	16,020 CY
Aggregate	942–1,256 CY	11,945–14,582 CY
Equipment pad depth of excavation	4 feet	4 feet
Building foundation depth of excavation	3–5 feet	3–5 feet
Utility lines depth of excavation	3.5 feet	3.5 feet
Foundation pads, structures footprint	0.30 acre/ 30%	3.0 acres/ 30%
Paved surfaces footprint	0.25 acre/ 25%	2.5 acres/ 25%
Permeable surface (gravel, dirt, grass) footprint	0.45 acre/ 45%	4.5 acres/ 45%
Excavation and trenching for utility installation footprint	0.33 acre/ 33%	3.3 acres/ 33%
Height of structures	Up to 100 feet	Up to 100 feet
Height of distribution lines	35 to 100 feet	35 to 100 feet
Diesel fuel consumption (gallons) [a]	22,750	135,918
Gasoline fuel consumption (gallons) [a]	2,166	55,682

Notes:
CY = cubic yards
a. Includes equipment use and worker, vendor, on-site truck, and hauling trips during construction.

2.4.3 Operations and maintenance

Activities for operations would vary based on type of facility, size, and site characteristics. Larger facilities are expected to have one to three staff on site 24 hours per day, 7 days per week. Smaller facilities would have limited staffing hours with remote operation. Green hydrogen facilities would require ongoing equipment maintenance similar to other industrial facilities. During maintenance, regular testing of hydrogen and industrial systems would occur. Routine testing of hydrogen systems such as tank leak tests would be conducted. Maintenance could include excavation of utility or transmission lines, which could require in-water work. Proton-exchange membrane (PEM) electrolyzers and alkaline electrolyzers require periodic (approximately every 20 years) replacement.

Training in safe hydrogen handling practices is a key element for ensuring the safe use of hydrogen. For smaller facilities, monitoring may be conducted remotely, while larger facilities are likely to have on-site monitoring staff. Monitoring allows for continual assessment of conditions to identify if and when hazardous conditions exist. A project-specific hazards analysis would identify the key hazards and monitoring thresholds that indicate a system failure and would trigger shutdown protocols. In the event of an emergency, on-site operators would be present or, for remotely operated facilities, dispatched from a regional call center, to respond. This protocol is similar to that of a refinery, liquefied natural gas terminal, or fuels terminal.

Facility access would be restricted using perimeter fencing, locked gates, and signs. Security fencing would likely consist of chain-link (or other wire) fencing. Equipment within the facility would be separately fenced and access-controlled for safety and increased security. Lighting would be provided at construction trailers, operations and maintenance buildings, and facility entrances as necessary for the safety and security of employees and the facilities.

2.4.4 Site decommissioning

A green hydrogen facility would be decommissioned following the end of its useful life. The lifespan of a green hydrogen facility can range from 20 to 50 years. At 20 years, a green hydrogen electrolyzer would need either a major overhaul or replacement. SMR and bio-gasification facilities' useful life could be 50 years.

Decommissioning actions include dismantling and removing structures, piping, roads, distribution lines, and other facility components. Foundations are expected to be removed to a level of 3 feet or more below the ground surface. Cables, lines, or conduit that are buried 3 feet below grade or more are not expected to be removed. The depth to which facilities and infrastructure would be removed would depend on agreements with landowners and follow applicable regulatory requirements. Facility access roadways no longer needed to access the site are expected to be restored or naturally revegetated. Phase I and Phase II site investigations would be performed across the entire facility to identify the presence or absence of contamination, and to support plans for decontamination, if required.

A green hydrogen facility site would be restored to its pre-project conditions and uses unless the project developer, permitting authority, and regulatory agencies agree on alternate actions. Special consideration of the type of technology employed and disposal of associated components would be required. A developer may prepare a decommissioning plan as part of its proposal. Some cities and counties require financial security as part of a decommissioning plan.

2.5 Types of facilities (alternatives) considered for this PEIS

The types of facilities considered in this PEIS are grouped into alternatives for the purposes of considering ranges of potential impacts in the analysis.

2.5.1 Green hydrogen production facility

Green hydrogen can be produced using various technologies and inputs (Table 2-2). Each of the technologies is described in detail below.

Table 2-2. Green hydrogen production pathways

Production Technology	Inputs
Electrolysis	Water, electricity
Steam-methane reforming	Renewable natural gas [a]
Pyrolysis	Renewable natural gas, biomass [a]
Bio-gasification	Biomass

Note:

a. See RCW 19.285.030 for definition of biomass and RCW 80.50.020 for definition of renewable natural gas.

2.5.1.1 Electrolysis

Electrolysis is a process that uses electricity to split water into hydrogen and oxygen. This reaction takes place in a device called an electrolyzer. The process uses electrical current to create reduction-oxidation (redox) reactions (see Figure 2-9). Such reactions occur when electrons from one chemical substance are transferred to another.

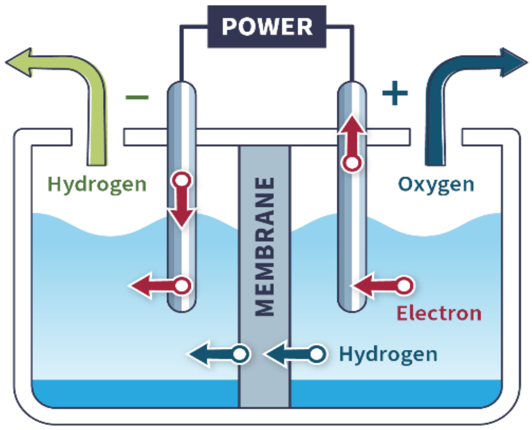

Figure 2-9. Electrolysis process flow diagram

An electrolyzer consists of an anode and a cathode separated by a membrane (also known as an electrolyte). There are three types of electrolyzers commonly used today[30]:

- Alkaline electrolyzers are the most widely established technology. This process uses a liquid alkaline solution of sodium or potassium hydroxide as the electrolyte.
- PEM electrolyzers are a newer technology. The electrolyte is a solid plastic material.
- Solid oxide electrolyzers use a specialized solid ceramic-based material as the electrolyte.

The following are assumptions used in this PEIS for green hydrogen production facilities using an electrolysis process:

- **Inputs:** Water would be used as source for hydrogen.
- **Electricity requirements:** Fifty kilowatt-hours (kWh) of energy would be required to produce 1 kilogram (kg) of hydrogen.
- **Water requirements and discharges:** Two to 3 gallons of water would be used to produce 1 kg of hydrogen. To maintain efficient operation, most large-scale electrolyzers require demineralized water. The water quality required to meet demineralized standards is typically more stringent than what can be supplied from a municipal water tap. On-site treatment through reverse osmosis would likely be required. Wastewater would be treated or routed to a wastewater treatment plant. The water treatment process result is not completely efficient; approximately 1 gallon of

[30] Hydrogen Production: Electrolysis | Department of Energy at https://www.energy.gov/eere/fuelcells/hydrogen-production-electrolysis

wastewater would result from treatment of the quantity of water necessary to produce 1 kg of hydrogen.

- **Air emissions:** A byproduct of green hydrogen production through electrolysis is oxygen. Most large-scale electrolyzers vent produced oxygen to the atmosphere. Because the electrolysis process is driven by electricity, it does not directly produce regulated pollutants such as NO_x (nitric oxide and/or nitrogen dioxide) and SO_x (sulfur oxides; sulfur monoxide, sulfur dioxide, and/or sulfur trioxide) or emit carbon dioxide (CO_2). There are no GHG emissions associated with operation of an electrolyzer.
- **Facility footprint:** The facility footprint would depend on the electrolyzer technology used (see Figure 2-10 and Figure 2-11). A large-scale PEM electrolyzer (approximately 1 MT (1,000 kg) of hydrogen per day) might occupy between 1,000 and 2,000 square feet (ft^2). A large-scale alkaline electrolyzer (approximately 1 to 9 MT of hydrogen per day) might occupy between 2,000 and 15,000 ft^2.

Figure 2-10. Electrolysis facility – Plug Power – Woodbine, GA

Source: Lutz 2024

Figure 2-11. Electrolysis facility – H2B2 SoHyCal – Fresno, CA

Source: H2B2 Electrolysis Technologies 2023

2.5.1.2 Steam-methane reforming using renewable natural gas

Green hydrogen produced from SMR would use renewable natural gas as the primary fuel source. The process involves three stages:

1. High-temperature (700 to 1,000°C) steam reacts with methane from the renewable natural gas in the presence of a catalyst to produce hydrogen, carbon monoxide, and a small amount of carbon dioxide.
2. Carbon monoxide and steam react using a catalyst to form carbon dioxide and hydrogen.
3. Hydrogen gas is purified by removing carbon dioxide and other impurities through a purification unit. The remaining gas is essentially pure hydrogen, and the separated carbon dioxide would be vented.

The simplified process flow of SMR is represented in Figure 2-12.

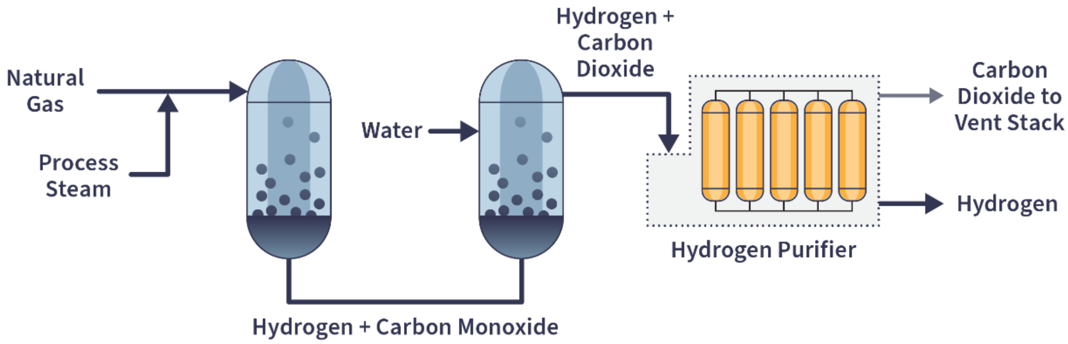

Figure 2-12. Steam-methane reformation process flow diagram

The following are assumptions used in this PEIS for green hydrogen production facilities using an SMR process:

- **Inputs:** Renewable natural gas[31] consisting of methane and other hydrocarbons derived from the decomposition of organic material in landfills, wastewater treatment facilities, and anaerobic digesters. Renewable gas may be provided directly or as a blended product in pipeline natural gas. Approximately 150 standard cubic feet (scf) of renewable natural gas would be used per 1 kg of hydrogen produced.
- **Electricity requirements:** About 0.1 to 3 kWh of energy to produce 1 kg of hydrogen.
- **Water requirements and discharges:** The water (steam) volume required can vary from approximately 6 to 8 gallons of water per kg of hydrogen produced. Wastewater discharges from the SMR process include the wastewater from cooling tower blowdown, boiler blown water, reverse osmosis reject water, and de-aerator vent water. This would be treated or routed to a wastewater treatment plant. Wastewater from the cooling tower may include biocides to prevent biofouling of the water. Use of 2 to 3 gallons per kg of hydrogen produced may be expected.
- **Air emissions:** The SMR process may include emissions from a furnace used to generate the steam or flares used to burn vented gases. In general, an SMR plant can be expected to emit 18–20 pounds (lbs) of CO_2 per kg of hydrogen produced. Additionally, the SMR process generates steam in a conventional gas-fired boiler. Combustion of renewable natural gas in boilers will also result in NO_x and carbon monoxide (CO) emissions from the facility. Emissions factors for the operation of these boilers can be expected to be 50 lbs per million scf of gas for NO_x and 84 lbs per million scf of gas for CO.[32]
- **Facility footprint:** A facility's footprint would depend on its function (see Figure 2-13). For example, a small containerized small-scale SMR facility capable of producing 2,000 kg per day with no hydrogen storage could occupy approximately 1 acre, whereas a full-

[31] https://app.leg.wa.gov/RCW/default.aspx?cite=80.50.020
[32] U.S. Environmental Protection Agency, 1998. Natural Gas Combustion, Section 1.4 in AP-42: Compilation of Air Emissions Factors from Stationary Sources, https://www.epa.gov/sites/default/files/2020-09/documents/1.4_natural_gas_combustion.pdf

scale industrial SMR facility capable of producing 50–100 MT (50,000–100,000 kg) per day may require up to 5 to 10 acres.


Figure 2-13. SMR and liquid storage facility – Air Liquide – Apex, NV

Source: Air Liquide 2022

2.5.1.3 Pyrolysis

Green hydrogen produced using pyrolysis occurs when methane from renewable natural gas or biomass is heated and decomposed, creating hydrogen and solid carbon. The process requires high temperatures of approximately 1,000°C. Once the hydrogen is produced, it is cooled by the ambient atmosphere.

Several processes are currently used, and new processes continue to be developed. Some of these processes are detailed below:

- **Thermal cracking:** Thermal cracking is the most basic pyrolysis process in that it simply relies upon high energy input (high temperature) to achieve methane decomposition.
- **Thermocatalysis:** Thermocatalysis uses one or more catalysts to reduce the temperature at which decomposition of methane can easily occur.
- **Plasma:** Plasma pyrolysis employs microwave discharges at atmospheric pressure as a source of reactive plasma, which is used to decompose methane into hydrogen.
- **Liquid metal:** Liquid metal pyrolysis utilizes liquid metal as a heat transfer fluid in a bubble column reactor.
- **Molten salt:** Molten salt pyrolysis is similar to liquid metal pyrolysis. However, instead of utilizing liquid metal, it utilizes molten salt as a heat transfer medium.

An example process flow is shown in Figure 2-14.

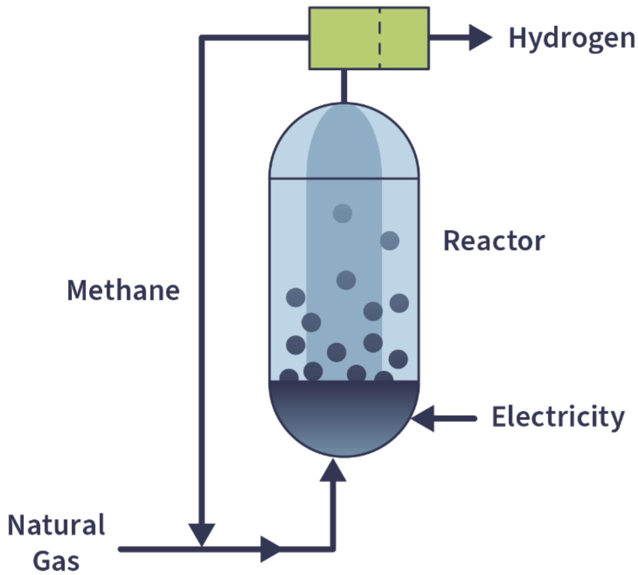

Figure 2-14. Methane pyrolysis process flow diagram[33]

The following are assumptions are used in this PEIS for green hydrogen production facilities using a pyrolysis process:

- **Inputs:** Renewable natural gas or biomass as source for hydrogen. Renewable gas may be provided directly or as a blended product in pipeline natural gas. Approximately 200 scf of renewable natural gas should be expected per kg of hydrogen produced. Approximately 13.5 kg of biomass is needed to produce 1 kg of hydrogen.
- **Electricity requirements:** 10 kWh of energy to produce 1 kg of hydrogen.[34]
- **Water requirements and discharges:** Unless its heat source involves the use of steam, pyrolysis has no water requirements and does not produce water.
- **Air emissions:** Solid carbon is produced during the process, so very minimal carbon dioxide air emissions are expected to occur. For large-scale electrically driven hydrogen production from pyrolysis NO_x and CO emission are not expected. The system may result in methane emissions however the quantity involved would need evaluation on a case-by-case basis, depending on the technology used.
- **Facility footprint:** A pyrolysis facility (see Figure 2-15) with no hydrogen storage capable of producing 5–10 MT of hydrogen per day may be expected to require 1–2 acres.

[33] *Methane Pyrolysis for CO_2-Free H_2 Production: A Green Process to Overcome Renewable Energies Unsteadiness* at https://onlinelibrary.wiley.com/doi/full/10.1002/cite.202000029
[34] https://hydrogen.monolith-corp.com/process-comparison

Figure 2-15. Pyrolysis facility – Monolith Olive Creek – Hallam, NE

Source: Power Technology partnered with Mitsubishi Heavy Industries (MHI) Group 2022

2.5.1.4 Bio-gasification

Bio-gasification is a controlled process involving heat, steam, and oxygen to convert biomass into hydrogen and other products.

State law requires biomass used for green hydrogen production to come from solid organic fuels, including forest or field residues, wood, or from dedicated energy crops, such as switchgrass, that do not include wood pieces that have been treated with chemical preservatives.[35] These different types of biomass are comprised of a variety of materials and, when processed to produce energy, produce a variety of outputs. A comparison of three types of biomass considered in this PEIS is provided in Table 2-3.

Table 2-3. Materials produced through bio-gasification by weight

Weight %	Forest residues	Wood pellets	Switchgrass
Moisture	48.91	8.7	9.84
Ash (solid carbon)	2.03	0.5	8.09
Carbon dioxide	25.69	45.8	42
Hydrogen	2.35	5.5	5.24
Nitrogen	2.35	0.08	0.69
Chlorine	0.53	0.01	0.17

[35] https://app.leg.wa.gov/RCW/default.aspx?cite=80.50.020

Weight %	Forest residues	Wood pellets	Switchgrass
Sulfur	0.02	0.01	0.17
Oxygen	0.06	39.4	33.8
Total	100	100	100

To produce hydrogen, the biomass is partially burned in the presence of a catalyst to produce carbon dioxide, which reacts with the carbon-based matter to form carbon monoxide.

Figure 2-16 shows the different types of gasification processes.

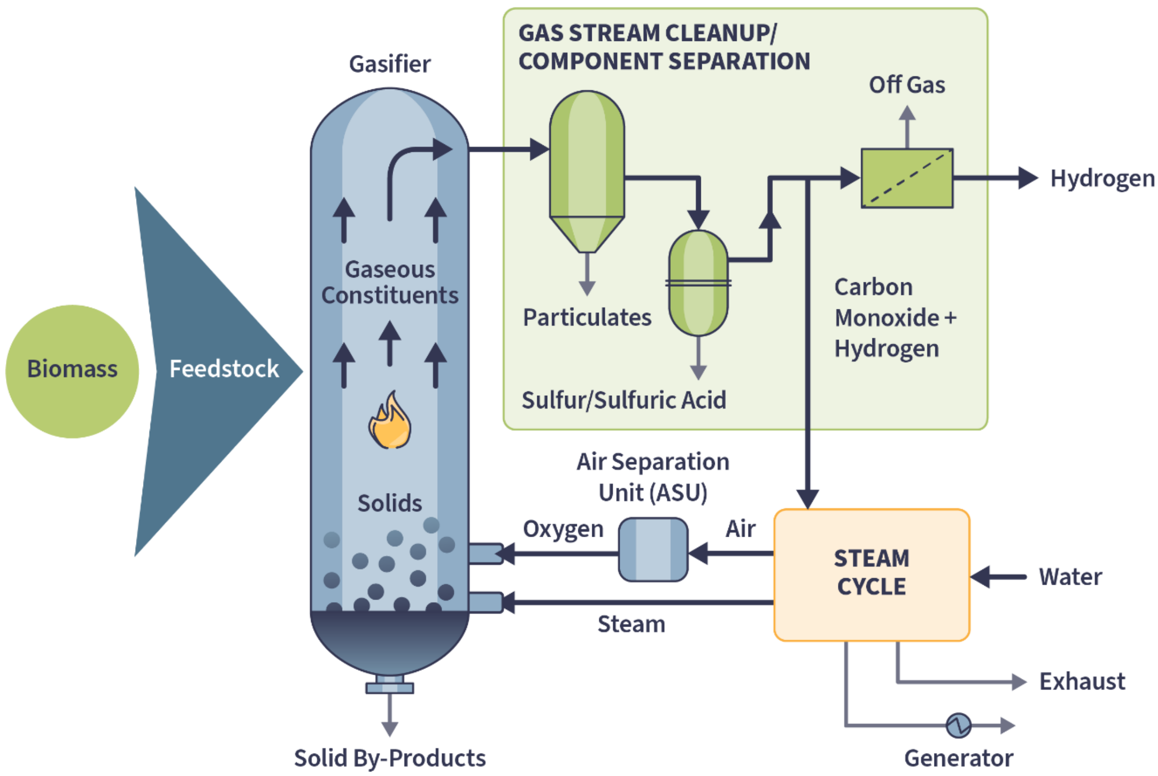

Figure 2-16. Bio-gasification process flow diagram[36]

The following are assumptions are used in this PEIS for green hydrogen production facilities using a bio-gasification process:

- **Input:** Biomass. It takes approximately 13.5 kg of biomass to produce 1 kg of hydrogen.[37]

[36] 5.1. Gasification Introduction | Department of Energy at https://netl.doe.gov/research/Coal/energy-systems/gasification/gasifipedia/intro-to-gasification
[37] Recent progress in thermochemical techniques to produce hydrogen gas from biomass: A state of the art review at https://www.sciencedirect.com/science/article/abs/pii/S0360319919329477#

- **Electricity requirements:** A study determined that a bio-gasification facility would require approximately 30 kWh of energy to produce 1 kg of hydrogen.[38]
- **Water requirements and discharges:** Generally, biomass will contain sufficient water to be processed without additional water. Certain gasification feedstocks contain sulfur, most of which would be discharged in a liquid form that requires disposal. Wastewater would be dependent on the size of the installation and the feedstock used.
- **Air emissions:** Production of hydrogen from bio-gasification will result in air emissions including NO_x, SO_2, and particulates. The total amount of these emissions will depend heavily on the feedstock used and the project-specific emissions control procedure implemented. Values for the emissions would need to be evaluated on an individual basis. Production of hydrogen via bio-gasification should also be expected to result in on-site CO_2 emissions on the order of 50–60 lbs per kg of hydrogen (H_2) produced depending on the feedstock used.
- **Solid waste:** Approximately 0.5–8.1% of waste produced through bio-gasification, by weight, would be ash (solid carbon), which would require off-site disposal.
- **Facility footprint:** A typical bio-gasification facility (see Figure 2-17) with no hydrogen storage capable of producing 50–100 MT (50,000–100,000 kg) per day may require up to 5 to 10 acres.

[38] Raven SR Bioenergy Project Updated Initial Study – Mitigated Negative Declaration at https://www.ci.richmond.ca.us/DocumentCenter/View/64961/Raven-SR-Project_Updated-ISMND_030923-PLN21-282_OCR_w-ERRATA1

Figure 2-17. Bio-gasification facility – Vaasa, Finland

Source: Photograph from Energy Monitor 2014

2.5.2 Green hydrogen production facility with co-located battery energy storage system

RCW 43.21C.535 requires this PEIS to consider facilities with co-located BESS. For green hydrogen facilities, batteries would be used to balance loads or to provide power in case of an outage or power quality deviation. One BESS would provide 2.85 megawatts (MW) of electricity for 4 hours (a capacity of 11.4 megawatt hours or 11,400 kWh).

A BESS system could include:

- Battery storage modules on racks or in containers with inverters, isolation transformers, and switchboards, which distribute power from one or more sources of supply to several smaller loads
- Converters, which convert AC power to DC power
- High-, medium-, and low-voltage electrical systems
- Heating, ventilation, and air conditioning units
- Building auxiliary electrical systems

- Fire suppression and prevention systems
- Control system, usually including a data acquisition system

The PEIS assumes that a green hydrogen production facility would require up to two 2.85-MW co-located BESSs of lithium-ion battery systems. Lithium-ion battery systems are the most common type of energy storage technology and are anticipated to be used for BESSs at green hydrogen storage facilities. Each BESS would be approximately 60 by 12 feet wide and 10 feet tall. They would be located on concrete pads or housed in larger buildings, like a shipping container. Containers must be constructed in compliance with state structural and electrical code requirements.

Green hydrogen produced by electrolysis has the greatest electricity need of the processes evaluated in this PEIS. For example, a large-scale (10-acre site) electrolyzer facility is expected to require up to 19 MW of electricity. A total of 15% of this (3 MW) can be provided by two 2.85-MW BESS batteries.

Example of a BESS exterior

Example of a BESS interior

Source: Glacier Battery Storage Innovation Pilot Project | Puget Sound Energy

2.5.3 Green hydrogen storage facility (gas or liquid form)

Hydrogen can be stored in gas or liquid form, depending on several factors, such as the use, the amount of hydrogen output and storage needed, geographical constraints, and what is needed if it is co-located with a production facility. The storage technologies discussed below are not dependent on any specific hydrogen production type.

A green hydrogen storage facility could be:

- Co-located at green hydrogen production facilities
- A standalone facility
- At transport terminals
- At an end-use location such as an industrial facility or fueling facility

If co-located with a production facility, the storage method used would be selected based on the amount of hydrogen generated and the associated on-site storage needs. If a standalone facility, the storage method used would be selected based on the amount of hydrogen needing to be stored. If at transport terminals or an end-use location, the storage method used would be selected based on the amount of hydrogen needing to be stored to support use.

At normal temperature and pressure, hydrogen is a gas. To become a liquid, the gas is compressed or liquefied and must be stored at very low temperatures. Gaseous storage is typically at high pressure ranging from 5,000 to 10,000 pounds per square inch. Liquid storage requires a liquefaction process to create very low temperature (cryogenic) conditions below -423°F (-253°C).[39] Gas compression and liquefaction require additional electricity to enable storage. Liquefaction requires more energy than compression but provides significant storage density advantages.

Hydrogen storage could be in a cylindrical or spherical gas tank or liquid tank. The storage of hydrogen would require setbacks to provide safe distance from adjacent properties. A facility would need to meet regulatory requirements for construction, maintenance, and operation. The space required for storage tanks would include the storage tanks, separation between tanks, equipment (pumps, compressors, piping, electrical enclosure, unloading station), and on-site access roads, all of which would be located within the estimated footprints presented in Table 2-4. The estimated footprint of storage facilities at three hydrogen output levels is approximately 0.03 to 0.70 acre. For this reason, construction and operation needs for storage facilities are estimated conservatively, based on a 1-acre site (Table 2-1).

Table 2-4. Estimated footprint of storage facilities at three hydrogen output levels

Hydrogen output level (kg)	Gas tank (ft^2)	Liquid cylindrical tank (ft^2)	Liquid spherical tank (ft^2)
1,000 (small-scale)	500 ft^2 (two 240 ft^2 tanks) +2 ft (2-ft separation between each tank)	Liquid storage not used for capacities 1,000 kg or less	Liquid storage not used for capacities 1,000 kg or less

[39] Hydrogen Storage | Department of Energy at https://www.energy.gov/eere/fuelcells/hydrogen-storage

Hydrogen output level (kg)	Gas tank (ft^2)	Liquid cylindrical tank (ft^2)	Liquid spherical tank (ft^2)
	+ 1,000 equipment and on-site access roads		
Estimated site footprint	**1,500 ft^2 (0.03 acre)**	**Liquid storage not used for capacities 1,000 kg or less**	**Liquid storage not used for capacities 1,000 kg or less**
10,000 (mid-scale)	5,000 ft^2 (twenty 240 ft^2 tanks) +40 ft (2-ft separation between each tank) + 15,000 ft^2 equipment and on-site access roads	800 ft^2 (two 400 ft^2 horizontal tanks) +20 ft (10 ft separation between each tank – horizontal and vertical) 200 ft^2 (two 400 ft^2 vertical tanks) +20 ft (10 ft separation between each tank – horizontal and vertical) + 1,200–1,600 ft^2 equipment and on-site access roads	625 ft^2 (one 25-ft-diameter tank) + 5,375 ft^2 equipment and on-site access roads
Estimated site footprint	**20,000 ft^2 (0.45 acre)**	**2,000 ft^2 (0.05 acre)**	**6,000 ft^2 (0.13 acre)**
100,000 (large-scale)	N/A – gas tank storage not used for capacities 100,000 kg or more	N/A – liquid cylindrical tank storage not used for capacities 100,000 kg or more	2,500 ft^2 (one 50-ft-diameter tank) + 27,500 ft^2 equipment and on-site access roads
Estimated site footprint	**N/A – gas tank storage not used for capacities 100,000 kg or more**	**N/A – liquid cylindrical tank storage not used for capacities 100,000 kg or more**	**30,000 ft^2 (0.70 acre)**

Note: ft = feet/foot; ft^2 = square feet; N/A = not applicable.

While there are pressure and cryogenic industry standards to address construction and maintenance best practices, hydrogen storage is not specifically currently addressed by federal or international regulations. Liquefied hydrogen has similar properties to liquefied natural gas, so some of the same siting and safety requirements may be used. The DOE is working on developing standards. Project-level review should consider the most updated requirements to identify risks and mitigation. Risks, safety requirements, and best practices are described in Section 4.8 and Appendix I, *Environmental Health and Safety Technical Appendix*.

2.5.3.1 Gas tank storage

Green hydrogen in a gas form would be stored in stationary, above ground, cylindrical tank, as shown in Figure 2-18. Storage is typically at high pressure, ranging from 5,000 to 10,000 pounds per square inch gauge (350 to 700 bar gauge), requiring approximately 2–3 kWh of electricity per kg of hydrogen stored. All-metal or composite-overwrapped pressure tanks would be used for bulk gaseous hydrogen storage. Storage of the same amount of hydrogen in gas versus liquid form requires greater tank volume; as such, gaseous storage is typically suitable for facilities requiring less than 1,000 kg of on-site storage. A typical 1,000 kg gaseous storage consists of two 30- by 8-foot platforms and requires a total of 500 ft^2 of land.

Figure 2-18. Example of a gas storage tank

Source: On-Site and Bulk Hydrogen Storage | Department of Energy | DOE

2.5.3.2 Liquid tank storage

The sizes, operating conditions, types, and quantity of storage tanks would determine the size of the facility and the complexity of the associated pressure management system. Due to its extremely low boiling point of -423°F (-253°C), liquid hydrogen is stored in double-walled, vacuum-insulated cryogenic (very low temperature) storage tanks, requiring approximately 7–12 kWh of electricity per kg of hydrogen stored. These can be either cylindrical or spherical tanks, with spherical tanks used for larger storage volumes. Cryogenic storage tanks are equipped with pressure relief devices and automated vents. If the internal pressure increases over a specific level, safety relief valves would vent to open air and hydrogen would be released as a gas. Storage tanks would generally be outside, but any indoor storage tanks are required to be in well-ventilated areas in accordance with 29 Code of Federal Regulations (CFR) 1910.103.

Hydrogen stored in liquid form will likely require refrigeration systems such as chillers and condensers. Large refrigeration systems must meet the requirements of Ecology's Refrigerant Management Program. Additionally, these cooling systems would require more energy to operate than gas storage which is discussed in Appendix H, *Energy and Natural Resources.*

Cylindrical tanks

Liquid hydrogen can be stored in cylindrical tanks. These are typically used for mid-scale facilities requiring approximately 10,000 kg/day. A horizontal cylindrical tank capable of storing approximately 4,000 kg of hydrogen would be approximately 40 feet long with a diameter of 10 feet. It would need approximately 500 ft^2 of land per tank.

Spherical tanks

Large spherical storage tanks would typically be used if a storage facility was co-located with a hydrogen production facility (Figure 2-19). Storage volumes for a single sphere range from 10,000 cubic feet (approximately 20,000 kg) to 1,000,000 cubic feet (approximately 2,000,000 kg). A tank capable of storing 300,000 kg of hydrogen would be approximately 25 or 60 feet in diameter and need an area of up to 30,000 ft^2, including the space required for the supporting equipment.

Figure 2-19. Example of a liquid storage tank

Source: DOE/NASA Advances in Liquid Hydrogen Storage | DOE

Converting hydrogen to liquid for storage requires additional equipment to cool the hydrogen gas to cryogenic conditions and liquefy it. This is done using a liquefaction system which includes turbo-expanders and heat exchangers (see Figure 2-20). An industrial-scale liquefaction system capable of supporting 5–10 MT per day would be expected to require 1–1.5 acres of land.[40] A small-scale liquefaction system creating 1,000 to 2,000 kg/day would be expected to require 2,500 ft^2 and could be housed in a building.

[40] Based on Linde's Leuna, Germany, installation - 10 tons/day of liquefaction.

Figure 2-20. Example of a liquefaction system

Source: Liquefying Hydrogen for Storage & Transport | Linde Hydrogen

2.5.4 No Action Alternative

Under the No Action Alternative, agencies would continue to conduct environmental review and permitting for green hydrogen facilities on a project-by-project basis. The potential impacts from facilities developed under the No Action Alternative would be similar to the impacts for the types of facilities described above for construction, operations, and decommissioning, depending on facility size and design.

2.6 Alternatives considered but eliminated

Alternatives that did not meet the legislative direction were eliminated from further consideration. This PEIS does not evaluate the source of power, electricity, or inputs used to produce green hydrogen. For example, the PEIS does not evaluate a solar energy facility that provides the electricity used for green hydrogen production. The source of electricity would vary depending on a proposal that would be evaluated during future project-level review.

This PEIS does not evaluate the transportation or end uses of green hydrogen. These facilities would vary widely, and impacts would be site-specific based on the use and if the proposal was a modification to an existing facility or a new facility. These would be evaluated during project-level reviews.

This PEIS does not evaluate the construction or use of transmission pipelines for transporting green hydrogen. The U.S. Department of Transportation’s Pipeline and Hazardous Materials Safety Administration is responsible for regulating pipelines. New pipelines are likely to cover multiple jurisdictional areas and require federal, state, and local permits and would be reviewed on a case-by-case basis. However, pipelines at green hydrogen production or storage facilities for on-site operations are evaluated in this PEIS.

3 Scope of Study

The scope of study for green hydrogen facilities was defined considering areas where facilities could be built (geographic bounds) and the time period in which facilities may be constructed and operational (time scale or temporal bounds).

As described in 2020 legislation,[41] the scope of this PEIS is limited to the probable, significant adverse environmental impacts in geographic areas that are suitable for green hydrogen facilities.

To develop the geographic scope of study for this PEIS, Ecology sought input from Tribes, agencies, members of the public, and interested parties to provide input on the geographic scope of study.

Figure 1-1 presents the geographic scope of study for this PEIS.

3.1 Geographic scope of study

Areas included in the geographic scope of study for green hydrogen energy facilities were based on the assumptions listed below:

- For a green hydrogen production or storage facility:
  - 50 miles or less from freight highway routes
  - In an area zoned for industrial or industrial-supporting uses
- Additionally, for a green hydrogen production facility:
  - 25 miles or less from transmission lines of 55 kV and above

However, because a statewide zoning dataset is not currently available, identifying areas zoned for industrial or supporting uses requires obtaining zoning data from individual cities and counties. Given the large number of cities and counties in Washington, obtaining zoning data from individual cities and counties was not practicable for this PEIS. Therefore, the geographic scope of study in Figure 1-1 only shows areas zoned for industrial or supporting uses for the following:

- Counties
- Large cities (populations greater than 50,000)
- Cities near proposed Pacific Northwest Hydrogen Hub (PNWH2) projects
- Other cities with established industrial areas where green hydrogen could be used by existing industries including, but not limited to, refineries, commercial ports, and commercial airports

[41] https://apps.leg.wa.gov/rcw/default.aspx?cite=70A.45.020

Ecology used publicly available county and city zoning data to identify areas zoned for industrial or supporting uses to include in the geographic scope of study. The industrial areas depicted on Figure 1-1 are a snapshot in time as of summer 2024. County and city updates to zoning data in the future may change the areas mapped as suitable to industrial or supporting uses.

The following areas were excluded from the geographic scope of study:

- Tribal reservations and trust land
- Military installations
- Federal lands, with the following exception:
  - The DOE has identified a small area of land at the Hanford Site as available for lease to develop utility-scale carbon pollution-free electricity projects. This area is included in the geographic scope of study, but the rest of the Hanford Site is excluded.
- National parks, wilderness areas, wildlife refuges, and state parks

The PEIS geographic scope of study is approximately 248,216 acres, with the majority made up of industrial lands. These lands include city and county industrially zoned areas or areas zoned to support industrial uses, such as areas with major port facilities that handle freight shipments, intermodal facilities, and airports.

This PEIS does not approve, authorize, limit, or exclude projects on a site-specific basis. Projects could be built on private, city, county, state, or federal lands with agreement from the landowner or manager. This PEIS does not limit the geographic extent of the state where green hydrogen facilities could be proposed. The purpose for the geographic scope of study is to identify the geographical areas where probable, significant adverse environmental impacts from green hydrogen facilities are likely to occur.

For projects on Tribal reservation lands, each federally recognized Tribe would determine use of their lands. Tribal reservation lands are not included in the PEIS geographic scope of study. Ecology will continue to offer consultation with each Tribe that has reservation lands, and if a Tribe chooses to include their lands, they will be added to the geographic scope of study for the Final PEIS.

3.2 Study areas for analysis of impacts

The geographic scope of study shown in Figure 3-1 shows lands suitable for green hydrogen facilities. These lands are adjacent to or surrounded by lands that are used for various purposes and that may be affected by green hydrogen facilities proposed in the geographic scope of study. Therefore, where applicable, the study areas for the analysis of impacts to the elements of the environment (e.g., earth) may extend beyond the geographic scope of study. For example, the study areas may include natural and built areas next to the industrial and industrial-supporting lands on which green hydrogen facilities may be constructed, operated, and decommissioned.

3.3 Time scale of study

This PEIS considers green hydrogen facilities that may be constructed after June 30, 2025, and before January 1, 2050. Washington State greenhouse gas limits require net-zero GHG emissions by 2050. CETA requires all of Washington's electric utilities to meet 100% of their retail electric load using non-emitting and renewable resources by 2045.

For the PEIS, a green hydrogen facility is expected to have an operational life of 20 to 50 years, at which time it is expected to be decommissioned. Therefore, an approximate 75-year time period is used for resource analyses. This includes when developments are likely to be constructed and operational.

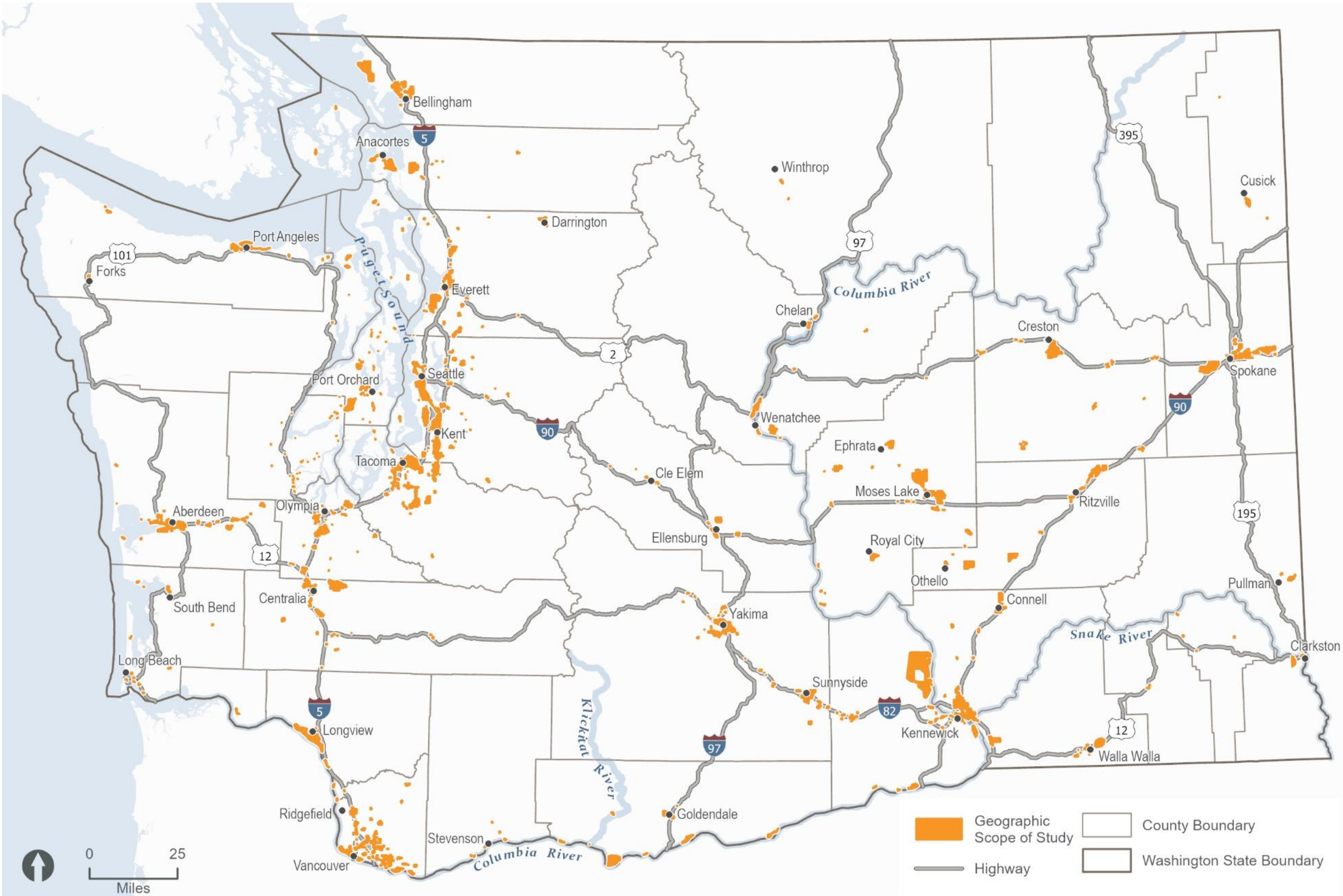

Figure 3-1. Green Hydrogen Energy Facilities PEIS geographic scope of study

4 Affected Environment, Potential Impacts, and Mitigation

This chapter summarizes the affected environment, impacts, and actions that could avoid or reduce impacts for each resource considered. The following paragraphs summarize the general approach that was used for the analysis in this chapter and the attached reports. Key terms are highlighted and explained below.

The **affected environment** is the existing condition within the study area for each resource. The **study area**—or the area of focused analysis—is defined in Chapter 3. For some resources, additional areas adjacent to industrial lands where green hydrogen facilities are anticipated to be located were also considered to determine the impacts on the resource within a larger community or landscape. Because this programmatic review considers a large study area, and because specific locations for facilities are not known, descriptions of the affected environment within the study area for this PEIS are broad and qualitative.

Impacts are the effects or consequences of actions. This chapter discusses potential impacts that site characterization, construction, operation, and decommissioning of green hydrogen facilities may have on resources. The chapter also considers the potential impacts of the No Action Alternative.

The PEIS focuses on significant adverse environmental impacts, with some information provided on less severe impacts. “Adverse” means an impact would have a negative change in the condition of the resource. Determining if an impact is “significant” involves consideration of both the intensity of the impact (magnitude and duration) and the context of the impact, which can vary with the setting and existing conditions for a particular resource. This programmatic analysis considers potential environmental effects over a broad geographic and a time horizon of 75 years. As a result, it is fairly general and focuses on probable significant impacts in a qualitative manner, often characterizing a range of probable impacts. Where there is overlap between resource areas, the related section is noted.

This chapter also identifies **actions that could avoid or reduce impacts**, often called mitigation measures. **Mitigation** is the avoidance, minimization, rectification, compensation, reduction, or monitoring of adverse impacts on the environment and a contingency plan for correcting problems if they occur. The PEIS evaluates types of mitigation actions developers could use to address the probable impacts. Some mitigation measures would need more details specific to each project design and location. Developers can use the mitigation measures in this PEIS to develop mitigation plans for potential impacts.

To identify **probable significant adverse environmental impacts**, the potential adverse environmental impacts of the different types of facilities were first evaluated at a broad level. Mitigation measures required by existing environmental laws and rules were then considered. Next, mitigation measures typically provided by permit conditions, required plans (e.g., Temporary Erosion and Sediment Control Plans), and standard best management practices

(BMPs) that would avoid and reduce impacts were considered. The latter types of mitigation measures are listed in the PEIS technical appendices for each resource under the category "permits, plans, and BMPs." If these actions were sufficient to reduce impacts to levels below significance, they were identified as **less than significant impacts**.

Where these mitigation measures are not sufficient to reduce impacts below a level of significance, those impacts were identified as **potentially significant adverse impacts**. Two categories of mitigation measures could potentially mitigate significant adverse impacts to a non-significant level. These are listed in the PEIS as:

- **Siting and design considerations:** Provided for all environmental resources to help all facilities avoid and reduce environmental impacts
- **Additional mitigation measures to address potentially significant impacts:** Provided specifically to address potential significant impacts only for environmental resources for which potential significant impacts have been identified

Even with these mitigation measures, in some cases, some significant impacts would still not be able to be mitigated to a non-significant level. These impacts are identified in this PEIS as potentially **unavoidable significant adverse impacts**.

Avoiding and reducing impacts

When developing proposals, developers should seek to avoid or minimize impacts through thoughtful siting and design. Each appendix includes a list of siting and design considerations which can help avoid impacts. **Refer to the technical appendices for detailed actions to avoid and reduce impacts.**

If significant impacts are likely, site-specific mitigation actions would be developed during project-specific review to be included in permit applications. These include plans and BMPs. BMPs are activities, maintenance procedures, managerial practices, or structural features that prevent or reduce pollutants or other adverse impacts. These may be required in permits or plans by a regulatory agency.

RCW 43.21C.538 says green hydrogen energy project proposals following the recommendations developed this PEIS must be considered to have mitigated the probable significant adverse project-specific environmental impacts for which recommendations were specifically developed, unless the project-level environmental review identifies project-level probable significant adverse environmental impacts not addressed in the PEIS.

The analysis of each resource was based on incorporation of the best available science and information, including:

- Studies, modeling, reports, and regulatory findings relevant to the study area
- Information received through the scoping process (see Appendix A, *Scoping Summary Report*)
- Information received from Tribes and interested parties (see Chapter 6)

- Expertise of state agency staff relevant to specific resources

Appendices B through P are **technical appendices** with more detailed information and specific analyses. The sections in this chapter are intended to be a summary and reference the corresponding report(s). The appendices are the official technical documentation for this PEIS.

Separate from the effects considered in the sections of this chapter, **cumulative impacts** are effects that could result from the incremental addition of effects of a facility to the impacts from past, present, and reasonably foreseeable future actions (RFFAs). These effects are summarized in Chapter 5 to determine whether cumulative impacts could result from incremental, but collectively significant, effects that occur over time with other actions. Full details can be found in the *Cumulative Impacts Technical Appendix* (Appendix Q).

4.1 Tribal rights, interests, and resources

Key findings

Facilities could impact Tribal rights, interests, and resources. The significance of impacts to Tribal rights, interests, and resources can be understood only from within the cultural context of an affected Tribe. This will depend on the project and the federally recognized Tribes potentially affected. Accordingly, the impact assessment and determinations of significance or non-significance would be done with engagement and in consultation with potentially affected Tribes at the project level.

Tribes are recognized as unique sovereign people who exercise self-government rights that are guaranteed under treaties and federal laws. Tribal rights, interests, and resources refer to the collective rights and access to traditional areas and times for gathering resources associated with an Indian Tribe's sovereignty since time immemorial. They include inherent rights or formal treaty rights associated with usual and accustomed territories. Tribal resources include Tribal cultural lands, archaeological sites, sacred sites, fisheries, and other rights and interests in Tribal lands and lands within which a Tribe or Tribes possess rights reserved or protected by federal treaty, statute, or executive order. Resources include plants, wildlife, and fish used for commercial, subsistence, and ceremonial purposes.

The analysis of impacts to Tribal rights, interests, and resources is different than for the impact analysis for environmental resources. Natural and built resources were analyzed in the appendices to determine whether green hydrogen facilities would have significant impacts from a non-Tribal perspective and whether those impacts could be mitigated. For impacts to Tribal rights, interests, and resources, any determinations of significance or non-significance would be done with engagement and in consultation with each potentially affected Tribe at the project level. This would be done through the SEPA process or the federal Section 106 process.

The *Tribal Rights, Interests, and Resources Technical Appendix* (Appendix B) includes the full analysis and technical details used to evaluate Tribal resources in this PEIS. This section contains a summary of the affected environment, how impacts were analyzed, and the key findings. This section uses information from the other resource sections later in this PEIS. Refer to other resource sections for additional information and impact analysis.

4.1.1 Affected environment

The range of Tribal resources considered for the affected environment includes biological resources, cultural and historic resources, water resources, recreation resources, environmental health and safety, noise and vibration, aesthetics and visual quality, transportation, air quality, and cumulative resources.

Historic and cultural resources are analyzed in Section 4.13 of this PEIS. This section focuses on cultural resources associated with Tribes. These include archaeological sites and objects and historic sites and structures, representing people, events, and trends significant to the history of affected Tribes. These include ceremonial sites, sacred sites, places of funerary activity, and Traditional Cultural Properties (TCPs).

Many archaeological and ethnographic studies have been conducted in the study area and have inventoried archaeological sites and TCPs. This information may be public, but it may be sensitive information protected under state law. The Washington State Department of Archaeology and Historic Preservation's (DAHP's) predictive model classifies areas with different levels of risk of containing archaeological sites. However, only about 5% of the state has been surveyed for cultural resources. Therefore, it should not be assumed that a site has been intensively surveyed. Existing surveys may not account for all cultural resources that may be present within a particular area. Projects will need their own surveys for a specific site.

Natural resources of interest to Tribes include but are not limited to plants, animals, water, and natural settings. Built resources include transportation, noise, and visual quality. Resources can be used for food, medicine, recreation, or spiritual purposes. Areas important to traditional cultural practices and the resources associated with those practices include waterways, trails, plants, wildlife, or fish used for commercial, subsistence, and ceremonial purposes. Natural resources may also include landforms that have an important role in oral histories or use of the landscape.

Culturally significant plants are often used for medicine, food, clothing, basketry, structures, and aesthetic or ritual purposes. Plants and animals within the study area provide important subsistence and medicinal resources. Water plays an important role in the histories and oral traditions of Tribes. Tribal rights include recreation and access to traditional hunting, fishing, or gathering areas, or to areas where other traditional practices occur.

4.1.2 How impacts were analyzed

The significance of Tribal resources can only be understood from within the cultural context of an affected Tribe. The impact assessment considered comments provided by Tribes for early drafts of the *Tribal Rights, Interests, and Resources Technical Appendix* (Appendix B), and the Final PEIS will consider comments provided on the Draft PEIS. Specific project impacts and determinations of significance or non-significance will be determined through engagement and in consultation with each potentially affected Tribe at the project level.

The analysis of impacts on Tribal resources considered the following:

- Impacts on plant and animal species used by Tribal members, including loss or modification of habitats, fragmentation of migration corridors, and loss of medicinal and traditional plants and foods
- Loss of access to traditional hunting, fishing, or gathering areas, to an area where other traditional practices occur, and to recreation areas
- Impacts to TCPs, historical sites, and archaeological sites and objects
- Interruption of spiritual practices
- Changes in transportation routes that may interfere with access to culturally significant resources, health and safety, or economic activity
- Disruption and degradation of the health and mental well-being of Tribal members

4.1.3 Findings for all green hydrogen facility types evaluated in the PEIS

4.1.3.1 Impacts

Impacts from construction and decommissioning
Most site characterization activities would involve little or no ground disturbance. However, some ground-disturbing activities could result in impacts on historic and cultural resources.

Activities that could impact Tribal resources during construction and decommissioning include ground disturbance, restrictions to access, and degradation of visual quality. Other activities could cause noise and disturbance of the landscape, habitats, and species. Tribal spiritual practices could be interrupted by construction impacts to land areas and cultural or sacred sites. Access to traditional gathering areas for medicinal and traditional plants and foods could be restricted during construction or permanently lost. Impacts to archaeological sites, sacred sites, TCPs, burials, and specific habitats for culturally important species could result from clearing, grading, and excavation. These could also be affected from construction or decommissioning of facilities and associated infrastructure.

Potential impacts on habitats and species include alteration of species migration routes, loss of biodiversity, and habitat fragmentation. Construction and decommissioning could have impacts on plants and changes in water chemistry and soil compaction. Mortality of species and changes to habitats could impact wildlife and plants important to Tribes. These impacts could disrupt traditional subsistence practices. Access to treaty-reserved fishing areas and food harvesting areas may be limited during construction. Construction could impact terrestrial wildlife associated with Tribal use and could interrupt hunting and other cultural practices.

Noise, aesthetics, and air quality impacts from constructing facilities and associated land disturbances may degrade settings associated with cultural resources and sacred landscapes.

Increases in human access and disturbance of resources important to Tribes could result from the establishment of corridors or facilities in otherwise intact and inaccessible areas.

Ground disturbance may emit dust and result in erosion with potential to impact cultural and natural resources. Vehicle and equipment traffic has the potential to introduce invasive species to the area, and the removal of infrastructure and site restoration could also disturb or cause the mortality of species.

Newly disturbed ground could create a visual contrast that could persist for several seasons before vegetation could begin to mature and restore the pre-facility visual landscape. For decommissioning, restoration of vegetation to pre-facility conditions may take much longer, along with the return of species and functioning habitats. Invasive species may colonize newly and recently reclaimed areas and could produce visual contrasts.

Impacts from operation
Ongoing operations and maintenance are not anticipated to include ground disturbance because the use of vehicles and equipment would generally be limited to access roads and facility areas developed during construction. Erosion, compaction, trampling, or exposure of Tribal resources could occur due to vehicles, equipment, workers, ongoing maintenance activities, and vegetation management. Ongoing ground disturbance could reveal previously unknown resources such as archaeological sites.

Impacts that degrade fisheries, affect migration patterns of species, and reduce biodiversity and impacts to ecological communities from long-term vegetation management may impact Tribal resources. Air quality impacts from vehicle and dust emissions, ongoing noise and visual impacts, and facility fencing or other access restrictions may continue to impact Tribal rights and resources, including hunting. Facility security and fencing could restrict access to areas used for resource gathering, hunting, fishing, and cultural and spiritual practices.

4.1.3.2 Actions to avoid and reduce impacts

The following are some actions to avoid and reduce impacts of green hydrogen facilities. See Appendix B, *Tribal Rights, Interests, and Resources Technical Appendix*, for typical mitigation measures that may be included in plans or permit conditions and additional measures that may apply for facilities.

Siting and design considerations

- Contact potentially affected Tribes early in the siting process, ideally, before land is acquired for a project or before permit applications are developed and offer information relevant to Tribal technical staff to help identify potential impacts to Tribes.
- Include Tribal treaty-reserved rights, Tribal reservations, off-reservation rights, trust lands, other Tribal-owned land, and other areas of significance to Tribes in consideration of potential impacts and mitigation.
- Consider requiring a Tribal monitor for each potentially affected Tribe on archaeological survey crews to provide input on TCPs, sacred sites, and culturally significant sites.

- Design and site projects to avoid, to the maximum extent, impacts to Tribal rights, interests, and resources.
- Tribal preferred aesthetic or visual quality mitigation practices may vary from those considered for other visual quality mitigation; consult with potentially affected Tribes on aesthetic or visual quality mitigation practices.
- Consider maintaining open Tribal access routes and aligning construction, operations, and decommissioning to avoid disrupting Tribal access to sites and resources.
- Additional actions will be determined after engagement and consultation with Tribes.

4.2 Environmental justice

Key findings

Green hydrogen facility development could have **disproportionate impacts** on historic and cultural resources, Tribes, and Tribal communities. The impact assessment and determinations of significance or non-significance would be determined through engagement and consultation with potentially affected Tribes and the Washington Department of Archaeology and Historic Preservation at the project level.

Impacts associated with plants and animals that provide important subsistence and medicinal resources to Tribal communities could potentially result in **disproportionate impacts** on Tribal communities.

People of color populations or low-income populations may live in proximity to industrial facilities and be at increased risk of vibration impacts from certain construction and decommissioning activities. If a facility is located near people of color populations or low-income populations, this would potentially result in **disproportionate impacts** on these populations.

There would be public services and utilities and environmental health and safety risks associated with fire and explosion if activities required a large emergency response in remote locations with limited response capabilities, or if a fire or explosion during operations spreads rapidly or impacts large areas. Facilities with a BESS would also have risks from hazardous air emissions if a fire were to occur. If a facility is located near people of color populations or low-income populations, this would potentially result in **disproportionate impacts** on these populations.

Impacts associated with public services and utilities and environmental health and safety would potentially result in **significant and unavoidable disproportionate impacts** on people of color populations or low-income populations. Determining if mitigation options would reduce or eliminate impacts below significance would be dependent on the specific project and site.

RCW 70A.02.010(8) defines environmental justice as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, rules, and policies." The *Environmental Justice Technical Appendix* (Appendix C) includes the full analysis and technical details used to evaluate whether potential impacts in this PEIS disproportionately affect people of color populations and low-income populations. The report also identifies where overburdened community areas are located in the study area. This section contains a summary of the affected environment, how impacts were analyzed, and the key findings. This section uses information from the other resource sections in this PEIS. Refer to other resource sections for additional information and impact analysis.

4.2.1 Affected environment

Census Bureau 2018–2022 data were used to determine census tracts identifying people of color populations or low-income populations that overlap the study area. People of color were defined as all people who identify in the census as a race other than white alone and/or list their ethnicity as Hispanic or Latino. Of the 692 census tracts that overlap the study area, 275 (or 40%) are identified as having a people of color population. Low-income populations were defined as those households with an income at or below twice the federal poverty level. Of the census tracts that overlap the study area, 373 (or 54%) are identified as having low-income populations.

The census tracts overlapping the study area were also evaluated for whether or not they meet the criteria to be considered in an overburdened community area. An "overburdened community" is "a geographic area where vulnerable populations face combined, multiple environmental harms and health impacts and includes, but is not limited to, highly impacted communities" (RCW 19.405.020). Of the census tracts that overlap the study area, a total of 214 (or 31%) were identified as overburdened community areas. Overburdened community areas identified in the study area are spread throughout industrial urban areas and rural areas across the state.

4.2.2 How impacts were analyzed

The determinations of potential impacts and potential mitigation measures were reviewed for each element of the environment analyzed in the PEIS for each type of facility. Only resource areas with impacts that could affect people are analyzed further. Potential impacts that are less than significant are not anticipated to result in disproportionately adverse effects on people of color populations or low-income populations and are not discussed further in this section.

Potentially significant adverse environmental impacts were overlaid with census tracts that are identified as having people of color populations and low-income populations. This was used to determine the relative type and severity of effects and the potential for environmental impacts to disproportionately affect those populations.

4.2.3 Findings for green hydrogen production facilities

Green hydrogen development could have **disproportionate impacts** on historic and cultural resources and on Tribal rights, interests, and resources. The level of impact to these resources can only be understood from within the cultural context of an affected Tribe. Accordingly, the impact assessment and determinations of significance or non-significance would be done with engagement and in consultation with potentially affected Tribes and DAHP at the project level. For this reason, the impacts are not discussed further in this section. For more information on these resources, see the *Historic and Cultural Resources Technical Appendix* (Appendix N) and the *Tribal Rights, Interests, and Resources Technical Appendix* (Appendix B).

4.2.3.1 Impacts

Impacts from construction and decommissioning
Potentially significant adverse environmental impacts that could affect people during construction and decommissioning were identified for biological resources.

Construction and decommissioning of facilities could result in the direct or indirect mortality of species and changes to habitats. Construction and decommissioning of facilities could result in impacts to larger animals such as deer, bobcats, coyotes, and foxes. Small mammals may also be affected, especially mice, shrews, and voles. Plants and animals provide important cultural, subsistence, and medicinal resources to Tribal communities. Potentially significant adverse environmental impacts that could affect people during construction and decommissioning were identified for biological resources.

Findings
Construction and decommissioning impacts on plants and animals could potentially result in **disproportionate impacts** on Tribal communities.

Depending on the specific location, fire severity, and emergency response capacity, construction and decommissioning would have potentially significant adverse impacts on emergency response.

Findings
If activities required a large emergency response in remote locations with limited response capabilities or if there are other unique aspects of a facility site, impacts could exacerbate health disparities associated with the historical and current industrial land use conditions experienced by people in overburdened communities. If construction or decommissioning of a facility is located near people of color populations or low-income populations, this would potentially result in **disproportionate impacts** on these populations.

If vibration from specific construction or decommissioning activities occurs closer than 350 feet from residential land uses, or in close proximity to conventional or historic structures, a potentially significant adverse impact with respect to human annoyance or building damage could occur. If some types of blasting during construction are conducted within 2,000 feet of historic structures, it would result in a potentially significant adverse impact from vibration.

Findings
People of color populations or low-income populations may live in proximity to industrial facilities and be at increased risk of adverse impacts. The potential increase in vibration during construction and decommissioning would be temporary in nature but would potentially result in **disproportionate impacts** on these populations.

Impacts from operation

Biological resources may be affected by continued fragmentation, vegetation maintenance, and fire suppression, and increased traffic as well as increased potential to introduce invasive species. Plants and animals provide important cultural, subsistence, and medicinal resources to Tribal communities.

Findings
Operation impacts on plants and animals could potentially result in **disproportionate impacts** on Tribal communities.

Depending on the specific location, fire severity, and emergency response capacity, there is potential that operations would have potentially significant adverse impacts on emergency response. If activities required a large emergency response in remote locations with limited response capabilities, a fire or explosion spreads rapidly or impacts large areas, or there are other unique aspects of a facility site, impacts could exacerbate health disparities associated with the historical and current industrial land use conditions experienced by people in overburdened communities.

Findings
A facility would result in potentially significant adverse impacts on public services and utilities if activities required a large emergency response in remote locations with limited response capabilities or if there are other unique aspects of a facility site. If a facility is located near people of color populations or low-income populations, operations would potentially result in **disproportionate impacts** on these populations.

The potential environmental health and safety impacts from operation would vary depending on the type of production technology used and quantities of materials present. Operating a green hydrogen production facility would involve the production, use, and storage of hazardous materials. Unintended hydrogen and methane releases during operations could cause fire and explosion. If a fire or explosion were to occur, it could result in property damage and injury or loss of life on-site. These impacts may also extend beyond the facility boundary. The severity of these impacts would vary by the type of incident and land uses of the surrounding properties, as well as emergency response capabilities.

Hydrogen and methane explosion risk can be reduced, but may not be completely eliminated, through compliance with regulations requiring the proper siting, design, and operations. Depending on the specific location, severity, and emergency response capacity, operation activities would likely have less than significant to potentially significant adverse impacts from fires and explosions.

Findings

Health disparities associated with the historical and current industrial land use conditions could be exacerbated if the operation-related risks of fire and explosion spread to surrounding areas near people of color populations or low-income populations. This would potentially result in **disproportionate impacts** on these populations. The severity of risks would need to be assessed for each facility based on the project location, production method, and quantities of flammable materials produced or stored on-site.

4.2.3.2 Actions to avoid and reduce impacts

The following are actions to avoid and reduce impacts of green hydrogen facilities.

Siting and design considerations

The following siting and design considerations could be used to reduce impacts on people of color populations and low-income populations:

- Design and site projects to avoid, to the extent practicable, adverse impacts to populations with environmental justice considerations and overburdened community areas:
  - Use available information and mapping tools.
  - Use the latest Washington State guidance to identify people of color populations, low-income populations, and overburdened community areas potentially affected by a proposed project.
- Engage potentially affected communities early in the process to understand their concerns and issues, identify potential impacts, and consider preferred mitigation options.
- Consult with local community service providers on potential issues and concerns.

Additional mitigation measures to address potentially significant impacts

Additional mitigation measures developers may consider could include, but are not limited to, the following:

- Develop and implement public information sharing to provide technical and environmental health information directly to potentially affected populations, overburdened communities, local agencies, and representative groups:
  - Include information on potential impacts and mitigation proposed.
  - Engage with communities on how they prefer to receive information and tailor communications to provide this.

    - Use a variety of media tailored to affected communities, such as local print, online publications, and radio.
- Develop Community Benefit Agreements in coordination with potentially affected communities to address impacts through mutually agreed upon mitigation, if possible.
- Consider economic actions that communities may consider mitigation, such as the following:
    - Develop workforce development opportunities.
    - Provide opportunities for training, apprenticeships, and high-quality jobs.
    - Include labor standards, workforce agreements, and local hiring provisions.

4.2.4 Findings for production facilities with co-located BESS

4.2.4.1 Impacts

Impacts from construction, operation, and decommissioning
Impacts from facilities with co-located BESSs would be generally the same as for green hydrogen facilities. The BESSs present additional fire risk and risks from hazardous air emissions.

Findings
If a facility with a BESS is located near people of color populations or low-income populations, this would potentially result in **disproportionate impacts** on these populations from hazardous air emissions.

4.2.4.2 Actions to avoid and reduce impacts

The actions to minimize, reduce, and/or mitigate impacts for facilities with co-located BESSs would be the same as those in Section 4.2.3.2.

4.2.5 Findings for green hydrogen storage facilities

4.2.5.1 Impacts

Impacts from construction, operation, and decommissioning
Impacts from green hydrogen storage facilities would be generally the same as for production facilities. Storage facilities could impact plants and animals, which provide important cultural, subsistence, and medicinal resources to Tribal communities. Liquid and gaseous hydrogen tanks pose fire and explosion risks. The severity of risks would need to be assessed for each facility based on the project location and quantities of flammable materials stored on site.

Findings
Depending on the specific location, severity, and emergency response capacity, operation activities would likely have less than significant to potentially significant adverse impacts

from fires and explosions. This would potentially result in **disproportionate impacts** on people of color populations or low-income populations.

4.2.5.2 Actions to avoid and reduce impacts

The actions to minimize, reduce, and/or mitigate impacts for green hydrogen storage facilities would be the same as those in Section 4.2.3.2.

4.2.6 Findings for the No Action Alternative

The potential impacts from facilities developed under the No Action Alternative would be similar to the disproportionate impacts on people of color populations and low-income populations identified for the types of facilities described above for construction, operation, and decommissioning.

4.2.7 Unavoidable significant adverse impacts

Green hydrogen facility development could have **disproportionate impacts** on historic and cultural resources, Tribes, and Tribal communities. The impact assessment and determinations of significance or non-significance would be done with engagement and in consultation with potentially affected Tribes and DAHP at the project level.

Impacts associated with fire and explosion risks may be potentially significant and unavoidable. A facility may result in potentially significant and unavoidable adverse impacts related to public services and utilities and environmental health and safety if activities required emergency response in remote locations with limited response capabilities, or if a fire or explosion during operations spreads rapidly or impacts large areas. If a facility is located near people of color populations or low-income populations, this would potentially result in **significant and unavoidable disproportionate impacts** on these populations. Determining if mitigation options would reduce or eliminate impacts below significance would be dependent on the specific project and site.

4.3 Earth resources

Key findings

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the construction, operation, and decommissioning of green hydrogen facilities would likely result in **less than significant adverse impacts** on earth resources (soil and geologic hazards).

No significant and unavoidable adverse impacts related to earth resources would occur.

This section evaluates earth resources, which relate to the region's geologic resources and geologic hazards, referred to as “earth” in this PEIS. The *Earth Resources Technical Appendix* (Appendix D) includes the full analysis and technical details used to evaluate earth resources.

4.3.1 Affected environment

4.3.1.1 Geography and topography

The study area is located within eight of the nine major geological provinces in Washington, each with unique topography, geology, and climate conditions (Figure 4-1). Central Washington is composed of the Cascade Mountain range, which is characterized by higher levels of precipitation on the western side and decreasing amounts of precipitation and vegetation density on the eastern side. Eastern Washington includes the Columbia River basin and plateau, and the Okanogan region in the north, which are generally higher in elevation and more arid. The northern half of the state is also characterized by historic glacial activity. Western Washington is located west of the Cascade Mountain range, with the Olympic Mountains towards the northwestern corner of the state, weathered coastal mountains and beaches south of the Olympic Peninsula, and low-lying areas between the Cascade Mountains and Olympic Mountains also known as the Puget Sound region.

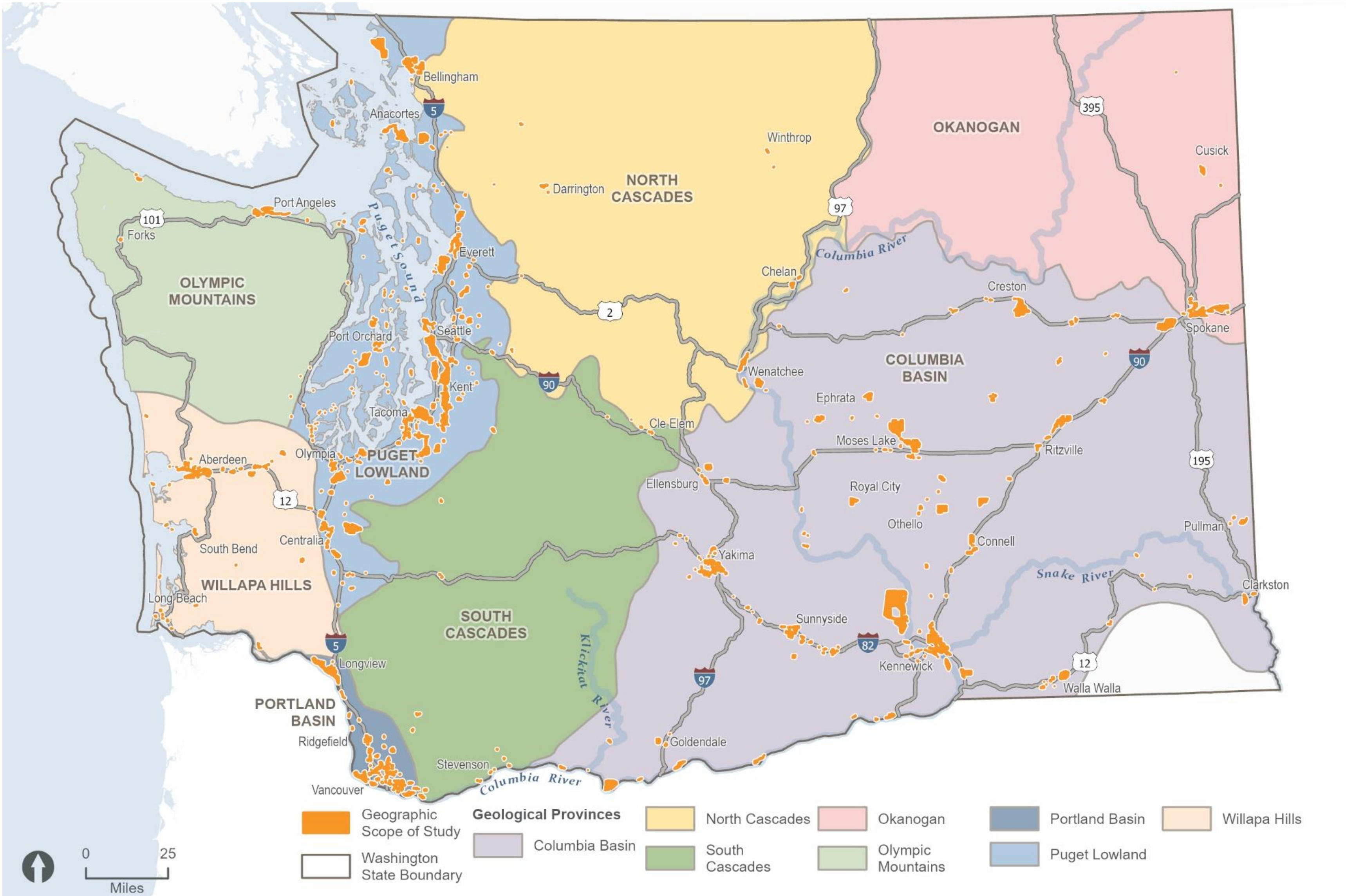

Figure 4-1. Geologic provinces in the study area

4.3.1.2 Surface soils

The formation of soil is a long-term, complex interaction between climate, topography, ecology, and other characteristics of a given area. The study area encompasses several regions of the state that contain sensitive soil structures that play an important role in local ecology and, if disturbed, can take long periods to recover. Soil contains living organisms such as lichens, mosses, microfungi, bacteria, and green algae. The study area includes several regions in Washington that may contain these sensitive soil structures. Studies to identify soil types on a site are expected to be done in researching project sites and during site characterization. On city and county industrially zoned areas or areas zoned to support industrial uses, designated agricultural soils and forest land types are not expected to occur.

4.3.1.3 Geologic hazards

Many regions in the study area are at risk from the following geologic hazards:

- **Fault ruptures** are a physical separation of opposite sides of a fault, which can cause damage to infrastructure.
- **Tsunamis and seiches** are waves caused by rapid displacement of water, generally resulting from seismic events; tsunamis occur in the ocean, and seiches occur in contained bodies of water. Landslide-induced tsunamis may occur within the study area where there are large bodies of water near physical features that could have a sudden movement of soil and rock downhill due to gravity. The potential for tsunami occurrence throughout the study area is widespread near waterbodies.
- **Liquefaction** is an event where water-saturated sediment temporarily loses strength and acts like a fluid. Earthquake hazard maps from the Washington State Department of Natural Resources (DNR) can be used to identify geologically sensitive areas, though areas susceptible to liquefaction may not be sufficiently identified.
- **Volcanic areas** in Washington include Mt. Saint Helens, Glacier Peak, Mt. Rainier, Mt. Adams, Mt. Baker, and Mt. Hood. Effects from an eruption could affect the study area. Effects could include ashfall, lahars (mud or debris flows), lava flows, and pyroclastic flows (fast-moving gas and volcanic matter). Earthquakes caused by volcanoes could also occur.
- **Landslides** are the movement of a mass of rock, debris, or earth down a slope. Landslides can be natural or human-caused, and nature and various ecological factors contribute to an area’s susceptibility. Generally, landslides are associated with areas containing slopes greater than 20%. Mapped landslide features are numerous in the study area.
- **Subsidence** is the gradual settling or sudden sinking of the Earth’s surface due to removal or displacement of subsurface earth materials. Water withdrawals using groundwater sources could cause subsidence; however, water use must meet state law, which considers this effect.
- **Sea-level rise** can increase local flooding, result in saltwater affecting groundwaters, cause coastal erosion, and degrade habitat and ecosystems that can buffer the effects of storms and flood events. Coastal locations throughout the study area may be affected.

4.3.2 How impacts were analyzed

The assessment of impacts was qualitative and considered the impacts described below.

4.3.2.1 Impacts on soil resources

- The potential for soil erosion and accretion to be affected by ground-disturbing activities associated with soil and/or rock excavation, grading, and filling
- The potential impacts caused by construction materials (such as rock, sand, and fill)
- The potential for slope instability from ground-disturbing activities, underground construction, or other activities that could increase local susceptibility to certain geologic hazards
- The potential for subsidence from activities related to tapping, withdrawal, or disturbance of groundwater reserves

4.3.2.2 Impacts from geologic hazards

- The potential for a site to be affected by naturally occurring geologic or seismic hazards
- The potential for a site to be affected by geologic hazards that are influenced or altered by human activity

4.3.3 Findings for green hydrogen production facilities

4.3.3.1 Impacts

Impacts from construction and decommissioning

Soil resources

Site characterization activities done before construction would typically include desktop analysis and feasibility and site studies, as well as site characterization that would result in soil compaction, creation of ruts, and erosion due to the passage of vehicles and equipment. These activities would include site investigation, localized site clearing for subsurface investigation, and limited earthwork associated with test pit excavations, if required. Site grading as well as removal of surface and subsurface materials may be required if existing access routes are unavailable or unsuitable for the equipment. Appropriate demolition considerations would be made during site characterization if existing structures are on the site.

Construction and decommissioning activities for facilities would include excavation, blasting, vegetation removal, and grading for foundations, pilings, and utility and underground service line trenches. Limited excavation and vegetation removal is expected for distribution lines, as they are assumed to be placed in existing road rights-of-way or co-located with existing distribution lines. The stockpiling of site soils, importing of off-site soils, placement and compaction of low-permeability materials, and use of aggregate resources and structural concrete from local suppliers could occur. Impacts associated with these activities would include potential soil compaction, mixing of different layers of soil, surface erosion and runoff, sedimentation of nearby waterways, and soil contamination. The potential loss of vegetation during clearing would reduce the ability of remaining plant root structures to resist the effects of wind and water, resulting in increased soil erosion. The degree of impact from ground-disturbing activities would depend on site-specific factors such as surface soil properties, vegetation density and type, slope angle and extent, distance to waterways or water collection infrastructure, and weather. Stormwater permits would require stormwater pollution prevention plans to address erosion and ensure compliance with state and federal water quality standards.

Construction activities include handling of hazardous materials typical of industrial facility construction, including solids, fluids, and gases that could result in release or spills. A spill could lead to contamination of soil, groundwater, and surface water. BMPs and other preventive measures, including those found under the National Pollutant Discharge Elimination System (NPDES) program, would reduce potential for spills and contamination. Accidents or failures during construction that could result in the release of hazardous materials are rare and are unlikely to happen at a scale that could result in risk of environmental contamination.

In general, impacts during construction would be greater for facilities that require a large footprint or if demolition is required, due to the increased disturbance area and potentially greater number of large vehicles and equipment.

Decommissioning impacts would be similar to construction impacts but would be of lesser intensity and duration because of the availability of previously developed access routes and staging areas. Site restoration activities would include re-establishing native vegetation.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the construction and decommissioning of green hydrogen production facilities would likely result in **less than significant impacts** to soil resources.

Geologic hazards

Green hydrogen production facilities are expected to be built on relatively flat areas, with slopes less than 15%. The effects of geologic hazards during construction are associated with increasing slope instability and landslide risks. Construction activities that can potentially increase this risk include grading that results in steepening of slopes, cutting mid-slope or at the base of a slope (e.g., for an access road or building pad), and alteration of drainage patterns and water infiltration rates. These activities are mainly related to building roads and would increase the potential likelihood of landslides, which would affect surface waters through diversion or sedimentation. Landslides could also affect surrounding buildings, infrastructure, or people.

The potential that regional geologic hazards would occur (e.g., earthquake or volcanic hazards) or local geologic hazards would be triggered (e.g., landslide) during construction or decommissioning for an individual project is low. A geologic event midway through construction or decommissioning could result in collapse of temporary support systems or toppling of unsecured equipment or materials. This would also increase the potential for releases or spills. These types of impacts are further discussed in the *Environmental Health and Safety Technical Appendix* (Appendix I).

Facilities constructed along the coast could experience the results of sea level rise. This could include small changes over time or major events happening periodically. Using groundwater for construction could affect the local water table and potentially cause subsidence. Due to the limited size of the facilities (1 to 10 acres), subsidence would be unlikely to go beyond the facility footprint.

Impacts during decommissioning are similar to impacts during construction.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the construction and decommissioning of green hydrogen production facilities would likely result in **less than significant impacts** from geologic hazards.

Impacts from operation

Soil resources

Operational activities may have increased potential for soil erosion along roads, parking areas, buildings, or other on-site developments. Runoff or wind would result in increased soil erosion. BMPs could reduce and eliminate erosion. Site operations could result in changes to local drainage patterns, and soil may be moved around for maintenance. New or expanded impervious surfaces would create potential for pollutants to enter soils through stormwater discharges or spills and degrade soil resources. Stormwater permits would require stormwater pollution prevention plans to address erosion and ensure compliance with state and federal water quality standards.

Operation and maintenance of green hydrogen production facilities would involve the use and on-site storage of hazardous materials. This would be used and managed according to state and federal law and stored in areas with secondary containment. Electrolysis, SMR, and bio-gasification processes would generate wastewater as part of hydrogen production. All wastewater discharge requires a permit, whether it is disposed to surface or groundwater or to a municipal sanitary sewer. If hydrogen was released, it would become a gas and would not affect soil. Spills would likely be of small quantities and within containment areas or able to be cleaned up.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the operation of green hydrogen production facilities would likely result in **less than significant impacts** on soil resources.

Geologic hazards
A green hydrogen production facility is required to be designed to withstand earthquakes. If earthquake ground shaking intensity were to exceed design standards, damage to facility infrastructure may occur. Additionally, ground shaking may dislodge or topple materials stored on site, which could result in a fluid release or spill. A tsunami or seiche could cause flooding, erosion, and debris that could damage facilities and corrode materials.

There is a potential for volcanic flows to affect facilities located in the pathways. An extensive seismic activity monitoring network has been installed at active volcano sites throughout the region to provide advance warning of a potential volcanic eruption, which may allow for safe relocation of select equipment and personnel. Ashfall hazards on a facility may include general accumulation and potential corrosion of surfaces, damage to ventilation systems, damage to site equipment and electronics, and temporarily reduced or suspended operations. The impacts associated with ashfall on a facility are highly dependent on wind conditions.

While it is possible to avoid mapped landslide hazards during siting, the potential exists for sloughing of near-surface soils on cut and fill slopes during sustained or extreme rainfall events. Such instances would require maintenance activity to clean up and repair slopes but are not expected to result in damage to a facility or impair general facility operation.

Sea level rise could affect operation and maintenance requirements over the lifetime of the facility.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the operation of green hydrogen production facilities would likely result in **less than significant impacts** from geologic hazards.

4.3.3.2 Actions to avoid and reduce impacts

The section below includes actions to avoid and reduce impacts of green hydrogen production facilities. See Appendix D, *Earth Resources Technical Appendix*, for a more detailed list of actions to avoid and reduce impacts, including typical BMPs and actions that may be included in plans or permit conditions and additional measures.

Siting and design considerations

- Conduct detailed geotechnical engineering, soil, and hydrologic studies to characterize site conditions.
- Avoid geologic hazards and hazard areas such as mapped landslide hazard areas, surface fault rupture hazard areas, and volcanic flow hazard areas.
- Select sites with minimal impacts on soil health and stability to avoid soil erosion and compaction.
- Prioritize locations with suitable topography and soil characteristics to minimize the need for extensive land grading and excavation, thereby reducing soil disturbance. By

focusing on sites with more gentle slopes, developers could mitigate erosion risks and preserve soil stability because steep slopes are more prone to soil erosion and landslides.

- Select areas with favorable soil characteristics, such as well-drained soils with good permeability, to minimize soil disturbance during construction activities by reducing the likelihood of soil compaction and waterlogging. These soil properties facilitate efficient water infiltration and drainage, mitigating erosion risks and preserving soil structure and fertility throughout the facility's life cycle.
- Design facilities to account for current seismic design parameters and building codes, including the latest version of the International Building Code and American Society of Civil Engineers Minimum Design Loads and Associated Criteria for Buildings and Other Structures 7-10[42] and 7-16[43].
- Limit construction of new roads. Design new roads based on federal, state, and county requirements; and local climate conditions, soil moisture, and erosion potential.
- Identify the level of seismic design, material types, and development strategies needed, based on the potential risk of earthquakes.

4.3.4 Findings for production facilities with co-located BESS

4.3.4.1 Impacts

Environmental impacts from facilities with BESSs would be similar to the impacts considered for facilities without BESSs related to site characterization, construction, operation, and decommissioning. Specific differences are summarized in the following sections.

Impacts from construction, operation, and decommissioning

Soil resources

A BESS requires storage facilities, spill containment, additional electrical infrastructure, and operational management systems. This means a larger overall footprint and more soil disturbance during construction.

State regulations require fire and spill containment measures for lithium-ion batteries (WAC 51-54A-0322 and 51-54A-1207). Although the likelihood is remote, in the event of a BESS failure, there is a risk of environmental contamination to soil. Emergency response would not typically use water for battery fires, so soil contamination would be limited to the BESS site. Cleanup actions include removal and proper disposal of contaminated soils. Decommissioning of BESS components may need soil testing to determine if contamination has occurred. If contamination is identified, soil remediation efforts would be necessary.

[42] https://ascelibrary.org/doi/book/10.1061/9780784412916
[43] https://sp360.asce.org/personifyebusiness/Merchandise/Product-Details/productId/233133882

Geologic hazards

The risk of impacts from ashfall would increase for facilities with co-located BESSs. Impacts would include equipment vulnerability due to ash particle infiltration, insulation challenges from ash accumulation, and air intake blockages affecting cooling systems.

> *Findings*
> Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the construction, operation, and decommissioning of facilities would likely result in **less than significant impacts** on earth resources.

4.3.4.2 Actions to avoid and reduce impacts

Actions for reducing impacts from green hydrogen production facilities with a co-located BESS include those identified for facilities without a co-located BESS.

4.3.5 Findings for green hydrogen storage facilities

4.3.5.1 Impacts

Environmental impacts from green hydrogen storage facilities (gas or liquid form) would be similar to the impacts considered for production facilities related to site characterization, construction, operation, and decommissioning. Hydrogen released from either type of storage would become gaseous and would not impact soil resources.

> *Findings*
> Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the construction, operation, and decommissioning of facilities would likely result in **less than significant impacts** on earth resources.

4.3.5.2 Actions to avoid and reduce impacts

Actions for reducing impacts from green hydrogen storage facilities include those identified for green hydrogen production facilities.

4.3.6 Findings for the No Action Alternative

The potential impacts from facilities developed under the No Action Alternative would be similar to the impacts from the types of facilities described above for construction, operation, and decommissioning, depending on facility size and design, and would be **less than significant.**

4.3.7 Unavoidable significant adverse impacts

Through compliance with laws and permits, and with implementation of measures to avoid and mitigate significant impacts, green hydrogen facilities would have **no significant and unavoidable adverse impacts** on earth resources from construction, operation, or decommissioning.

4.4 Air quality and greenhouse gases

Key findings

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the construction, operation, and decommissioning of facilities would likely result in **less than significant impacts** on air quality.

Life-cycle greenhouse gas (GHG) emissions for green hydrogen production will vary based on the production method and source of energy. The life-cycle amount of carbon dioxide equivalent emitted for production of 1 kilogram (kg) of hydrogen is:

- Electrolysis using average grid electricity in Washington: 12.19 kg CO_2e/kg H_2 produced
- Electrolysis using renewable energy for electricity: 0.40–4.83 kg CO_2e/kg H_2 produced
- SMR using renewable feedstock from landfills (i.e., landfill gas): negative 51.40–11.13 kg CO_2e/kg H_2 produced
- Pyrolysis using renewable feedstock from landfills: 11.13 kg CO_2e/kg H_2 produced
- Bio-gasification using biomass feedstock: negative 1.00–1.70 kg CO_2e/kg H_2 produced

Facilities with a co-located BESS could have additional life-cycle GHG emissions of 1.1 to 1.7 kg of CO_2e per kilowatt-hour (kWh) of delivered electricity. Life-cycle GHG emissions from liquid H2 storage facilities would emit an estimated 5.01 kg CO_2e per kg H_2 liquefied and stored. Liquefaction equipment and liquid hydrogen storage would emit an estimated maximum of 18,292 MT of CO_2e per year.

In general, per kg of hydrogen produced, electrolysis using all renewable energy sources for electricity would have the lowest amount of life-cycle GHG emissions. Impacts from electrolysis, SMR, pyrolysis, bio-gasification production and storage would range from **less than significant impacts to potentially significant adverse impacts** on life-cycle GHG emissions.

Electrolysis using fossil fuel as a source of electricity, SMR, pyrolysis, and bio-gasification production may have **significant unavoidable adverse impacts** on life-cycle GHG emissions. Determining if mitigation options would reduce or eliminate impacts below significance would be dependent on the specific project and site.

Air quality refers to the condition of the breathable air and the presence of pollutants or particles. The *Air Quality and Greenhouse Gases Technical Appendix* (Appendix E) includes the full analysis and technical details used to evaluate air quality and GHGs in this PEIS.

4.4.1 Affected environment

Pollutants can be local and affect a small area, or regional, such as ozone. Pollutants are regulated under state and federal laws. National Ambient Air Quality Standards (NAAQS) and Washington Ambient Air Quality Standards are established for common “criteria pollutants.” In general, if potential emissions from stationary sources exceed certain thresholds, they must get a Notice of Construction permit before beginning construction. The following common criteria pollutants have standards set by the U.S. Environmental Protection Agency (EPA):

- Particulate matter smaller than 10 microns in diameter (PM_{10})
- Particulate matter smaller than 2.5 microns in diameter ($PM_{2.5}$)
- Ozone
- Sulfur dioxide (SO_2)
- Nitrogen dioxide
- Carbon monoxide (CO)
- Lead

Existing industrial uses within the study area may include facilities and activities with associated air emissions, such as manufacturing facilities, ports, refineries, and airports. Stationary sources of air emissions include boilers, industrial processes (e.g., chemical production, energy production, waste treatment), incinerators, generators, and chemical and fuel storage tanks. Mobile sources of air emissions include internal combustion engines in generators, vehicles, equipment, aircraft, trains, vessels, and vehicles traveling within or near industrial areas.

Almost all areas in Washington State currently meet the NAAQS set by EPA for criteria pollutants. There is only one exception (called a "nonattainment" area): the area around the Intalco Aluminum Smelter in Whatcom County is not currently meeting the NAAQS for SO_2.[44] A few areas in Washington are in "maintenance" status, meaning that they currently meet the NAAQS but have not demonstrated continued compliance for 20 years. Those areas and their associated maintenance pollutants are:

- **CO:** Vancouver, Seattle-Tacoma, Spokane, and Yakima
- **PM_{10}:** Kent, Seattle, Tacoma, Olympia, Tumwater, Lacey, Wallula, Spokane County, and Yakima County
- **$PM_{2.5}$:** Tacoma

The Tri-Cities area (Kennewick, Pasco, and Richland) is an area of concern for ozone. Sunnyside, Toppenish, Yakima, Omak, and Colville are all areas of concern for particulate matter, along with Omak in the north and Colville in the northeast.

In addition to criteria pollutants, 188 pollutants are designated as hazardous air pollutants (HAPs) by EPA and 21 pollutants are designated as toxic air pollutants (TAPs) by Ecology. HAPs and TAPs can be emitted from industrial processes, burning of fossil fuels in power plants, industrial boilers, and vehicles, and from waste treatment and incineration.

[44]The EPA is considering a proposal requesting a redesignation of Whatcom County SO_2 nonattainment area, which could determine Whatcom County (partial) SO_2 NAA is attaining the 2010 SO_2 primary NAAQS; approve Washington's plan for maintaining attainment of the 2010 SO_2 primary NAAQS in the area; and redesignate the Whatcom County (partial) SO_2 NAA to attainment for the 2010 1-hour primary SO_2 NAAQS (Docket ID No. EPA-R10-OAR-2024-0371).

Regulatory programs are in place to ensure that air pollution levels do not increase to concentrations that threaten air quality. Any new industrial sources of air pollution must receive an air quality permit prior to operation.

Gases that trap heat in the atmosphere are referred to as GHGs because they capture heat radiated from the sun as it is reflected back into the atmosphere from the Earth, like a greenhouse does. Increasing amounts of GHGs trap more solar radiation and decrease the amount that is reflected back into the atmosphere, resulting in an increased global average temperature and climate change impacts to people and the environment. The Washington Legislature set new GHG emission limits (RCW 70A.45.020) to combat climate change. By 2050, the state must achieve net zero GHG emissions. CETA requires all electric utilities in Washington to be 100% carbon-free electricity by 2045.

The single most dominant GHG emitted into the atmosphere is carbon dioxide (CO_2). In addition to CO_2, the principal GHGs include methane (CH_4) and nitrous oxide (N_2O). Other, less common GHGs include hydrofluorocarbons (HFCs), chlorofluorocarbons (CFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). GHG emissions are typically reported as MT of carbon dioxide equivalent. Carbon dioxide equivalent, or CO_2e, is the number of MT of CO_2 emissions with the same global warming potential as 1 MT of another greenhouse gas. In 2019, Washington produced approximately 102.1 million MT of CO_2e. Transportation is the largest source, at 40% of the state's GHG emissions, followed by residential, commercial, and industrial energy use at 31%, and electricity consumption at 21%. The remaining 8% of emissions are from agriculture, waste management, and industrial processes.

Although hydrogen is not a GHG, hydrogen emissions are evaluated in the PEIS because hydrogen in the atmosphere may extend the lifetime of some GHGs.

4.4.2 How impacts were analyzed

This analysis evaluates how green hydrogen facilities could affect air quality and contribute to GHG emissions. Projected emissions from each facility phase were compared to state and federal laws, policies, guidance, and permitting thresholds for context and to evaluate impacts.

In most cases, air emissions were estimated for range based on likely facility sizes. The California Emissions Estimator Model was used to calculate the estimated emissions from construction. Where data was available, emission factors were used to estimate emissions from green hydrogen production and storage. An emission factor equals the mass of a pollutant emitted per mass of hydrogen produced or stored. These vary because emissions depend on the type of equipment and technology being used.

Argonne National Laboratory's Greenhouse gases, Regulated Emissions, and Energy use in Technologies (GREET) model was used to identify emission factors for green hydrogen production technologies for the following air pollutants: volatile organic compounds (VOCs), NO_X, CO, SO_X, PM_{10}, $PM_{2.5}$, CO_2, CH_4, and N_2O.

For life-cycle GHG emissions, life-cycle GHG emissions factors published in life-cycle assessment (LCA) studies and carbon intensity values published in WAC 173-424-900 using the Washington Greenhouse gases, Regulated Emissions, and Energy use in Technologies (WA-GREET) model were used to identify probable CO_2e emissions from 1 kg of hydrogen produced using the different production methods. LCA studies cover on-site, upstream, and downstream emissions from resource extraction to use or disposal. These are provided for context. Upstream and downstream emissions considered in LCA studies include emissions from extracting raw materials; manufacturing facility components; generating the electricity used at the facility; transporting goods and employees; constructing, operating, maintaining, and decommissioning the facility; disposal; end-uses of green hydrogen; and hydrogen leakage. Because the overall GHG emissions will vary based on the production method used, source of energy for production, and use of hydrogen, a project-level analysis would be required to assess life-cycle GHG emissions.

4.4.3 Findings for green hydrogen production facilities

4.4.3.1 Impacts

Air quality impacts from construction and decommissioning

Air quality emissions associated with construction and decommissioning activities would be generated by construction equipment (e.g., bulldozers, pavers, excavators/loaders, cranes, portable concrete batch plants, generator sets), haul-truck trips, on-road worker trips, vehicle travel on paved and unpaved surfaces, and fugitive dust from soil/material handling activities. These would be the same, regardless of the production method used at the facility. Estimated emissions for 1-acre and 10-acre facilities are provided in Table 4-1. Air emissions associated with decommissioning activities are expected to be similar to or less than the emissions generated from construction. Based on estimated emissions for facility construction, air quality emissions from construction and decommissioning are not expected to exceed criteria pollutant thresholds.

Table 4-1. Estimated annual maximum criteria pollutant emissions from construction (tons/year)

Construction scenario	VOC	NO_X	CO	SO_2	PM_{10}	$PM_{2.5}$
1-acre facility	0.32	0.82	1.08	<0.01	2.63	0.36
10-acre facility	2.45	1.58	2.51	<0.01	10.84	1.35
Threshold	100	100	100	100	100	100
Exceeds threshold?	No	No	No	No	No	No

Note: Emissions for each construction scenario were calculated using the California Emissions Estimator Model. Methodology and detailed emissions results are included in Appendix E, *Air Quality and Greenhouse Gases Technical Appendix*.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the construction and decommissioning of facilities would likely result in **less than significant impacts** on air quality.

Air quality impacts from operation

Vehicles and maintenance equipment/machinery

During operation, vehicles, equipment, and machinery used at the facility would generate emissions similar to those discussed for construction. These would be the same regardless of the type of production method used. There would be one to three employees, and the use of vehicles and maintenance equipment/machinery would be on a smaller scale than during construction. Therefore, activities during operation would result in fewer emissions than facility construction.

Building heating and cooling

Heating and cooling systems would be required for administrative, storage, and other indoor areas. The types of emissions specifically from heating and cooling buildings (not heating and cooling related to hydrogen production) would be the same, regardless of the type of production method used. If heating or cooling is electric-powered, no criteria air pollutant, HAP, or TAP emissions would be expected. Table 4-2 shows estimated annual criteria air pollutant, HAP, and TAP emissions from natural gas-fired boilers. Emissions from operation of facility heating and cooling systems would not exceed air quality thresholds.

Table 4-2. Estimated annual criteria pollutant emissions from industrial natural gas boiler operation (tons/year)

Facility size	Boiler capacity (MMBtu)	VOC	NO_X	CO	SO_X	PM_{10}	$PM_{2.5}$
Small	1	<0.01	0.07	0.06	<0.01	0.01	0.01
Medium	5	0.02	0.36	0.30	<0.01	0.03	0.03
Large	10	0.04	0.71	0.60	<0.01	0.05	0.05
Threshold	N/A	100	100	100	100	100	100
Exceeds threshold?	N/A	No	No	No	No	No	No

Note: Emissions calculated for natural gas-fired boiler operations at 1,500 hours per year. Methodology and emissions calculations are included in Appendix E, *Air Quality and Greenhouse Gases Technical Appendix*. MMBtu = metric million British thermal units.

Hydrogen production

Emissions from green hydrogen production vary by production method. The sections below describe air quality emissions from electrolysis, SMR, pyrolysis, and bio-gasification. Types and quantities of air emissions from the green hydrogen production process depend on the source and chemical composition of the feedstock (e.g., proportion of CH_4, CO_2, and other trace gases), operational conditions, and hydrogen production capacity of the facility. The emissions shown in this section are estimates based on the facility types analyzed.

Electrolysis

Producing hydrogen via electrolysis does not emit any direct criteria air pollutants, HAPs, or TAPs. Oxygen is the only byproduct. However, the electricity that would be used for electrolysis have GHG emissions depending on the types of energy source used for electricity generation, which would be analyzed as part of the project-specific life-cycle GHG analysis.

SMR of renewable natural gas

Emissions from the SMR process occur from the reformation of CH_4 to produce hydrogen using high heat, which could result in the release of CO_2, CO, CH_4, NO_X, and potential sulfur compounds and particulate matter. GHG emissions are included in the life-cycle analysis in the next section. Table 4-3 includes estimated emissions for the range of SMR facilities. Emissions from SMR facilities are not expected to exceed air quality thresholds for criteria pollutants. Depending on the capacity and size of the boilers and flares used in the SMR process, there is potential for the air quality thresholds for HAPs and TAPs to be exceeded. SMR facilities would be required to operate in a way that keeps their HAP and TAP emissions below applicable thresholds, which could include use of clean fuels, implementation of emissions control systems, high-efficiency combustion, and best practices.

Table 4-3. Estimated annual criteria pollutant emissions from SMR (tons/year)

Facility capacity	VOC	NO_X	CO	SO_X	PM_{10}	$PM_{2.5}$
2,000 kg H_2/day facility	0.17	0.55	0.20	0.01	0.23	0.23
100,000 kg H_2/day facility	8.73	27.34	10.05	0.31	11.48	11.28
Threshold	100	100	100	100	100	100
Exceeds threshold?	No	No	No	No	No	No

Note: Assumes facility operation at 365 days per year. kg H_2 = kilogram of hydrogen.

Pyrolysis of renewable natural gas or biomass

The primary byproduct of hydrogen production via pyrolysis is solid carbon, but the process also produces some air emissions. These are from auxiliary equipment and the thermal decomposition of biomass. Table 4-4 shows estimated emissions for the range of pyrolysis facilities. Emissions from hydrogen production through pyrolysis are not expected to exceed air quality thresholds for criteria pollutants. Depending on the feedstock quantities required for the pyrolysis reaction, there is potential for the air quality thresholds for HAPs and TAPs to be exceeded. Pyrolysis facilities would be required to operate in a way that keeps their HAP and TAP emissions below applicable thresholds, which could include emissions control systems, high-efficiency combustion of feedstock, and best practices.

Table 4-4. Estimated annual criteria pollutant emissions from pyrolysis (tons/year)

Facility capacity	NO_X	CO
5,000 kg H_2/day facility	0.03	0.01
10,000 kg H_2/day facility	0.07	0.03
Threshold	100	100
Exceeds threshold?	No	No

Note: Assumes facility operation at 365 days per year. Emissions for other pollutants (VOC, SO_X, and particulate matter) would be less than those shown for CO and NO_X and would be considered negligible.

Bio-gasification

Emissions from the bio-gasification process occur from the incomplete combustion of biomass, which can result in emissions of CO, CO_2, CH_4, and VOCs. Emissions can also include particulate matter, sulfur compounds, and NO_X. Table 4-5 shows estimated emissions for the range of bio-gasification facilities. Emissions from hydrogen production through bio-gasification are not expected to exceed air quality thresholds for criteria pollutants. As with pyrolysis, there is a potential for the air quality thresholds for HAPs and TAPs to be exceeded depending on the feedstock quantities required for the bio-gasification process. As identified for pyrolysis, bio-gasification facilities would be required to operate in a way that keeps their HAP and TAP emissions below applicable thresholds, which could include emissions control systems, high-efficiency combustion of feedstock, and best practices.

Table 4-5. Estimated annual criteria pollutant emissions from bio-gasification (tons/year)

Facility capacity	VOC	NO_X	CO	SO_X	PM_{10}	$PM_{2.5}$
50,000 kg H_2/day facility	0.30	11.24	2.64	37.55	0.42	0.42
100,000 kg H_2/day facility	0.60	22.49	5.27	75.10	0.83	0.83
Threshold	100	100	100	100	100	100
Exceeds threshold?	No	No	No	No	No	No

Note: Assumes facility operation at 365 days per year.

Operation impact summary

Actual annual emissions from green hydrogen production projects may differ from the values presented above due to variable and project-specific design characteristics. Annual emissions would be calculated at the project level based on its unique design prior to the permitting process and facility operations.

Findings

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, operations activities would likely result in **less than significant impacts** on air quality.

GHG emissions over the lifetime of a facility

For electrolysis, the GHG emissions would depend on the types of energy sources used for electricity generation. This is analyzed as part of the life-cycle GHG analysis.

GHG emissions from construction and decommissioning

During construction, GHG emissions would be produced primarily from internal combustion engines such as those found in gas and diesel-powered vehicles and equipment, and generators. It was estimated that construction would produce an annual maximum of between 202.8 and 689 MT CO_2e per year. Estimated CO_2e emissions from facility construction would be between approximately 0.0002% and 0.0007% of recorded CO_2e emissions in 2019 for the state. GHG emissions associated with decommissioning activities would be similar to the emissions generated from construction with the addition of emissions from landfill waste.

GHG emissions from facility operation

During operation, the number of on-site employees and vehicles/equipment during operation would be on a smaller scale than during construction; therefore, GHG emissions from vehicles, non-road equipment, and machinery would be less than those estimated for construction. It was estimated that GHG emissions from boilers used to heat administrative, storage, and other indoor areas during operation would be between 78.28 and 787.98 MT CO_2e per year.

Direct GHG and hydrogen emissions can be produced directly from the hydrogen production process, from equipment operated to directly support the hydrogen production process, or from leaks in hydrogen production machinery and equipment. Estimated direct annual GHG emissions from hydrogen production for the range of facilities are listed in Table 4-6. These emissions do not include the GHG emissions that may occur from auxiliary operations at a green hydrogen production facility, such as from vehicles, non-road equipment, and machinery, and from natural gas boiler operation, which is described above. The GHG emissions listed in Table 4-6 do not include emissions from upstream or downstream processes. Based on the probable emissions that could be produced directly from the hydrogen production process, the following GHGs are expected from the green hydrogen production methods:

- Electrolysis: 0.00 kg CO_2e/kg H_2 produced
- SMR: 10.83 kg CO_2e/kg H_2 produced
- Pyrolysis: 0.18 kg CO_2e/kg H_2 produced
- Bio-gasification: 26–60 kg CO_2e/kg H_2 produced

Table 4-6. Estimated direct annual GHG emissions from hydrogen production process (MT/year)

Facility capacity	CO_2e	Hydrogen
Electrolysis		
Lower bound – 1,000 kg H_2/day	None	0.37–14.60
Upper bound – 9,000 kg H_2/day	None	3.29–131.40
SMR		
Lower bound – 2,000 kg H_2/day	7,903.60	3.65–7.30
Upper bound – 100,000 kg H_2/day	395,179.78	182.50–365.00
Pyrolysis		
Lower bound – 5,000 kg H_2/day	336.56	N/A
Upper bound – 10,000 kg H_2/day	673.11	N/A
Bio-gasification		
Lower Bound – 50,000 kg H_2/day	474,500.00–1,095,000.00	182.50–365.00
Upper bound – 100,000 kg H_2/day	949,000.000–2,190,000.00	365.00–730.00

Note: Assumes facility operation at 365 days per year. N/A = not available.

The maximum GHG emissions that could be directly produced from any hydrogen production process would be from bio-gasification, which was estimated to produce up to 2,190,000 MT of CO_2e per year under an upper bound (100,000 kg H_2/day) production scenario. Estimated CO_2e emissions from green hydrogen production under this scenario would be as high as approximately 2% of the statewide CO_2e emissions recorded for 2019.

Direct GHG emissions are produced from SMR, pyrolysis, and bio-gasification. Electrolysis does not directly produce GHGs. Siting and design considerations, such as those listed in Section 4.4.3.2, could be implemented to reduce the potential for GHG emissions and reduce the effects from green hydrogen production on climate change. Net GHG emissions over the entire lifetime of the production process are captured as life-cycle GHG emissions, which are summarized below.

Life-cycle GHG emissions

Life-cycle GHG emission factors were derived from published LCA studies and WA-GREET carbon intensity values published in WAC 173-424-900. Life-cycle GHG emissions account for both direct and indirect (i.e., upstream and downstream) emissions:

- Electrolysis using average grid electricity in Washington: 12.19 kg CO_2e/kg H_2 produced
- Electrolysis using renewable energy for electricity: 0.40–4.83 kg CO_2e/kg H_2 produced
- SMR using renewable feedstock from landfills (i.e., landfill gas): negative 51.40–11.13 kg CO_2e/kg H_2 produced
- Pyrolysis using renewable feedstock from landfills: 11.13 kg CO_2e/kg H_2 produced
- Bio-gasification using biomass feedstock: negative 1.00–1.70 kg CO_2e/kg H_2 produced
- Liquid storage facilities: 5.01 kg CO_2e/kg H_2 liquefied and stored

Estimated annual life-cycle GHG emissions from hydrogen production for the range of facilities are listed in Table 4-7. For green hydrogen production through electrolysis and SMR, the life-cycle GHG estimates could be more than those estimated for green hydrogen facility operation alone in Table 4-6, which is likely attributable to electricity generation and feedstock production.

For green hydrogen production through bio-gasification, life-cycle GHG estimates would be less than those estimated for green hydrogen production alone. It was estimated that direct GHG emissions from the bio-gasification process could be up to 2.19 million MT of CO_2e per year under an upper-bound (100,000 kg H_2/day) production scenario. The high rate of direct GHG emissions can be attributed the release of carbon from the biomass, which is converted into CO_2 during gasification. Lower life-cycle GHG emissions for bio-gasification can be attributed to carbon capture technology, which can reduce CO_2 emissions by more than 90%; use of biomass feedstock for energy, which displaces the need for other forms of energy (e.g., natural gas, grid electricity); and consideration for the uptake of CO_2 during biomass production, or the storage of CO_2 in biomass as part of the carbon cycle.

Table 4-7. Estimated annual LCA GHG emissions from hydrogen production (MT/year)

Green hydrogen production method	Life-cycle CO_2e (MT/year)
Electrolysis using average grid electricity in Washington	
Lower bound – 1,000 kg H_2/day	4,449
Upper bound – 9,000 kg H_2/day	40,044
Electrolysis using renewable energy for electricity	
Lower bound – 1,000 kg H_2/day	146 to 1,763
Upper bound – 9,000 kg H_2/day	1,314 to 15,867
SMR using renewable feedstock from landfills	
Lower bound – 2,000 kg H_2/day	-37,522 to 8,125
Upper bound – 100,000 kg H_2/day	-1,876,100 to 406,245
Pyrolysis using renewable feedstock from landfills	
Lower bound – 5,000 kg H_2/day	20,312
Upper bound – 10,000 kg H_2/day	40,625
Bio-gasification using biomass feedstock	
Lower bound – 50,000 kg H_2/day	-730 to 1,241
Upper bound – 100,000 kg H_2/day	-36,500 to 62,050

Note: Assumes facility operation at 365 days per year.

For context, Table 4-8 shows a comparison of estimated life-cycle CO_2e emissions from coal, natural gas, and hydrogen electricity generation technologies in terms of kWh produced or stored.

Table 4-8. Comparison of estimated annual LCA GHG emissions from coal, natural gas, and hydrogen electricity generation technologies

Hydrogen production capacity (kg H_2/day)	kWh equivalent (kWh)[a]	CO_2e (MT/yr)		
		Coal – electricity generation	Natural gas – electricity generation	Hydrogen fuel cell storage
1,000	39,400	14,395.381	546.478	0.004
10,000	394,000	143,953.810	5,464.780	0.041
100,000	3,940,000	719,769.050	27,323.900	0.205

Note:
Assumes facility operation at 365 days per year.
a. The energy content of 1 kg of hydrogen is equal to 141.9 megajoules (higher heating value), or 39.4 kWh.

Findings
Impacts from electrolysis, SMR, pyrolysis, and bio-gasification production would likely have **less than significant to potentially significant adverse impacts** on GHG emissions. The potential for GHG emissions and effects from green hydrogen production on climate change could be reduced based on siting and design considerations.

4.4.3.2 Actions to avoid and reduce impacts

The following subsections list some actions to avoid and reduce impacts of green hydrogen facilities. See Appendix E, *Air Quality and Greenhouse Gases Technical Appendix*, for typical mitigation measures that may be included in plans or permit conditions and additional measures that may apply for facilities.

Siting and design considerations

- Design project to minimize use of fossil fuels and maximize renewable energy sources to reduce GHG and air emissions.
- Design facilities and processes with energy-efficient technologies, such as high-efficiency heating, ventilation, and air conditioning systems, energy-efficient lighting, and improved insulation.
- Consider options to reduce embodied carbon when selecting construction and operations materials and equipment.
- Surface access roads, on-site roads, and parking lots with aggregate with hardness sufficient to prevent vehicles from crushing the aggregate and causing dust or compacted soil conditions. Paving could also be used on access roads and parking lots.
- Optimize the hydrogen production process and implement advanced process controls to increase efficiency, reduce waste, and minimize energy use to lower potential CO_2e emissions.

Additional mitigation measures

- Develop a mitigation plan to reduce the amount of GHGs in the atmosphere. The plan could include offset projects, which must result in GHG reductions that are real, permanent, quantifiable, verifiable, and enforceable.

4.4.4 Findings for production facilities with co-located BESS

4.4.4.1 Impacts

Impacts from construction, operation, and decommissioning

Air emissions for construction, operation, and decommissioning of facilities with a co-located BESS would be slightly higher than the impacts considered for facilities without BESSs described in Section 4.4.3.1. Estimated emissions from construction of a 2.85-MW BESS are shown in Table 4-9, and when combined with the estimated emissions from green hydrogen facility construction, are not expected to the thresholds listed in Section 4.4.2. No emissions of criteria air pollutants, HAPs, TAPs, hydrogen, or GHGs other than those related to refrigerants (e.g., CFCs, HFCs, PFCs, or SF_6) are expected from BESS operation. Therefore, operation of a facility with a co-located BESS would generate emissions similar to those analyzed for facilities without a BESS.

If a thermal runaway event due to damage or a battery management system failure were to occur for facilities with lithium-ion BESS, there could be risk of hazardous air emissions that include toxic gases. Hazardous material risks from green hydrogen facilities and BESS are addressed further in Section 4.8, Environmental health and safety.

Table 4-9. Estimated construction emissions for green hydrogen production facility with co-located BESS (tons/year)

Construction type	VOC	NO_X	CO	SO_2	PM_{10}	$PM_{2.5}$
2.85-MW BESS	0.02	0.21	0.10	0.01	0.01	<0.01
Lower-bound facility (1 acre) and 2.85-MW BESS	0.34	1.0	1.18	0.01	2.64	0.36
Upper-bound facility (10 acres) and 2.85-MW BESS	2.47	1.79	2.61	0.01	10.85	1.35
Threshold	100	100	100	100	100	100
Exceeds threshold?	No	No	No	No	No	No

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, construction, operation, and decommissioning of facilities with co-located BESS would likely result in **less than significant impacts** on air quality.

GHG life-cycle assessment
The GHG emissions for facilities with a co-located BESS would be greater than the range described in Section 4.4.3.1, with the addition of upstream and downstream LCA emissions from the BESS. The lifecycle emissions factor for 1 kWh of delivered electricity from a lithium-ion BESS have been estimated at 1.1 to 1.7 kg (0.0011 to 0.0017 MT) CO_2e. The BESS at a green hydrogen facility would provide backup energy for facility operations or could be used as additional energy storage to balance loads from renewable resources with the demand of green hydrogen production. Based on delivering 2.85 MW of electricity for 4 hours, or 11.4 MW hours (11,400 kWh), the BESS would be between 12.54 and 19.38 MT of CO_2e each time the total energy capacity of the BESS is delivered.

Findings
GHG life-cycle emissions for a facility with co-located BESS could include an additional 1.1 to 1.7 kg of CO_2e per kWh of delivered electricity. These impacts on GHG emissions are similar to those from production facilities without a co-located BESS and would likely have **less than significant to potentially significant adverse impacts**. The potential for GHG emissions and effects from green hydrogen production on climate change could be reduced based on actions to avoid and reduce impacts.

4.4.4.2 Actions to avoid and reduce impacts

Actions for reducing air and GHG-related impacts for production facilities with co-located BESS would be the same as those identified for facilities without a BESS.

4.4.5 Findings for green hydrogen storage facilities

4.4.5.1 Impacts

Impacts from construction, operation, and decommissioning
Air emissions resulting from construction and decommissioning of green hydrogen storage facilities would be similar to those for green hydrogen production facilities described in Section 4.4.3.1. Operational differences in air quality and GHG emissions for storage facilities are described below.

No emissions of GHGs, criteria air pollutants, HAPs, or TAPs are expected from operation of compression equipment or gaseous hydrogen storage, assuming that compression equipment would be electric-powered. The only potential emissions from the use of compression equipment and gaseous storage are hydrogen emissions. Hydrogen can leak through compressor seals, through on-site pipeline connections, and during transportation. The leakage rate is estimated to be 0.3% during liquefaction, 1.5% during transportation and distribution, and 3% during liquid hydrogen storage, resulting in an overall hydrogen leakage rate of 4.86% for liquefied hydrogen.

The amount of hydrogen emissions would depend on the facility's storage capacity and the quality of compression equipment. Based on a hydrogen leakage rate of 4.86% per day, a typical 1,000 kg gaseous storage may result in hydrogen leakage of up to approximately 19.6 tons per year.

Emissions from operation of liquefaction equipment may include criteria pollutants, GHG, and hydrogen emissions. Assuming liquefaction equipment is electric-powered, no HAP or TAP emissions would be expected. The only potential emissions from liquid hydrogen storage are hydrogen emissions and emissions related to leakage of refrigerants (e.g., CFCs, HFCs, PFCs, or SF6). Table 4-10 shows estimated annual air emissions from liquefaction for select capacities. Emissions from liquefaction are not expected to exceed the thresholds listed in Section 4.4.2.

Table 4-10. Estimated annual emissions from green hydrogen liquefaction

Liquefaction capacity (kg/day)	VOC (tpy)	NO_X (tpy)	CO (tpy)	SO_2 (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	CO_2e (MT/year)	Hydrogen (MT/year)
5,000	1.14	7.15	4.04	5.98	1.03	0.58	9,145.88	5.62
10,000	2.07	14.30	8.08	11.96	2.07	1.17	18,291.75	11.23
Threshold	100	100	100	100	100	100	N/A	N/A
Exceeds threshold	No	No	No	No	No	No	N/A	N/A

Note: Emissions calculated for liquefaction operations at 365 days per year. tpy = tons per year.

Findings

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, construction, operation, and decommissioning activities associated with gaseous or liquid green hydrogen storage facilities would likely result in **less than significant impacts** on air quality.

GHG life-cycle assessment

As shown in Table 4-10, GHG emissions from liquefaction equipment could add up to an estimated 18,292 MT of CO_2e per year.

Findings

Life-cycle GHG emissions from liquefaction equipment could add up to an estimated 18,292 MT of CO_2e per year. Impacts for hydrogen storage would range from **less than significant impacts to potentially significant adverse impacts** on life-cycle GHG emissions. Add-on pollution control technologies could reduce the life-cycle GHG emissions produced at a storage facility and offsets could be used to reduce the amount of GHGs in the atmosphere.

4.4.5.2 Actions to avoid and reduce impacts

Available means of reducing air quality and GHG-related impacts for green hydrogen storage facilities are the same as those identified in Section 4.4.3.2.

4.4.6 Findings for the No Action Alternative

Under the No Action Alternative, agencies would continue to conduct environmental review and permitting for green hydrogen facilities under existing state and local laws on a project-by-project basis. The potential impacts would be similar to the impacts for the types of facilities described above for construction, operation, and decommissioning, depending on facility size and design, and there would range from **less than significant impacts to potentially significant adverse impacts.**

4.4.7 Unavoidable significant adverse impacts

Electrolysis using fossil fuel as a source of electricity, pyrolysis, and bio-gasification production may have **significant unavoidable adverse impacts** on life-cycle GHGs emissions. Determining if mitigation options would reduce or eliminate GHG impacts below significance would be dependent on the specific project and site.

4.5 Water resources

Key findings

When choosing a site, developers will consider if resources needed for their project are available. The amount of water available will vary based on a project and its location, and this study does not evaluate specific sites. If the water needed for a project to be built and operated is not available, the project would not be feasible.

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the construction, operation, and decommissioning of facilities would likely result in **less than significant impacts** on water resources (surface water, groundwater, wetlands, floodplains, water availability or water rights).

No significant and unavoidable adverse impacts related to water resources would occur.

This section evaluates surface water, groundwater, wetlands, and floodplains as well as the following features related to water resources: water quality, water quantity, and water availability and water rights.

The *Water Resources Technical Appendix* (Appendix F) includes the full analysis and technical details used to evaluate water resources in this PEIS.

4.5.1 Affected environment

4.5.1.1 Surface water

Surface water includes streams, rivers, lakes, reservoirs, estuaries, wetlands, and marine waters. Surface waters in the study area vary considerably in size and flow. The study area encompasses land along surface waters ranging from the Columbia River and major river tributaries including the Yakima, Snake, White Salmon, and Klickitat Rivers; to small to large-size perennial creeks; to unnamed smaller creeks with only seasonal flow. All eight hydrologic sub-regions in Washington as identified by the U.S. Geological Survey (USGS) are found within the study area. The study area also falls within all of Washington's 62 Water Resource Inventory Areas (WRIAs). WRIAs provide a framework for water resources management in the state.

Water quality is a key element of surface water regulation and management in Washington. Water quality conditions across the study area vary by location and are affected by physical conditions of the waterbody (width, depth, flows), underlying soils and geology, and human influences. In general, surface water quality conditions are typically better higher in a watershed, upstream of intensive land uses. Common water quality issues that affect some waters in Washington and the study area include elevated temperature, low dissolved oxygen, high turbidity, bacteria, and toxics and other pollutants from industrial activities and stormwater runoff.

4.5.1.2 Groundwater

Groundwater is the water found underground in the spaces of saturated soil and rock. A saturated soil or rock layer with spaces that allow water to move through it is called an aquifer. There are seven main aquifers in Washington as identified by USGS. The study area includes land over portions of most of these aquifers.

Sole source aquifers are defined as aquifers that supply at least 50% of the drinking water for its service area and for which there are no reasonably available alternative drinking water sources if the aquifer becomes contaminated. EPA has designated 13 sole source aquifers in Washington, and nine of them overlap the study area: Camino Island Aquifer Area, Central Pierce County Aquifer Area, Cross Valley Aquifer Area, Vashon-Maury Island Aquifer Area, Whidbey Island Aquifer Area, Troutdale Aquifer System Source Area, Spokane Valley-Rathdrum Prairie Aquifer Source Area, Lewiston Basin Aquifer Area, and Cedar Valley Aquifer Source Area.

Cities and counties in Washington protect groundwater resources by establishing critical aquifer recharge areas, as required by the state’s Growth Management Act (GMA). Development activities within critical aquifer recharge areas are regulated by city and county critical areas codes.

4.5.1.3 Sea level rise

Increases in sea level, or sea-level rise, occur due to expansion of warm water and melting of land ice. It does not occur uniformly and is affected if the land raises or lowers, such as by seismic uplift or erosion. This can increase local flooding and result in saltwater intrusion of groundwater in the study area. It can also increase coastal erosion and degrade habitat and ecosystems that can buffer the effects of storms and flood events.

4.5.1.4 Wetlands

Wetlands are waters of the state and are a specific type of water resource that often occur in transitional areas between terrestrial and aquatic systems. They include areas that are commonly referred to as swamps, marshes, bogs, and fens. Wetlands can occur in and adjacent to stream and river channels, on floodplains, in low-lying areas and depressions, around the edges of ponds and lakes, on slopes, and in estuaries and coastal areas. Wetlands occur throughout the study area; however, there is no detailed single source that identifies the presence of all wetlands. For this reason, developers would be required to conduct wetland surveys and delineations to determine wetland presence. In Washington, wetlands are rated and categorized using Ecology’s Washington State Wetland Rating System. Under this system, wetland categories range from Category I wetlands, which are a unique or rare wetland type, are more sensitive to disturbance, have the highest levels of function, or are relatively undisturbed and difficult to replace, to Category IV wetlands, which have the lowest levels of function and are often heavily disturbed. State law requires wetland mitigation plans to ensure no net loss of function.

4.5.1.5 Floodplains

Floodplains are low-lying areas around surface waters that may sometimes flood. Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps identify flood hazard areas regulated under the National Flood Insurance Program (NFIP). Special flood hazard areas are areas that would be inundated by a flood event that has a 1% chance of occurring in any year (i.e., the "100-year" flood). These special flood hazard areas generally are the basis for floodplain management regulations. Flood risks vary across the study area based on location and setting. Information on flood risks for a given site should be evaluated using FEMA's Risk Mapping, Assessment, and Planning program tools available on the FEMA website.[45] Local critical area ordinances include requirements to define and protect frequently flooded areas, and some local governments may require greater protection from floods.

4.5.1.6 Water availability and water rights

Water availability is dependent upon physical availability and the legal availability. This is based on instream flow requirements and water rights held by others within each watershed, sub-basin, aquifer, or similar body of water. Across the study area, water availability varies by location and is dependent on many factors such as local hydrology and climate conditions, land uses, and existing water rights. Ecology has responsibilities for managing waters of the state, including issuing rights to use water while protecting instream resources for public benefit. Nearly 80% of the state's overall water use is for irrigation and public supply, with more water used for public supply on the west side of the state, and more water used for irrigation on the east side of the state. In addition to water rights for withdrawal, water availability is also influenced by the requirement to maintain minimum instream flows. These requirements are in place to protect fish and wildlife, Tribal resources, water quality, recreation, aesthetics, and navigation. Ecology considers instream flow requirements and closed waterbodies when reviewing new water rights applications.

All surface diversions and many groundwater withdrawals in Washington require a permit prior to water use. However, the groundwater code provides a qualified exemption to groundwater withdrawal permitting for certain uses including water for industrial purposes not exceeding 5,000 gallons per day. Daily limits may be less, or water may not be available based upon local conditions.

4.5.2 How impacts were analyzed

The assessment of impacts was qualitative, and considered the following:

- Changes in surface water quality
- Disruption of the groundwater flow regime (including groundwater recharge)
- Alterations to water availability or rights
- Wetland area, function, or buffer area alteration or loss
- Alterations to floodplain functions and/or any loss of floodplain storage

[45] https://www.fema.gov/flood-maps/tools-resources/risk-map

- Disturbance to known groundwater pollution or contamination.

Potential impacts considered applicable laws and regulations (e.g., water quality standards, water rights laws, and wetland regulations).

A green hydrogen facility developer would need to ensure that there is sufficient water available for a project, both physically and legally. Water availability will vary based on the project and location. If water is needed for a project and is not available, a project would not be able to operate. This PEIS assumes a proposed project will have water rights as needed.

4.5.3 Findings for green hydrogen production facilities

4.5.3.1 Impacts

Impacts from construction and decommissioning
The extent and magnitude of impacts on water resources would vary depending on the geographical region of the facility, as well as its size and production type.

Surface water quantity
Construction would require a water supply for fugitive dust control, equipment cleaning, and concrete mixing and pouring. The total gallons of water estimated for a 1-acre site for 1 year of construction is 759,398 gallons and is approximately 21,580,990 gallons for 3 years of construction of a 10-acre site.

Site characterization, construction, and decommissioning activities could impact surface water flows for facilities that involve elements within or adjacent to waterbodies, such as for a facility access road crossing a stream. Streamflows could be temporarily re-routed from their natural channels by diversions needed to construct such crossings. Permanent alterations to streams could occur if culvert installations are needed at access road crossings, which, if not adequately designed and sized, could restrict streamflow conveyance. These impacts would be minimized by following design guidelines and adhering to water crossing regulations, including Washington Department of Fish and Wildlife's (WDFW's) Water Crossing Guidelines for fish-bearing streams.

Ground disturbance for facility construction or decommissioning would impact flow rates and volumes of surface runoff reaching nearby streams. Vegetation clearing and soil compaction in site investigation and construction areas would reduce the land's potential to absorb and infiltrate precipitation, potentially leading to increases in stormwater peak flows.

Construction of site access, vehicle access and service roads, and foundations associated with green hydrogen production facilities would add impervious surface area (foundation pads, structures, paved surfaces) comprising of up to 23,958 ft^2 of a facility on a 1-acre site and up to 239,580 ft^2 of a facility on a 10-acre site (or 55 percent of a site). The addition of impervious surfaces would increase surface water runoff from those areas. Depending on how stormwater drainage is managed, this could permanently change the amount and timing of surface flows reaching nearby waterbodies. Impervious surfaces would be removed during decommissioning. Permit requirements and BMPs would be implemented, which would reduce impacts.

Surface water quality

Site characterization, construction, and decommissioning activities could adversely affect surface water quality in several ways. Typical construction equipment for industrial facilities includes bulldozers, front-end loaders, graders, portable generators, mobile cranes, pumps, pile-drivers, and trucks. Additional equipment may be needed for in-water work. Potential pollutants from operating such equipment would include fuel (gasoline and diesel fuel), oil, grease, coolant, and hydraulic fluid.

In-water construction for elements such as new stream crossings for roads would temporarily elevate stream turbidity levels from sediment disturbance and changes to flows. Erosion would temporarily increase soil disturbance from establishing site access or from activities on site. This would increase the risk of runoff of soil, organics, and pollutants to water.

Construction would include on-site concrete mixing and pouring. Concrete pouring and demolition could create the potential for introducing high-pH discharges to surface waters. Discharge of wastewater from a range of construction activities could increase flow rates, temperature, pH, dissolved oxygen, or turbidity of receiving surface waters.

Equipment, activities, and materials would have the potential for release or spills. Hazardous materials used during construction would be typical of most industrial facility construction, such as fuels, oils, solvents, compressed gases, paint, coatings, herbicides, pesticides, and battery electrolytes. Improper handling or spills could affect surface water. Hazardous material storage requirements and federal requirements for facilities storing more than 1,320 gallons of petroleum fuel would require secondary containment. For the quantities expected for these facilities, spills would likely be to secondary containment, within buildings, or to soil and able to be cleaned up. Spills that reach water would need to be contained, assessed, and remediated, with hazardous waste transported and disposed of in compliance with state and federal regulations. Potential impacts of spills are further discussed in the *Environmental Health and Safety Technical Appendix* (Appendix I).

Industrial land may have areas that have been contaminated from previous activities. Construction within or near contaminated soil, groundwater, or sediment may impact water quality. Prior to construction, a site assessment would evaluate potential on-site hazards. Plans could be implemented based on findings to avoid risks of release.

Decommissioning would include demolition of concrete pads and foundations that could result in water coming into contact with freshly exposed concrete surfaces and debris/dust, which could lead to elevated water pH levels. Temporary ground disturbance from removing structures and access roads and from site would temporarily increase the erosion potential of the site and increase the potential for exposed soils to reach nearby waterbodies through runoff or by wind. In-water work to remove any intake or discharge pipes could disturb sediments, thereby causing turbidity. Revegetation of temporary disturbance areas would limit the length of time soils are exposed. Developers would be required to comply with applicable authorizations, such as a NPDES permit, Section 404 permit, or Section 401 Water Quality Certification. BMPs would be implemented to minimize impacts from in-water work and manage stormwater and wastewater discharges. Implementation of permit requirements, such as implementation of a Water Quality Monitoring and Protection Plan, would reduce impacts to surface water quality. Any blasting adjacent to waters, including wetlands, would also require site-specific BMPs.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, construction and decommissioning activities would likely result in **less than significant impacts** on surface water.

Groundwater
Site characterization, construction and decommissioning activities for green hydrogen production facilities—including groundwater or geotechnical drilling and testing to gather information or construction of foundations for buildings—would include subsurface excavation and fill and concrete work and could potentially require dewatering during construction. Such activities would depend on the site but could locally affect shallow groundwater flows to approximately the depth of the excavation.

New buildings, vehicle access, and service roads could locally change surface-to-groundwater interactions and reduce groundwater recharge capability within those footprints. Facilities would be required to obtain water quality permits for construction, and BMPs would be implemented to manage stormwater and wastewater discharges.

Industrial sites in more rural environments may include on-site water well installation and groundwater extraction to support construction and would require a water right (see Section 4.5.1.6). Wells using groundwater may result in localized water table drawdown. Industrial lands in developed areas would likely have water sourced from a water utility provider connection on site or nearby because of established connections associated with an already-developed area.

Industrial land use areas may have areas that have been contaminated from previous activities. Construction within or near contaminated soil, groundwater, or sediment may impact water quality. Construction within or near an existing groundwater pollution plume could cause contaminants to move between aquifers and result in disruption to groundwater beyond the development footprint. Conducting a site assessment prior to any construction work would help evaluate potential on-site hazards, and plans could be implemented based on findings to avoid risks of contaminant release.

As described for surface water above, hazardous materials would need to be stored properly and spills managed in compliance with state and federal regulations. Removal of structures and their foundations and access roads, and restoration to pre-facility conditions would allow surface-groundwater interactions, including infiltration of rain and snowmelt and groundwater recharge. Hazardous materials may be present during decommissioning from decommissioning equipment or may be present on site in known contaminated areas. These materials could mobilize during construction and directly impact groundwater quality.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, construction and decommissioning activities would likely result in **less than significant impacts** on groundwater.

Wetlands

Impacts to areas and functions of wetlands could occur during site characterization, construction, and decommissioning of green hydrogen production facilities. Wetlands may be cleared and/or filled for the construction of staging and laydown areas, permanent site access routes, and other supporting infrastructure. Roads and other infrastructure constructed in the vicinity of wetlands could introduce invasive plant species, change surface drainage patterns, or introduce sediments or pollutants into adjacent wetlands via runoff.

Alteration of drainage patterns during construction could alter surface or groundwater connections and could introduce pollutants and sediments or alter the depth, timing, and frequency of surface waters flowing into wetlands. Increases in impervious and hardened surfaces may limit surface water infiltration, resulting in a decrease of groundwater availability for nearby wetlands. Additionally, groundwater withdrawals necessary for construction could interface with surface waters and reduce water availability for wetlands.

Decommissioning activities (removal of facilities, access roads, and culverted road crossings from wetlands or areas adjacent to wetlands) could introduce invasive plant species and temporarily increase erosion potential in those areas. Decommissioning activities could result in or increase soil compaction that could affect soil infiltration and alter drainage patterns. As with construction and operation, decommissioning work would increase the potential for spills and leaks of fuel and other vehicle fluids from equipment to enter wetlands.

Wetlands may be present on a potential facility site, and the types of wetlands would be identified as part of site characterization. The type, size, and extent of wetlands would determine the degree of potential impact. If wetland impacts are likely, project developers would comply with a mitigation sequencing process to achieve the state goal of no net loss of wetland area and function, starting with avoidance and minimization. Compensatory mitigation would be required to ensure there is no net loss of wetland functions for wetlands and wetland buffers. A project-specific wetland mitigation plan would be required as part of the regulatory review process.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, construction and decommissioning activities would likely result in **less than significant impacts** on wetlands.

Floodplains

Site characterization, construction, and decommissioning activities could impact floodplains if there are activities within or adjacent to a stream, such as building an access road across a stream. The amount of impermeable surface required for a green hydrogen facility (approximately 10% of a 10-acre site) would not be likely to affect floodplain functions.

Potential decommissioning-related impacts on floodplains would be similar to those described previously for surface waters. Temporary work activity and ground disturbance in the floodplain could result in temporary impacts on floodplain functions. Floodplain functions could be restored to pre-facility conditions following structure and road removal, and restoration grading and planting.

Permanent alterations to waterbodies could occur with culvert installations at access road crossings, which could restrict natural surface water flow and floodplain functions. WAC 220-660-190 requires that culverts for fish-bearing streams be designed to pass 100-year flood flow and debris. City and county floodplain development permits are required to prevent development that would lead to alteration of floodplain functions, cause loss of storage, increase hazards, or cause a net rise in flood elevation during a 100-year flood.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, construction and decommissioning activities would likely result in **less than significant impacts** on floodplains.

Water availability and water rights

Construction of green hydrogen production facilities would create a water use need for supplying drinking water to construction workers, which are estimated to number between approximately 10 and 100 workers. Additionally, facilities would require a water supply during construction for fugitive dust control, equipment cleaning, and concrete work. Water for some facilities may be available from existing municipal sources or may be transported by truck to the site, depending on the volume required. Some sites may require obtaining water from new surface water diversions or groundwater withdrawals.

Water sourced from new surface water diversion or groundwater could temporarily alter surface water quantity and availability in areas downstream.

Facility construction could impact stream buffers or permanently alter local drainages and drainage patterns, which could alter the quantity and availability of surface waters in nearby water bodies. Permanent alterations could occur with culvert installations at access road crossings, which, if not adequately designed and sized, could restrict streamflow conveyance.

Developers would need a water right for diversions of surface water for construction. Groundwater pumping would also require a water right if withdrawals exceeded groundwater permit exemption thresholds of 5,000 gallons per day for industrial uses. Water used for construction activities that exceed 5,000 gallons per day would require a water right. Water availability and the likelihood of obtaining new water rights for construction vary by location in the study area. Water rights may not be granted in watersheds that are already over-appropriated and subject to instream flow requirements that are often not met. If facilities need a water supply from ground or surface water on-site, they would be required to obtain a water right for construction water needs. If water is not available, a water right would not be issued.

A green hydrogen facility developer would need to ensure that there is sufficient water available for a project, both physically and legally. Water availability will vary based on the project and location. If water is needed for a project and is not available, a project would not be able to operate.

Findings

A green hydrogen facility developer would need to ensure that there is sufficient water available for a project, both physically and legally. With this assumption, through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, construction and decommissioning activities would likely result in **less than significant impacts** on water availability and water rights.

Impacts from operation

Impacts from operations would vary by the type of production facility and its water requirements and discharges. A summary of the water requirements and discharges for the facility types evaluated is below. Additional details are provided in Appendix F, *Water Resources Technical Appendix*.

Water use will vary based on the production type:

- **Electrolysis:** Requires about 2 to 3 gallons of water to produce 1 kg of hydrogen. The electrolysis process typically requires demineralized water, which would be produced on site through reverse osmosis.
- **Steam-methane reforming (SMR):** Requires approximately 6 to 8 gallons of water per kg of hydrogen produced and may also require demineralized water produced through reverse osmosis.
- **Pyrolysis:** No water required.
- **Bio-gasification:** Requires approximately 1.3 gallons of water per kg of hydrogen produced.

Surface water quantity
Water would be needed to operate green hydrogen production facilities. All production types would require small volumes of water for potable and sanitary water supply needs as well as for irrigation of vegetation and other miscellaneous facility maintenance and operation needs.

As discussed above, the quantity of water needed for producing green hydrogen would vary by production facility type. Operations impacts related to water availability and water rights are discussed below.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, operations activities would likely result in **less than significant impacts** on surface water quantity.

Surface water quality
Operation and maintenance for green hydrogen production facilities includes the on-site storage and use of hazardous materials, including hydrogen, alkaline electrolyzers, methane, nickel-based catalysts, and bio-gasification byproducts (see Table 10 of Appendix I, *Environmental Health and Safety Technical Appendix* for details). Fuel and oil for generators would be required to provide backup power. Fuel is expected to be stored in aboveground storage tanks with containment. If more than 1,320 gallons are stored on site, a facility must have a spill prevention, control, and countermeasure (SPCC) plan to prevent, control, and respond to spills. Hazardous material storage requirements and federal requirements for facilities storing more than 1,320 gallons of petroleum fuel would require secondary containment. For these types of quantities, spills would likely be to secondary containment or nearby soil and able to be cleaned up. Impacts related to hazardous materials and spills are also discussed in Appendix D, *Earth Resources Technical Appendix,* and Appendix I, *Environmental Health and Safety Technical Appendix.* The addition of impervious surfaces for buildings and vehicle access roads, combined with on-site oil and fuel storage and the periodic presence of maintenance vehicles and equipment on the site, would create potential for pollutants in stormwater discharges. Maintenance of facilities could also involve periodic use of herbicides to manage unwanted vegetation, which could impact water quality in receiving waterbodies if not applied properly.

Periodic ground disturbance required to maintain access, fencing, buildings, utility lines, and infrastructure, and vegetation could temporarily increase erosion potential and soil transport to receiving waters, resulting in decreased surface water quality. Use of certain dust-suppression methods could degrade water quality through introduction and increase of total dissolved solids concentrations in surface waters.

All production facilities would include small volumes of sanitary wastewater from other operations and maintenance activities such as office building kitchens and restroom facilities. Smaller facilities may be remotely operated, while larger facilities may have one to three operations personnel on site 24 hours per day, 7 days per week. Sanitary water usage in industrial settings is approximately 10 gallons per person per shift where there are only toilets at the facility, and up to 25 gallons per person per shift where there are toilets, showers, and full kitchen services (i.e., food preparation and dish washing).

Impacts to surface water quality during operations would vary by production facility type (electrolysis, SMR, pyrolysis, and bio-gasification) due to differences in the types of chemicals and pollutants used and stored on site and differences in production processes and wastewater discharges. Water availability is discussed later in this section. Storage and treatment of wastewater from reverse osmosis could also create the potential for pollutants to enter surface waters and degrade water quality. Wastewater from the reverse osmosis process would be treated on-site or routed to a wastewater treatment plant. The pyrolysis process would not produce wastewater. For each kg of hydrogen produced, the daily range of wastewater production would be 1,000–9,000 gallons for the electrolysis process and 2,000–100,000 gallons for SMR. Bio-gasification is estimated to generate 15,000 to 30,000 gallons of wastewater daily, though this would vary based on the type of biomass. For facilities with intake and discharge pipes, operation and maintenance could require in-water work and could affect turbidity or temperature.

Production of green hydrogen facilities could result in production of air emissions as a byproduct that could be transported to receiving waters through atmospheric deposition. Atmospheric pollutants are addressed in Appendix E, *Air Quality and Greenhouse Gases Technical Appendix.* Any inadvertent release of liquid or gaseous hydrogen would become gaseous and would not impact water resources.

Developers would be required to comply with applicable authorizations, such as an NPDES permit, Section 404 permit, Section 401 Water Quality Certification. BMPs would be implemented to minimize impacts from in-water work and manage stormwater and wastewater discharges. Wastewater would be treated on site to meet NPDES permit requirements or routed to a wastewater treatment plant. Facilities proposed in locations discharging to impaired surface waters with total maximum daily loads (TMDLs) could receive a Water Quality-based Effluent Limitation consistent with TMDL waste load allocations. If an NPDES permit is not required, under state law developers would still be required to manage projects to prevent pollutants from reaching surface waters.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, operations activities would likely result in **less than significant impacts** on surface water quality.

Groundwater

Buildings for operation of green hydrogen facilities could include sanitary wastewater discharges (e.g., from restrooms) to the subsurface through on-site septic systems. Septic systems could present risks of bacterial contamination of groundwater if not designed and maintained in accordance with local codes.

Improperly designed groundwater wells could create conduits for poor-quality groundwater, as well as contaminants, to move between aquifers, including previously stationary groundwater pollution plume. On-site storage and use of generator fuel and transformer oil present some risk of spills or releases of pollutants to the subsurface. Chemical, fuels, and wastewater spills could result in infiltration of pollutants and pathogens into groundwater. Hazardous material requirements and BMPs discussed in relation to surface water would prevent similar impacts to groundwater.

Sea level rise could result in the intrusion of salt water into groundwater aquifers. This could cause decreased groundwater quality and the need to either increase water treatment for use in facility operations or develop a new water source. Groundwater withdrawals could impact groundwater quantity through a reduction in volumes and overall availability. Groundwater availability and quantity could be lowered through surface water diversion or reduction. Water availability impacts are discussed later in this section.

As described above for surface water quality, green hydrogen facilities may be required to comply with NPDES standards and requirements. Wastewater would be treated on site to meet NPDES permit requirements or routed to a wastewater treatment plant. If an NPDES permit is not required, under state law developers would still be required to manage projects to prevent pollutants from reaching groundwater. Underground injection control facilities may be used to manage wastewater and require approval from Ecology. All applicable laws and regulations would be followed for use of on-site groundwater wells, and coordination with local treatment facilities would be necessary for off-site disposal and discharges to wastewater treatment facilities.

Findings

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, operations activities would likely result in **less than significant impacts** on groundwater.

Wetlands

If pipelines or other structures were constructed in wetlands, maintenance activities may cause impacts. Potential water quality impacts on wetlands could occur during rain events, which could create runoff that carries soil. Spills of pesticides, fuel, vehicle fluids, or other hazardous materials used or stored at the facility could impact nearby wetlands if outside of containment. Surface and groundwater withdrawal to support green hydrogen production and facility operations could reduce the amount of water available to support wetlands. This would result in degradation to the function of nearby wetlands and associated buffers.

As described above for surface water quality, green hydrogen facilities may be required to comply with NPDES standards and requirements. Wastewater would be treated on site to meet NPDES permit requirements or routed to a wastewater treatment plant. If an NPDES permit is not required, under state law, developers would still be required to manage projects to prevent pollutants from reaching surface waters.

If wetland impacts are likely, project developers would comply with a mitigation sequencing process to achieve the state goal of no net loss of wetland acreage and function. Compensatory mitigation would be required to ensure that there is no net loss of wetland area and functions for wetlands and wetland buffers. A project-specific wetland mitigation plan would be required as part of the regulatory review process.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, operations activities would likely result in **less than significant impacts** on wetlands.

Floodplains and frequently flooded areas
Operation and maintenance impacts on floodplains would be similar to those described previously for surface waters. Maintenance of facility elements within floodplains could interfere with floodplain functions. For example, if vegetation maintenance at facilities and along access roads were to prevent natural vegetation from re-establishing, it could affect vegetation support for floodplain functions. Floodplain development permits would be required and would consider alterations to floodplain functions and/or any loss of floodplain storage that would cause a net rise in flood elevation during a 100-year flood.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, operations activities would likely result in **less than significant impacts** on floodplains.

Water availability and water rights
Water availability varies by location and may be limited for new uses. Water may be obtained as a result of a new water right or a water right modification that alters the use of an existing permit or perfected right from another consumptive use (e.g., agricultural, mining). Water could be obtained from local wholesalers and providers, or it may be obtained through on-site surface water diversions or groundwater withdrawal.

The water needed for each production type to produce 1 kg of green hydrogen is described at the start of this section. Based on the types of facilities analyzed in this PEIS, the potential annual ranges of water requirements for electrolysis, bio-gasification, and SMR production are broad, ranging from slightly over 2 acre-feet[46] (AF) per year for the smallest electrolysis facilities to nearly 900 AF per year for the largest SMR facilities. Pyrolysis does not require water for operations.

[46] An acre-foot (AF) is the amount of water required to cover 1 acre of land (about a football field) with water to a depth of 1 foot. There are 325,851 gallons or 43,560 cubic feet of water in 1 AF.

Water needs during operation of green hydrogen production facilities is similar to other industries that produce fuels. For example, gasoline production requires approximately 1–11 gallons to produce 1 kg of gasoline.[47] When siting a green hydrogen production facility, water availability through a water right or municipal supply, drought conditions, and water scarcity would need to be considered in relation to potential water quantity needed.

Water would also be required, in smaller volumes, for potable and sanitary water supply needs as well as for irrigation of vegetation and other miscellaneous facility maintenance and operation needs.

Water for some facilities may be available from existing municipal sources and supplies. In this instance, it is assumed that a developer would obtain a letter of water availability from a wholesaler for the project-level review. The letter would confirm that water requirements of a particular facility could be met. Other facilities may require obtaining water from new on-site surface water diversions or groundwater withdrawals. If facilities need a water supply from ground or surface water on-site, they would be required to obtain a water right for operation water needs. If water is not available, a water right would not be issued.

A green hydrogen facility developer would need to ensure there is sufficient water available for a project, both physically and legally. Water availability will vary based on the project and location. If water is needed for a project and is not available, a project would not be able to operate.

Findings
A green hydrogen facility developer would need to ensure there is sufficient water available for a project, both physically and legally. With this assumption, through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, operations activities would likely result in **less than significant impacts** on water availability and water rights.

4.5.3.2 Actions to avoid and reduce impacts

The following are some actions to avoid and reduce impacts of green hydrogen facilities. See Appendix F, *Water Resources Technical Appendix*, for typical mitigation measures that may be included in plans or permit conditions and additional measures that may apply for facilities.

Siting and design considerations

- Identify water use and suitable source availability for the anticipated life of the facility.
- Characterize and quantify the potential volume of wastewater and pollutant loading to be discharged. Identify potential treatment options as applicable.
- Site facility in location where anticipated pollutant loading is compatible with receiving water body assimilative capacity.

[47] https://www.epa.gov/sustainability/lean-water-toolkit-chapter-2

- Conduct a hydrologic study of the site to understand the local surface water and groundwater hydrology. Identify site surface runoff and drainage patterns and groundwater levels and flow direction.
- Perform a wetland delineation on the site to identify and map any potential wetlands that may be present. Assess wetland functions and rate all on-site wetlands using the appropriate Washington State Wetland Ratings System method to determine their categories and local buffer requirements. Examine adjacent properties for the presence of off-site wetlands that could be affected by facility construction and operation, map their locations, and identify any off-site connections to surface waters.
- Avoid siting structures and roads within waterbodies, wetlands, associated buffers, shorelines of state, mapped floodplains and other frequently flooded areas, and critical aquifer recharge areas.
- Avoid siting structures in areas of known soil or groundwater contamination and in direct proximity to impaired receiving waters.
- Avoid crossing waters of the state. Where crossings of waterbodies or wetlands cannot be avoided, prevent impacts to surface waters by spanning the waterbody or wetland (e.g., road bridges or aboveground lines) or using horizontal directional drilling to cross beneath it (e.g., underground lines).
- Where in-water and wetland impacts cannot be avoided, minimize impacts to water quality by working below the ordinary high-water mark (OHWM) during the dry season when no rain is predicted.
- Where in-water work cannot be avoided, minimize impacts to aquatic species by working within the WDFW-recommended in-water work window.
- Follow applicable design guidelines (e.g., WDFW Water Crossing Design Guidelines[48]) and adhering to regulations, including WAC 220-660-190 (Water Crossing Structures).
- Avoid alteration of existing drainage patterns to the extent practicable, especially in sensitive areas such as erodible soils or steep slopes.
- If floodplains cannot be avoided, design the structures located within them so as not to restrict or redirect flows from their natural flow path and to meet local critical areas requirements.
- Use design and construction methods to avoid and minimize impacts to waters of the state.
- Avoid siting proposed facilities and infrastructure within shoreline jurisdiction where possible.

[48] https://wdfw.wa.gov/sites/default/files/publications/01501/wdfw01501.pdf

4.5.4 Findings for production facilities with co-located BESS

4.5.4.1 Impacts

Impacts from construction, operation, and decommissioning
The potential impacts on water resources described for facilities also apply to construction, operation, and decommissioning of facilities with co-located BESSs.

Co-locating BESSs would require a small additional construction-related ground disturbance and increased building footprint relative to facilities with no BESS. A battery storage container would be installed on a concrete foundation designed for secondary containment. A warehouse-type enclosure of a similar scale and size may also be used.

A BESS would add another stormwater consideration to a facility and potentially another regulated element to be included in an Industrial stormwater pollution prevention plan (SWPPP). Specific stormwater management controls during construction, operation, and decommissioning for each facility would be dependent on the facility design and project site. Firefighters are not expected to use water for combatting a fire at a BESS. Emergency response actions are to allow the fire to burn to prevent water contaminated with pollutants to affect surface water and groundwater quality.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the construction, operation, and decommissioning of facilities with co-located BESSs would likely result in **less than significant impacts** on water resources.

4.5.4.2 Actions to avoid and reduce impacts

The actions for reducing impacts for facilities with co-located BESSs are also the same as those identified for facilities without a BESS, with the added recommendation:

- BESSs and associated infrastructure should be located away from surface waters and wetlands, as well as buffer areas.

4.5.5 Findings for green hydrogen storage facilities

4.5.5.1 Impacts

Impacts from construction, operation, and decommissioning
Potential construction, operation, and decommissioning impacts to water resources, as described for green hydrogen production facilities, largely apply to green hydrogen storage facilities. However, a green hydrogen storage facility would only have the water resource requirements, water resource discharges, or types and volumes of hazard materials as a green hydrogen production facility on a 1-acre site.

During operations, if hydrogen was released from either type of storage, it would become gaseous and would not impact water resources. The amount of hydrogen stored on-site could be higher than a green hydrogen production facility, but the same BMPs and precautions described previously would reduce the risk of liquid hydrogen leaks.

Water is not a required input for either storage method, or for the liquefaction process. Wastewater would not be generated through the storage for liquid or gas green hydrogen. Sanitary wastewater associated with potable consumption during operation would be anticipated, similar to that of green hydrogen production facilities due to a similar number of on-site operation staff (some facilities may be remotely operated sites, while larger facilities may have one to three operations personnel).

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, activities associated with green hydrogen storage facilities would likely result in **less than significant impacts** on water resources.

4.5.5.2 Actions to avoid and reduce impacts

The same regulatory requirements, permitting, and actions for reducing impacts for green hydrogen storage facilities would apply as those identified for a green hydrogen production facility.

4.5.6 Findings for the No Action Alternative

The potential impacts from facilities developed under the No Action Alternative would be similar to the impacts for the types of facilities described above for construction, operation, and decommissioning, depending on facility size and design, and would be **less than significant**.

4.5.7 Unavoidable significant adverse impacts

Through compliance with laws and permits, and with implementation of actions to avoid and mitigate significant impacts, green hydrogen facilities would have **no significant and unavoidable adverse impacts** on water resources from construction, operation, or decommissioning.

4.6 Biological resources

Key findings

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, most construction, operation, and decommissioning activities of green hydrogen facilities would result in **less than significant impacts** to terrestrial and aquatic habitats, including special status habitats. Activities that cause the permanent degradation, loss, or conversion of suitable habitat that is crucial to species viability or disrupt habitat continuity along migration routes would result in **potentially significant adverse impacts** on terrestrial habitats.

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, most construction, operation, and decommissioning activities of green hydrogen production facilities would result in **less than significant impacts** to terrestrial and aquatic species, including special status species. Activities that affect species viability, the mortality of any individual species, or disturbance that disrupts successful breeding and rearing behaviors would result in **potentially significant adverse impacts** on terrestrial species.

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, construction, operation, and decommission of green hydrogen production facilities would result in **less than significant impacts** to wetlands.

Construction and operation of green hydrogen facilities may result in **potentially significant and unavoidable adverse impacts** on terrestrial and aquatic special-status habitats and species if activities cause the permanent degradation, loss, or conversion of suitable habitat that is critical to habitat or species viability; affect the mortality of any individual species or disturbance that disrupts successful breeding and rearing behaviors; or disrupt habitat continuity along migration routes. Determining if mitigation options would reduce or eliminate impacts below significance would be dependent on the specific project and site. Mitigation to reduce impacts below significance for terrestrial and aquatic special-status habitats or species may not be feasible.

This section evaluates potential impacts and mitigation related to aquatic and terrestrial species and habitats. The *Biological Resources Technical Appendix* (Appendix G) includes the full analysis and technical details used to evaluate biological resources in this PEIS. This section contains a summary of how impacts were analyzed and the key findings.

4.6.1 Affected environment

4.6.1.1 Terrestrial habitat and species

Terrestrial habitats refer to non-aquatic or upland areas of the landscape that support plants and wildlife. Examples include forests, shrubsteppe, grasslands, deserts, shorelines, and underground habitats like caves and burrow systems. Terrestrial species are plants or animals that live in or use terrestrial habitats for the majority of their life functions. Terrestrial plants typically include various species of trees, shrubs, herbs, and mosses that prefer upland or riparian habitats. Terrestrial animals typically include mammals, birds (including waterfowl), reptiles, insects, spiders, and other invertebrates.

Terrestrial habitats within the study area encompass diverse landscapes such as mountains, deserts, forests, and agricultural lands. These areas provide critical habitats for a wide range of species. There are many state and federal resources with maps and data on habitats and species. These are described in the *Biological Resources Technical Appendix* (Appendix G). Figure 4-2 and Figure 4-3 are examples of the type of information available about specific habitats that should be considered during siting and design to avoid impacts and for evaluation in project-level reviews. This map describes priorities for dry shrubsteppe habitat from the Washington Shrubsteppe Restoration and Resiliency Initiative (WSRRI).

Ecoregions are geographic areas where ecosystems, and the type, quality, and quantity of environmental resources that compose them, are generally similar. The study area for green hydrogen facilities in Washington includes portions within nine ecological regions (Figure 4-4) including the following:

- **Coast Range:** Olympic mountain range, coastal plain, temperate rainforest, alpine meadows
- **Puget Lowland**: Broad rolling lowland, glacial trough, coniferous forest, floodplains, oak woodlands, prairies
- **Willamette Valley:** Broad lowland valley, prairies, deciduous/coniferous forests, wetlands
- **North Cascades:** High rugged mountain range, active alpine glaciers, coniferous forests, deciduous forests
- **Cascades:** Steep mountain range, volcanoes, glaciers, coniferous forests, subalpine meadows
- **Eastern Cascades Slopes and Foothills:** Coniferous forest, sagebrush steppe, grassland, dry climate
- **Columbia Plateau:** Arid sagebrush steppe, fertile agricultural lands, Palouse Hills
- **Northern Rockies:** Mountainous region, thick volcanic ash deposits, boreal forest, alpine meadows, riparian woodlands, grasslands

Wildlife migration corridors and landscape-scale habitat connectivity are critical for species movement. The study area is part of the Pacific Flyway, one of the four main north-south migratory routes in North America. Ungulate (small hooved mammals) migration corridors within the study area span broad landscapes, including the Northern Rockies, North Cascades, Eastern Cascades Slopes and Foothills, Cascades, and Columbia Plateau. Species include elk, moose, deer, bighorn sheep, mountain goats, pronghorn antelope, and woodland caribou. Seasonal migration between distinct summer and winter ranges is common among ungulate herds. The *Biological Resources Technical Appendix* (Appendix G) and *Cumulative Impacts Appendix* (Appendix Q) include information on reports and websites with these data and maps.

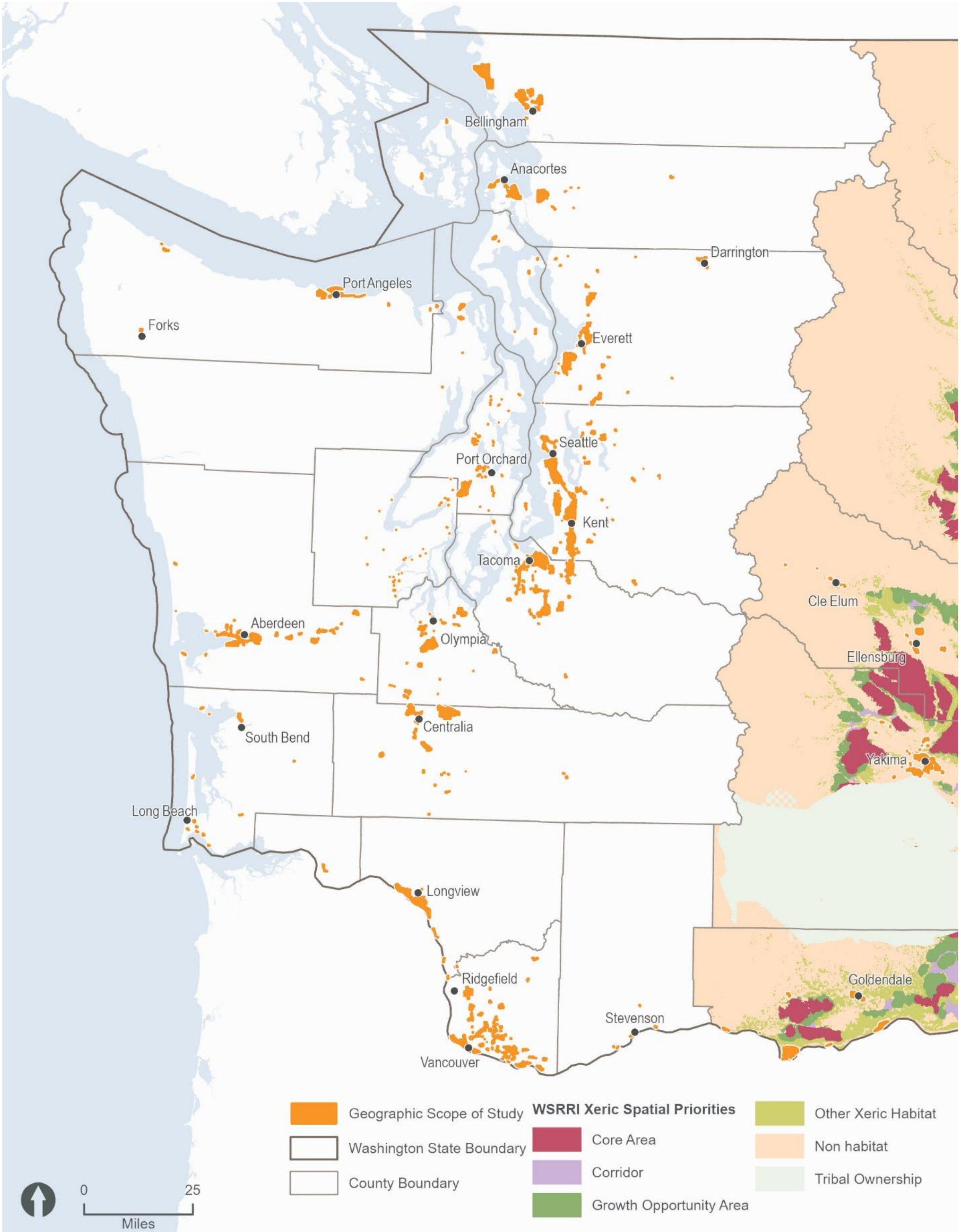

Figure 4-2. WSRRI objective areas in western Washington's xeric shrubsteppe habitats

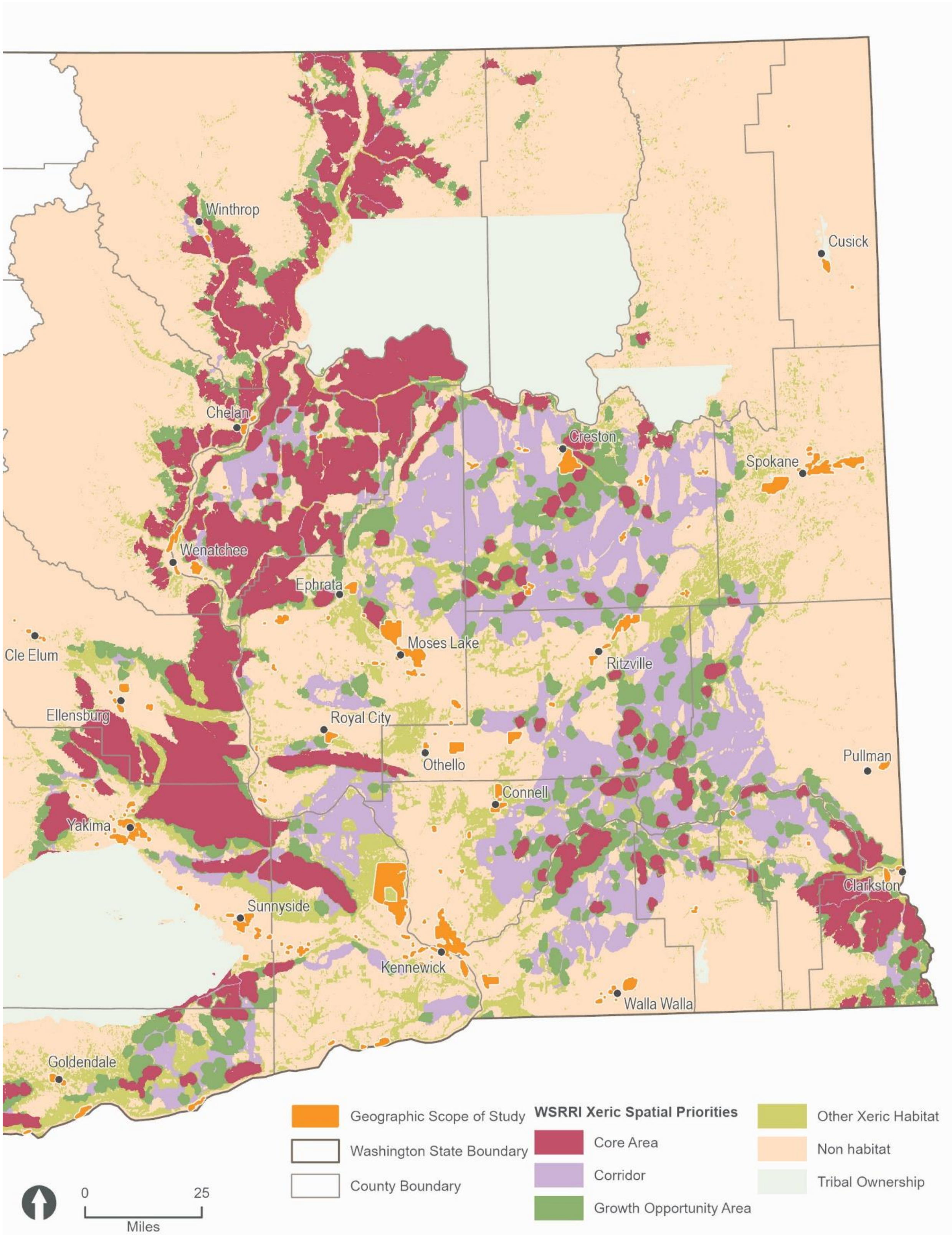

Figure 4-3. WSRRI objective areas in eastern Washington's xeric shrubsteppe habitats

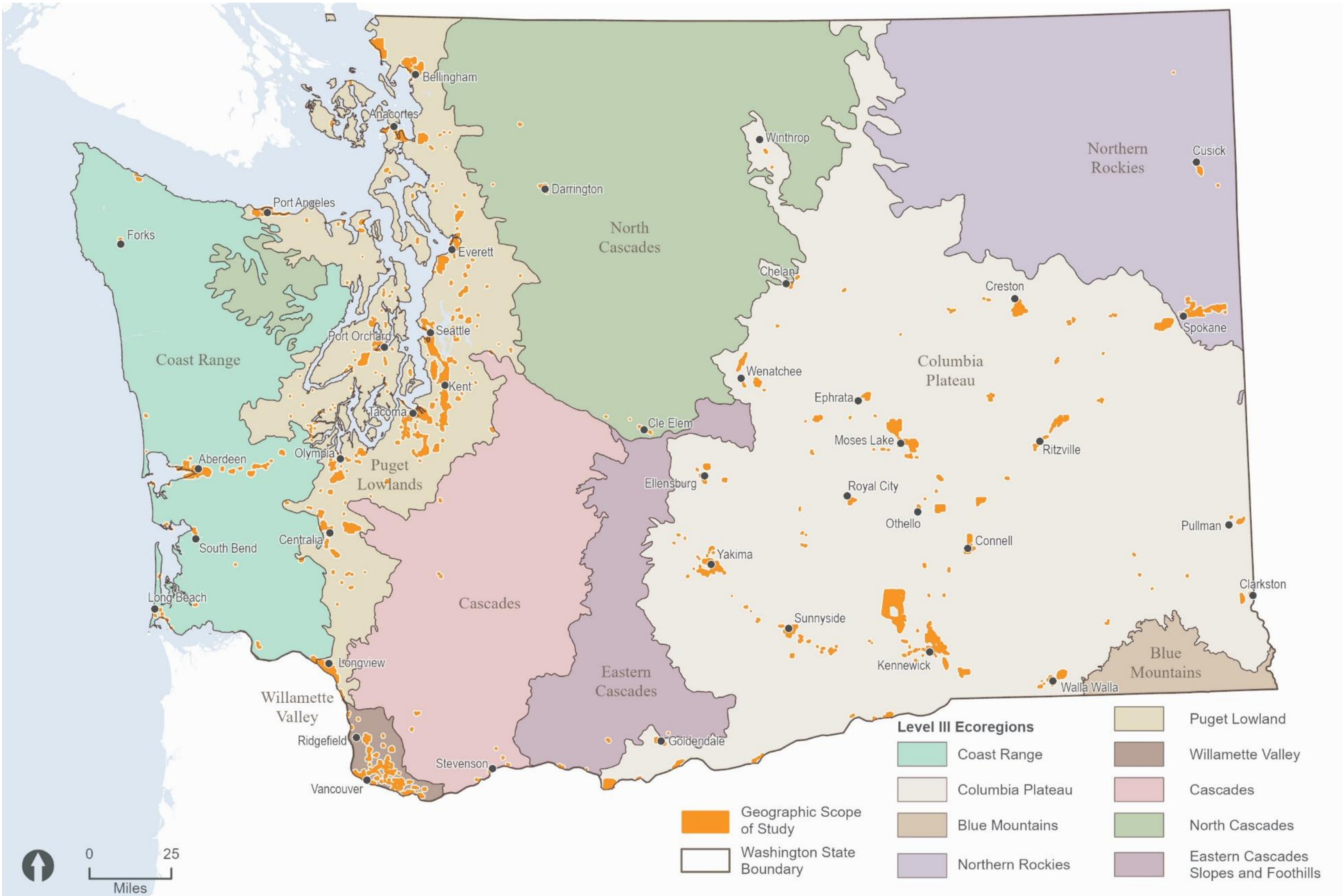

Figure 4-4. Level III Ecoregions within Washington State and the PEIS geographic scope of study

4.6.1.2 Aquatic habitat and species

Aquatic habitats are areas that have surface water that may be rain or snowmelt dependent (ephemeral), seasonally intermittent (flowing during certain times of the year), or year-round (perennial) that provide spawning, rearing, foraging, and migration areas for aquatic and amphibious species. Aquatic habitats commonly include rivers, streams, lakes, ponds, and wetlands, which are often generally described as transitional areas that occur between aquatic and terrestrial habitats. Instream and freshwater wetlands, fresh deepwater, shoreline and nearshore aquatic habitats occur throughout all eight ecoregions in the study area.

Essential Fish Habitat (EFH) is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" and is designated for groundfish, Pacific salmon, and coastal pelagic composites. EFH is mapped throughout most of the state and potentially occurs in some sites in the study area.

Aquatic species are those that require water for some or all of their life-cycles. Species that could be present in the study area include fish, marine mammals, mollusks, aquatic invertebrates, and crustaceans. Amphibious species (i.e., amphibians) are those that use both aquatic and terrestrial habitats in their life cycles and include frogs, toads, newts, and salamanders. Several highly migratory aquatic species use Washington's major river basins and tributaries, sometimes traveling hundreds of miles between spawning, rearing, and foraging habitats. These include native anadromous species of salmon, steelhead, lamprey, and sturgeon, which migrate from freshwater spawning and rearing areas to the ocean to grow, and then back to freshwater to complete their unique life cycles. These fish species are prey for marine mammals, including Southern Resident killer whales.

4.6.1.3 Wetlands

Wetlands are a specific type of habitat that often occur in transitional areas between terrestrial and aquatic systems. Wetlands are areas frequently inundated or saturated by surface or groundwater and supporting wetland vegetation and functions. They include areas that are commonly referred to as swamps, marshes, bogs, and fens. Wetlands can occur in and adjacent to stream and river channels, on floodplains, in low-lying areas and depressions, around the edges of ponds and lakes, on slopes, and in estuaries and coastal areas. Wetlands provide numerous ecological functions, including water filtration, flood control, and habitat for a wide range of species.

Wetlands typically support vegetation that is specifically adapted to growing in saturated or flooded soil conditions and includes herbs, shrubs, vines, and trees. Wetlands occur throughout the study area where green hydrogen facilities are considered, but not all wetlands have been identified at a site level. For this reason, developers would be required to conduct wetland determinations or delineations to determine if wetlands are present. If wetlands are affected, a mitigation plan will be required to ensure there is no net loss in function and acreage of wetlands.

4.6.2 How impacts were analyzed

The assessment of impacts was qualitative and considered the following:

- Terrestrial species and habitat, including:
  - Terrestrial species (including avian species and waterfowl) listed under the Endangered Species Act (ESA), Washington State species of concern (listed and candidate species), and those listed by county specific code ordinances identifying species of local importance
  - Unique, priority, and culturally important terrestrial species and habitats
  - Wildlife migration routes
- Aquatic species and habit, including:
  - Aquatic and amphibious species listed under the ESA, Washington State species of concern (listed and candidate species), and those listed by county-specific codes or ordinances identifying species of local importance
  - Unique, priority, and culturally important aquatic and amphibious species and habitats
  - Salmon, steelhead, trout and other fish migration routes
  - Wetlands
- Special status species and habitats, including:
  - ESA-listed species
  - Washington State-listed species (including those on the Priority Habitats and Species List)
  - DNR heritage species
  - Species defined in county code or ordinance as species of local importance

The assessment of impacts in this PEIS was qualitative, and potential impacts considered applicable laws and regulations.

4.6.3 Findings for green hydrogen production facilities

4.6.3.1 Impacts

Impacts from construction and decommissioning

Site characterization, construction, and decommissioning of green hydrogen facilities would occur in floodplains, upland areas, and near shorelines and would be similar to other industrial facilities. Roads, fencing, and distribution lines may cross wetlands, streams, or rivers, and sites may include wetlands. Activities would vary depending on the facility type, size, and site characteristics. Some facilities may be built on previously disturbed areas or replace existing facilities. Some industrial lands may not have been previously developed and have intact habitat. These activities could affect a wide variety of aquatic and terrestrial species in the areas where it occurs. Impacts from construction of a green hydrogen production facility would generally be greater the less developed the land and the larger the area. Decommissioning activities would be similar to impacts from construction, except at a smaller scale.

Terrestrial habitat

Impacts on terrestrial habitats associated with construction of green hydrogen facilities include fragmentation, degradation, or loss of habitat associated with ground disturbance from activities. Activities include grading and constructing for staging areas and building equipment, installing electrical power facilities and buildings, erecting fencing and road access gates, road construction or modification. Land clearing, grading, and fill placement can alter existing habitats or habitat connectivity and may introduce invasive species. The reduction of habitat can also isolate communities, which could affect population sizes and movement.

Even if the facility is sited in a previously disturbed area, development could still result in erosion, dust, changes in water flows, increased human access, spills, soil compaction or removal, or sedimentation. Adjoining habitats may also be affected by habitat fragmentation, degradation, or loss. Wildlife migration routes are unlikely to be affected by the development of green hydrogen production facilities, as the facilities would be sited in industrial lands outside of these corridors. Disturbances from humans and construction-related noise, dust, and nighttime lighting could also affect nearby habitat.

Most designated critical habitat for listed terrestrial species is not on industrial land. Special status habitats of shrubsteppe, forest, westside prairie, and riparian areas could be adversely affected by construction. Impacts on special-status habitats would be similar to those for non-special-status habitats. However, because of the more sensitive nature of special-status habitats and the special-status species those habitats support, the impacts would be greater.

The magnitude of impacts would depend on the size and location of a facility as well as the location and extent of access roads and distribution lines. Facility lighting, noise, and dust generation would also affect the level of impacts.

During decommissioning, it is assumed that habitat disturbance would primarily occur in the previously disturbed areas. The degree of impact would vary depending on how much the previously disturbed habitat had recovered during the operational phase.

Findings

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, most construction activities of green hydrogen facilities would result in **less than significant impacts** to terrestrial habitats, including special status habitats. Activities that cause the permanent degradation, loss, or conversion of suitable habitat that is critical to species viability or disrupt habitat continuity along migration routes would result in **potentially significant adverse impacts** on terrestrial habitats.

Terrestrial species

Construction of facilities may adversely affect terrestrial wildlife species, depending on the types of wildlife and the stressors associated with specific construction activities. Wildlife may be affected by site clearing and grading, building construction, access road and distribution line construction, and the movement of construction vehicles and equipment. It may also be affected by construction noise, visual disturbance, and the movement of construction vehicles and equipment.

The magnitude of potential impacts on wildlife depends on how long construction takes, if activities happen in the day or night, and the season of wildlife activity (e.g., nesting, wintering, migration). The type of impacts associated with construction activities are generally related to habitat disturbance or conversion and wildlife disturbance, injury, or mortality.

More-mobile wildlife would avoid areas where activities are occurring. Wildlife species that are less capable of avoiding disturbance include non-winged invertebrates, reptiles, juvenile mammals, burrowing species, and nesting birds. These would be more severely affected than more-mobile wildlife species by construction or decommissioning activities.

Construction of green hydrogen facilities and associated distribution lines and access roads could result in new edge habitats and removal of vegetation. Adverse effects may include increasing predation of animals in the vicinity of edges, altering wildlife distribution and movement patterns, and reducing contiguous habitat size, resulting in possible modification of foraging, nesting, breeding, rearing, and migration activities.

Impacts on special-status species would be greater than those described for non-special-status species because special-status species vitality and populations are more sensitive to impacts, and these populations are often geographically restricted.

Impacts from decommissioning would be similar to impacts from facility construction. Vegetation would be removed or damaged in areas of disturbed soil, and these areas would require the re-establishment of plant communities. However, the disturbance of vegetation would be expected to primarily occur in areas previously disturbed by construction. Wildlife could be affected by changes to existing habitats depending on the extent of infrastructure that would need to be removed, generation of waste materials and accidental spills, future land use, and the amount of required site restoration (e.g., regrading, revegetation).

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, most construction activities of green hydrogen production facilities would result **less than significant impacts** to terrestrial species, including special status species. Activities that affect species viability or the mortality of any individual species, or disturbance that disrupts successful breeding and rearing behaviors would result in **potentially significant adverse impacts** on terrestrial species.

Aquatic habitat
Construction activities may affect aquatic habitats and wetlands through site clearing and grading, constructing access roads, excavating, and building infrastructure. The impacts to aquatic habitats and wetlands would likely be less than those for terrestrial habitats, as the facilities would generally not be sited directly in aquatic habitats. However, they may be near

shorelines. Some facilities may be built on undisturbed land that may not have been previously developed and may have intact aquatic habitat such as wetlands.

Surface water flow rates and volumes of water runoff reaching surface waters could be altered during facility construction, which could also impact stream buffers or permanently alter drainage patterns. The removal of riparian vegetation during site clearing could affect aquatic habitats by reducing the area of shading over the water, leading to higher water temperatures. During construction and decommissioning, aquatic habitats and species could be affected by a temporary increase in erosion during the building of access roads and distribution lines. They can also be affected by soil compaction, vehicle and foot traffic through aquatic habitat, release of hazardous materials, introduction of invasive plant species, and disturbance. Such impacts could be minimized by the implementation of erosion control, soil decompaction, and hazardous material management plans and BMPs.

Impacts from decommissioning would be similar to impacts from construction except smaller, as the objective would be to return the site to pre-existing conditions. Restoring a site to pre-project conditions could take several years and for some habitat types, restoration could take several decades.

Findings
Through compliance with laws, permits, and with implementation of actions that could avoid and reduce impacts, most construction activities of green hydrogen production facilities would result in **less than significant impacts** to aquatic habitats, including special-status habitats. Activities that cause the permanent degradation, loss, or conversion of suitable habitat that is critical to species viability or disrupt habitat continuity along migration routes would range from **less than significant to potentially significant adverse impacts** on aquatic habitats.

Aquatic species
Construction could affect aquatic species during site clearing and grading, constructing access roads, excavating, and building infrastructure. Impacts associated with construction activities are generally related to habitat disturbance and wildlife disturbance, injury, or mortality. Aquatic species are more likely to experience impacts from altering ecological conditions through vegetation removal and changes in water temperatures.

Construction of access roads and distribution lines through aquatic habitat, resulting in vehicle and foot traffic, could injure or kill aquatic organisms, introduce invasive or noxious weeds, or disturb aquatic habitats adjacent to a facility site. Vehicle traffic could result in the accumulation of cobbles in fish passages that prevents fish from moving freely throughout the stream. This would result in the disturbance of migration, foraging, and rearing behavior. Species most likely to be affected include migratory fish species such as salmon, steelhead, and lamprey. If spills occur, pollutants could enter waterbodies and cause injury or mortality to aquatic species. Special status species could also be affected from the degradation or loss of aquatic habitats.

Impacts on aquatic species from decommissioning activities would be similar to impacts from construction.

Findings
Through compliance with laws, permits, and with implementation of actions that could avoid and reduce impacts, most construction activities of green hydrogen production facilities would result in **less than significant impacts** to aquatic species, including special-status species. Activities that affect species viability, the mortality of any individual species, or disturbance that disrupts successful breeding and rearing behaviors would range from **less than significant to potentially significant adverse impacts** on aquatic species.

Wetlands
Wetlands may need to be cleared and/or filled to establish initial site access for geotechnical surveys during the site characterization phase or for the construction of staging/laydown areas, permanent site access routes, and other supporting infrastructure. Groundwater withdrawals necessary for construction could interface with surface waters and reduce water availability for wetlands. Roads, distribution lines, and other infrastructure construction in the vicinity of wetlands could change surface drainage patterns and/or introduce sediments, pollutants, or noxious weeds into adjacent wetlands via runoff. Work disturbing soil would be done to establish site access, develop the facility footprint, create laydown areas, construct or improve road and site access, install fencing, construct buildings, install powerlines, and revegetate the site could affect wetlands and wetland buffers.

Some facilities may be built on undisturbed land that may not have been previously developed and may have intact aquatic habitat such as wetlands. Impacts may occur from the fragmentation, degradation, or loss of habitat associated with ground disturbance from construction activities associated with facility development (grading and constructing for staging areas and building equipment, installing electrical power facilities and buildings, erecting fencing and road access gates, constructing or modifying roads).

Impacts from decommissioning would be similar to impacts from construction except smaller, as the objective would be to return the site to pre-existing conditions. Similar to construction impacts, the duration and magnitude of impacts from decommissioning would depend on the facility type, size, and location.

State law requires a mitigation plan be developed and approved to ensure there is no net loss of wetland functions for wetlands and wetland buffers from facility construction or decommissioning. A facility would require an approved wetland mitigation plan before permits are issued.

Findings
Through compliance with laws, permits, and with implementation of actions that could avoid and reduce impacts, construction of green hydrogen production facilities would result in **less than significant impacts** to wetlands.

Impacts from operation
Roads and fencing may cross wetlands, streams, or rivers, and sites may include wetlands. Operations could cause ongoing or repeated disturbance of terrestrial and aquatic habitats.

Terrestrial habitat
Construction impacts that would continue into the operational period and impact terrestrial habitats include the long-term effects of habitat fragmentation, degradation, or loss. Adjacent habitats may also be affected by the long-term effects of habitat fragmentation, degradation, or loss, as well as by disturbances from human activities and movement from maintenance vehicles and noise. The introduction and spread of invasive vegetation from vehicle and human disturbance could result in long-term impacts on terrestrial habitats. Vehicle movements and trampling of vegetation may lead to soil erosion. Oil or contaminant spills from maintenance activities could also adversely affect terrestrial habitats.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, most operation activities of green hydrogen facilities would result in **less than significant impacts** to terrestrial habitats, including special status habitats. Activities that cause the permanent degradation, loss, or conversion of suitable habitat that is critical to species viability or disrupt habitat continuity along migration routes would result in **potentially significant impacts** on terrestrial habitats.

Terrestrial species
Construction impacts would continue into the operational period and could affect the viability of plant communities re-establishing within and adjacent to green hydrogen production facilities. This is as a result of mowing and vegetation maintenance, application of herbicides, trampling and soil compaction from humans and vehicles, and from fire suppression. The introduction and spread of invasive vegetation could also result in long-term impacts on plant communities. The increase in edge habitats, vehicle movements, and trampling by humans can create gaps in vegetation and allow exotic, non-native plant species to become established and displace native species over time. In addition, changes to wildlife diversity could affect pollinators for plants. These factors could lead to loss of native plant species and vegetation communities, including those that are special status.

The operation of these facilities would not result in such a disturbance that it would cause migratory birds to change their flight trajectories and would therefore be unlikely to have adverse impacts on the Pacific Flyway.

The fragmentation, degradation, or loss of habitat within undeveloped industrially zoned areas or areas zoned to support industrial uses land could result in a long-term decrease in wildlife richness, abundance, and distribution, affecting overall native wildlife diversity. Some wildlife could become displaced into adjoining habitats that may not be able to sustain population levels. The potential for loss of habitat and displacement of species is much lower if these facilities are constructed on previously disturbed and developed land. Even if adjacent habitats remain unaffected, wildlife may use these areas less due to the increased presence of human and related disturbance from increased noise, light, and vehicular traffic that would occur during operation and maintenance of the facility.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, most operation activities of green hydrogen production facilities would result **less than significant impacts** to terrestrial species, including special status species. Activities that affect species viability, the mortality of any individual species, or disturbance that disrupts successful breeding and rearing behaviors would result in **potentially significant impacts** on terrestrial species**.**

Aquatic habitat
Construction impacts would continue into the operational period and increasing water turbidity, sedimentation, and altering temperature and oxygen regimes. During operations, potential impacts from the use of equipment and runoff of surface soils would be minimized through limiting the amount of maintenance activities occurring near riparian and aquatic habitat. The risk of waterbody contamination from hazardous materials for site maintenance can be minimized through restriction of machinery use and herbicide and pesticide application near waterways.

Bio-gasification, electrolysis, and SMR processes used during operation create contaminants that could degrade water quality. Bio-gasification from certain gasification feedstocks may contain sulfur, electrolysis requires demineralized water, and SMR creates wastewater that could include biocides. Discharges would need to meet permit requirements as described in Section 3.3 of Appendix I, *Environmental Health and Safety Technical Appendix*. Hazardous materials would need to meet storage, use, and spill requirements as described in Section 3.2.1 of the same appendix.

Production of green hydrogen and operation of associated facilities could result in certain air emissions, including carbon dioxide (CO_2), methane (CH_4), hydrogen (H_2), and other pollutants, as byproducts, which could be transported to receiving waters through atmospheric deposition. Green hydrogen production that is dependent upon surface water diversions could affect the temperature of surface waters because of potential reductions in flows and volumes. If surface or groundwater is diverted for green hydrogen production facility operation and maintenance activities, that would reduce streamflow from water intake areas, potentially causing the loss of aquatic habitats, which could lead to adverse effects on the species that depend on them. The extent of the impacts on aquatic ecosystems depends on the facility size, type, and surrounding hydrologic conditions.

Findings
Through compliance with laws, permits, and with implementation of actions that could avoid and reduce impacts, most operation activities of green hydrogen production facilities would result in **less than significant impacts** to aquatic habitats, including special-status habitats. Activities that cause the permanent degradation, loss, or conversion of suitable habitat that is critical to species viability or disrupt habitat continuity along migration routes would range from **less than significant to potentially significant impacts** on aquatic habitats**.**

Aquatic species
Impacts to aquatic species would depend on facility location, type, and size. The type of impacts associated with operation activities are generally related to habitat disturbance. If water drainage patterns, sediment delivery to waterbodies, riparian area function, or water quality are changed during construction, those impacts could continue to affect aquatic habitat and species during the operational period. Regularly used maintenance roads could affect aquatic habitat and species by continuing to fragment fish passage corridors.

Findings
Through compliance with laws, permits, and with implementation of actions that could avoid and reduce impacts, most operation activities of green hydrogen production facilities would result in **less than significant impacts** to aquatic species, including special-status species. Activities that affect species viability, the mortality of any individual species, or disturbance that disrupts successful breeding and rearing behaviors would range from **less than significant to potentially significant impacts** on aquatic species.

Wetlands
Impacts to wetlands could occur during routine operations and maintenance including washing and cleaning, which would mobilize potential pollutants into nearby wetlands. Pollutants could enter wetlands during rain events from impervious surfaces for buildings and access roads and the presence of maintenance vehicles and equipment on the site. Water quality impacts on wetlands could occur from spills of hazardous material or from stormwater discharge. Such impacts could affect a wetland’s ability to provide habitat for terrestrial and aquatic species. Surface and groundwater water withdrawal to support green hydrogen production and facility operations could reduce the amount of water available to support wetlands, which could result in the loss and degradation of wetland habitat and the species they support.

Findings
Through compliance with laws, permits, and with implementation of actions that could avoid and reduce impacts, operation activities of green hydrogen production facilities would result in **less than significant impacts** to wetlands**.**

4.6.3.2 Actions to avoid and reduce impacts

The following are actions to avoid and reduce impacts of green hydrogen production facilities. See Appendix G, *Biological Resources Technical Appendix*, for typical mitigation measures that may be included in plans or permit conditions.

Siting and design considerations

Terrestrial habitats and species

- Site projects on disturbed lands (e.g., those that are developed, cultivated, or otherwise disturbed by roads or other corridors), except where such lands host significant aggregations of wildlife or are used by state or federally listed species.
- If existing information suggests the probable occurrence of state or federal threatened, endangered, or sensitive-status species on the project site, recommend focused surveys during the appropriate season to determine the presence or likelihood of presence of the species. If special-status species are observed during surveys, avoid inhabited areas such as nests, denning sites, or critical habitat
- Site and design the facility to avoid priority habitats.
- Conduct surveys for special-status plant species prior to clearing activities in areas of increased potential presence, including all priority habitat. If special-status plant species are observed during preconstruction surveys, avoid individuals and populations.
- Place linear facilities (such as access roads) in or adjacent to existing disturbed corridors in order to minimize project footprint, habitat fragmentation, and habitat degradation.
- Contact appropriate agencies early to identify potentially sensitive ecological resources, including but not limited to aquatic habitats, wetland habitats, unique biological communities, crucial wildlife habitats, and special-status species locations and habitats, as well as designated critical habitat, that might be present in the area proposed for a facility and associated access roads.
- Screen potential project sites through local, state, and federal mapping resources to identify sensitive habitat and wildlife areas and critical areas such as wetlands and steep slopes, priority habitats, and sensitive species occurrence locations.
- Design the project to avoid and minimize impacts to surrounding landscape and landscape connectivity. Use mapping data to design and site the project to avoid impacts on important, sensitive, or unique habitats identified in predisturbance surveys.
- Establish buffer zones around sensitive habitats and exclude or modify project facilities and activities in those areas.
- Complete preconstruction surveys if native habitat is present on site.
- Minimize habitat loss, habitat fragmentation, and resulting edge habitat due to project development. Habitat fragmentation could be reduced by consolidating facilities (e.g., access roads and utilities could share common rights-of-way), reducing the number of access roads to the minimum amount required, minimizing the number of stream crossings, and locating facilities in areas where habitat disturbance has already occurred.
- Locate staging and parking areas within the facility site to minimize habitat disturbance in areas adjacent to the site.

- Cap or otherwise modify vertical pipes and piles to prevent cavity-dwelling and nesting birds from entering and entrapment of other small species.

Aquatic habitats and species, and wetlands

- Conduct an aquatic habitat survey of the site to identify surface waters, their drainage routes, and the potential habitat that they provide.
- Contact appropriate agencies early to identify potentially sensitive ecological resources, including but not limited to aquatic habitats, wetland habitats, and special-status species locations and habitats, as well as designated critical habitat, that might be present in the area proposed for a facility and associated access roads and rights-of-way.
- Conduct all pre-construction surveys by qualified biologists following accepted protocols established by federal or state regulatory agencies to identify and delineate the boundaries of important, sensitive, or unique aquatic habitats and wildlife within and adjacent to the facility including waters of the United States, wetlands, springs, seeps, ephemeral streams, intermittent streams, 100-year floodplains, ponds and other aquatic habitats, and habitats supporting special-status species populations.
- Avoid surface water or groundwater withdrawals that affect sensitive habitats (e.g., aquatic, wetland, and riparian habitats) and any habitats occupied by special-status species.
- Minimize the impacts of stream crossings through design as required in WAC 220-660-190 and local regulations.
- Use design and construction methods to avoid impacts to waters of the state. If impacts are unavoidable, reduce impacts when working below the OHWM by working during the dry season when no substantial rain is forecast.
- Avoid siting access roads and facilities near open water or other areas known to attract a large number of birds.
- Avoid siting and/or minimize disturbance in areas of known soil or groundwater contamination.
- Perform a wetland delineation on the site to identify and map any potential wetlands that may be present. Assess wetland functions and rate all on-site wetlands using the appropriate Washington Wetland Ratings System method (Ecology 2014) to determine their categories and local buffer requirements. Examine adjacent properties for the presence of off-site wetlands that could be affected by facility construction and operation, map their locations, and identify any off-site connections to surface waters.
- Avoid siting structures and roads within streams, wetlands, and their buffers; mapped floodplains and other frequently flooded areas; and critical aquifer recharge areas to the greatest extent practicable.
- Where stream and wetland impacts cannot be avoided, minimize impacts on water quality by working below the OHWM or within the wetland boundary during the dry season when no rain is predicted, and/or within the WDFW-recommended in-water work window for minimizing impacts on aquatic species.

- Minimize impacts of stream and wetland crossings by following applicable design guidelines (e.g., WDFW Water Crossing Design Guidelines [WDFW 2013]) and adhering to regulations, including WAC 220-660-190 (Water Crossing Structures).

Additional mitigation measures to address potentially significant impacts

- Develop and implement a Wildlife Habitat Mitigation Plan to mitigate for impacts on important ecological resources. Request input from WDFW to determine appropriate mitigation.
- For projects in shrubsteppe habitat, mitigation through further no net loss alone would be insufficient for habitat and species recovery in this landscape; therefore, higher compensatory mitigation ratios are recommended.
- Based on survey results, include mitigation measures to subgrade over excavation and fill, compaction, moisture conditioning, and minimizing disturbed areas.
- Designate a qualified biologist who would be responsible for overseeing compliance with all mitigation measures related to the protection of ecological resources throughout all project phases, particularly in areas requiring avoidance or containing sensitive biological resources such as special-status species and important habitats.
- Prior to any ground-disturbing activity, have a qualified biologist or team of biologists conduct seasonally appropriate walkthroughs to ensure that important or sensitive species or habitats are not present in or near project area. Attendees at the walkthrough should include appropriate federal agency representatives, state natural resource agencies, and Tribal staff, as appropriate.
- Develop and implement a water resource monitoring and mitigation plan. Consideration for aquatic habitats and species should include mitigation and monitoring to identify the presence of and prevent the permanent loss of priority habitats for special-status aquatic species or measures to prevent mortality of those species.
- Address compensatory mitigation for unavoidable impacts on wetlands through the Clean Water Act Section 404 Permit process for federally jurisdictional wetlands and the Administrative Order process under Chapter 90.48 RCW (the Washington Water Pollution Control Act).
- If wetlands would potentially be impacted, develop and implement a wetland mitigation plan using the interagency "Wetland Mitigation in Washington State" guidance.[49]
- For projects in shrubsteppe habitat, reference WDFW's WSRRI Long Term Strategy 2024–2054 document and online mapper to identify potential mitigation sites and actions.
- Based on survey results, include mitigation measures to subgrade over excavation and fill, compaction, moisture conditioning, and minimizing disturbed areas.
- Minimize removal of native vegetation to reduce erosion and minimize invasion of non-native plants.
- Replant project areas with native vegetation to the extent possible to break up areas of exposed soil and reduce soil loss by wind erosion.

[49] https://ecology.wa.gov/water-shorelines/wetlands/mitigation/interagency-guidance

- Return temporarily disturbed areas to their original, preconstruction contours and conduct site restoration and revegetation measures before or at the beginning of the first growing season following construction.
- Conduct tree removal in a manner that minimizes disruption to remaining plants and shrubs.
- Implement measures to minimize noxious weed spread, including inspection of vehicles before entering construction areas, remaining on established roads as much as possible, and installation and use of weed wash stations or use of other appropriate equipment cleaning measures.

4.6.4 Findings for production facilities with co-located BESS

4.6.4.1 Impacts

The potential construction, operation, and decommissioning impacts to biological resources described for green hydrogen production facilities would also apply to green hydrogen production facilities co-located with BESSs. The footprint would slightly change with the addition of a BESS, but the potential impacts would be similar.

Impacts from construction, operation, and decommissioning

Co-locating a BESS with a green hydrogen production facility would require some additional construction-related ground disturbance and an increased building footprint relative to facilities with no BESS. The presence and use of a BESS at a green hydrogen facility would add another stormwater consideration and potentially another regulated element to be included in an industrial SWPPP due to the container and concrete foundation. BESSs would require heating, ventilation, and air conditioning units, which could generate increased noise that may disturb wildlife.

Overall, potential impacts from construction, operation, and decommissioning from a facility with a BESS on terrestrial habitats and species, aquatic habitats and species, and wetlands would be the same as those described in Section 4.6.3 for green hydrogen production facilities.

Findings

Impacts from construction, operation, and decommissioning of facilities with co-located BESSs would be similar to findings for green hydrogen production facilities.

4.6.4.2 Actions to avoid and reduce impacts

Actions for reducing the biological resources impacts for a facility with a co-located BESS would be the same as those identified for green hydrogen production facilities without co-located BESSs with the additional measure to site all BESS facilities and associated infrastructure away from streams, wetlands, and other water resources.

4.6.5 Findings for green hydrogen storage facilities

4.6.5.1 Impacts from construction, operation, and decommissioning

The potential construction, operation, and decommissioning impacts to biological resources described for green hydrogen production facilities would largely apply to green hydrogen storage facilities. A green hydrogen storage facility would have a footprint less than 1 acre and would have less water requirements than a green hydrogen production facility, so there would be less impact to aquatic species and habitats and wetlands.

Findings
Impacts from construction, operation, and decommissioning of green hydrogen storage facilities would be the same as those described for green hydrogen production facilities.

4.6.5.2 Actions to avoid and reduce impacts

Actions for reducing the biological resources impacts for a green hydrogen storage facility would be the same as those identified for green hydrogen production facilities.

4.6.6 Findings for the No Action Alternative

The potential impacts from facilities developed under the No Action Alternative would be similar to the impacts for the types of facilities described above for construction, operation, and decommissioning, depending on facility size and design, and there would be **less than significant to potentially significant adverse impacts**.

4.6.7 Unavoidable significant adverse impacts

Construction and operation of green hydrogen facilities may result in **potentially significant and unavoidable adverse impacts** on terrestrial and aquatic special-status habitats and species if activities cause the permanent degradation, loss, or conversion of suitable habitat that is critical to habitat or species viability; affect the mortality of any individual species or disturbance that disrupts successful breeding and rearing behaviors; or disrupt habitat continuity along migration routes. Determining if mitigation options would reduce or eliminate impacts below significance would be dependent on the specific project and site. Mitigation to reduce impacts below significance for terrestrial and aquatic special-status habitats or species may not be feasible.

4.7 Energy and natural resources

Key findings

A green hydrogen facility developer would need to ensure there is sufficient electricity for a project available by establishing an agreement with a utility for access to the electrical grid or with a producer of electricity. The amount of electricity available will vary based on the project location. If electricity is not available, a project would not be able to operate.

This PEIS assumes that a developer has contracted for sufficient electricity. With this assumption, through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the construction, operation, and decommissioning of green hydrogen facilities would likely result in **less than significant impacts** on electricity supply.

This PEIS assumes that a developer would contract for RNG through local natural gas providers to determine if RNG is available in their area. With this assumption, through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the operation of SMR and pyrolysis green hydrogen production facilities would have **less than significant impacts** on the availability of RNG fuels. Electrolysis and bio-gasification facilities would have **no impact** on the availability of RNG fuels.

The PEIS assumes that a developer would contract for biomass through a local provider to determine if biomass is available in their area. With this assumption, through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the operation of bio-gasification facilities would have **less than significant impacts** on the availability of biomass fuels. Electrolysis, SMR, and pyrolysis facilities would have **no impact** on the availability of biomass fuels.

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the construction, operation, and decommissioning of green hydrogen facilities would likely result in **less than significant impacts** on fuels and construction aggregate.

No significant and unavoidable adverse impacts related to energy and natural resources would occur.

This section describes sources and availability of energy and natural resources and the amount that would be required by the facilities considered in this PEIS. Impacts on public service or utility providers are described in the public services and utilities resource section. Emissions associated with use of energy and natural resources are described in the air quality and greenhouse gases section.

The *Energy and Natural Resources Technical Appendix* (Appendix H) includes the full analysis and technical details used to evaluate energy and natural resources in this PEIS.

4.7.1 Affected environment

The type and quantity of energy and natural resources used in construction and operation can affect overall availability of these resources for other uses. The resources evaluated include electricity, renewable natural gas (RNG), biomass, transportation fuels, and construction aggregate.

4.7.1.1 Electricity

Washington generates more electricity that it consumes. In 2023, Washington State used 88,702 million kWh of electricity, while it produced 98,725 million kWh. In 2023, hydroelectric power accounted for 60% of Washington's total electricity generation and typically contributes between one-fourth and one-third of all hydroelectric generation in the United States. Natural gas, nonhydroelectric renewable sources, nuclear energy, and coal provide nearly all the remainder of the state's electricity generation. Renewable sources other than hydroelectric power accounted for approximately 10% of electricity generation in the state in 2023.

The State Energy Strategy identifies that the demand for electricity in Washington will double by 2050. Development of hydrogen and renewable fuels production, in coordination with expanded renewable electricity capacity, is needed to meet the high demand.

4.7.1.2 Renewable natural gas

The decomposition of plant and animal material at solid waste landfills, water treatment plants, livestock farms, and other facilities produces a biogas primarily composed of methane, carbon dioxide, nitrogen, and oxygen. This biogas is then upgraded to pipeline quality and injected into the pipeline grid as RNG for use in place of fossil natural gas. Washington consumed approximately 294,613 million cubic feet (MMCF) of renewable natural gas in 2018 (Find Energy 2024).

As described in the *Energy and Natural Resources Technical Appendix* (Appendix H), RNG requirements for larger SMR and pyrolysis facilities exceed current statewide RNG supply. Facilities that could produce enough RNG to replace approximately 1.3% of fossil natural gas consumption in Washington have sold out as of 2018. RNG from these facilities is subject to long-term supply contracts for transportation consumption outside of Washington. The market demand for RNG is Washington is expected to grow, and RNG infrastructure and supply are expected to increase accordingly.

4.7.1.3 Biomass

Biomass is renewable organic material that comes from plants and animals and that can be burned for heat or converted to liquid and gaseous fuels through various processes. RCW 80.50.20 requires that biomass used for green hydrogen production come from solid organic fuels including wood, forest, or field residues, or from dedicated energy crops that do not include wood pieces treated with chemical preservatives.

Estimates indicate that biomass was used as a primary energy source to generate about 351 million kWh of electricity in 2023.

4.7.1.4 Transportation fuel

Transportation fuels include gasoline and diesel fuel. In 2019, Washington consumed 2.8 billion gallons of gasoline and 950 million gallons of diesel fuel. Washington has several refineries and imports crude oil from Alaska and other locations and exports refined products. The state has a processing capacity of 648,000 barrels of crude oil per day, which produces 4.2 billion gallons of gasoline and 2.5 billion gallons of diesel annually. Much of this is exported.

4.7.1.5 Construction aggregate

Construction aggregate is a collective term for sand, gravel, and crushed stone. State production is monitored by USGS, and surface mine permitting is handled by DNR. Though it is a non-renewable resource, construction aggregate is readily available in Washington. In 2023, the state produced 30.9 million MT of sand and gravel, and 14.4 million MTs of crushed stone.

4.7.2 How impacts were analyzed

The assessment of impacts was qualitative and considered if green hydrogen facilities could result in increased demand for electricity, renewable natural gas, biomass, transportation fuel, or construction aggregate that could or affect statewide annual production.

4.7.3 Findings for green hydrogen production facilities

4.7.3.1 Impacts

Impacts from construction and decommissioning
Electricity
During construction and decommissioning activities, electricity would be needed to power tools and machinery, lighting, communication and safety systems, and site offices. This demand could either be met with diesel fuel from portable generators or with electricity provided by a utility.

Renewable natural gas
During construction and decommissioning activities, RNG would not be needed. There would be no effect to supply chains or management and distribution of resources.

Biomass
During construction and decommissioning activities, biomass would not be needed. There would be no effect to supply chains or management and distribution of resources.

Fuels
Facilities would consume fuels during construction and decommissioning for worker commuting, haul-truck trips, and site equipment. The combined transportation fuel consumed by worker commuting, delivery, and site equipment at green hydrogen production facilities during construction would be 5,074 to 104,166 gallons. Diesel or gasoline for construction

would be purchased from suppliers in Washington. Relative to the total annual gasoline production in Washington (4.2 billion gallons of gasoline), 2,166 to 55,682 gallons of gasoline represents 0.00005% to 0.001% of the total available fuel resource produced in the state. Decommissioning activities are expected to require similar fuels as required during construction.

Construction aggregate

Construction of facilities would use aggregate for concrete building and equipment foundations or hard-pack gravel equipment pads. Concrete and gravel may also be used for parking areas, equipment storage areas and corporation yards, and perimeter hardening. No demand for aggregate is expected for decommissioning.

Facilities would require between 942 and 1,256 cubic yards for a 1-acre facility and between 11,945 and 14,582 cubic yards for a 10-acre facility. This is 0.03% to 0.04% of the total available resource produced annually in the state. If off-site access roads are needed, an additional 4,693 to 46,933 cubic yards of aggregate would be needed. Aggregate may need to be obtained from multiple mines, depending on the facility location.

Findings

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the construction and decommissioning of facilities would likely result in **less than significant impacts** on energy and natural resources.

Impacts from operation

Electricity

A facility would consume electricity during operations and for maintenance. Electricity would be used to power buildings, sensors, lights, cameras, gates, and other basic site functions. For a green hydrogen production facility, the majority of the electrical energy used would be for the production process.

The anticipated maximum electricity requirements for each green hydrogen production method would be 0.05% to 0.24%of the 2023 production demand for total statewide electricity production and renewable statewide electricity production.

Renewable natural gas

RNG may be used during operation of facilities relying on the SMR and pyrolysis methods of production. RNG requirements for upper-bound SMR facilities may exceed 143% of current statewide RNG supply, and RNG requirements for upper-bound pyrolysis facilities may exceed 19% of current statewide RNG supply. At current levels, RNG demand for energy during operations of large SMR and pyrolysis facilities could result in a reduction in access or create a substantial reduction in availability of RNG. Depending on the location, timing, size, and type of facility, the operation of a green hydrogen production facility could consume or exceed available supply of RNG fuels in Washington State. Developers would not be able to propose or build facilities that utilize RNG where unavailable.

Biomass

Biomass would be used for feedstock during operation of bio-gasification and pyrolysis facilities; of the two methods, bio-gasification would consume the larger volume of biomass during hydrogen production.

Biomass requirements for bio-gasification for a single large bio-gasification facility may be equal to 3.6% of the 2022 total statewide consumption of biomass. Demand for biomass to operate large bio-gasification facilities could result in a local reduction in access or create a substantial reduction in availability of biomass feedstocks. Bio-gasification production facilities could alter the sector of the economy in which biomass is predominantly consumed. This may result in a minor and temporary reduction in access or availability of biomass feedstocks for current consumers.

Depending on the location, timing, size, and type of facility, the operation of a green hydrogen production facility could result in use of biomass fuels. Developers would not be able to build facilities where the market supply could not cost-effectively or feasibly provide for demand for biomass.

Fuels

Green hydrogen production facilities would consume transportation fuels during site characterization, construction, and decommissioning for three broad purposes: equipment use, vendor trips, on-site trucks and haul trucks (diesel) and worker (gasoline) trips. The combined diesel and gasoline fuel consumed by worker commuting, vendors, on-site trucks and hauling would be 22,750–135,918 gallons of diesel and 2,166–55,682 gallons of gasoline. Diesel or gasoline would be purchased from suppliers in Washington. Relative to the total annual diesel production in Washington, 22,750–135,918 gallons of diesel represent 0.009% to 0.05% of the total available diesel fuel resource produced in the state. Relative to the total annual gasoline production in Washington, 2,166–55,682 gallons represent 0.0005% to 0.02% of the total available transportation fuel resource produced in the state.

Construction aggregate

During operations, gravel would be needed for upkeep of access roads and other rocked surfaces. For a 1-acre site, this would be 0.45 acre, and for a 10-acre site, this would be 4.5 acres. If it is assumed that new surface gravel is needed once every 5 years and gravel would be 4 inches deep, average annual demand would range from 500 to 16,000 cubic yards per year depending on facility size and access points. It is not expected that aggregate needs during operations would cause aggregate resources in the vicinity of a facility site to result in a reduction in available supply of those materials for other projects.

Findings
A green hydrogen facility developer would need to ensure there is sufficient electricity for a project available by establishing an agreement with a utility for access to the electrical grid or with a producer of electricity. The amount of electricity available will vary based on the project location. If electricity is not available, a project would not be able to operate.

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the construction, operation, and decommissioning of green hydrogen production facilities would likely result in **less than significant impacts** on electricity, fuels, and construction aggregate.

This PEIS assumes that a developer would contract for RNG or biomass through local providers to determine if they are available in their area. With this assumption, through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the operation of green hydrogen production facilities would have **less than significant impacts** on the availability of RNG or biomass fuels.

4.7.3.2 Actions to avoid and reduce impacts

The following are some actions to avoid and reduce impacts of green hydrogen production facilities. See Appendix H, *Energy and Natural Resources Technical Appendix*, for typical mitigation measures that may be included in plans or permit conditions and additional measures that may apply for production facilities.

Siting and design considerations

- Minimize electricity demand by using facility power for operational needs whenever possible, using high-efficiency fixtures and appliances in operations buildings, and using high-efficiency security lighting.
- For SMR, pyrolysis, and bio-gasification facilities, identify and confirm resource availability with providers.
- Install high-efficiency electrical fixtures and lighting wherever possible.
- Estimate electrical energy needs during construction, operation, and decommissioning and confirm adequate resource availability with providers.

4.7.4 Findings for production facilities with co-located BESS

4.7.4.1 Impacts

Potential construction, operation, and decommissioning impacts to energy and natural resources described for green hydrogen production facilities apply to green hydrogen production facilities with up to two co-located BESSs. Relative to a green hydrogen production installation, the addition of co-located BESSs would require a small amount of additional resources during construction for the BESS portion of the facility.

Impacts from construction, operation, and decommissioning

Electricity

Electricity use may be more intensive for short periods during testing of the installed BESS equipment. Similar to green hydrogen production facilities, the demand for energy during construction, operation, and decommissioning is not expected to require new or substantially modified production or energy transmission. Electricity demands during production for facilities with a BESS would be similar to demands for facilities without a co-located BESS; however, the BESS would provide some on-site electrical supply during times of maximum grid load or strain. Impacts to electricity from decommissioning would be similar to impacts from construction.

Renewable natural gas

During construction and decommissioning activities, RNG would not be needed. There would be no effect to supply chains or management and distribution of resources.

The addition of a BESS unit to a green hydrogen production facility would not alter the characterization of RNG impacts discussed in Section 4.7.3.1. Developers would not build facilities where the market supply could not cost-effectively or feasibly provide for demand for RNG fuels.

Biomass

During construction and decommissioning activities, biomass would not be needed. There would be no effect to supply chains or management and distribution of resources.

The addition of a BESS unit to a green hydrogen production facility would not alter the characterization of biomass impacts discussed in Section 4.7.3.1. At current levels, RNG demand for energy during operations of large SMR and pyrolysis facilities could result in a reduction in access or create a substantial reduction in availability of RNG. Developers would not build facilities where the market supply could not cost-effectively or feasibly provide for demand for biomass fuels.

Transportation fuel

Adding BESSs to green hydrogen facilities would require additional hours for construction and installation, increasing demand for transportation fuels to support worker commuting. more truck trips would be required to transport the BESS and any additional gravel needed for the areas around the BESS, and a few additional containers of support materials and equipment delivery may be required. The relative increase in fuel for construction of the BESS would be minimal compared to what would be required for construction and operation of the green hydrogen facility. Decommissioning would have approximately the same demand for transportation fuels as construction.

Construction aggregate

A BESS container would typically be installed on a concrete slab approximately 60 feet by 12 feet, requiring approximately 16.5 cubic yards of aggregate. During operations and maintenance, construction aggregate would be needed only to maintain maintenance roads.

Since the BESS would be co-located with other facility areas, there would be no additional demands for aggregate resources during operations.

Because new foundations and infrastructure would not be created, decommissioning is not expected to require additional construction aggregate. The addition of BESSs would not represent an overall change to the potential range of aggregate demand.

Findings
Impacts would be similar to findings for green hydrogen production facilities above.

4.7.4.2 Actions to avoid and reduce impacts

Actions to avoid and reduce impacts would be the same as those identified for green hydrogen production facilities (Section 4.2.3.2), with the addition of the below siting and design measure.

4.7.4.1 Siting and design considerations

- Co-locate BESSs with other facilities to minimize footprint of the facility.

4.7.5 Findings for green hydrogen storage facilities

4.7.5.1 Impacts

Impacts from construction, operation, and decommissioning
Electricity
The demand for electricity during construction, operation, and decommissioning of storage facilities is not expected to require new or substantially modified production or energy transmission.

A green hydrogen storage facility would consume electricity during operations. Gas compression and liquefaction would require electricity to enable storage. Electricity would be needed to compress the hydrogen gas to liquid form. Upper-bound kilowatt hour requirements for each storage type were based on electricity required to store 1 kg of hydrogen. Gas storage would require approximately 2–3 kWh/kg of hydrogen stored. Liquid storage would require 7–12 kWh/kg of hydrogen stored. Maximum storage demands for both gas and liquid methods would be 0.2% to 0.6% of the annual percentage of the total statewide electricity production. Compared to production facilities, the maximum storage capacity considered was larger than production capacity.

Impacts to electricity from decommissioning would be similar to impacts from construction.

Renewable natural gas
During construction, operation, and decommissioning activities, RNG would not be needed. There would be no effect to supply chains or management and distribution of resources.

Biomass
During construction, operation, and decommissioning activities, biomass would not be needed. There would be no effect to supply chains or management and distribution of resources.

Fuels
demand for transportation fuels to support worker commuting. Impacts would be similar to those for facilities described in Sections 4.7.3 and 4.7.4, except that more truck trips would be required to transport the storage facility components and any additional gravel needed for the areas around the storage facilities. The relative increase in fuel for construction of the storage facilities would be minimal compared to what is already demanded for construction of the green hydrogen facility.

Adding storage facilities would require additional hours for maintenance, which would result in a minor increased demand for transportation fuels beyond what is already demanded for operation of the facility as a whole.

Decommissioning would also have approximately the same demand for transportation fuels as construction.

Construction aggregate
Demand for construction aggregate could increase if the storage tanks are co-located at a green hydrogen production facility, depending on the size and type of facility. Liquid hydrogen can be stored in cylindrical tanks or spheres, which would require approximately 23 to 505 cubic yards of aggregate for support pads.

The resulting increase in construction aggregate demand would not be enough to materially increase overall consumption as analyzed for other facility types.

Findings
Impacts would be similar to findings for green hydrogen production facilities above.

4.7.5.2 Actions to avoid and reduce impacts

Actions to avoid and reduce impacts would be the same as those identified for green hydrogen production facilities

4.7.6 Findings for the No Action Alternative

The potential impacts from facilities developed under the No Action Alternative would be similar to the impacts for the types of facilities described above for construction, operations, and decommissioning, depending on facility size and design, and would be **less than significant.**

4.7.7 Unavoidable significant adverse impacts

Demand for biomass for operations of green hydrogen bio-gasification facilities could result in a reduction in access or create a substantial reduction in availability of biomass resources.

Demand for RNG for operations of green hydrogen SMR or pyrolysis facilities could result in a reduction in access or create a substantial reduction in availability of RNG resources. These impacts could be mitigated through development of new additional biomass or RNG facilities for use by green hydrogen facilities.

Through compliance with laws and permits, and with implementation of actions to avoid and mitigate significant impacts, green hydrogen facilities would have **no significant and unavoidable adverse impacts** on energy or natural resources from construction, operation, or decommissioning.

4.8 Environmental health and safety

Key findings

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, most construction, operations, and decommissioning activities would likely result in **less than significant impacts** related to hazardous materials and health and safety.

Depending on the specific location, severity, and emergency response capacity, operation activities would likely have **less than significant to potentially significant adverse impacts** from fires and explosions. The severity of risks would need to be assessed for each facility based on the project location, production method, and quantities of flammable materials produced or stored on-site.

A thermal runaway event due to damage or battery management system failure at a facility with a co-located lithium-ion battery energy storage system (BESS) would likely have **potentially significant adverse impacts** related to hazardous air emissions.

A facility may result in **potentially significant and unavoidable adverse impacts** if new ignition sources are in remote locations with limited response capabilities, or if a fire or explosion during operations spreads rapidly or impacts large areas. Determining if mitigation options would reduce or eliminate impacts below significance would be dependent on the specific project and site.

Environmental health and safety (EHS) refers to the risks or hazards that threaten the well-being of people or other elements of the environment. The *Environmental Health and Safety Technical Appendix* (Appendix I) includes the full analysis and technical details used to evaluate EHS in the PEIS. Impacts related to emergency response services are discussed in Section 4.15, Public services and utilities. Impacts related to air emissions are discussed in Section 4.4, Air quality and greenhouse gases.

4.8.1 Affected environment

Workplace accidents or system failures can result in EHS hazards, such as fires, explosions, hazardous material spills, injury, or structural damage. In this section, EHS includes hazardous materials, worker health and safety risks, fire and explosion risk, and emergency response services.

4.8.1.1 Hazardous materials

The quantities and uses of hazardous materials vary greatly by land use. Hazardous materials can be present at industrial lands as well as commercial and agricultural land uses. Hazardous materials that could be present at businesses or other sites may include, but are not limited to, petroleum products (e.g., gasoline, diesel, or oil), heavy metals (e.g., lead, cadmium, mercury, or arsenic), pesticides, solvents, compressed gases, and batteries. Low concentrations of hazardous materials (heavy metals, petroleum products, or hydraulic fluids) may also be present along roads as a result of vehicular activity.

Ecology regulates and monitors the storage, use, and disposal of hazardous materials. Active land uses that handle hazardous materials must document their presence. Industrial lands may have areas that have been contaminated from previous activities. Toxic substance cleanup sites are recorded in Ecology's Contaminated Site Register. Within the study area, there are 19 cleanup sites, recorded in Ecology's Contaminated Site Register and approximately 14,145 Model Toxics Control Act (MTCA) sites in Washington with known or suspected contaminants. Many of the cleanup sites that are within the study area are in western Washington. These sites have hazardous material contamination present in the soil, surface water, or groundwater. Following remediation or cleanup, some sites may be viable for new land uses.

4.8.1.2 Worker health and safety risks

Hazards at industrial facilities can pose risks to human health and the environment. The risks may include job site hazards for construction workers, operational risks and hazards for future workers and site occupants, inadvertent release of hazardous materials to the natural and built environment, and exposure to existing hazardous materials sites and utilities. Common workplace hazards at industrial facilities can include getting caught in or between machinery, materials, and other objects; chemical or substance exposure; electrical exposure; falls; fire or explosion; getting hit by projectiles, debris, vehicles, and other objects; high temperature exposure; noise; and sprain or strain.

Measures and BMPs can be implemented to either prevent or address workplace hazards include changing the chemicals, materials, or equipment to be safer; and changing the method or tool used to be safer or improve the location (limit access or improving ventilation). The use of personal protective equipment to protect eyes, face, feet, hands, ears, torso, and lungs and provide fall protection can be required depending on the anticipated risk.

4.8.1.3 Hydrogen safety and risks

Hydrogen has been produced for decades using fossil fuel feedstocks. Approximately 10 million tons of hydrogen are produced annually in the United States to make products like gasoline, silicon chips, and food products. The major hydrogen-producing states are California, Louisiana, and Texas. In Washington, hydrogen production facilities using fossil fuel feedstocks provide hydrogen for use by oil refineries.

Hydrogen gas is non-toxic and non-poisonous as a chemical alone. Most of this hydrogen is produced near large industrial sites. This analysis considers the risks associated with handling hydrogen.

All fuels have some degree of associated risk and advantages. The health and safety risks of hydrogen production and use are comparable to those of oil refineries, which produce and use hydrogen in production. Some risks unique to hydrogen are that it burns with a colorless flame making hydrogen fires hard to detect and, it is odorless making hydrogen leaks hard to detect. It has a high energy content by weight making it challenging to store, and it is a small molecule making it prone to leakage. Hydrogen has a wider flammability range and a lower ignition energy than gasoline vapor and natural gas, but hydrogen requires greater concentrations in air to ignite or explode.

Following safety procedures and taking preventative actions are critical for reducing risks. Regulations, guidelines, and codes and standards have been established through years of hydrogen use (refer to the *Environmental Health and Safety Technical Appendix* (Appendix I). Industry requirements and standard practices identify ways to reduce the risks associated with gas or liquid hydrogen. These help reduce the risk of an incident; however, risk cannot be completely eliminated.

Hydrogen facilities use safety equipment to reduce unnecessary risk. Hydrogen leak detectors are used to detect a leak of the odorless gas reducing ignition and asphyxiation risk. Flame detectors are used to detect the colorless flame of a hydrogen fire to reduce the risk of a fire getting out of control or leading to an explosion. Ventilation equipment is used to reduce the risk of leaks into a confined space reducing the risk of ignition or asphyxiation. Certain materials are best suited for hydrogen production, use, and storage. Material choices differ between liquid and gaseous hydrogen. Maintenance of all components of a hydrogen facility, including safety equipment, also helps reduce unnecessary risk.

4.8.1.4 Facility fire and explosion risk

Industrial facilities commonly include flammable materials, gases, and dust. Explosions can occur when flammable gases or dusts are exposed to a heat source such as fire and an oxidizer such as oxygen. Explosions can also occur when fires are not properly contained and are then exposed to flammable gases or dusts. Risk of explosion is reduced through proper dust control and ignition source when handling flammable dusts and proper emergency response. The use of detection systems for flammable gases can detect leaks before they reach explosive concentrations. Proper handling and storage of flammable materials would reduce fire risks.

Hydrogen gas has a wide flammability range between 4% and 74% in air and requires 0.02 millijoule of energy to ignite at higher concentrations. At concentrations of less than 10% in air, the energy required to ignite increases to levels similar to that of natural gas or gasoline in their respective flammable ranges. Hydrogen burns with a colorless flame, making it difficult to detect that it is burning.

The severity of fires and explosions would vary by incident and the quantity of hazardous materials and hydrogen on site. Facility fires and explosions can impact surrounding properties. Site-specific facility hazard analysis and risk assessments of fire and explosion risks are required by National Fire Protection Association (NFPA) 55, codified in Washington's building and fire codes, and identify risks to surrounding properties and setbacks. A hazard analysis and risk assessment calculates a setback by considering the highest risk of the proposed system and potential release scenarios. Setbacks are calculated using a prescribed scientific model that predicts the extent of specific hydrogen concentrations and heat fluxes, and risk criteria are identified. The risk factors that can increase setback requirements are different for gas and liquid. Gas risk factors include storage pressure, leak diameter, pipe diameter, and distance to combustible and non-combustible equipment. Liquid risk factors include use and storage of flammable or combustible liquids and materials, sources of ignition like electrical equipment, ventilation, and welding or cutting operations nearby.

Materials and conditions are also identified and considered when prescribing setback, including lot lines, buildings, wall openings, air intakes, ignition sources, parked cars, utilities, and places of public assembly, among others.

Minimum setbacks provided by NFPA 55 are based on pressure (gas) or storage size (liquid) alone and do not include risk factors, site-specific characteristics, or fire resistance measures (Figure 4-5). Minimum setbacks for a facility would be identified through a site-specific hazard analysis and risk assessment. Facilities with multiple storage tanks require larger setbacks and considers the greater combined risk of multiple storage tanks. Where there are fire barrier walls, setbacks could be reduced. Calculating a minimum setback distance setback requires detailed site-specific information on risk factors and exposure groups. The example setback distances shown in Figure 4-5 and described in Table 9 of the *Environmental Health and Safety Technical Appendix* (Appendix I) are provided for context and are not reflective of the site-specific risk factors and exposure groups that would be considered in the hazard analysis and risk assessment study required by NFPA 55. Figure 4-5 shows example minimum setbacks for structures and materials typically found in industrial areas. Minimum setbacks for other structures, such as houses, would be determined during a site-specific hazard analysis and risk assessment study and would also include local building and fire code setbacks.

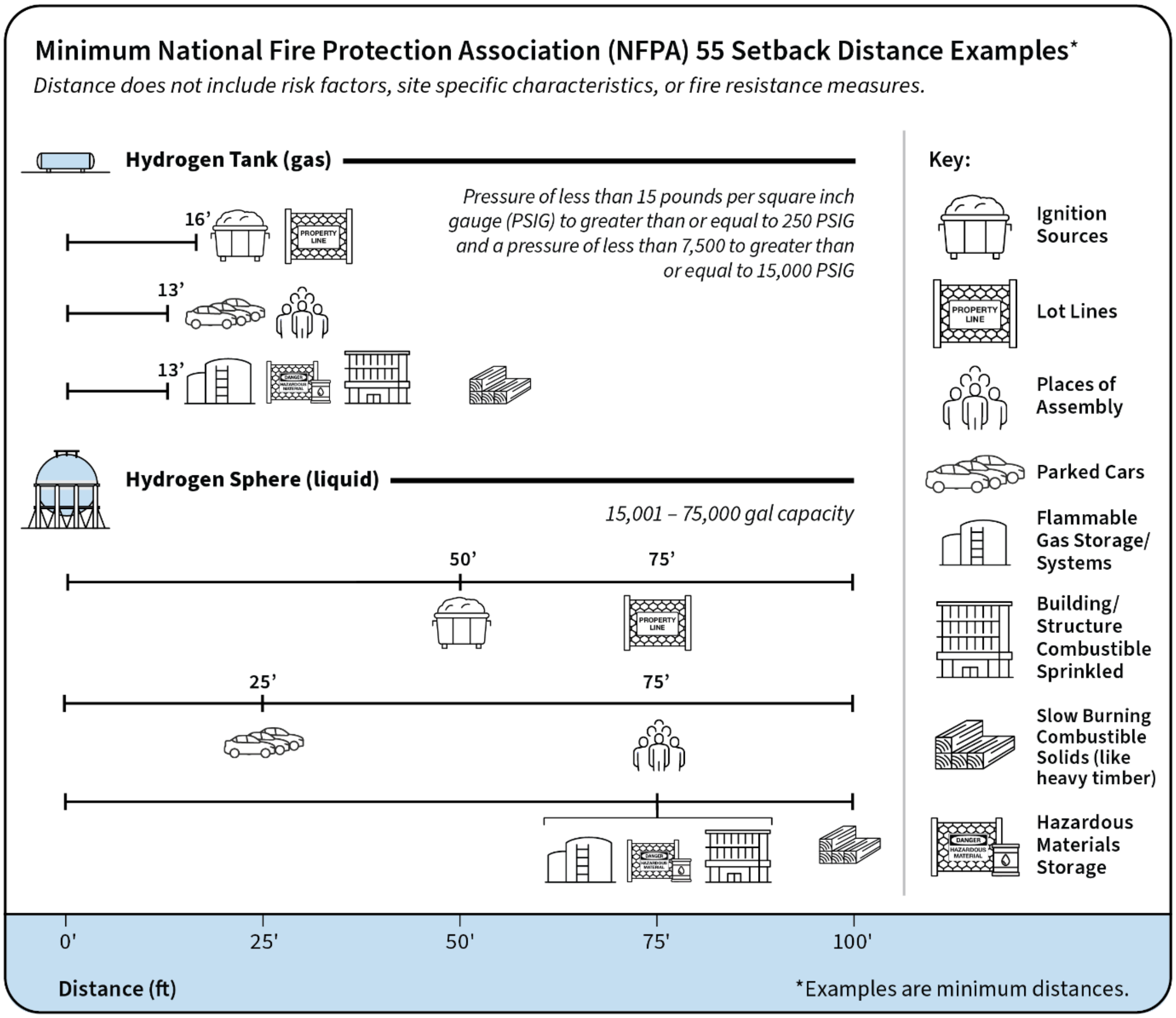

Figure 4-5. Minimum NFPA setback distance examples

Source: NFPA 55, Table 11.3.2.2 for liquid hydrogen and NFPA 2, 7.3.2.3.1.2(B)(a) for gas hydrogen

Wildland fires affect habitats as well as structures on or adjacent to these lands. The type and amount of topography (e.g., slope, elevation, and aspect), weather/climate conditions (e.g., wind, temperature, and humidity), and vegetation/fuels are the primary factors influencing the degree of fire risk and fire behavior in an area. Washington has experienced many extreme fire events in recent years, partly attributed to climate change effects and the legacy of forest fire suppression practices, and this is expected to increase in the future. The combination of longer fire seasons, population growth, declining forest health, and other changing risk factors has made wildfire considerations a top priority in the state. Development is denser, and risk of wildfire is lower in western Washington. The study area also includes areas that are transitions between land and human development, known as wildland-urban interface (WUI) areas, which have greater risk of wildfire than fully developed areas.

4.8.1.5 Emergency response services

Emergency response includes law enforcement, fire departments, and emergency medical services (EMS). Impacts to emergency response services is addressed in the *Public Services and Utilities Technical Appendix* (Appendix P).

4.8.2 How impacts were analyzed

The assessment of impacts was qualitative, and considered the following:

- Release of hazardous materials to the environment that increases the risk of environmental contamination (e.g., air or water) or threats to human health and safety
- Hazard to the public or environment through transport, use, or disposal of hazardous materials or waste
- Increased risk of fire or explosion
- Increase in physical safety risks resulting in a high likelihood of harm to facility workers or the public
- Increase in wildfire risk

4.8.3 Findings for green hydrogen production facilities

4.8.3.1 Impacts

Impacts from construction and decommissioning

Hazardous materials

Hazardous materials used during construction and decommissioning would be typical of most industrial facility construction and decommissioning and include solids, fluids, and gases such as petroleum products, compressed gasses, solvents, finishes, pesticides, batteries, dielectric fluids, and concrete. Improper handling of these materials could release hazardous materials into the environment, increasing the risk of environmental contamination and leading to health and safety risks to construction workers and members of the public within the vicinity of a proposed green hydrogen production facility.

Washington state's MTCA dictates the handling and cleanup of hazardous materials. Releases would need to be contained, assessed, and remediated, with hazardous waste transported and disposed of in line with state and federal regulations. An SPCC plan would be required if more than 1,320 gallons of fuel is stored on site to reduce the risk of hazardous materials entering navigable waters.

Airborne pollutants such as dust, fumes, and aerosolized particles would increase due to construction of a green hydrogen production facility. Most, if not all, construction vehicles and heavy machinery would likely use internal combustion engines, which produce exhaust that includes particulate matter. Construction activities may encounter contaminated sites that have previously existing hazardous materials such as underground chemical storage tanks and asbestos-containing materials and building material. Damaging an underground storage tank could cause leaks that could contaminate soil, groundwater, and surface water. Conducting a site assessment prior to construction work would help evaluate potential on-site hazards. Plans could be implemented based on findings to avoid risks of exposure and release.

Hazardous materials associated with construction and operation (discussed below) could be present at the site during decommissioning. Decommissioning could involve a higher risk of releasing hazardous materials due to degradation of facility components or dismantling facility components.

Accidents or failures during construction or decommissioning that could result in the release of hazardous materials are rare, and if they do occur, they are unlikely to happen at a scale that could result in risk of environmental contamination or an increase in threats to human health and safety.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the construction and decommissioning of facilities would likely result in **less than significant impacts** related to release of hazardous materials.

Worker health and safety
Construction activities for green hydrogen facilities would present similar health and safety risks to workers as those that are present on other industrial construction sites. Common occupational health and safety risks include falls from facility structures, collisions with construction vehicles, and exposure to electricity, hazardous materials, fire, the elements, or noise. Impacts on the public are unlikely. Decommissioning could involve a higher risk of exposure for workers to hazardous materials, electricity, or fire due to degraded or malfunctioning facility components. Public access to the facility would be restricted by fences which would limit public exposure to potential hazards.

Facilities would follow Occupational Safety and Health Administration (OSHA) regulations. Additional health and safety requirements would be established during site-specific, project-level planning to address hazards specific to the facility.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, construction and decommissioning activities would likely result in **less than significant impacts** related to worker health and safety.

Fire and explosions
Fire and explosion risks during construction and decommissioning include activities or materials that could cause or feed fire or explosions, such as flammable hazardous materials and vegetation. Construction ignition risks require careful management in areas of high wildfire risk. Wildfires could also spread to a construction site and be exacerbated by the presence of flammable materials on site.

Developers would be required to meet NFPA 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations. This has requirements for proper storage of equipment and materials that are flammable, processes to avoid and address fire hazards, and fire protection equipment.

BMPs for reducing fire risk include developing a fire safety program prior to construction or demolition; removing accumulated flammable waste material, debris, and dust from structures and their vicinity after each work shift; not obstructing access to existing fire hydrants; and having internal combustion engine equipment exhaust face away from combustible materials. Standards in NFPA 241 are designed to reduce the risk of ignition of flammable materials by putting in safeguards that limit the availability of ignition sources within the vicinity of flammable materials.

In addition, developers would be required by law to abide by federal and state construction safety standards for construction projects, including fire protection and prevention standards for flammable liquids, liquefied petroleum gas, and temporary heating devices. Typical measures include fire extinguisher standards set by the NFPA, setbacks for flammable materials and liquids, and maintenance of proper ingress and egress. Additionally, proactive coordination with emergency managers and project-specific planning would reduce construction-related risks.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the construction and decommissioning of facilities would likely result in **less than significant impacts** related to wildfire, fire and explosion risk.

Impacts from operation
Hazardous materials
Operating a green hydrogen production facility would involve the production, use, and storage of hazardous materials. Different hazardous materials such as methane gas, solid, or liquid alkaline electrolyzers, nickel solids, and biomass gasification byproducts solids could be present depending on the production method. Hydrogen gas or liquid would be present at all facilities.

Methane is non-toxic, but a methane leak in a confined space could displace air, leading to asphyxiation. Methane is flammable and could increase fire risk. Methane leaks can be prevented through proper maintenance and detection systems that could be utilized at a green hydrogen production facility.

An alkaline electrolyzer is required for electrolysis. It is common to use potassium hydroxide and sodium hydroxide. There are health risks associated with exposure to these chemicals in both their solid and liquid forms. Workers handling electrolytes would be equipped with proper personal protective equipment (PPE) such as gloves, coveralls, and goggles. Liquid electrolytes also pose a risk of spill. Proper handling and spill prevention measures, including secondary containment measures, would be in place to reduce these risks.

Hydrogen gas is non-toxic and non-poisonous; however, there are fire and explosions risks, as described above and below. Hydrogen is lighter than air and diffuses rapidly, so asphyxiation is unlikely unless a leak were to occur in a confined space. Hydrogen risks to human health and safety generally come from exposure to liquid hydrogen, which can cause severe freeze burns that may be lethal. In addition to proper maintenance and redundant design features, operators who work around liquid hydrogen should wear personal protective equipment to reduce the risk of exposure. Hydrogen can also weaken metals, which may lead to metal piping fracturing and leakage. There are safety codes and standards for hydrogen piping systems, transport, and storage; however, they may not be adopted under local code.

A nickel-based catalyst would be required in green hydrogen production facilities using SMR or may be required for some methane pyrolysis facilities. There are health risks associated with exposure to nickel. The nickel used on site during production would be entirely contained in pellet form within the catalyst inside the reformer tubes and would have low likelihood of exposure. The catalyst would be replaced once every 5 to 6 years as part of routine maintenance. Nickel would be disposed of as part of the process of disposing of the catalyst. Failure to dispose of or handling of reformer tubes could lead to release of nickel, leading to required spill prevention measures.

Solid byproducts from biomass would be dependent on the feedstock. State law requires that biomass used for green hydrogen production to come from solid organic fuels, including wood, forest, or field residues, or from dedicated energy crops that do not include wood pieces that have been treated with chemical preservatives. Based on these feedstocks, the potential waste from biomass can include moisture, ash (solid carbon), carbon dioxide, hydrogen, nitrogen, chlorine, sulfur, or oxygen. With proper maintenance, most of these compounds would not come in contact with workers. Operators would need to analyze their feedstock to address hazardous material concerns and needed secondary containment systems.

Operations and maintenance of a facility would require fewer on-site personnel and less-intensive labor than construction, which would result in lower use of vehicles and equipment that could release hazardous materials.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the operation activities would likely result in **less than significant impacts** related to hazardous materials.

Worker health and safety
The types of occupational health and safety hazards during operation would be similar to those present during construction. While the types of hazards that people could be exposed to remain the same during operation, the risk of exposure would decrease in conjunction with a decrease in the scale and intensity of on-site labor during operations (up to three employees) compared to construction. In particular, the risk of falls from facility structures, vehicle collisions, and exposure to high-volume noises would be greatly reduced during typical

operation and on-site maintenance. While accidents could occur, laws, regulations, and industry standards are in place to prevent health and safety hazards in the workplace.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the operation activities would likely result **in less than significant impacts** related to worker health and safety.

Fire and explosions
Green hydrogen production facilities would have hydrogen present on site, which is highly flammable. Depending on the production method, green hydrogen production facilities could also have the following flammable or combustible substances on site: methane, oxygen, and biomass. Biomass flammability would depend on the source of biomass. Oxygen, while not flammable, is highly combustible and can cause explosions from hydrogen or methane fires. Methane gas is flammable at levels of 5% to 15% by volume in air.

Activities involving regular maintenance of a green hydrogen production facility may include periodic electrical repair, welding, and equipment use and fueling. These activities could also increase fire danger. Having an emergency response plan, working flame and leak detectors, and working fire suppressant systems would reduce the risk of fires spreading. Fires could get out of control if these safeguards are not in place.

Hydrogen explosions cannot occur with pure hydrogen; an oxidizer such as oxygen must be present. Hydrogen combined with oxygen can explode when the concentration of oxygen is between 10% and 41% in air and the concentration of hydrogen is between 18.3% and 59%. Methane can explode at levels above 5.5% in air. It is impossible for either methane or hydrogen to explode when they are isolated away from an oxidizer.

As described above in Section 4.8.1.4, explosion risk can be reduced through proper siting, design, and operations according to NFPA 55 requirements, which is necessary for building and operation permit approval and operational inspections to minimize fire and explosion incident severity and consequence. Developers in Washington are required to follow building and fire codes for design to reduce fire hazards that can lead to explosions. Operators would have to adhere to WAC 296-24-31503 for gaseous hydrogen systems and 29 CFR 1910.103, which include regulations to safeguard hydrogen systems, including requiring detectors and establishing setbacks to reduce mixing. mixing. In addition, NFPA 2, Hydrogen Technologies Code, which may or may not be codified at the local level, provides standards to reduce explosion risk. As stated above, explosions require a flammable gas like hydrogen to mix with an oxidizer and be ignited. Due to hydrogen’s low density, it is nearly impossible for hydrogen explosions to occur in an open-air environment. If a fire or explosion were to occur, it could result in property damage and injury or loss of life on site. These impacts may also extend beyond the facility boundary. The severity of these impacts would vary by the type of incident and land uses of the surrounding properties, as well as emergency response capabilities. Providing proper setbacks between flammable materials and maintaining gas leak and flame detectors are ways to limit destruction and loss of life from explosions. Coordination with local fire departments would help emergency responders properly assess and fight fires, should they need to mobilize.

Findings
Depending on the specific location, severity, and emergency response capacity, operation activities would likely have **less than significant to potentially significant adverse impacts** from fires and explosions. The severity of risks would need to be assessed for each facility based on the project location, production method, and quantities of flammable materials produced or stored on-site**.**

Wildfires
Similar to construction, green hydrogen production facilities would generate ignition risks that require careful management, especially in areas of high wildfire risk. Wildfires could also spread to a green hydrogen production facility and be exacerbated by the presence of flammable materials on site. Proactive planning and compliance with OSHA and NFPA requirements would reduce operation-related risks that could otherwise threaten workers or spread to surrounding urban or wildland areas.

Findings
Depending on the specific location, severity, and emergency response capacity, there is potential that operation activities would likely have **less than significant to potentially significant adverse impacts** of wildfire due to risk of ignition.

4.8.3.2 Actions to avoid and reduce impacts

The following are some actions to avoid and reduce impacts of green hydrogen facilities. See the *Environmental Health and Safety Technical Appendix* (Appendix I), for typical mitigation measures that may be included in plans or permit conditions and additional measures that may apply for facilities.

Siting and design considerations
The following siting and design considerations could be taken into consideration to alleviate impacts to workers, the public, and the environment from EHS risks:

- Site and design facilities to include appropriate setbacks based on project-specific hazard analysis and risk assessment (required by NFPA 55).
- Design facilities with safety systems such as hydrogen heater, hydrogen leak sensors and flame sensors, fire extinguishers, automatic fire suppression system, and employee alarm system.
- Design per NFPA 55 requirements with a defensible space clearance around the site perimeter fencing and structure, particularly buildings, to serve as a fire, explosion, and spill break.

- Comply with applicable design and safety standards from the following associations for construction and operation:
    - American Society of Mechanical Engineers
    - National Standards Institute – Environment, Health, and Safety Management System Standards
    - ASTM – Industrial Hygiene Standards and Safety Standards
    - NFPA
    - Underwriters Laboratory
    - Institute of Electrical and Electronics Engineers

Additional mitigation measures to address potentially significant impacts

- Create a robust emergency response plan for worst-case scenario hazards described in Sections 4.8.1.1 and 4.8.3.1 that includes plans for notifying emergency response, notifying the public, and planning for evacuation.
- Where NFPA guidelines are not required by law, follow NFPA guidelines, specifically NFPA 2, Hydrogen Technologies Code.

4.8.4 Findings for production facilities with co-located BESS

4.8.4.1 Impacts

Impacts from construction, operations, and decommissioning

Co-located BESSs introduce the following hazards and risks:

- The BESS would result in the presence of additional hazardous materials on site that could ignite, spill, or otherwise require specialized response, cleanup, and remediation following an accident.
- Battery fires require specialized response training for first responders due to ignition risks with these hazardous materials.
- The BESS could increase the risk of structural fire or exacerbate wildfires.
- Battery fires can be difficult to extinguish and can easily reignite above certain temperatures.

Additional discussion regarding public services and utilities impacts related to BESS is in the *Public Services and Utilities Technical Appendix* (Appendix P).

Thermal events are very rare for BESSs if properly installed and maintained. Lithium-ion batteries from the BESS would contain toxic chemicals that could be hazardous in the event of a system failure, which could result in the battery leaking. If the batteries overheat or are damaged, they could leak toxic gases, including hydrogen fluoride, hydrogen chloride, hydrogen cyanide, and carbon monoxide. Attempts to extinguish battery fires with water, which manufacturers typically advise against, could increase exposure to toxic chemicals through smoke, vapor, or contaminated runoff.[50] Toxic chemical leaks from battery failures are rare. The risk of hazardous materials leaks from batteries in the BESS could increase during operation

[50] https://cleanpower.org/resources/first-responders-guide-to-bess-incidents/

compared to construction due to the increased potential for batteries to leak or ignite when overheating from energy storage.

BESSs can create hazards for worker health and safety and firefighters and emergency responders, with the possibility of explosions, flammable gases, toxic fumes, water-reactive materials, electrical shock, corrosives, and chemical burns. Once extinguished, release of flammable or toxic gases can enter the environment through the air plume and contaminated water. This could affect people and buildings beyond the facility. Incident response includes air monitoring and modeling to identify potentially affected areas. The site should be entered only by trained firefighters or emergency responders wearing full protective gear. For additional information pertaining to lithium-ion BESS incidents, including guidance for first responders, see Attachment 1 of the *Public Services and Utilities Technical Appendix* (Appendix P).

Battery unit installation or replacement should follow manufacturers' specifications for spacing and clearance distances. Further, BESS generally come equipped with remote alarms for operations personnel and emergency response teams, including voltage, current, or temperature alarms from the battery management system. Other protective measures include ventilation, overcurrent protection, battery controls to operate the batteries within designated parameters, temperature and humidity controls, smoke detection, and maintenance in accordance with manufacturers' guidelines. However, should a thermal runaway event occur, it can be serious.

WAC 51-54A-0322 includes requirements for storage of lithium-ion and lithium metal batteries. Permits are required for when more than 15 cubic feet of batteries are accumulated. A fire safety plan is required and must include emergency responses to be taken upon detection of a fire or possible fire. Where required by the fire code official, a technical opinion and report complying with IFC Section 104.8.2 shall be prepared to evaluate the fire and explosion risks associated with the storage area and to make recommendations for fire and explosion protection. The report shall be submitted to the fire code official and shall require the fire code official's approval prior to issuance of a permit. In addition to the requirements of IFC Section 104.8.2, the technical opinion and report shall specifically evaluate the potential for deflagration of flammable gases released during a thermal runaway event. The handling and cleanup of these types of hazardous materials would be required under state law.

Specialized advance planning and procedures for enhanced emergency response training would be required to ensure that green hydrogen facilities with co-located BESSs do not generate hazards for the public or emergency responders. Proactive planning and compliance with requirements would reduce risks of wildfire ignition and spread. An emergency response plan would specify emergency response measures to be taken upon detection of a possible fire, and adherence to setback distances (in siting and design) would reduce risks of a fire spreading. The Washington State Patrol, Ecology, and representatives from industry and local fire protection districts are studying electric vehicle fires, which could result in additional best practices for battery incident response risk reduction.

Similar to green hydrogen production facilities without a BESS, decommissioning of facilities would include disposal of solid and hazardous waste. While most, if not all, materials that comprise lithium-ion batteries are recyclable, they are often disposed of as hazardous waste due to a lack of recycling service providers for batteries. Washington State adopted regulations under Chapter 70A.555 RCW, requiring battery manufacturers to collect and recycle small batteries, with a mandate that the Washington State Legislature assess and recommend options for collection and end-of-life management of large batteries, such as those used in BESSs. Implementation of a statewide large battery collection and recycling system could greatly reduce impacts on local hazardous waste management capacity.

Findings
Most impacts related to hazardous materials would be similar to findings for green hydrogen production facilities described above. If a thermal runaway event due to damage or battery management system failure were to occur, facilities with lithium-ion BESSs would likely have **potentially significant adverse impacts** due to hazardous air emission risks.

4.8.4.2 Actions to avoid and reduce impacts

Available actions for facilities with BESSs would be the same as those proposed for production facilities without BESSs. Additional actions relative to the BESSs are detailed below.

Siting and design considerations

- BESSs should be designed and sited in a manner consistent with the current IBC and NFPA Standards to minimize overheating and enable clearing of hazardous gases in the event of battery leaks or thermal runaway events. They must also comply with the latest Washington State Building Code Council regulations for batteries.
- Setback distances allowing for emergency access and management or removal of dry vegetation would also reduce risks of explosion and potential release of hazardous materials. If there is a thermal runaway event, the required setback distances also prevent spread from one container to another.

Additional mitigation measures to address potentially significant impacts

- Develop and implement fire protection, prevention, and detection measures and design features in accordance with NFPA 855 Standards for Installation of Energy Storage Facilities and the current Washington Fire Code, including requirements for providing redundant separate methods of BESS failure detection. In addition, the developer should develop an Emergency Response Plan in advance of construction.
- Develop and implement comprehensive training programs and safety protocols for personnel involved in BESS operations and maintenance.
- Develop and implement regular maintenance schedules and inspections for BESS components to ensure optimal performance and early detection of potential issues.
- Develop and implement detailed emergency response plans specific to BESS operations to mitigate the consequences of potential damage or failure of battery management systems.

4.8.5 Findings for green hydrogen storage facilities

4.8.5.1 Impacts

Impacts from construction, operations, and decommissioning

Both liquid and gaseous hydrogen pose similar fire and explosion risk to those described in Sections 4.8.3.1 and 4.8.4.1. Storage tanks pose no risk of fire and explosion unless a leak causes hydrogen to mix with an oxidizer and there is an ignition source present. Liquid hydrogen storage tanks contain denser hydrogen, which could provide more fuel for a fire or explosion. Because of this, industry guidelines, such as NFPA 55, have different proposed setbacks for liquid and gaseous hydrogen storage. Because of the density of liquid hydrogen, setbacks for liquid hydrogen are greater than setbacks for gaseous hydrogen tanks. Facilities with multiple storage tanks require larger setbacks and considers the greater combined risk of multiple storage tanks. Where there are fire barrier walls, setbacks could be reduced. Fire barrier walls can add fire resistance by blocking flames and explosions between any potential leak points and exposure groups.

In addition, 29 CFR 1910.103 requires safety relief valves if tanks are over-pressurized and setbacks for hydrogen tanks that account for the distance where people congregate, locations where flammable material is stored, locations near oxidizers, and other hazards. Storage tanks would generally be outside, but any indoor storage tanks are required to be in well-ventilated areas in accordance with 29 CFR 1910.103.

Findings

Depending on the specific location, severity, and emergency response capacity, operation activities would likely have **less than significant to potentially significant adverse impacts** from fires and explosions. The severity of risks would need to be assessed for each facility based on the project location, production method, and quantities of flammable materials produced or stored on-site.

4.8.5.2 Actions to avoid and reduce impacts

Actions for storage facilities would be the same as those proposed for production facilities.

4.8.6 Findings for the No Action Alternative

The potential impacts from facilities developed under the No Action Alternative would be similar to the impacts for the types of facilities described above for construction, operations, and decommissioning, depending on facility size and design, and would range **from less than significant to potentially significant adverse impacts**.

4.8.7 Significant and unavoidable adverse impacts

A facility may result in **potentially significant and unavoidable adverse impacts** if new ignition sources are in remote locations with limited response capabilities, or if a fire or explosion during operations spreads rapidly or impacts large areas. Determining if mitigation options would reduce or eliminate impacts below significance would be dependent on the specific project and site.

4.9 Noise and vibration

Key findings

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, most construction, operation, and decommissioning activities would likely result in **less than significant impacts** related to noise and vibration.

Potentially significant adverse impacts related to vibration would occur if:

- Vibration from specific construction activities occurs at distances closer than 350 feet from residential land uses, or in close proximity to conventional or historic structures.
- If some types of blasting during construction are conducted within 2,000 feet of historic structures.

No significant and unavoidable adverse impacts related to noise or vibration would occur.

Noise is unwanted sound that can affect people, fish, and wildlife. Vibration is motion through something solid, like the ground, which can affect living creatures or damage buildings. The information in this section summarizes the full analysis and technical details used to evaluate noise and vibration in the PEIS, which can be found in the *Noise and Vibration Technical Appendix* (Appendix J).

4.9.1 Affected environment

4.9.1.1 Ambient noise levels

Due to the large extent of the study area, ambient, or background, noise levels and their effects on the surrounding environment vary based on location. Generally, noise levels are higher around transportation corridors, airports, industrial facilities, and construction activities. Noise levels associated with general community activities throughout the study area can be estimated based on population density. More densely populated counties have ambient values between 45 and 55 A-weighted decibels (dBA); counties with sparser densities are less than 35 dBA.

Sound moving through the air is affected by air temperature, humidity, wind and temperature gradients, vicinity and type of ground surface, obstacles, and terrain features. Natural terrain features such as hills, and constructed features such as buildings and walls, can significantly affect noise levels.

Areas zoned for industrial uses are generally anticipated to have greater ambient noise levels than other land uses due to the types of industrial activities occurring. The study area includes some lands that are zoned for industrial or industrial-supporting uses but are currently undeveloped in rural areas. This analysis assumes that the city and county jurisdictions considered the potential for noise from industrial facilities when approving zoning designations.

Existing sources of noise could include motor vehicle traffic on local roadways and highways, periodic aircraft flyovers, industrial activities such as manufacturing and shipping, as well as natural sounds such as bird calls and wind. Sound moving through the air is affected by air temperature, humidity, wind and temperature gradients, vicinity and type of ground surface, obstacles, and terrain features. Natural terrain features such as hills, and constructed features such as buildings and walls, can significantly affect noise levels.

Noise-sensitive receptors
Some land uses are considered more sensitive to noise than others due to the amount of noise exposure and the types of activities typically involved. Residences, motels and hotels, schools, libraries, churches, hospitals, nursing homes, and auditoriums generally are more sensitive to noise than are commercial and industrial land uses. While green hydrogen facilities are anticipated to be located on land that is zoned for industrial or industrial-supporting uses, adjacent land uses could contain noise-sensitive receptors.

Other resources can also be affected by noise, including sensitive wildlife and habitats (*Biological Resources Technical Appendix* [Appendix G], human health and safety (*Environmental Health and Safety Technical Appendix* [Appendix I]), recreational uses (*Recreation Technical Appendix* [Appendix M]), and environmental justice populations and overburdened community areas (*Environmental Justice Technical Appendix* [Appendix C]).

4.9.1.2 Vibration

Common sources of ground vibrations associated with human activities include vibration from trains; loaded haul-trucks on rough roads; and construction activities such as blasting, pile-driving, and operation of heavy earth-moving equipment. Vibrations from naturally occurring phenomena such as earthquakes are addressed in the *Earth Resources Technical Appendix* (Appendix D).

The effects of vibration include movement of building floors, rattling of windows, shaking of items on shelves or hanging on walls, and rumbling sounds. In extreme cases, vibration can damage buildings. Vibration can also result in annoyance for residential areas. The threshold vibration levels for annoyance are bellow damage thresholds for structures.

Vibration-sensitive land uses and structures
Sensitive receptors for vibration include conventional (modern) structures and historic structures, including older masonry structures. People and residential areas are also sensitive receptors for vibration, particularly during nighttime hours. Information on vibration impacts on historic properties is included in the *Historic and Cultural Resources Technical Appendix* (Appendix N). Sensitive receptors for vibration could occur within the geographic scope of study or on adjacent lands.

4.9.2 How impacts were analyzed

Construction-related noise impacts were evaluated using the General Assessment methodology of the Federal Transit Administration (FTA) *Noise and Vibration Impact Assessment Manual*. The Federal Highway Administration's Roadway Construction Noise Model was also used to calculate noise levels at certain distances for comparison to FTA's published construction noise criteria. The FTA criteria is 90 dBA for daytime or a nighttime criterion of 80 dBA for a substantial (longer than a 2-week) period. The approach for construction-related vibration impact assessment used an estimate of vibration generation at varying distances from specific construction equipment known to generate vibration.

Site characterization, construction, and decommissioning-related noise impacts were evaluated for likely conflicts with local ordinances, potential exposure of noise-sensitive land uses in excess of the FTA criteria, or potential to exceed the maximum permissible environmental noise levels specific to land use as codified in Chapter 173-60 WAC. Most local jurisdictions adopt the stated noise standards, which also include an exemption for sounds originating from blasting and temporary construction sites between the hours of 7:00 a.m. and 10:00 p.m.

For operational impacts from green hydrogen facilities, reference noise levels from sources associated with these facilities were researched from existing project-level analysis (proxy projects) that included three-dimensional noise modeling of noise generation. Using the existing analysis from proxy projects that fall within the scale of the PEIS facility types, a conservative estimate of noise generation with distance was developed for distances at which potential impacts of operational noise may occur from the extent of a green hydrogen facility footprint.

Green hydrogen facilities would be sited in areas currently zoned for industrial or industrial-supporting uses with Environmental Designation for Noise Abatement [EDNA] Class C noise levels of 70 dBA). Adjacent land uses could be Class C industrial properties, Class B receiving properties (e.g., commercial properties, automobile services, office buildings) with EDNA of 65 dBA, or Class A receiving properties (e.g., residential, recreational and entertainment, community service) with EDNA of 60 dBA for daytime and 50 dBA for nighttime.

Construction vibration impacts were evaluated for the potential to expose nearby land uses and structures to peak particle velocity levels that would meet or exceed FTA criteria of 0.5 inch per second for conventional structures or 0.12 inch per second for historic structures.

The extent of noise impacts would depend on the existing ambient noise level at any given receptor, and site- and project-specific modeling would be needed to evaluate potential impacts. The extent of vibration impacts would depend on the types of activities and equipment used and distance to vibration sensitive receptors.

4.9.3 Findings for green hydrogen production facilities

4.9.3.1 Impacts

Impacts from construction and decommissioning

Noise

Potential site characterization, construction, or decommissioning noise impacts would depend on the activities, terrain, vegetation, and local weather conditions as well as distance to the nearest sensitive receptors. Temporary noise would be generated from multiple sources, including:

- Geotechnical investigation and drilling rigs
- Off-road equipment used for site preparation and construction
- Blasting
- Pile driving for facility building construction
- Noise generated steam blows for steam boilers in the gasification process

Blasting is not expected to be needed for construction of most facilities but may occur as part of site preparation activities, depending on subsurface conditions. Noise levels would vary with the level of activity, number and type of equipment, and location and type of activity. Noise levels would be highest during early construction, when most of the noisy and heavy equipment would be used for land clearing, grading, and road construction. Decommissioning noise would be highest during demolition of structures.

Although green hydrogen facilities would be located in areas zoned for industrial or industrial supporting uses, some adjacent non-industrial land uses could include noise-sensitive receptors. Construction activities would be from 1 to 3 years.

Off-road equipment noise

Heavy equipment use would vary during the site preparation, construction, and decommissioning activities. All activities would be within 57 to 73 dBA when the noise receptor is located 200 feet away.

Pile-driving noise

Green hydrogen production facilities may include pile driving for facility foundations and may include either impact or vibratory pile-driving. Pile driving activities would produce the loudest source of noise if needed during construction and would exceed the FTA daytime construction noise criterion of 90 dBA if located within 50 feet of a noise-sensitive receptor. Pile-driving activities would not occur during the full time of construction and would be limited to a span of several days in which to install the piles for foundations. Pile driving is not expected during decommissioning.

Blasting noise

Blasting is not expected to be needed for construction of most facilities but may occur as part of site preparation activities, depending on subsurface conditions. If needed, blasting would typically be done during site preparation and therefore would not occur simultaneously with pile driving or other construction building activities for an individual facility. Due to its low usage factor, blasting noise is similar in magnitude to that of other construction activities and would affect noise sensitive receptors within 50 feet. Noise generated by blasting is similar in magnitude to that of other construction activities. Decommissioning is not expected to require blasting.

Noise from trucks

Noise from trucks moving materials to and from a construction site would potentially increase noise levels along roadways used to access the green hydrogen facility. These truck trips would typically be made throughout the day, and, except in cases where substantial volumes of material would be hauled, the increase in noise levels would not be enough to result in a noticeable increase in traffic noise.

Noise generated by steam blows

Specific to the bio-gasification production process, steam blowdown for steam boilers would occur during the later stages of facility construction. Steam blowdown is a procedure using pressurized steam to clear certain equipment of debris and residue from manufacturing. Steam blowdown activities typically consist of a series of blows over a brief period of days before the commencement of operation and can produce sound at a level of approximately 102 dBA at a distance of 50 feet from the source. This noise would likely attenuate to levels approaching human annoyance beyond the limits of construction, depending on the attenuating factors of the site and be further reduced by zoning setbacks required by the local development code and noise blocking mechanisms during design. Silencers could be installed on piping vents during steam blows to reduce noise levels.

Findings

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, most construction and decommissioning activities would likely result in **less than significant impacts** related to noise.

Vibration

Vibration impacts would depend on the equipment, methods, and distance to sensitive receptors or structures. Construction may involve blasting and the use of equipment such as impact pile drivers and vibratory rollers, which can generate substantial vibration. Vibration from pile driving during construction would exceed the applicable FTA criterion at distances closer than 350 feet, while vibration from vibratory rollers would exceed FTA criterion at distances closer than 50 feet. All other construction and decommissioning equipment could be 25 feet or closer without exceeding FTA criteria. Therefore, vibration from specific activities occurring at distances closer than 350 feet from residential land uses could be a potential impact with respect to human annoyance.

Vibration has the potential to result in architectural damage to nearby structures. Cosmetic damage could result from pile driving closer than 30 feet to a conventional building, or closer than 80 feet to a historic building. Vibration from specific construction and decommissioning activities occurring close to modern or historic structures could result in building damage. Control measures and monitoring programs in place and as required by permits would reduce vibration impacts.

Blasting could cause cosmetic damage to sensitive structures because of vibration or acoustic overpressures. Some types of blasting would result in vibration impacts on historic structures located within 2,000 feet.

Facility decommissioning would result in similar vibration levels as would occur during construction, except for pile driving and blasting activities, which are not expected during decommissioning.

Findings

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, most construction and decommissioning activities would likely result in **less than significant impacts** related to vibration.

Vibration from specific construction and decommissioning activities occurring at distances closer than 350 feet from residential land uses, or in close proximity to conventional or historic structures, would be a **potentially significant adverse impact** with respect to human annoyance or building damage. If some types of blasting are conducted within 2,000 feet of historic structures, it would result in a **potentially significant adverse impact.**

Impacts from operation

Green hydrogen facility noise

The major noise sources during operations are compressors, water pumps, and air blowers. It is expected that all equipment would operate during the day and at night. SMR and bio-gasification methods would produce slightly greater noise levels than pyrolysis and electrolysis due to the greater volume of pump and process equipment. The exact quantity and types of equipment and subsequent noise produced would vary depending on the size and type of green hydrogen facility.

For green hydrogen production facilities, project-level noise assessments for proxy projects were used to estimate the noise generation potential, and the results of the analysis are presented below for the production facility types.

Developers would need to consider site-specific ways to reduce noise for a project as appropriate. Proxy studies from similar types of projects suggest that noise produced during facility operation are below the thresholds for EDNA Class C noise levels in industrial and industrial-receiving areas and thresholds for receiving sensitive land uses (EDNAs Class A and Class B). Green hydrogen production facilities are anticipated to be sited in areas zoned for industrial uses that, through land use planning, have considered industrial sources of noise relative to noise-sensitive receptors.

Electrolysis and pyrolysis

While the proxy study for electrolysis considered only electrolysis-type hydrogen production, the noise levels for pyrolysis production types are expected to be similar. Noise modeling for the proxy project show that the compressors, hydrogen electrolyzers, and cooling towers are the predominant noise sources for the facility and produced noise below the thresholds for EDNA Class C noise levels in industrial and industrial-receiving areas and the thresholds for receiving sensitive land uses (EDNAs Class A and Class B).

Steam-methane reforming and bio-gasification

SMR and bio-gasification noise impacts would be greater than electrolysis and pyrolysis due to the greater volume of pump and process equipment such as water pumps and compressors. Noise modeling for the proxy project produced average noise levels over a 24-hour period below the thresholds for EDNA Class C noise levels in industrial and industrial-receiving areas and the thresholds for receiving sensitive land uses (EDNAs Class A and Class B).

Vibration

Sources of operational vibration from green hydrogen production facilities are expected primarily from rotational equipment such as fans, generators, cooling towers, pumps, and compressors. All machinery would be required to comply with equipment standards in terms of vibrations discharged to the baseplates of the foundations, relevant testing, and measurement. Based on the type of anticipated equipment and design standards, these types of facilities are not expected to generate high vibration levels during operation beyond the footprint of the facility.

Findings

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, operations activities would likely result in **less than significant impacts** related to noise and vibration.

4.9.3.2 Actions to avoid and reduce impacts

The following are some actions to avoid and reduce impacts of green hydrogen production facilities. See Appendix J, *Noise and Vibration Technical Appendix*, for typical mitigation measures that may be included in plans or permit conditions and additional measures that may apply for facilities. Careful site selection and layout for a green hydrogen production facility is the best tool available to reduce the potential for noise and vibration impacts.

Siting and design considerations

- Complete a project-level noise and vibration analysis during siting.
- A buffer distance from noise-sensitive receptors would reduce the need for additional mitigation measures. For facility construction, a buffer distance to noise-sensitive receptors based on facility and site-specific noise modeling should be provided.

- A buffer distance to residential land uses and structures should be provided based on facility and site-specific equipment and vibration impacts. If some types of blasting are included in construction, additional buffer distances should be provided for this activity.

Additional mitigation measures to address potentially significant impacts

- If facility and site-specific noise modeling indicate a potential for exceedance of WAC noise level thresholds of EDNAs of receiving sensitive land uses (Class A and Class B), additional noise mitigation measures would need to be incorporated into the facility design to comply with WAC thresholds. These could include:
  - Siting noise sources to take advantage of existing topography and distances.
  - Engineered sound barriers and/or berms or sound-insulated buildings.
  - Low-noise systems could be incorporated and equipment selected that does not have prominent discrete tones.
- Develop and implement a Construction Noise Management Plan.
- Develop and implement a Construction Vibration Management Plan for any construction.

4.9.4 Findings for production facilities with co-located BESS

4.9.4.1 Impacts

Impacts from construction and decommissioning

Site characterization, construction, and decommissioning would generate similar noise and vibration levels as those analyzed for production facilities of the same size without a BESS.

> *Findings*
>
> Noise and vibration impacts during construction and decommissioning would be similar to findings for green hydrogen production facilities above.

Impacts from operation

Operation of a green hydrogen facility with a co-located BESS would add BESS to the same equipment analyzed for facilities evaluated in Section 4.9.3. Noise would be generated by battery storage liquid cooling units as well as inverters specific to the BESS. In general, these sources would likely operate 24 hours a day and would generate noise during the more noise-sensitive nighttime hours. The proxy project described in Section 4.9.3.1 included a BESS; as described in that section, noise modeling for the facility was found to produce noise levels below the thresholds for EDNA Class C noise levels in industrial and industrial-receiving areas and the thresholds for receiving sensitive land uses (EDNAs Class A and Class B).

The BESS would not be expected to generate operational vibration.

> *Findings*
>
> Noise and vibration impacts during operation would be similar to findings for green hydrogen production facilities above.

4.9.4.2 Actions to avoid and reduce impacts

Actions for reducing noise and vibration-related impacts for green hydrogen facilities with co-located BESSs include those identified for facilities without a BESS. Additionally:

- Include acoustical enclosures or barriers for BESS containers to reduce potential operational noise impacts.

4.9.5 Findings for green hydrogen storage facilities

Impacts from construction, operation, and decommissioning
Site characterization, construction, and decommissioning of a green hydrogen storage facility would generate similar noise and vibration levels as those analyzed for production facilities under Section 4.9.3.1, with the exception that noise from blasting or pile driving for structural foundations may not be necessary depending on the type of facility and size of storage.

Findings
Noise and vibration impacts during construction and decommissioning impacts would be similar to findings for green hydrogen production facilities above.

Impacts from operation
For a green hydrogen storage facility, impacts from operation would vary depending on the sizes, operating conditions, types, and quantity of storage tanks. Primary noise sources would be produced from compressors and cooling equipment, which would produce similar levels of noise as similar equipment listed under green hydrogen production facilities and the proxy projects described in Section 4.9.3.1, but in a lesser volume since storage facilities would have a smaller footprint and require a lesser volume of noise- and vibration-producing equipment. Vibration from operations equipment is not expected past the footprint of the facility.

Findings
Noise and vibration impacts during operation would be similar to findings for green hydrogen production facilities above.

4.9.5.2 Actions to avoid and reduce impacts

Actions for reducing noise and vibration-related impacts for green hydrogen storage facilities are the same as those identified for green hydrogen production facilities.

4.9.6 Findings for the No Action Alternative

The potential impacts from facilities developed under the No Action Alternative would be similar to the impacts for the types of facilities described above for construction, operation, and decommissioning, depending on facility size and design, and would range from **less than significant to potentially significant adverse impacts**.

4.9.7 Significant and unavoidable adverse impacts

Through compliance with laws and permits, and with implementation of actions to avoid and mitigate significant impacts, green hydrogen facilities would have **no significant and unavoidable adverse impacts** on noise or vibration from construction, operation, or decommissioning.

4.10 Land use

Key findings

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, construction, operation, and decommissioning activities would result in **less than significant impacts** on land use.

No significant and unavoidable adverse impacts related to land use would occur.

Land use refers to how land is developed for various human uses or preserved for natural purposes. The *Land Use Technical Appendix* (Appendix K) includes the full analysis and technical details used to evaluate land use in the PEIS. This section contains a summary of how impacts were analyzed and the key findings. See Chapter 3 of this PEIS for a description of the study area that was used in the analyses. The study area does not include federal lands, national parks, wilderness areas, wildlife refuges, state parks, or Tribal reservation lands, but information related to these areas is provided as context.

4.10.1 Affected environment

4.10.1.1 Population

The local jurisdiction political subdivisions (cities and counties) of the state that overlap the PEIS geographic scope of study includes portions of 37 of the 39 counties in Washington; only Ferry and Stevens counties do not have any lands in the study area.

The estimated population of Washington state was approximately 7.95 million in 2023. Population densities are generally highest on the west side of the Cascades. Between 2020 and 2023, the state's population increased by 244,840 people, driven largely by people moving into the state. In 2023, population growth remained concentrated in more metropolitan areas, consistent with trends over the past few decades. Washington's population is expected to continue growing in all counties to a total of almost 9.9 million in 2050.

4.10.1.2 Land ownership

There is a mix of private, public, and Tribal land ownership within the geographic scope of study, which totals approximately 248,216 acres. The only Tribal land adjacent to industrial land is the industrial zoned Puyallup Reservation property around the Port of Tacoma. Public ownership of industrial lands is largely associated with the port facilities and airports. Industrial sites are privately owned.

4.10.1.3 Land uses

The study area encompasses various types of land uses, which present unique considerations and potential for impacts associated with the development of green hydrogen facilities. Washington's cities and unincorporated Urban Growth Areas (UGAs) support much of the state's population and more intensive land uses, such as high-density residential, industrial, and concentrated commercial uses. Outside of cities and UGAs, common land uses include agricultural, rural residential, forestry, wildlife conservation, and undeveloped recreation areas.

Industrial land use

Industrial land uses include various land-intensive activities, often involving patterns of noise, light, and hours of operation. Industrial uses can include refineries, manufacturing, transportation (e.g., airports, rail, ports), warehousing, freight terminals, and laboratories. Suitable site characteristics often include ease of accessibility to rail or highways; large parcels; locations along major electrical transmission lines or pipelines; and locations near or adjacent to ports and commercial navigation routes. Other considerations include the availability of infrastructure and surrounding land use compatibility.

Washington has many small communities located in rural areas outside of the designated urban areas. Counties may establish a process for approval of a major industrial development outside of the UGA for a specific business. A "major industrial development" is defined in RCW 36.70A.365 as a "master planned location for a specific manufacturing, industrial, or commercial business."

Ports and airports

Washington's public port districts include seaports, river ports, and airports. Ports facilitate trade, the movement of passengers, tourism, supply chains, industrial activities, and public spaces such as parks and other recreational spaces. Many public port districts invest in industrial and commercial lands to foster economic development in their communities.

Airports are integral parts of the state's transportation system. Airports range in size from the busiest airports in metropolitan areas, to community airports serving businesses and other private aircraft, to small landing strips in outlying locations. All towns, cities, and counties in Washington must discourage development of incompatible land uses adjacent to public-use airports through adoption of comprehensive plan policies and development regulations (RCW 36.70.547).

Refineries

A refinery is an industrial facility used to produce fuels from crude oil, unfinished oils, natural gas liquids, or other hydrocarbons. The fuels may be transported from the refinery by pipeline, marine vessel, rail, or truck. There are five refineries located in Washington State in four cities:

- Anacortes: HF Sinclair and Marathon
- Blaine: BP Cherry Point
- Ferndale: Phillips 66
- Tacoma: US Oil

Military use areas
Large areas of land, water, and air outside of military installations are used for military testing, operations, and training. The GMA prioritizes protecting lands around military installations from development that would reduce the ability of personnel to fulfill their mission requirements (RCW 36.70A.530). Development that is incompatible with this priority poses risks to operational efficiency and the safety of military personnel and the public. Energy developers and reviewers should consult with the U.S. Department of Defense (DoD) early during project planning to address these issues. Use the Compatible Energy Siting Assessment (CESA)[51] mapping tool to identify military utilized airspace and if applicable, submit plans to the DoD.

4.10.1.4 Other land use designations

Opportunity zones
Opportunity zones are created by Commerce based on the federal Tax Cuts and Jobs Act of 2017, which is designed to provide tax incentives to investors who fund businesses in underserved communities. The highest number of census tracts within the state that are designated as opportunity zones are in King, Pierce, Snohomish, and Spokane Counties.

4.10.2 How impacts were analyzed

Impacts that green hydrogen facilities would have on land use were analyzed by considering how a proposed green hydrogen facility could impact existing and planned land uses, including future viability. The analysis included the potential impacts associated with construction, operation, and decommissioning of green hydrogen facilities as related to the following:

- Changes to existing uses on public, state, Tribal, and private lands that surround or are near green hydrogen facilities
- Land use conflicts

4.10.3 Findings for green hydrogen production facilities

4.10.3.1 Impacts

Impacts from construction and decommissioning
Changes to existing uses
Construction and decommissioning of green hydrogen production facilities adjacent to land that is not zoned or suitable for industrial facilities could result in impacts to the existing character of the built environment. It is anticipated that the siting of green hydrogen production facilities on lands zoned for industrial facilities or lands that are currently experiencing industrial-related land uses would occur. Development within rural industrial areas could experience more intense impacts from construction, as construction would introduce a change in the character of the existing built environment. Future development, including green hydrogen energy facilities, would be required to comply with the comprehensive plan and zoning requirements, as updated.

[51] https://cesa-wacommerce.hub.arcgis.com/pages/tool

Industrial zones may also be adjacent to Tribal lands. Site characterization and construction on or near Tribal land would need to be coordinated with Tribal technical staff to identify any potential impacts and mitigation. See the *Tribal Rights, Interests, and Resources Technical Appendix* (Appendix B).

Potential impacts to existing land uses impacts would depend on the existing built environment, intensity of construction and local regulations. Changes to existing land uses are not anticipated to be significant in lands that are currently experiencing industrial-related land uses. Impacts would be less in lands zoned for industrial facilities or lands that are currently experiencing industrial-related land uses and greater in areas that are not.

Land use conflicts

Construction and decommissioning of green hydrogen production facilities have the potential to create impacts such as increased dust, noise, traffic, and visual changes that could affect properties adjacent to the facility. People most likely to notice these impacts are those living or working near the construction area. Nearby non-industrial land uses could be affected by increased dust, noise, traffic, and visual changes.

Land use impacts during facility decommissioning would be similar to those for construction. If a facility is not required to be restored to pre-facility conditions and uses, it is possible that a decommissioned site could be used for something other than its use prior to development of the facility.

Findings

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, construction and decommissioning activities would result in **less than significant impacts** on land use.

Impacts from operation

Changes to existing uses

Operation of green hydrogen production facilities would be located on lands zoned and used for industrial development. Therefore, where green hydrogen production facilities are located on industrially zoned lands surrounded by industrially zoned parcels, changes to existing land use would not occur. Future development, including green hydrogen energy facilities, would be required to comply with the comprehensive plan and zoning requirements, as updated. Where non-industrial land uses exist adjacent to industrial lands or industrial land uses that are in more rural areas could change the use of those sites to be more compatible with industrial facilities. This scenario would be addressed on a case-by-case basis with the applicable jurisdiction where impacts on adjacent properties would be addressed through the zoning and permitting approval process.

Findings
Changes in existing uses resulting from operation of a green hydrogen production facility would result in **less than significant impacts** on existing land uses.

Land use conflicts

The consistency of a proposed green hydrogen production facility with federal, state, and local regulations and planning documents would depend on a number of factors, such as:

- If allowed by local Comprehensive Plan future land use designations, zoning, and Shoreline Management Plan (SMP) designations
- If in an area with specific use restrictions and standards (such as SMP-regulated shorelines, critical areas, and floodplains) and mitigate impacts
- If the facility can be sited and designed to avoid interfering with civil air navigation and military operations, access, and training

If a facility is not consistent with the local jurisdiction comprehensive plan and development regulations (including shoreline and critical areas), the proposal could be modified to comply with local jurisdiction regulations or initiate regulation amendments.

Jurisdictions could modify comprehensive plan land use designations, zoning, and SMP designations in response to, or anticipation of, population growth or natural hazards. Requests to rezone properties by the public or jurisdictions to allow a prohibited use or deviation from development regulations could influence consistency.

Conflicts may occur if a green hydrogen production facility is proposed on a site adjacent to non-industrial, low-intensity uses (i.e., rural, agricultural, or resource land uses) or industrial land uses that are in more rural areas. Neighboring parcels may be acquired as approved by the local jurisdiction or zoning changes to accommodate future needs of a facility during operations and economic growth priorities and needs of the region. This could cause permanent conversion or changes to existing low-intensity uses. The intent of zoning is to preclude these types of conflicts, and land use conflicts would be unlikely to occur.

Depending on the extent of critical areas on the site proposed for a facility, impacts on critical areas can often be avoided through facility design. Certain critical areas impacts must be addressed through compensatory mitigation. See the other PEIS resource sections for additional discussion of impacts on water (Section 4.5), biological resources (Section 4.6), and earth resources (Section 4.3).

Findings
A green hydrogen production facility that is inconsistent with federal, state, and/or local plans and regulations could be proposed. Plans and regulations may be changed (e.g., through a rezone or comprehensive plan amendment) to resolve inconsistencies and allow a facility to proceed with **less than significant impacts.**

Military areas
Conflicts with civil air navigation and military spaces associated with potential physical or visual obstructions within navigable air space could result in safety hazards or interfere with military transport or training activities. However, early consultation with the Federal Aviation Administration (FAA) and DoD should allow facilities to be sited and designed to avoid these issues.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the operation of most facilities would likely result in **less than significant impacts** related to military areas.

4.10.3.2 Actions to avoid and reduce impacts

The following are some actions to avoid and reduce impacts of green hydrogen production facilities. See Appendix K, *Land Use Technical Appendix*, for typical mitigation measures that may be included in plans or permit conditions and additional measures that may apply for facilities.

Siting and design considerations

- Coordinate with federal, state, and local agencies; property owners; and other interested parties as early as possible in the planning process to identify potential land use conflicts and issues, as well as rules that govern the development of green hydrogen facilities.
- Contact the FAA early in the process to determine whether there could be impacts on aviation and whether mitigation might be required to protect military or civilian aviation use. To evaluate potential safety hazards, submit to the FAA plans for proposed construction of any facility that is 200 feet (approximately 61 meters) tall or taller and plans for other facilities located near airports.
- To identify and mitigate potential impacts on military operations, contact the DoD early in the process of siting a green hydrogen facility near or within military training routes, military bases, or training areas. When designing the site, consider military installations and air space needs.
- Use existing roads and utility corridors to the maximum extent feasible and to minimize the number and length of new roads and lay-down areas.
- Site and design a facility to avoid critical areas to the maximum extent possible.
- Consider siting and design options to preserve agricultural land, rangeland, and forest land to the maximum extent possible.
- Site and design a facility to minimize impacts on specially designated areas and land with wilderness characteristics.
- Consider wildland fire risk mapping from Pacific Northwest Quantitative Wildfire Risk Assessment when siting and designing and incorporate appropriate design criteria to achieve wildland fire resistance.

- To avoid or minimize impacts, consider the following when siting and designing a facility:
    - Local subarea plan or overlay zones
    - State-designated harbors
    - Air quality nonattainment areas
    - State salmon recovery plans
    - State wildlife plans
    - Watershed management plans
    - Habitat conservation plans
    - Wild and Scenic River designations
    - Designated FEMA flood zones

4.10.4 Findings for production facilities with co-located BESS

4.10.4.1 Impacts

Impacts from construction, operation, and decommissioning

Construction, operations, and decommissioning impacts for green hydrogen production facilities with co-located BESSs would be the same as for green hydrogen production facilities. The addition of battery storage could generate additional traffic for specialized equipment and construction workers. Co-locating BESSs with a green hydrogen production facility would require additional construction-related ground disturbance and an increased building footprint relative to facilities with no BESSs. General types of impacts potentially associated with BESSs include safety, noise, odor and emissions, screening and environmental (leakage and potential impacts of water contamination during firefighting).

> *Findings*
> Impacts on land use would be similar to findings for green hydrogen production facilities above.

4.10.4.2 Actions to avoid and reduce impacts

Actions for reducing land use-related impacts for green hydrogen production facilities with BESSs are the same as those identified for facilities without BESSs.

4.10.5 Findings for green hydrogen storage facilities

4.10.5.1 Impacts

Impacts from construction, operation, and decommissioning

Construction, operations, and decommissioning impacts for green hydrogen storage facilities would be similar to those for green hydrogen production facilities. Whether co-located, stand-alone, at transport terminals, or at an end-use location, storage facilities would require similar land use constraints and permitting requirements as a green hydrogen production facility.

Impacts from decommissioning a storage facility would be similar to those for decommissioning a production facility.

Findings
Impacts on land use would be similar to findings for green hydrogen production facilities above.

4.10.5.2 Actions to avoid and reduce impacts

Actions that can be taken to avoid and reduce impacts would be the same as for facilities without storage facilities.

4.10.6 Findings for the No Action Alternative

The potential impacts from facilities developed under the No Action Alternative would be similar to the impacts for the types of facilities described above for construction, operations, and decommissioning, depending on facility size and design, and would be **less than significant.**

4.10.7 Significant and unavoidable adverse impacts

Through compliance with laws and permits, and with implementation of actions to avoid and mitigate significant impacts, green hydrogen facilities would have **no significant and unavoidable adverse impacts** on land use from construction, operation, or decommissioning.

4.11 Aesthetics and visual quality

Key findings

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, construction, operations, and decommissioning activities would likely result in **less than significant impacts** related to aesthetics and visual quality.

No significant and unavoidable adverse impacts related to aesthetics and visual quality would occur.

Visual resources refer to all objects (built and natural, moving and stationary) and features (e.g., landforms and waterbodies) that are visible on a landscape. These resources add to or detract from the aesthetic or scenic quality (or visual appeal) of the landscape. A visual impact is the creation of an intrusion or perceptible contrast that affects the scenic quality of a landscape. A visual impact can be perceived by an individual or group as either positive or negative, depending on a variety of factors or conditions (e.g., personal experience, time of day, and weather/season). The information in this section summarizes the full analysis and technical details used to evaluate aesthetics and visual quality in the PEIS, which can be found in the *Aesthetics and Visual Quality Technical Appendix* (Appendix L).

4.11.1 Affected environment

Visual resources considered in this analysis include the following:

- Designated scenic vistas
- Designated scenic corridors, including roadways, trails, rivers, and streams (including federally designated Wild and Scenic Rivers)
- Designated viewsheds, ridgelines, and other elevated (i.e., visually prominent) natural features
- Areas with comprehensive plan, zoning, or other land controls that define an area as scenic or designated/protected rural character
- Publicly accessible vantage points having moderate to high visual or rural character and quality, that are well traveled and populated
- Recreational resources
- Areas sensitive to light and/or glare, including designated night sky areas, as well as areas potentially affecting military and commercial aircraft

The study area includes the industrial lands on which green hydrogen facilities are anticipated to be located, the surrounding viewsheds, and scenic resources. The study area varies widely from large urban areas in the cities of Seattle, Bellingham, the Tri-Cities, Olympia, Spokane, Yakima, and Vancouver and their surrounding metropolitan areas. Other parts of the study area are in smaller cities such as Aberdeen, Anacortes, Centralia, Moses Lake, Port Angeles, Pullman, Walla Walla, and Wenatchee. And others are in small towns or rural areas near highways in between sparsely populated areas. These areas generally have level terrain and are not located on ridgelines. The study area does not include federal lands, national parks, wilderness areas, wildlife refuges, state parks, or Tribal reservation lands, but information related to these areas is provided in this section as context.

Urbanized areas have experienced development that has modified the landscape from vegetation, open land, and tidal flats to a built environment comprised of pavement, concrete, and structures. Human influences have altered much of the visual landscape and will continue to do so over the 75-year timeframe of this study, especially with respect to land use and land cover in industrial areas closer to urban areas. Industrial areas in rural parts of the state are usually adjacent to lands that are undeveloped, agricultural, or in the early stages of development. Hence, the introduction of visual landscape changes in rural industrial areas may have a more noticeable impact than those closer to urban areas.

It is possible to see for great distances in the study areas with more rural surroundings, or near a large body of water. In urban surroundings, buildings and other structures may block visibility. The landscapes in the study area include the Columbia River basin, foothills of the Cascade Range, Yakima Valley, Palouse region, Puget Sound region, and the Pacific coast. The study area includes undeveloped areas with sparsely vegetated plains and plateaus or agricultural lands. Large Tribal reservations and federal and state government holdings also contribute to the undeveloped landscape, except for clusters of structures within those holdings. There are also scenic resources, including traditional cultural properties important to Tribes and state or locally designated scenic resources such as state-designated scenic highways, state parks, and county parks. Many of these designated scenic resources provide views of broad scenic vistas.

The experience of the visual character closer to urban areas includes views of the interstate, U.S., and state highways that cross the region, as these are roads that typically connect industrial areas to the rest of the state. Other views could include local roads, residential areas, or commercial areas near industrial zones.

Much of the study area has urban surroundings with existing sources of light pollution, including security and safety lighting for industrial uses, streetlights, lighting from homes and other buildings, and outdoor lighting at parking lots and sports fields. In general, the undeveloped areas have dark night skies, with relatively few sources of light pollution. Designated night sky areas would likely be found in more rural areas.

4.11.2 How impacts were analyzed

The assessment of impacts in the study area was qualitative and considered the following:

- Existing visual or rural character, land uses that may be sensitive to strong visual contrast (including light and glare), and sensitive viewer groups
- Potential impacts of facilities on existing visual or rural character and sensitive viewer groups or land uses
- Effects of lighting and glare on sensitive receptors

The magnitude of the aesthetics and visual quality impacts associated with a green hydrogen facility would depend on site- and project-specific factors, including the following:

- Distance of the facility from publicly accessible vantage points and their placement within the context of foreground, middleground, and background views
- Size of the facility and size and height of facility components
- Surface treatment and color of buildings and other structures
- The presence and arrangement of lights in the facility and on other structures
- The presence of workers and vehicles
- Viewer characteristics, such as the number and type of viewers (e.g., landowners in the vicinity, residents, tourists, recreationists, motorists, and workers) and their attitudes toward green hydrogen or industrial facilities
- The visual quality and sensitivity of the landscape, including the presence of sensitive visual, Tribal, and cultural resources, including historic properties
- The existing level of development and activities in the area and nearby areas, and the landscape's capacity to withstand human alteration without loss of landscape character (i.e., scenic integrity and visual absorption capability)
- Weather and lighting conditions

4.11.3 Findings for green hydrogen production facilities

4.11.3.1 Impacts

Impacts from construction and decommissioning

Long-term change or reduction in visual quality

Construction of a green hydrogen production facility would involve a range of activities that could have potential aesthetics and visual quality impacts. Construction activities are site- and project-specific; however, construction of a green hydrogen facility would normally involve the following major actions with potential visual impacts: clearing and grading for construction laydown areas, access roads, and foundations for on-site buildings and support facilities; constructing supporting elements like internal service roads, fences, gates, and buildings; and constructing facility components such as control rooms, storage areas for facility tools and materials, and hydrogen transfer stations or facility pipeline connections. Construction vehicles, equipment, and worker presence and activity may also generate dust and emissions that can result in visual impacts.

Most green hydrogen facilities would be constructed in an industrialized setting of low scenic value with similar facilities already visible, as the study area includes areas zoned for industrial or industrial-supporting uses. Facilities sited in rural areas or on undeveloped industrial zoned lands would have greater visual impact. Depending on the topography of the site, green hydrogen facilities constructed within or near sensitive landscapes such as state and national parks, historic sites, landscapes sacred to Tribes, scenic highways and trails, and other valued cultural features may be of concern.

Visual impacts associated with vegetation clearing include the potential loss of vegetative screening, which would result in the opening of views for viewers close to the green hydrogen production facility.

Decommissioning activities would produce visual impacts similar to construction activities. Decommissioning would include dismantling and removing all structures associated with the green hydrogen facility and restoring to previous site conditions or as outlined in a decommissioning plan that would be prepared as part of the construction proposal. Newly disturbed soils would create a visual contrast that could persist for several seasons before revegetation would begin to mature and restore the pre-facility visual landscape. Complete restoration of vegetation to pre-facility conditions may take much longer. The length of time it takes for native vegetation to re-establish varies greatly depending on location, weather patterns, soil fertility, surrounding land use, and the type of vegetation planted or recruited. Decommissioning impacts would last until restoration of the site is complete.

Findings

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, construction and decommissioning activities would likely result in **less than significant impacts** on visual quality.

Create new source of light or glare
Site characterization, construction, and decommissioning of a green hydrogen production facility would be expected to occur during daylight hours. Facility construction would not introduce new, substantial sources of light that could affect daytime views in the vicinity. Some nighttime activities may be performed such as electrical connection, inspection, and testing activities. Any lighting used during construction activities would be temporary and shielded downward.

Construction activities could temporarily increase glare conditions in and around a facility site if activities were associated with an increased presence of reflective materials, potentially including construction equipment, new materials (i.e., not yet subjected to weathering), and vehicle windows. However, any increase in glare that could result from the presence of construction equipment or materials is expected to be minimal and temporary during construction.

Although decommissioning activities would require the use of vehicles and equipment similar to those required for construction, sources of glare would be minimal and temporary, as equipment would be moved between active work locations on the facility site. Once the facility is decommissioned and dismantled, there would be no remaining permanent sources of light or glare.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, construction and decommissioning of facilities would likely result in **less than significant impacts** related to light or glare.

Impacts from operations
Long-term change or reduction in visual quality
Green hydrogen facilities could be constructed in an industrialized setting of low scenic value with similar facilities already visible. Facilities sited in rural areas or on undeveloped industrial zoned lands or near sensitive landscapes would typically be more conspicuous and therefore perceived as having greater visual impact.

Operations and maintenance of green hydrogen production facilities and associated facility components and buildings could result in long-term visual impacts. Site operation impacts would generally occur throughout the life of the facility. Impacts may occur from cleared areas, built facility components and buildings, and operational activities.

Cleared areas would include roads, and other support facilities. Visual contrasts associated with these cleared areas would include the potential loss of vegetative screening, which would result in the opening of views and potentially significant visual changes. Clearing of vegetation is overall not anticipated to bring drastic visual changes since green hydrogen production facilities would be in industrial areas of low scenic value with similar facilities already visible. Facilities sited in rural areas on undeveloped industrial zoned lands would typically have greater visual impact.

Green hydrogen facilities and components would typically introduce rectilinear forms of geometry to the landscape, with rectangular and uniform shaped buildings, and neutral-colored coatings, which fit into industrially zoned visual features and buildings. If the surrounding landscape character is dominated by industrial buildings similar to green hydrogen facilities, surrounding aesthetics and visual environment would not be greatly impacted due to the existing industrial character of the landscape. If the site is undeveloped, however, or surrounding areas are also undeveloped, potential impacts could be greater.

Operational activities would include the production of hydrogen using one of the three processes: electrolysis, SMR, pyrolysis, or bio-gasification. The SMR, pyrolysis, and bio-gasification processes could generate air emissions, which may be visible off site and generate visible dust plumes in some circumstances. Combustion of renewable natural gas in boilers may generate visible steam as part of the SMR process.

Paved or gravel maintenance roads may introduce visual contrasts to the landscape, depending on width, length, surface treatment, and route relative to surface contours. Most industrial areas that have been developed are anticipated to have existing established access, which would reduce the need for new access roads.

In urban areas of the study area with high population density and existing industrial developments, more viewers could potentially view the facility, but their sensitivity to industrial developments would be lower due to the existing urban and industrialized setting. Impacts on residents are generally greater than those on more transient viewers such as drivers or workers, in part because residents are likely to view green hydrogen facilities more frequently and for longer durations.

Findings

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, operation of facilities would likely result in **less than significant impacts** on visual quality.

Create new sources of light or glare

Green hydrogen facilities would require lighting for security, work, and maintenance. The external lighting at a green hydrogen production facility would be typical of lighting used for industrial facilities. There would be lights around buildings, parking areas, and other outdoor structures that are illuminated at nighttime for security purposes. These could produce light pollution if best management practices are not followed, such as designing facilities to keep outdoor lighting to the minimum required and use motion sensors wherever possible; using hooded or downward-directed lighting; and avoid steady-burning or high-intensity lights.

Light or glare associated with facility operation would not introduce new, substantial sources of light or glare that could affect daytime views if the facility were in industrial areas because these areas generally have existing sources of light and glare. Facilities sited in rural areas on undeveloped industrial lands could experience new light or glare. Safety and security lighting may be active during non-daylight hours, which could affect nighttime views and visual impacts towards military and commercial aircraft. If in the vicinity of a visually sensitive environment, light or glare associated with facility operation could introduce new, substantial sources of light or glare.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, operation of facilities would likely result in **less than significant impacts** related to light or glare.

4.11.3.2 Actions to avoid and reduce impacts

The following are some actions to avoid and reduce impacts of green hydrogen production facilities. See Appendix L, *Aesthetics and Visual Quality Technical Appendix*, for typical mitigation measures that may be included in plans or permit conditions and additional measures that may apply for green hydrogen facilities.

Siting and design considerations

- Locate facilities in areas zoned for industrial use.
- Locate facilities near existing electricity transmission to minimize the need for additional electrical infrastructure.
- Include a visual resource specialist on the planning team to evaluate visual impacts.
- Conduct a detailed visual resource analysis to identify and map landscape characteristics, key observation points (KOPs), and key viewsheds; prominent scenic, Tribal, and cultural landmarks; and other visually sensitive areas near the facility location.
- Consult with the appropriate land management agencies, planning entities, Tribes, and the local public early to provide input on the identification of important visual resources near a facility site and on the siting and design process.
- Use geographic information system tools and visual impact simulations for conducting visual analyses (including mapping), analyzing the visual characteristics of landscapes, visualizing the potential impacts of facility siting and design, and fostering communication.
- Avoid locating facilities that would alter the visual setting and reduce the historic significance or function.
- Site facilities outside the viewsheds of KOPs, highly sensitive viewing locations, and areas with limited visual absorption capability or high scenic integrity. If they must be sited within view of KOPs, they should be as far away as possible, as visual impacts generally diminish as viewing distance increases.

- In already developed landscapes, consider visual absorption capacity and possible cumulative effects.
- Locate facilities on sites that require minimal clearing of native vegetation.
- Design facilities to visually integrate with the surrounding landscape:
- Utilize topography and vegetation as screening devices to restrict views of the facility from visually sensitive areas.
- Avoid siting near prominent landscape features (e.g., peaks and waterfalls).
- Avoid siting linear features such as roads that would bisect ridge tops or run down the center of valley bottoms. Avoid siting on ridgelines, summits, or other locations where they would be silhouetted against the sky from important viewing locations.
- Site linear features to follow natural land contours rather than straight lines, particularly up slopes. Fall-line cuts should be avoided. Use natural topographic breaks.
- In forested areas or shrublands, linear facilities should follow the edges of clearings rather than pass through their center.
- Choose locations for linear feature crossings of other roads, streams, and other linear features within a corridor to avoid KOP viewsheds and other visually sensitive areas and to minimize disturbance to vegetation and landforms. The rights-of-way should cross linear features (e.g., trails, roads, and rivers) at right angles whenever possible to minimize the viewing area and duration.
- Co-locate linear features within a corridor to use existing or shared rights-of-way, existing or shared access and maintenance roads, and other infrastructure in order to reduce visual impacts.
- Match the siting and design of facilities, structures, roads, and other elements with existing landscape.
- Choose low-profile structures for ancillary buildings and other structures to reduce their visibility.
- Minimize the number of structures required or co-locate to share pads, fences, access roads, lighting, etc. Minimize the height of structures as much as feasible.
- Design structures and roads to minimize and balance cuts and fills.
- Set structures, roads, and other facility elements as far back from road, trail, and river crossings as possible and use vegetation to screen views from crossings.
- Select materials, textures, colors, and surface treatments that minimize visual contrast with surroundings.
- Use similar materials and paint colors for all structures to create visual consistency and uniformity in the facility's design.
- Use gravel for parking areas rather than asphalt to minimize contrast with the site's soil colors.
- Use chain-link fence with a dulled finish or coating to reduce contrast with surroundings.
- Use landscaping and vegetation screening to reduce the visual impacts of the facility.
- For new electrical distribution lines associated with the facility, consider buried lines instead of overhead lines, where feasible.
- Design facilities to minimize light pollution:

- Use the International Dark Sky Association’s Five Principles for Responsible Outdoor Lighting to design outdoor lighting.
    - Keep outdoor lighting to the minimum required for safety and security. Use motion sensors to keep lighting turned off when not required.
    - Use hooded, downward-directed lighting to minimize light pollution and prevent lighting from projecting onto adjacent properties.
    - Avoid steady-burning, high-intensity lights.
- Design facilities to prevent glare:
    - Use non-reflective materials or non-specular finishes and coatings on facilities to the greatest extent feasible to prevent glare.
- Design facilities to comply with applicable land use regulations related to light, glare, building height, setbacks, vegetation screening, exterior storage, fencing, and any other requirements related to the visual appearance of the facility.
- Design the facility to comply with FAA obstruction avoidance and safety and glare avoidance requirements.

4.11.4 Findings for production facilities with co-located BESS

4.11.4.1 Impacts

Impacts from construction, operation, and decommissioning

Change or reduction in visual quality and light or glare

The construction, operation, and decommissioning activities occurring for facilities with co-located BESSs would be similar to those described for green hydrogen production facilities. BESSs are usually installed in a graveled area where vegetation clearing and gravel surfacing would be required.

Installation of the BESS would be similar to the construction of other support facilities and structures included in a green hydrogen production facility. The addition of a BESS would not change or reduce the visual nature of green hydrogen production facility.

BESS construction and decommissioning may require night work lighting; however, these activities would be occasional, temporary, and shielded downward. The potential for nighttime lighting during construction or decommissioning to impact nighttime views would be minimal. Lighting associated with a BESS would not change the sources of light and glare of a green hydrogen facility. Because the facility site would be restored to pre-facility conditions following the operational life of the facility, there would be no remaining permanent sources of light or glare.

Findings

Impacts to aesthetics and visual quality would be similar to findings for green hydrogen production facilities above.

4.11.4.2 Actions to avoid and reduce impacts

Actions for reducing aesthetic and visual quality impacts of facilities with co-located BESSs would be the same as for facilities without a BESS.

4.11.5 Findings for green hydrogen storage facilities

4.11.5.1 Impacts

Impacts from construction, operation, and decommissioning

Change or reduction in visual quality and light or glare

The construction and decommissioning activities for a green hydrogen production facility with hydrogen storage would be the same as those for a green hydrogen production facility, with the addition of installing green hydrogen storage facilities. Installation of hydrogen storage facilities is similar to the installation of other support facilities and structures included in a production facility. Alternatively, hydrogen storage could be at a stand-alone facility, at a transport terminal, or transported off site. Locating at a transportation terminal or transported off site may have similar or fewer visual impacts than described for a stand-alone green hydrogen production facility in Section 4.11.3 given that the existing built environment should typically have established access or cleared vegetation. The operation of green hydrogen storage facilities would not change or reduce the visual nature of green hydrogen production facility development.

Long-term changes or reduction in visual quality from green hydrogen storage facilities would be the similar to green hydrogen production facilities and would not change or reduce the visual nature of a green hydrogen facility development.

Create new source of light or glare

Site characterization and construction activities required for a green hydrogen production facility with hydrogen storage, hydrogen storage as a stand-alone facility, at transport terminal, or transported off site would be the same as those described for a stand-alone green hydrogen production facility as described in Section 4.11.3. The additional construction of hydrogen storage facilities may require nighttime work lighting; however, these activities would be occasional and temporary, and the lighting would be shielded downward and the potential for nighttime lighting to impact nighttime views is minimal.

The operation of green hydrogen storage facilities would not create any new sources of light and glare and would have similar impacts as green hydrogen production facilities in Section 4.11.3.

Findings

Impacts to aesthetics and visual quality would be similar to the findings for green hydrogen production facilities above.

4.11.5.2 Actions to avoid and reduce impacts

Actions for reducing the aesthetic and visual quality impacts for green hydrogen storage facilities would be the same as those identified for green hydrogen production facilities above.

4.11.6 Findings for the No Action Alternative

The potential impacts from facilities developed under the No Action Alternative would be similar to the impacts for the types of facilities described above for construction, operations, and decommissioning, depending on facility size and design. Facilities would result in **less than significant impacts** on aesthetic and visual resources.

4.11.7 Unavoidable significant adverse impacts

Through compliance with laws and permits, and with implementation of actions to avoid and mitigate significant impacts, green hydrogen facilities would have **no significant and unavoidable adverse impacts** on aesthetics or visual quality from construction, operation, or decommissioning.

4.12 Recreation

Key findings

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, construction, operations, and decommissioning activities would likely result in **less than significant impacts** on recreation.

No significant and unavoidable adverse impacts related to recreation would occur.

Recreation provides people with the opportunity to engage with and enjoy both the natural and built environments. Washington has vast opportunities for outdoor recreation, from mountains to deserts, including both land- and water-based activities. Recreation opportunities include activities in parks, rivers, on state and federally managed lands, and on privately owned lands. Outdoor recreation is an important aspect of life and provides economic and health benefits to communities in the study area.

The *Recreation Technical Appendix* (Appendix M) includes the full analysis and technical details used to evaluate recreation in the PEIS. This section contains a summary of how impacts were analyzed and the key findings.

4.12.1 Affected environment

Varied recreational opportunities exist within the study area, which includes industrial lands with limited recreation and surrounding areas that have recreational opportunities.

Designated recreational areas within the study area include local parks, public schools, water access points, golf courses, swimming pools, and other lands open to public use, such as WDFW lands. Informal recreation occurs on public or private lands. Public schools and recreational sporting complexes provide a space for people to enjoy a variety of activities in one location, including soccer, football, baseball, softball, basketball, and other sporting activities.

Fishing, boating, hiking, skiing, and other activities that vary with the seasons occur across the state. Tribal fishing takes place throughout the state at various times during the year. More details are provided in the *Tribal Rights, Interests, and Resources Technical Appendix* (Appendix B).

4.12.2 How impacts were analyzed

The assessment of impacts was qualitative, and significant impacts were identified if a facility resulted in the following:

- Permanent change in use, loss of access, or substantial reduction in quality of recreational use and experience with no opportunity to relocate
- Crowding of alternative recreational uses due to the loss of recreational use

4.12.3 Findings for green hydrogen production facilities

4.12.3.1 Impacts

Impacts from construction and decommissioning
Impacts to recreational resources could occur from construction and decommissioning activities, including temporary increases in noise, dust, and vibration, as well as traffic delays and changes in access. There could be a temporary increase in use at alternative recreation sites during construction. The decommissioning and removal of a facility could result in the restoration of recreational opportunities that were previously lost from construction of the facility.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, construction and decommissioning activities would likely result in **less than significant impacts** on recreation.

Impacts from operation
Impacts to recreational resources from operation of green hydrogen facilities are expected to be limited because facilities would be located in areas that are compatible with the industrial setting because local jurisdictions would have considered recreational uses during preparation of comprehensive plans. Further, the limited amount of land required for green hydrogen facilities, from 1 to 10 acres, and the limited number of employees (up to three) reduces the potential for inducing land area or population-related impacts on recreation. Substantial reductions in quality of recreational experience are not anticipated.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the operation of facilities would likely result in **less than significant impacts** on recreation.

4.12.3.2 Actions to avoid and reduce impacts

The following are some actions to avoid and reduce impacts of green hydrogen production facilities. See Appendix M, *Recreation Technical Appendix*, for mitigation measures that may be included in plans or permit conditions and additional measures that may apply for facilities.

Siting and design considerations

- Do not site green hydrogen facilities in areas of unique recreational resources.
- When siting a facility, consider impacts to recreational resources.
- Avoid activities that would render recreational resources inaccessible to the public by identifying legal access to recreational opportunities that could be impacted.
- Design the facility to comply with applicable land use regulations related to light, glare, building height, setbacks, vegetation screening, exterior storage, fencing, and any other requirements related to the visual appearance of the facility.

4.12.4 Findings for production facilities with co-located BESS

4.12.4.1 Impacts

Impacts from construction, operation, and decommissioning
The construction and decommissioning activities for facilities with co-located BESSs would be the same as those for facilities without a BESS. For this analysis, it is assumed that the BESSs would be located within the green hydrogen facility site footprint and would require a small additional area of development but would not contribute other recreational impacts than described for facilities without a BESS.

Findings
Impacts to recreation would be similar to those for production facilities above.

4.12.4.2 Actions to avoid and reduce impacts

Actions for reducing impacts on recreation for co-located BESSs are the same as those identified for green hydrogen production facilities.

4.12.5 Findings for green hydrogen storage facilities

4.12.5.1 Impacts

Impacts from construction, operation, and decommissioning

The construction and decommissioning activities for green hydrogen storage facilities would be the same as those for green hydrogen production facilities. While a green hydrogen storage facility may be co-located with a green hydrogen production facility, it may also be located at a stand-alone facility, a transport terminal, or an end-use location such as an industrial facility or fueling facility. A green hydrogen storage facility located independently of the production facility would be subject to permitting requirements, and potential impacts to recreation would be similar to those of a production facility.

Findings

Impacts to recreation resources would be similar to those for production facilities above.

4.12.5.2 Actions to avoid and reduce impacts

Actions for reducing the recreational impacts of storage facilities would be the same as those for production facilities.

4.12.6 Findings for the No Action Alternative

The potential impacts from facilities developed under the No Action Alternative would be similar to the impacts for the types of facilities described above for construction, operations, and decommissioning, depending on facility size and design, and would be **less than significant**.

4.12.7 Significant and unavoidable adverse impacts

Through compliance with laws and permits, and with implementation of actions to avoid and mitigate significant impacts, green hydrogen facilities would have **no significant and unavoidable adverse impacts** on recreation from construction, operation, or decommissioning.

4.13 Historic and cultural resources

Key findings

Facilities could impact historic and cultural resources. Each historic or cultural resource's significance is unique to that resource; therefore, the impact analysis will also be unique and would need to be conducted during future project-level review for facilities. The significance of impacts to Tribal cultural resources can be understood only from within the cultural context of an affected Tribe. Accordingly, impact assessment and determinations of significance or non-significance would be done with engagement and in consultation with potentially affected Tribes and DAHP at the project level.

The land in Washington state has been utilized since before glaciers retreated at the end of the Pleistocene era. During the succeeding millennia, people have used a wide variety of strategies and approaches to interact with the landscape and its resources. As the environment has changed, so have those approaches. This has resulted in a history of human use and occupation that is reflected in historic and cultural resources. The *Historic and Cultural Resources Technical Appendix* (Appendix N) includes the analysis and technical details used to evaluate historic and cultural resources in this PEIS. This section contains a summary of the affected environment, how impacts were analyzed, and the key findings.

4.13.1 Affected environment

The study area includes a diverse range of geological formations, animals, and plants. Each of these ecoregions has a unique geological history that has formed the current landscape and that plays an important role in archaeological site formation. The presence of an archaeological site means that there was past human activity and that physical objects or remains have been preserved there. Archaeological resources are typically identified through archaeological survey work.

Throughout the study area, there are lands and shorelines where Tribes have lived for thousands of years and continue to live. Archaeological sites, historic resources, and Tribal place names exist throughout the study area. They include areas connected to Tribal cultural and spiritual practices and are represented within oral tradition stories and historic documents. Historic architectural resources include buildings, sites, structures, objects, and districts that have reached a particular age threshold to be considered for eligible for listing in a historic register. Many of these resources are present in the study area.

A Traditional Cultural Property (TCP) is a property or a place that is inventoried or determined to be eligible for inclusion on the National Register of Historic Places or the Washington Heritage Register because of its association with cultural practices and beliefs. These are rooted in history and are important to maintaining the continuing cultural identity of the community's traditional beliefs and practices. DAHP maintains a database of TCPs, but very few are publicly disclosed. TCPs can be any location, landform, or object that has distinct association and importance to a group. The scale can be as large as an entire river or mountain or be confined to a single boulder. Many TCPs are present in the study area.

4.13.2 How impacts were analyzed

This PEIS evaluates how green hydrogen facilities could affect the following key features of historic and cultural resources:

- Archaeological resources, both recorded and unrecorded
- Historic architectural resources listed in a historic register or not listed but eligible for listing in a historic register
- Human remains and cemeteries
- Sacred sites
- Documented and undocumented TCPs

DAHP's databases identify the risk of potential historic and cultural resources at a broad level and identify known resources. Only a small portion of the state has been mapped in detail for historic and cultural resources. A future proposed green hydrogen facility would need to conduct site-specific cultural surveys to evaluate potential impacts in accordance with DAHP and federal requirements and guidance. General language about potential impacts to historic and cultural resources is identified in this PEIS.

The significance of Tribal cultural resources can be understood only from within the cultural context of an affected Tribe. Accordingly, the impact assessment and determinations of significance or non-significance of Tribal cultural resources would be done with engagement and in consultation with Tribes. This would be done through the SEPA process or the federal Section 106 process.

4.13.3 Findings for all green hydrogen facilities evaluated in this PEIS

4.13.3.1 Impacts

Impacts from construction and decommissioning

Most site characterization activities would involve little or no ground disturbance. However, some ground-disturbing activities, such as drilling deep soil cores, blasting, and building access roads, could result in impacts to or inadvertent discoveries of historic and cultural resources. In mountainous terrain or at project sites that are located at a distance from existing surface streets, additional site grading and clearing may be required if existing access routes are unavailable or unsuitable for the planned investigation equipment.

Construction and decommissioning activities that could impact historic and cultural resources include ground disturbance, degradation of visual quality, noise, and interruption of the landscape and habitat. Tribal spiritual practices could be interrupted by construction impacts on land areas and cultural or sacred sites, including degradation of visual quality, noise, and interruption of access.

Construction could result in damage to or destruction of historic and cultural resources from the clearing, grading, and excavation of the site and from building facilities and associated infrastructure. Construction will likely include subsurface infrastructure (e.g., foundations, pilings, utility trenches). Site access could include modifying existing roads or building new roads. Ground disturbance during construction is likely to impact undiscovered archaeological resources because there are many such sites throughout the study area and because most of the study area has not been archaeologically surveyed.

Degradation and destruction of historic and cultural resources could result from changes to the landscape and water flow patterns. The removal of soils, erosion of soils, and runoff into adjacent areas could also affect resources. Oil or other contaminant spills could affect resources.

Increased human access and subsequent disturbance such as looting, vandalism, and trampling of cultural resources could result from creating corridors or facilities in otherwise intact and inaccessible areas. Visual changes, changes in light, dust, and human presence could affect cultural resources for which visual integrity is a component of sites' significance, such as Tribal sacred sites, historic architectural resources, trails, and historic landscapes.

Construction noise would depend on the activities, terrain, vegetation, and local weather conditions but may involve blasting and the use of equipment such as impact pile drivers and vibratory rollers. These can generate substantial noise and vibration. Cultural resources that are susceptible to noise impacts include TCPs or sacred sites because the cultural uses or practices that occur at these locations would be interrupted or diminished. Construction vibration could adversely affect cultural resources by damaging rock features or archaeological sites.

Decommissioning would involve similar types of activities as for construction. Site restoration activities may include recontouring, grading, seeding, planting, and perhaps stabilizing disturbed surfaces. The types of impacts would be similar to those associated with facility construction.

Impacts from operation

Operational activities that could affect historic and cultural resources include changes in access to natural and cultural resources and increased human activity with associated noise, light, dust, and human presence. Ongoing operations and maintenance are anticipated to include little new ground disturbance because the use of maintenance vehicles and equipment would generally be limited to access roads and areas already developed during construction.

Archaeological sites could still be affected by the increase in activity during operation of a facility. This includes increased vehicle traffic, vegetation management, or other activities, as well as the presence of people who might disturb surface artifacts. Ongoing ground disturbance could reveal previously unrecorded archaeological sites that are associated with TCPs.

Visual degradation of settings associated with cultural resources could result from the presence of green hydrogen facilities and associated land disturbances. Visual changes could include the presence of structures. These could also include lighting, fencing, roads, vehicles, and workers conducting maintenance activities. These could affect cultural resources for which visual integrity is a component of sites' significance, such as Tribal sacred sites and landscapes, historic architectural resources, trails, and historic landscapes.

Facility fencing and ongoing operations could impact access and travel paths traditionally utilized by Tribes for significant historic and cultural resources. This is most likely to impact TCPs, sacred sites, cemeteries, or precontact period archaeological sites where setting, feeling, and association are key aspects of the site.

4.13.3.2 Actions to avoid and reduce impacts

Mitigation would be done with engagement and in consultation with potentially affected Tribes and DAHP at the project level. Mitigation may be developed through consultation with affected Tribes as part of the SEPA process. Mitigation may also be developed under federal Section 106 of the National Historic Preservation Act. This is a separate, federal process.

The following are some actions to avoid and reduce impacts of green hydrogen facilities. See Appendix N, *Historic and Cultural Resources Technical Appendix*, for typical mitigation measures that may be included in plans or permit conditions and additional measures that may apply for facilities.

Siting and design considerations

- Design and site projects to avoid to the maximum extent impacts on cultural and historic resources. Begin with the use of the DAHP predictive model, then refine through the development of site-specific environmental and cultural context and Tribal coordination.
- Contact potentially affected Tribes early in the siting process, ideally before land is acquired for a project or before permit applications are developed and offer information relevant to Tribal technical staff to help identify potential impacts on Tribes.
- Consider potential impacts on Tribal treaty-reserved rights, Tribal reservations, off-reservation rights, trust lands, other Tribal-owned land, and other areas of significance to Tribes during project design and in siting decisions.
- Conduct a site-specific cultural survey to evaluate potential impacts in accordance with DAHP and federal requirements and guidance. Offer DAHP and cultural experts from potentially affected Tribes the option to help develop the survey strategy.
- Consider requiring a Tribal monitor for survey crews to provide input on TCPs, sacred sites, and culturally significant sites during site selection.
- Provide cultural resources survey results to potentially affected Tribes for early review.
- Use previously disturbed lands and lands determined by archaeological inventories to be devoid of historic properties to the maximum extent possible.
- In areas where homesteading was a prevalent historic activity, contact the local assessor's office and historical museums to determine if the area includes known homestead sites.

Additional mitigation measures

- Conduct a cultural resources survey of the entire project site.
- Use training/educational programs for workers to reduce occurrences of disturbances, vandalism, and harm to historic and cultural resources. Plans should incorporate adaptive management protocols for addressing changes over the life of the project, should they occur.
- Address impacts to historic and cultural resources that follow the best available guidance and strategies developed by the federal, Tribal, and state governments, including, but not limited to, compensatory mitigation, formalized ongoing consultation between Washington state and Tribes to address new concerns and monitor long-term mitigation, and the development and maintenance of new technologies and geospatial analysis that help identity and avoid historic and cultural resources.

Additional actions to avoid or minimize impacts would be determined after engagement and consultation with Tribes.

4.14 Transportation

Key findings

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the construction, operation, and decommissioning of facilities would likely result in **less than significant impacts** on transportation.

No significant and unavoidable adverse impacts related to transportation resources would occur.

The term "transportation" refers to the system of roads, transit routes, railroads, waterways, and airport facilities that move people and goods. This section of the PEIS considers the transportation system; traffic, public transit, and non-motorized or other transportation system conflicts; and the movement of trucks, trains, or vessels to transport equipment for construction, operation, or decommissioning of green hydrogen facilities. Freight transportation modes are the focus of this PEIS. The PEIS does not evaluate the transportation or distribution of green hydrogen, or transportation related to the end uses of green hydrogen.

The *Transportation Technical Appendix* (Appendix O) includes the full analysis and technical details used to evaluate transportation in the PEIS. This section contains a summary of how impacts were analyzed and the key findings.

4.14.1 Affected environment

4.14.1.1 Road infrastructure, traffic, and truck freight volumes

Washington's road network spans over 80,000 miles, with 764 Interstate System highway miles and 1,602 miles of U.S. highways. Major highways in the study area include Interstate (I-)5, I-405, I-90, I-205, and U.S. Highway 395, along with numerous state highways. These corridors serve as principal freight arterials, moving regional and international cargo, and providing commute and recreation routes. I-5 is the major north-south route through the state in western Washington, and I-405 is another major north-south route through the east side of King and Snohomish counties. I-90 is the major east-west route through Washington state. I-205 is a north-south highway connecting Washington and Oregon. U.S. Highway 395 connects Washington, Oregon, and California.

More than half of all goods in Washington are transported by trucks. Typical goods carried by trucks goods include foodstuffs, wood products, and agricultural products.

4.14.1.2 Rail freight system and infrastructure

Washington's rail transportation system moves over 95 million tons of freight annually. More than 3,200 miles of freight railroad tracks exist in the state. Rail freight is preferred for transporting high tonnage, oversize, and high-value cargo, such as construction and operational equipment for green hydrogen facilities. The study area includes highly populated counties and their urban areas, which are connected to a nearby major rail freight corridors. The study area includes all 39 intermodal facilities in the state for transferring cargo between rail and other transportation methods.

4.14.1.3 Maritime freight system and infrastructure

Navigable waterways and ports in the study area could be used to transport green hydrogen facility components. Two marine highway routes designated by the U.S. Department of Transportation serve Washington.

Within Washington, the maritime freight transport network includes the Salish Sea, Columbia-Snake River System, and the U.S. Pacific Coast. The highest tonnage of marine freight routes in the state (more than 25 million tons per year) is in the Salish Sea area, stretching from the northwestern part of the state (Port of Port Angeles to the Port of Tacoma). Washington has 18 public ports and numerous marine terminals. While travel times by barge take longer than rail or truck, it provides a lower-cost option that is very efficient.

4.14.1.4 Airports and FAA

Air cargo is not expected to be used for the construction, operation, and decommissioning of green hydrogen facilities; and if used, it is expected to be in minimal volumes. Air cargo in Washington is primarily handled at Seattle-Tacoma International Airport, King County International Airport–Boeing Field, and Spokane International Airport, which are all located in the study area.

There may be concerns related to the construction of structures in green hydrogen facilities with heights that may interfere with airspace, which could trigger FAA notification. Public use and military airports are of concern when it comes to the FAA regulation. There are 45 public use airports in the study area. There are also nine military bases in the study area, and some have airports.

4.14.2 How impacts were analyzed

The assessment of impacts in the study area was qualitative, and considered the following:

- Expected ranges of traffic volumes and distances
- Expected road, rail, and vessel traffic
- Expected improvements to transportation network

This programmatic analysis evaluated how green hydrogen facilities could result in the following:

- Traffic and conflict with local transportation network
- Truck, train, or vessel count increase

4.14.3 Findings for green hydrogen production facilities

4.14.3.1 Impacts

Impacts from construction and decommissioning

Traffic and conflict with local transportation network

Workers would likely commute using existing roads. Approximately 10–100 construction workers would be needed to build or decommission a green hydrogen facility, depending on the size of facility. Given the limited number of workers and the proximity to major roads, it is likely that there would be minimal congestion added to existing traffic and the transportation network from workers during construction and decommissioning.

For green hydrogen facilities, heavy equipment and materials needed for site access (road improvement), site preparation, and construction of on-site buildings and support facilities are typical of other industrial construction projects and would not pose unique transportation considerations. Trucks would be the primary mode used to transport construction inputs. There may be transportation of oversized loads and equipment, which could result in temporary impacts on traffic patterns (e.g., delays) or hazards experienced by other road users. Given the proximity of the industrial lands to urban areas, there could also be conflicts between heavy truck-haul routes and public transportation and nonmotorized routes during construction. Impacts are similar for decommissioning, depending on the amount and type of equipment brought in and taken out.

Usage of heavy freight trucks could also lead to safety conflicts and collisions with other transportation modes if there is inadequate haul route planning or if the facility site is located surrounding busy intersections.

Construction of required road or rail improvements or new roads or rail lines at a particular site can be highly disruptive to communities and interfere with the local transportation network. Most conditions modified for construction would be returned to existing conditions after construction, but some may remain, which could represent a permanent impact to the transportation system. Upon decommissioning, a project site would be restored to its pre-project conditions and uses unless the project owner, permitting authority, and regulatory agencies agree on alternate actions. Substantial damage to transportation modes and related infrastructure requiring major repairs or replacement to return to safe usage and pre-impact conditions is not expected.

Truck, train, or vessel count increase

It is not anticipated that a high number of roadway truck trips would be needed during construction or decommissioning for materials and equipment. The number of trips would vary based on the size of the facility. The anticipated daily one-way truck trips needed for industrial facility construction based on construction inputs for workers, vendors, hauling trips or any onsite truck trips could range from a maximum of 24 trips per day for a facility on a 1-acre site to 587 trips per day for a facility on a 10-acre site. It is also not anticipated that trains or vessels would be heavily used for transportation of typical construction or decommissioning equipment.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, construction and decommissioning activities would likely result in **less than significant impacts** on transportation.

Impacts from operation

Traffic and conflict with local transportation network

There would be occasional deliveries of materials during operation, which could include fuel for backup generators or maintenance vehicles. Hazardous materials are routinely shipped for other applications and pose no unusual hazards. No long-term road closures or interruptions to traffic patterns or volumes are expected for smaller facilities; however, larger facilities or facilities in urban areas may add to local traffic pattern interruptions due to increased frequency of deliveries or maintenance. Depending on the size of green hydrogen facilities, if routine use of heavy trucks during operations is required, this may degrade local or highway pavement conditions in the long run. If delivery routes for operational equipment require the frequent use of bridges, this could require major replacement or repairs. Transportation activities during operation would be unlikely to result in substantial damage or change to roads, rail, or marine freight corridors, and major repairs or replacement are not generally anticipated.

Truck, train, or vessel count increase

There may be an increase in vehicle trips due to maintenance employees periodically traveling to and from the facility site during operations. There may also be an increase in heavy truck counts for shipments, which could interfere with local traffic patterns and volumes. For larger facilities, the increased frequency of rail shipments could lead to an increase in train counts and could cause local traffic congestion due to longer at-grade rail crossing times. Larger facilities could also lead to an increase in water vessel (e.g., barge) transport counts, which could lead to traffic delays and congestion, as areas with bridges over waterway shipping channels could experience traffic congestion when bridges are raised and lowered to let shipping traffic pass.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, the operation of facilities would likely result in **less than significant impacts** on transportation.

4.14.3.2 Actions to avoid and reduce impacts

The following are some actions to avoid and reduce impacts of green hydrogen production facilities. See Appendix O, *Transportation Technical Appendix*, for typical mitigation measures that may be included in plans or permit conditions and additional measures that may apply for facilities.

Siting and design considerations
General

- Assess the potential for transportation impacts associated with the proposed facility in coordination with appropriate state and local agencies, consulting land use plans, transportation plans, and local plans.

Traffic and conflicts with local transportation network

- Consider proximity to rail crossings and site traffic when designing access roads to the site.
- Consider using existing roads, parking and staging areas, and utility corridors and if safe and structurally sound.
- Coordinate with interested agencies, Tribes, and interested parties if facility design proposes or requires a change in interstate access or a new interstate access.
- Proposed access changes should be considered in the context of statewide and local transportation and land use planning because they can affect local and regional traffic circulation.
- Design the facility to comply with applicable FAA regulations, including height and frequency requirements, to avoid or minimize potential safety issues associated with proximity to airports, military bases or training areas, or landing strips.
- Coordinate with FAA, military, and civilian airspace personnel to identify and minimize impacts on military and civilian airport and airspace use. For any temporary or permanent structure that exceeds any obstruction standard contained in 14 CFR 77.
- Consider the impacts of green hydrogen facility siting and design on non-motorized and public transit facilities and routes.
- Design and construct any new access roads to the appropriate standard no higher than necessary for the intended function.
- Coordinate with agencies having jurisdiction and other appropriate agencies (e.g., the DOE and Transportation Security Administration) to address critical infrastructure and vulnerabilities to minimize and plan for potential risks from natural events, sabotage, and terrorism.

Truck, train, or vessel count increase

- Consider traffic routes and peak-hour conditions in designing access roads to the facility.
- Implement mitigation measures to offset any adverse impacts to increased volumes.

4.14.4 Findings for production facilities with co-located BESS

4.14.4.1 Impacts

Impacts from construction, operation, and decommissioning
Impacts for green hydrogen production facilities with a co-located BESS would be similar to facilities without BESSs, except that the addition of a BESS could slightly increase construction worker numbers on-site. Construction worker travel times would likely be similar, but facilities with a BESS may require more workers or a longer construction period. A one-time oversized or

overload transportation shipment for construction of the BESS storage container and equipment would be required.

> *Findings*
> Impacts would be similar to those for production facilities above.

4.14.4.2 Actions to avoid and reduce impacts

Actions to avoid and reduce impacts from construction, operation, and decommissioning of facilities with co-located BESSs would be the same as those identified for facilities without a BESS.

4.14.5 Findings for green hydrogen storage facilities

4.14.5.1 Impacts

Impacts from construction, operation, and decommissioning
If located at a transport terminal or at an end-use location such as an industrial or fueling facility, temporary disruptions could occur to existing transportation networks, access points, and regular operational activities. During operations, there may be oversized or overweight shipments when equipment requires replacement. This could interfere with local traffic and transportation networks, as it could be a temporary hazard to road users. Green hydrogen storage facilities could have impacts on traffic counts, depending on the number of storage tanks. The volume of trips is expected to be the same or less than estimated for production at a 1-acre site.

> *Findings*
> Impacts would be similar to those for production facilities above.

4.14.5.2 Actions to avoid and reduce impacts

Actions to avoid and reduce impacts from construction, operation, and decommissioning of green hydrogen storage facilities would be the same as those identified for green hydrogen production facilities.

4.14.6 Findings for the No Action Alternative

The potential impacts from facilities developed under the No Action Alternative would be similar to the impacts for the types of facilities described above for construction, operations, and decommissioning, depending on facility size and design, and would be **less than significant.**

4.14.7 Unavoidable significant adverse impacts

Through compliance with laws and permits, and with implementation of actions to avoid and mitigate significant impacts, green hydrogen facilities would have **no significant and**

unavoidable adverse impacts on transportation from construction, operation, or decommissioning.

4.15 Public services and utilities

Key findings

A green hydrogen facility developer would need to ensure that there are sufficient utilities for a project available by establishing agreements with utility providers. A green hydrogen facility developer would also need to ensure that there is sufficient water available for a project, both physically and legally. The PEIS assumes that a project developer has contracted for sufficient electricity and renewable natural gas and obtained a water right as needed.

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, most construction, operation, and decommissioning activities would likely result in **less than significant impacts** on public services and utilities.

A facility would result in **potentially significant adverse impacts** on emergency response if activities required a large emergency response in remote locations with limited response capabilities, a fire or explosion during operations spreads rapidly or impacts large areas, or if there are other unique aspects of a facility site.

Potentially significant and unavoidable adverse impacts may occur if activities require a large emergency response in remote locations with limited response capabilities, a fire or explosion during operations spreads rapidly or impacts large areas, or if there are other unique aspects of a facility site or operations that affect emergency response. Determining if mitigation options would reduce or eliminate impacts below significance would be dependent on the specific project and site.

Public services and utilities include basic services and facilities that support development and protect public health and safety. The public services evaluated include:

- Fire and emergency response
- Wildfire response
- Law enforcement
- Health care facilities
- Public school enrollment

The utilities evaluated include:

- Solid waste disposal including landfill and recycling capacity
- Wastewater and stormwater infrastructure
- Water supply
- Electricity service and infrastructure

- Communications
- Natural gas

The *Public Services and Utilities Technical Appendix* (Appendix P) includes the full analysis and technical details used to evaluate public services and utilities in the PEIS. This section contains a summary of how impacts were analyzed and the key findings. Information on EHS can be found in the *Environmental Health and Safety Technical Appendix* (Appendix I), and information on energy and natural resources can be found in the *Energy and Natural Resources Technical Appendix* (Appendix H).

4.15.1 Affected environment

4.15.1.1 Public services

The study area is served by a variety of public service providers. Depending on the local conditions, public services may be provided by federal, state, county, or local governments, as well as volunteer groups including volunteer fire departments. Public services addressed in this section include emergency response services including fire response, emergency medical response, wildfire response, and law enforcement; health care facilities; and public schools.

Emergency response

Emergency response services include the following:

- **Law enforcement** services are provided by various county, municipal, and state entities including local county sheriff's offices and the Washington State Patrol. Emergency response services include fire and hazardous materials (HAZMAT) training through the Washington State Patrol Fire Protection Bureau. Ecology also has a HAZMAT spill response team.
- **Fire and wildfire prevention and response** are managed by local county fire departments, supported by volunteer units and other response teams. Wildfire response is provided by local fire departments as well as DNR, the U.S. Forest Service, and the Bureau of Land Management. DNR supports local responders and during high-risk conditions has helicopter and aircraft teams staged to respond to remote locations.
- **Emergency medical services and healthcare facilities** provide public health preparedness and response services, with emergency medical technician dispatch and medevac services supported by public and private entities. Major health care facilities in Washington include trauma centers and hospitals.

Public schools

A variety of public education school districts serve portions of the study area. These districts range in size from small, rural school districts to larger districts with numerous schools.

4.15.1.2 Utilities

The study area includes utilities provided by county, city, or private suppliers. Utilities described in this section include solid waste, wastewater, and stormwater management; water supply; electricity; communications; and natural gas.

Solid waste
Solid waste is managed by cities, counties, and private entities, with nearly 1,000 facilities in Washington, including 14 municipal solid waste landfills. Municipal and commercial solid waste is the largest contributor to solid waste. The next largest is construction and demolition debris, industrial waste, and cured concrete. The disposal of hazardous materials is described in Section 4.8, Environmental health and safety.

A substantial portion of the materials that make up green hydrogen facilities are recyclable, such as steel and aluminum. Metals and other materials capable of reuse may be collected and sold for reuse, recycled, or otherwise managed separately, consistent with state requirements.

Wastewater and stormwater
Wastewater and stormwater infrastructure in more populated areas is generally provided by local cities and counties, or public utility districts (PUDs)/water districts. In less-populated areas, sanitary wastewater can be managed with a permitted on-site septic system or trucked off site to an appropriate disposal location. Stormwater can infiltrate on site if feasible or would require a treatment and conveyance system to outflow to a local water body or conveyance system. The analysis assumes that wastewater and stormwater systems employed as part of a facility would be required to conform to local permit design and installation requirements to protect public health and surface and ground water resources.

Water supply
Water supply in the study area is provided through various sources, including public or private water utilities, groundwater wells, and surface water diversions. The Department of Health and Ecology share responsibilities under the state's Municipal Water Law under coordinated planning, engineering, and public health and safety agreements related to water resources and supply systems.

Water needs would vary depending on the green hydrogen production process. Some methods, such as methane pyrolysis, require no water for production, whereas others, like SMR, require 6–8 gallons of water per kg of hydrogen produced. Water used for electrolysis needs to be de-mineralized for the production process, which would require additional treatment not provided by public or private water utilities.

Electricity
Electrical utilities are provided in the State of Washington through PUDs and three main corporations including Avista Corporation, Pacific Power and Light, and Puget Sound Energy. Washington State is the nation's largest producer of hydroelectric power, with 60% of the state's power being generated by hydroelectric dams in 2023. Including biofuels and thermal energy, approximately 90% of Washington's power generation comes from renewable sources.

The study area only includes areas within 25 miles of minimum 55-kV transmission lines to meet the energy requirements of green hydrogen facilities. All facility types would require electricity during construction, operation, and decommissioning. Based on the regulatory definitions, green hydrogen production facilities could use electricity generated by different types of energy sources. This would decrease over time to meet the state's greenhouse gas limits. The primary source of energy for an electrolysis facility would need to be evaluated in the project-level environmental review. Some facilities may include co-located BESSs to balance loads from renewable resources with the demand of the production system. On-site energy storage also provides resilience to the facility in case of a power outage or power quality deviation.

Communications

Internet, broadband, and cell phone services are available throughout the study area. Public emergency alert systems report natural hazards (such as flooding or wildfire) through local radio stations, cell phones, and email notifications. Unpopulated or sparsely populated areas where cell service and internet systems are unavailable would utilize radio signals to broadcast alerts and communicate information pertaining to fire, police, severe weather, and other public hazards. Stand-alone communications sites include cell towers, radio towers, and microwave towers, which serve to relay communications signals.

Renewable natural gas

RNG is a gas consisting largely of methane and other hydrocarbons derived from the decomposition of organic material in landfills, wastewater treatment facilities, and anaerobic digesters (RCW 80.50.020). RNG is also known as biogas. Green hydrogen facilities using SMR or methane pyrolysis as a production method would require renewable natural gas as feedstock.

RNG is available from all major gas companies in Washington except for Pacific Gas and Electric Company Gas Transmission Northwest. As discussed in the *Energy and Natural Resources Technical Appendix* (Appendix H), the market demand for RNG in Washington is expected to grow, and RNG infrastructure and supply are expected to increase accordingly.

4.15.2 How impacts were analyzed

The assessment of impacts was qualitative and considered the following:

- Increased demand for public services that would exceed existing capacities of existing service providers or require construction of new or modified utilities needed to serve the facility
- If hazards associated with green hydrogen facilities would have the potential to impact emergency response capabilities

A green hydrogen facility developer would need to ensure that there are sufficient utilities for a project available by establishing agreements with utility providers. A green hydrogen facility developer would also need to ensure that there is sufficient water available for a project, both physically and legally. This PEIS assumes that a project developer has contracted for sufficient electricity and RNG and obtained a water right as needed. Impacts to energy resources are discussed in the *Energy and Natural Resources Technical Appendix* (Appendix H), and impacts to water resources are discussed in the *Water Resources Technical Appendix* (Appendix F).

4.15.3 Findings for green hydrogen production facilities

4.15.3.1 Impacts

Impacts from construction and decommissioning

Emergency response

Construction and decommissioning of green hydrogen facilities would employ a temporary workforce. Some workers could be local, and others could temporarily relocate to work on a green hydrogen facility. These temporary workforces may impact demand for public services in the area.

Materials and equipment on site may increase the potential for theft, vandalism, trespass, fire, safety issues, and/or accidents requiring law enforcement or other emergency response services. Facilities are expected to have site security including a combination of fencing, lighting, security patrols, security cameras, no trespassing signs, and other electronic security monitoring systems. It is anticipated that proactive planning would reduce potential law enforcement response demands.

Activities during construction and decommissioning could include welding, removal of vegetation, and use of vehicles and equipment and associated fuels, all of which introduce ignition risks during construction. The potential for increased emergency response demand at construction of any facility varies by facility type and location. The study area includes industrially zoned areas or areas zoned to support industrial uses, which are usually already suited for land-intensive activities. In general, facilities proposed in more-populated areas would have faster response times and more fire-fighting resources available than facilities proposed in less-populated areas. Facilities proposed in less-developed areas may also be at greater risk of wildfire impacts, especially when conditions are dry. Wildfire risks are also discussed in Section 4.8, Environmental health and safety.

Construction and decommissioning would also increase the potential for accidents and incidents requiring emergency medical response services or health care facility services for 10–100 construction workers. Worker safety training and adherence to safety procedures during construction and decommissioning would reduce risks of accidents and incidents and the potential to decrease the capabilities of emergency medical response demands. Additional discussion regarding emergency response is included in the *Environmental Health and Safety Technical Appendix* (Appendix I).

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, most construction and decommissioning activities would likely result in **less than significant impacts** on emergency response.

A facility would result in **potentially significant adverse impacts** to emergency response if activities required a large emergency response in remote locations with limited response capabilities or if there are other unique aspects of a facility site.

Public schools
The impact on local schools would be minor and temporary because few out-of-area construction workers would be likely to permanently relocate their families to the community where a green hydrogen facility is being developed. Facilities developed in more urban areas could also draw from the local construction workforce.

Findings
Impacts on school enrollment during construction and decommissioning would be **less than significant**.

Solid waste
During construction, the primary solid waste generated would consist of solid construction debris and a negligible amount of waste associated with the construction workforce. Some of this waste, such as scrap metal or cardboard, could be recycled; the remainder would be transported to a licensed transfer station or landfill.

During decommissioning, remediation work and disposal of hazardous materials maybe required. The precise quantities and content of solid waste would vary depending on the facility size, and the actions associated with decommissioning would depend on construction materials used and specific site restoration actions needed based on the local environment. Decommissioning would involve the removal of all above-ground components, so debris generated would be greater than during construction. There may be opportunity to reuse or recycle other materials such as steel tanks.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, construction and decommissioning activities would likely result in **less than significant impacts** on solid waste.

Wastewater and stormwater
Information on impacts on water resources is included in Section 4.5. Sanitation and wastewater could be managed through contracted portable systems or discharged to an available sanitary sewer system with the proper permits and BMPs in place. Potable water

would be needed for drinking and could be supplied by a commercial supplier of bottled water or a water utility provider. Construction stormwater would be managed using construction stormwater BMPs compliant with the required NPDES Construction Stormwater General Permit. Compliance with this permit would likely require pretreatment before discharge of stormwater to surface waters or a stormwater or sewer system that discharges to surface waters.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, construction and decommissioning activities would likely result in **less than significant impacts** on wastewater and stormwater utilities.

Water supply
Water demand would consist of the supply needed for activities such as concrete production, dust control, equipment cleaning, potable water and wastewater for construction crews, and revegetation and landscaping. Depending on the proposed location of the facility, this could be sourced from groundwater, surface water, or a water utility provider connection on site, or could be trucked to the site. Water provided from a utility provider would be obtained through application of permits with the municipality, water district, or PUD, which would coordinate availability and applicable design standards.

Coordination with water utility providers would also be necessary to avoid conflicts and damage to existing water lines, which would be required prior to construction ground disturbances. This PEIS assumes that a project developer will have water rights as needed.

Findings
Through proper siting and design and coordination with service providers, construction and decommissioning impacts to water supply would be **less than significant**.

Electricity, communications, and natural gas
Construction activities would require electricity and communications, but not natural gas. Electricity for construction work may be powered through generators, or connections to local power, depending on location and contractor needs. Internet may be required for mobile offices at job sites, and on-site communication would use walkie-talkies.

The contractor and developer would have to coordinate, apply for permits, and meet the design specifications of the local providers for service connections. Occasional and temporary service interruptions could occur during construction; however, coordination with service providers would reduce the potential for outages.

Additionally, construction would require coordination with gas, electrical, and communications providers of the location of their infrastructure so construction activities do not impact existing infrastructure.

Findings
Through proper siting and design and coordination with service providers, construction and decommissioning impacts to electricity, communications, and natural gas utilities would be **less than significant**.

Impacts from operation

Emergency response

Demand for law enforcement services due to potential theft, accidents, vandalism, or trespassing could increase during operation. However, various security measures would typically be in place as part of normal operations to protect the facilities. Such measures would reduce demand for law enforcement services.

Fire and explosion risks associated with facility operations are described in Section 4.8, Environmental health and safety. The severity of risks would need to be assessed at the project level based on the project location, production method, and quantities of flammable materials produced or stored on site. Fire risks during facility operation include those caused by green hydrogen facility operational activities and fires started outside of facilities that have altered behavior (i.e., spread, movement, or ability to be suppressed) due to the presence of a green hydrogen facility. This analysis assumes that green hydrogen facilities would be regularly maintained and monitored to reduce these risks and proper fire control measures and procedures would limit the need for emergency response services. However, accidents and fires could still occur.

The production of green hydrogen would introduce fire and explosion risk due to the presence of hydrogen and other flammable materials used in the production of hydrogen. Hydrogen is a flammable gas that when ignited burns with a clear flame. It is also odorless, making it hard for humans to detect leaks. Fire and building code requirements, proper procedures and trainings, proper detection systems, and coordination with local fire departments would provide knowledge of the facility so that local fire responders are better prepared to fight a fire. Additionally, fires that start outside of the facility could be exacerbated by the presence of hydrogen and other flammable materials at a green hydrogen production facility. These risks can be reduced through project siting and consideration of other fire risks in the surrounding area.

If a fire or explosion were to occur during operations, facilities in more-populated areas would have faster response times and more fire-fighting resources available than facilities proposed in less-populated areas. Additionally, much of the study area has similar types of industrial operations occurring with similar types of industrial emergency response considerations.

If a fire during operation is not contained, it could spread outside of the operation perimeter, potentially leading to a wildfire. Facilities proposed in less-developed areas may also be at greater risk of wildfire impacts, especially when conditions are dry. In remote locations with limited response capabilities, the emergency response demand in the event of an operation-related wildfire could limit emergency response resources needed to address other fires in the vicinity.

Facilities located in areas with greater risk of wildfire could reduce risks through BMPs, including having non-flammable ground cover (e.g., gravel or pavement) surrounding the facility and flammable materials, irrigating any perimeter landscaping, and monitoring local wildfire conditions.

EMS and health care facilities could be required for employees (up to three) during routing operations and maintenance. For example, periodic routine maintenance activities could involve accidental fire, electrical shock, or a medical emergency. The challenges of an emergency medical response could be exacerbated by winter conditions, distance of the facility site from medical services, and access to the site. As described in Section 4.8, Environmental health and safety, operation of green hydrogen facilities includes risk of fires, explosions, and other accidents that could result in chemical burns from sodium or potassium hydroxide, hypothermia or frostbite from liquid hydrogen exposure, steam burns, asphyxiation from gas leaks, falls, or similar incidents. Given the size of the workforce (up to three employees), medical emergencies are unlikely to exceed response capabilities within the study area.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, operations of a facility would likely result in **less than significant impacts** on emergency response.

A facility would result in **potentially significant adverse impacts** to emergency response if activities required a large emergency response in remote locations with limited response capabilities, a fire or explosion during operations spreads rapidly or impacts large areas, or if there are other unique aspects of a facility site.

Public schools
Green hydrogen production facilities would employ up to three full-time employees. Local public school districts would be able to accommodate any enrollment if a worker were to permanently relocate to work at a green hydrogen production facility.

Findings
Facilities would not increase the population such that new or modified public schools would be needed and impacts on local school enrollment during operations would be **less than significant**.

Solid waste
Solid waste such as garbage, food waste, and recyclables from employees would be generated from employees during operation. The solid waste generated by employees would be collected in dumpsters on site. Solid waste such as cardboard, paper, packing materials, and metals

would also be generated from operation of an industrial facility. Developers would need to coordinate with local waste management services to determine trash and recycling pickup, as well as to determine the appropriate handling and disposal location for any waste that cannot be recycled to disposed of in a general-use landfill.

Different production methods produce different byproducts, some of which have other uses and some of which would need to be disposed of. Solid byproduct disposal from green hydrogen operations would be required for pyrolysis and biomass production methods. Methane pyrolysis would create particulate carbon. Particulate carbon has uses in industries that use or create carbon composite materials, including carbon-based composite building construction. Since this byproduct has monetary value, it is unlikely that any operator using methane pyrolysis would directly dispose of this byproduct.

Solid byproducts from biomass would be dependent on the feedstock. State law requires biomass used for green hydrogen production to come from solid organic fuels including wood, forest, or field residues, or from dedicated energy crops that do not include wood pieces that have been treated with chemical preservatives. Based on these feedstocks, the potential waste from biomass includes moisture, ash (solid carbon), carbon dioxide, hydrogen, nitrogen, chlorine, sulfur, and oxygen. Feedstocks that contain sulfur would be discharged in a liquid form that requires disposal.

The amount of solid waste from green hydrogen facilities varies vastly, based on the exact feedstock used, process efficiency, and requirements for preprocessing of feedstock or post-processing of product streams. Coordination with local waste management to characterize the waste, transport it, and treat it to compliance would be required. A waste hauler that receives waste from industrial sources would be identified during facility planning.

A solid waste collection service that is under contract with a private hazardous waste management firm would be identified based on location. A local disposal company would assist with management to a disposal location through disposal contracts. Long-term capacity needs are required to be identified in county hazardous waste management plans. These plans base the anticipated capacity of landfills on current population and tonnage projections. If the amount of disposal material or the type of hazardous waste is not accepted, it may require disposal service through a private hazardous waste management firm. The developer and contractor would need to coordinate with local disposal facilities to properly dispose of large quantities or contaminated material and determine capacity limits.

During the life of the facility, equipment and materials would reach their lifespans and have to be replaced. Waste would include but is not limited to large pieces of metal, tanks that have with housed hazardous fluids, and site electronics. In general, most waste generated would not require special treatment, but items like soiled PPE, tanks, and cleanup supplies from any potential spills would require specific handling and disposal.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, operation of facilities would likely result in **less than significant impacts** on solid waste.

Wastewater and stormwater

Sanitary wastewater would be managed using a local sanitary sewer system or an on-site septic system. Facilities using electrolysis as wastewater would discharge to sanitary sewer or a stormwater system after wastewater was treated in an on-site wastewater treatment facility. Stormwater on site would be discharged to an existing stormwater conveyance and treatment system or would be infiltrated if feasible. Facilities connecting to wastewater or stormwater conveyance systems would need to coordinate with utility providers for on-site connections. Green hydrogen facilities would be required to comply with NPDES standards and requirements. Wastewater would be treated on site to meet NPDES permit requirements or routed to a wastewater treatment plant.

Depending on availability in a proposed green hydrogen production facility's location, stormwater and wastewater utility providers may need to expand sewer lines, conveyance systems, or treatment facilities. Developers would need to confirm with local utility providers and may be required to pay for some or all infrastructure improvements to support a green hydrogen production facility.

Findings
Through proper siting and design and coordination with service providers, operation impacts to wastewater and stormwater utilities would be **less than significant**.

Water supply

Potable water would be needed for operations staff. In addition, water would be required for three of the four production methods of green hydrogen as described in Section 4.5, Water resources. To produce 1 kg of hydrogen, electrolysis requires 2–3 gallons of water, SMR requires 6–8 gallons, and the water requirements of bio-gasification are variable based on feedstock composition. Pyrolysis does not require water. Prior to operations, facilities would need to obtain water rights or confirmation of water supply from water provider. Depending on the facility location, water would be sourced from a municipal, water district, or PUD water supply; from groundwater using an on-site well; or through on-site surface water diversions. The developer would need to coordinate with the local jurisdiction or water district to assess proposed water needs and confirm what utility connections would be required. Additional discussion of water supply is provided in Section 4.5, Water resources.

This PEIS assumes a project developer will have water rights as needed.

Findings
Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, operation impacts to water supply would be **less than significant**.

Electricity, communications, and renewable natural gas
Green hydrogen facilities would require electrical and communications systems. Some facilities would require renewable natural gas services, depending on the production method.

Electricity would be needed for site lighting, site electronics, and production methods. SMR production requires the lowest electrical demand (0.1–3 kWh per 1 kg of hydrogen) and electrolysis having the greatest demand (50 kWh per 1 kg of hydrogen).

The study area includes areas in Washington within 25 miles of transmission lines of 55 kV and above. Facilities typically connect to the main transmission line through distribution lines, the length of which would be determined at the project level based on the distance between a selected site and existing electricity grid infrastructure. More than 81% of the study area is within 1 mile of existing 55-kV or greater transmission lines. The study area includes many areas already developed for industrial use with existing electrical infrastructure.

As described in Section 4.7, Energy and natural resources, based on the regulatory definitions, green hydrogen production facilities could use electricity generated by different types of energy sources. This would decrease over time to meet the state's greenhouse gas limits. The primary source of energy for an electrolysis facility would need to be evaluated in the project-level environmental review.

A green hydrogen facility developer would need to ensure there is sufficient electricity for a project available by establishing an agreement with a utility for access to the electrical grid or with a producer of electricity, such as from a new renewable energy facility. If electricity is not available, a project would not be able to operate.

Communications systems would be used for internet, site communications, and monitoring systems. Since staff may not be on-site 24/7, detectors need to be able to notify local staff and emergency service providers. Operations staff would also utilize walkie-talkies for site communication using frequencies that do not interfere with emergency frequencies used by law enforcement, fire departments, and EMS. Green hydrogen production facility developers would need to coordinate with their local communications providers to make sure their demands can be met with the existing service provided in their area.

Renewable natural gas is required for green hydrogen production facilities using SMR and pyrolysis. SMR requires 150 scf of renewable natural gas to produce 1 kg of hydrogen, and methane pyrolysis requires 200 scf of renewable natural gas to produce 1 kg of hydrogen. Renewable natural gas is available from all major gas companies in Washington except for Pacific Gas and Electric Company Gas Transmission Northwest.

RNG requirements for upper-bound SMR and pyrolysis facilities exceed current statewide RNG supply. As discussed in Section 4.7, Energy and natural resources, the market demand for RNG in Washington is expected to grow, and RNG infrastructure and supply are expected to increase accordingly. It is assumed that facilities requiring renewable natural gas would be sited in areas that provide renewable natural gas through existing pipelines or in areas capable of providing pipelines to a facility. Developers would need to coordinate with their local natural gas providers to determine if RNG is available in their area and to make sure they can provide the renewable natural gas needs of SMR and pyrolysis green hydrogen production facilities.

This PEIS assumes a project has contracted for sufficient electricity and renewable natural gas.

Findings
Through proper siting and design and coordination with service providers, operation impacts to electricity, communications, and renewable natural gas utilities would be **less than significant**.

4.15.3.2 Actions to avoid and reduce impacts

The following are some actions to avoid and reduce impacts of green hydrogen production facilities. See Appendix P, *Public Services and Utilities Technical Appendix*, for typical mitigation measures that may be included in plans or permit conditions and additional measures that may apply for facilities.

Siting and design considerations

- Coordinate with the local fire district, emergency management departments, and/or DNR (if facility siting is proposed on or near forests or wildlands) prior to and during construction and throughout the life cycle of the facility.
- Site green hydrogen production facilities in areas with adequate utility infrastructure, including electrical, communications, and renewable natural gas, to meet the demands of the facility. This varies between production methods (e.g., renewable natural gas is not needed for all green hydrogen production methods).
- Site green hydrogen production facilities in areas with adequate water availability for construction and green hydrogen production facility operation needs. Take into account the proposed production method, as water needs varies between production methods.
- Design facilities to reduce risks to neighboring land uses, including potential setbacks, to reduce the risk of ignitions in fire-prone environments. Determine appropriate setbacks in consultation with local or state land managers and consider the need to maintain access for maintenance and emergency response.
- Develop and implement a site-specific fire prevention and response plan. This plan would include specific measures for coordinating and training response personnel, such as guidelines for first responders to safely shut down electrical systems in the event of fire, management requirements to reduce ignition risks throughout the sites, and site management fire safety and awareness protocols including tracking fire conditions in the surrounding region, among others.

- Develop and implement a decommissioning and site reclamation restoration plan to include fire prevention measures.

Additional mitigation measures to address potentially significant impacts

- Provide funding for local emergency responders for training and equipment to address fire and explosion risks.

4.15.4 Findings for production facilities with co-located BESS

4.15.4.1 Impacts

Impacts from construction, operation, and decommissioning

The construction, operation, and decommissioning of a facility co-located with a BESS is anticipated to include the same impacts on public services and utilities as those described for facilities without BESS.

Co-location of BESS introduces an additional fire risk management, emergency response, and solid waste consideration.

Fire and emergency response

The types of BESSs evaluated in this PEIS rarely start fires if properly installed and maintained. BESSs come equipped with remote alarms for operations personnel and emergency response teams. Other protective measures include ventilation, overcurrent protection, battery controls to operate the batteries within designated parameters, temperature and humidity controls, smoke detection, and maintenance in accordance with manufacturers' guidelines.

Batteries may contain hazardous materials that pose potential risks for environmental release if not handled correctly and could introduce hazards for first responders. BESS facilities could create hazards for firefighters and emergency responders with the possibility of explosions, flammable gases, toxic fumes, water-reactive materials, electrical shock, corrosives, and chemical burns. BESSs require specialized and reliable equipment to perform firefighting operations safely and effectively to the Washington Fire Code, NFPA, OSHA, and Underwriters Laboratories codes and standards, as discussed in the environmental health and safety section, as well as the applicable county fire protection district codes and standards.

Specialized advanced planning and procedures for enhanced emergency response training would be required to ensure that the green hydrogen facilities and co-located BESSs do not initiate or exacerbate wildfires during construction, operation, or decommissioning or otherwise generate hazards that could interfere with or exceed emergency response capabilities. The recommended approach from the American Clean Power Association is not to use water for firefighting but allow the battery to burn in a controlled manner. This would result in air emissions which could be hazardous to emergency responders and would require protective gear.

Findings
Impacts to public services and utilities would be similar to findings for production facilities above, with additional fire risk management and emergency response considerations for BESSs.

Solid waste
Lithium-ion batteries have lifespans that are shorter than a typical green hydrogen production facility. Lithium-ion batteries typically last 5 to 10 years, and because their performance gradually degrades over time, a green hydrogen facility operator may choose to change them sooner than 5 years after installation. The operator would need to coordinate with a universal waste transporter to transport old lithium-ion batteries to a treatment, storage, and disposal facility or a recycling facility.

When a battery reaches its end of life, the operator or decommissioner should follow Ecology's guidance for managing universal waste, which includes the managing of batteries.

Findings

Through compliance with laws and permits, and with implementation of actions that could avoid and reduce impacts, impacts to solid waste from green hydrogen production facilities co-located with BESSs would be **less than significant**.

4.15.4.2 Actions to avoid and reduce impacts

Available actions for facilities with BESSs would be the same as those proposed for production facilities without BESSs. Additional actions to address BESS impacts are described below:

- Develop and implement the fire protection, prevention, and detection measures and design features in accordance with NFPA 855 Standards for Installation of Energy Storage Facilities and the current Washington Fire Code, including requirements for providing redundant separate methods of BESS failure detection.
- Develop and implement an Emergency Action Plan in advance of construction to train local emergency response personnel on hazards specific to BESSs during development and operation of the facility.
- Develop and implement regular maintenance schedules and inspections for BESS components to ensure optimal performance and early detection of potential issues.

4.15.5 Findings for green hydrogen storage facilities

4.15.5.1 Impacts

Impacts from construction, operation, and decommissioning
Impacts on public services and utilities are anticipated to be similar to those of green hydrogen production facilities. The size of storage facilities would depend on the amount of hydrogen to be stored. Hydrogen storage facilities, including storage tanks, separation space between tanks

(if more than one), on-site access roads, and ancillary equipment would be less than 1 acre in size. Public services and utilities would generate or require fewer public services and utilities than what is required of a 1-acre green hydrogen facility site. Both the gas and liquid storage method demands for electricity would require a range from 0.001% to 0.6% of the 2023 total statewide electricity production (kWh).

While none of the risks associated with the production of hydrogen would be present, green hydrogen storage facilities would store liquid or gaseous hydrogen which poses a risk of fire and explosion as well as cryogenic burn for liquid hydrogen. The pressure required to store green hydrogen could create hazards for employees, firefighters and emergency responders. The severity of these impacts could be wide ranging, depending on the type and quantity of hydrogen exposure. Incidents involving spills, fires and uncontrolled releases of hydrogen can be prevented with operator training and proper system design. Developing an emergency response plan and training responders to be familiar with its implementation would reduce impacts from incidents.

Findings
Impacts to public services and utilities would be similar to impacts for green hydrogen production facilities above.

4.15.5.2 Actions to avoid and reduce impacts

The actions to avoid, reduce, and mitigate impacts for facilities would be the same as those identified for green hydrogen production facilities.

4.15.6 Findings for the No Action Alternative

The potential impacts from facilities developed under the No Action Alternative would be similar to the impacts for the types of facilities described above for construction, operations, and decommissioning, depending on facility size and design, and would range from **less than significant to potentially significant adverse impacts**.

4.15.7 Unavoidable significant adverse impacts

Potentially significant and unavoidable adverse impacts could occur if activities require a large emergency response in remote locations with limited response capabilities, if a fire or explosion during operations spreads rapidly or impacts large areas, or if there are other unique aspects of a facility site or operations that affect emergency response. Determining if mitigation options would reduce or eliminate impacts below significance would be dependent on the specific project and site.

5 Cumulative Impacts

5.1 Cumulative impacts analysis

Cumulative impacts are effects that would result from the impacts of green hydrogen facilities added to the impacts from other past, present, and Reasonably Foreseeable Future Actions (RFFAs). Cumulative impacts can result from incremental, but collectively significant, actions that occur over time. The cumulative impacts analysis was prepared in accordance with SEPA (WAC 197-11-060) and RCW 43.21C.535. The purpose is to make sure that decision-makers consider the full range of consequences under anticipated future conditions. Future project-specific environmental reviews would need to consider the cumulative impacts of the project with other local and regional actions.

The cumulative impacts analysis considered the following:

- Effects of multiple actions in the geographic scope of study (see Figure 1-1)
- Effects on the same resource
- Long-term effects

The following steps were used:

- Identify the resources that could be adversely affected by the future green hydrogen facilities evaluated in the PEIS.
- Assess the current condition and historical context for each resource, including trends affecting the resource.
- Consider RFFAs in the same timeframe and affecting the study area for each resource.
- Analyze cumulative impacts using the best available data.
- Analyze PNWH2 Hub locations where green hydrogen facilities may be likely to be co-located.

Key findings

Due to the large geographic study area and broad trends of RFFAs identified in Table 5-1 that are considered in this planning document, all resources in this section would have impacts that range from **less than significant to potentially significant**. Future projects would need to conduct cumulative analyses relative to their proposal.

For some resources, the study area for cumulative impacts may extend beyond the geographic scope of study in Figure 1-1 to evaluate the incremental impacts on the resource within a larger community or landscape, such as migration corridors. Appendix Q is the *Cumulative Impacts Technical Appendix,* with more detailed information and specific analyses.

5.2 Past, present, and reasonably foreseeable future actions

Current conditions are a result of past and present actions. The current conditions in the study area were used as the baseline existing environmental conditions for the resource analyses in this PEIS and are described as part of the affected environment for those resources. Therefore, past actions were not considered again for most resources. Tribes have noted that resources in the study area are part of a much larger integrated cultural network and that impacts can extend far beyond the study area in space and time. To analyze the full range of consequences of potential cumulative impacts on Tribal rights and interests, as well as resources and cultural resources, some additional past and present actions are considered in this analysis (see Sections 5.3.1 and 5.3.13).

RFFAs, including the green hydrogen facilities evaluated in this PEIS, are activities that could affect the geographic study area over the 75-year timeframe (July 2025 through June 2100). These include trends that could affect humans and the environment within the study area during the study period. This trend analysis is appropriate for this planning document.

Table 5-1 outlines the types of future actions identified as reasonably foreseeable in the relevant geographic study area and timeframe. These were used to identify trends that were used for the cumulative analysis.

Table 5-1. Summary of reasonably foreseeable future actions affecting the study area

RFFA	Associated activities	Trends identified
RFFA 1	Energy Projects including Clean Energy Developments and Changes to Existing Energy Systems	• Development of new energy-generating facilities, transmission systems, and distribution networks • Modification of existing energy generation, transmission, and distribution infrastructure including those for electricity, natural gas, and petroleum products (e.g., gasoline and oil) • Decommissioning, decontamination, and demolition of former coal-fired power plants and associated facilities
RFFA 2	Urban, Commercial, and Industrial Activities and Development	• Local residential developments • Urban redevelopment projects • Utility infrastructure (e.g., water/sewer, electrical distribution, and communications) rehabilitation and expansion • Industrial development • Industrial facility decommissioning
RFFA 3	Rural and Agricultural Activities and Development	• Crop changes • Conversion of non-designated agricultural land • Irrigation system maintenance and upgrades • Livestock grazing development and expansion

RFFA	Associated activities	Trends identified
RFFA 4	Federal, State, Tribal, and Local Wildlife and Habitat Projects	• Growth management programs • Stream, riparian, and wetland habitat projects, including restoration and mitigation banks • Watershed planning and implementation
RFFA 5	Transportation Infrastructure Development and Modification	• Highway and road expansion and maintenance • Rail transportation expansion and maintenance • Port and navigation channel expansion and maintenance • Airport and aviation support infrastructure expansion and maintenance • Mass transit projects
RFFA 6	Contaminated Site Cleanup and Remediation	• Initial and remedial site investigations and feasibility studies • Site cleanup activities • Monitoring and maintenance activities
RFFA 7	Mining Operations	• Expansion of existing mining and processing facilities • Development of new mines and processing facilities • Changes in mining processes and procedures • Performance of reclamation activities
RFFA 8	Recreation Activities	• Changes in hiking, biking, and equestrian trail systems • Changes in existing winter recreation areas • Changes in camping and RV sites • Changes in areas available for hunting, fishing, and off-road motor vehicle use
RFFA 9	Military Use	• Development or modification at military facilities • Changes in land use and management • Runway resurfacing • Changes in surface and air training operations, training, and testing
RFFA 10	Water Supply Development and Withdrawals for Municipal, Agricultural, Industrial, and Conservation Uses	• Development and use of reservoirs, well fields, water distribution systems, water treatment plants, and pump stations for municipal, agricultural, and industrial uses • Implementation of projects designed to improve water conservation and encourage water storage and flood risk reduction • Implementation of projects that support streamflow for aquatic species • Changes in water rights policy and water availability • Dam removal

5.3 Cumulative impacts by resource

This section provides a summary of potential cumulative effects from the types of facilities considered in this PEIS and other RFFAs on resources. In general, the larger the facility, the greater the potential for cumulative impacts because of the larger footprint, the increased need for construction materials, and the increased scale of the supporting infrastructure.

5.3.1 Tribal rights, interests, and resources

Tribes are recognized as unique sovereign people who exercise self-government rights that are guaranteed under treaties and federal laws. Tribal rights, interests, and resources refer to the collective rights and access to traditional areas and times for gathering resources associated with an Indian Tribe's sovereignty since time immemorial. They include inherent rights or formal treaty rights associated with usual and accustomed territories.

Tribal resources include areas important to traditional cultural practices and the natural and cultural resources associated with those practices, including plants, wildlife, and fish used for commercial, subsistence, and ceremonial purposes. Tribal resources may also include archaeological or historic sites or TCPs associated with Tribal use and sites considered sacred by Tribes. Tribal resources, archaeological sites, historical and cultural sites, TCPs, and natural resources can often be interconnected and overlapping as Tribal resources. Additional details can be found in the *Tribal Rights, Interests, and Resources Technical Appendix* (Appendix B).

Tribal rights, interests, and resources have been repeatedly affected by past and present actions. Construction of past and present projects has included a range of ground disturbance and alterations to the landscape, some of which persist and contribute to the cumulative impacts that may result from green hydrogen facilities. The assessment of cumulative impacts on Tribal rights, interests, and resources includes these considerations.

All RFFAs identified in Table 5-1 have the potential to contribute to cumulative impacts on Tribal rights, interests, and resources. These could be from ground disturbance; restrictions to access; noise impacts; degradation of visual quality; or by affecting landscape, habitats, and species. The development of new energy, industrial, commercial, and agricultural facilities and transportation, mining, or forestry activities would impact Tribal resources. This could be from erosion, water quality impacts and water consumption, biological resource impacts, and disruption of access to resources. Federal, state, Tribal, and local wildlife and lands management and habitat projects would be expected to maintain, restore, or create habitats, including wetlands. Contaminated site cleanup and remediation projects would also be expected to improve habitats in the long term, but there would be short-term risks from leaks or spills during cleanup and remediation. Increased human access from recreational activities could potentially disrupt, alter, or degrade habitats and species. Water supply development and withdrawals for municipal, agricultural, industrial, and conservation uses could result in improvements to water resources but could also potentially disrupt, alter, or degrade habitats and species.

Construction and decommissioning activities of green hydrogen facilities could result in cumulative impacts when combined with the impacts of these activities. Cumulative impacts on plants, animals, and ecological communities used by Tribal members could occur if multiple facilities and other activities are in the same area. These could result in changes to vegetation, fragmentation of habitats, degradation of fisheries, or restricted movement of animals and impacts to migration paths due to increased fencing, roads, and other structures. Tribal spiritual practices could be interrupted by construction impacts, and access to land areas and cultural or sacred sites could be limited. Sensitive viewers or sensitive receptors of noise impacts could include members of Tribes, and some landscapes have special meaning because of Tribal connections or values. Multiple green hydrogen facilities and other activities developed close to each other could intensify disruption to sacred religious and ceremonial practices. As such, projects that are being constructed at the same time and near each other could intensify impacts from degradation of visual quality, noise, and interruption of culturally significant landscapes and habitats.

Potential cumulative impacts on Tribal rights, interests, and resources during operation of green hydrogen facilities include disturbance of previously unrecorded archaeological sites and visual degradation of settings associated with Tribal resources. Impacts could also include limitation of access and travel paths traditionally utilized for hunting, fishing, and other ritual and cultural activities. Impacts from limiting access and travel and from visual degradation are likely to be more significant cumulatively than on an individual project basis.

5.3.2 Environmental justice

RCW 43.21C.535 requires this PEIS to consider environmental justice and overburdened community areas. This PEIS considers whether potential environmental impacts disproportionately affect people of color populations and low-income populations. Of the 692 census tracts that overlap the study area, 275 census tracts (40%) are identified as having populations of people of color and 373 census tracts (54%) are identified as having low-income populations. This PEIS also identifies where overburdened community areas are located in the study area. An overburdened community is defined as a geographic area where highly impacted communities and vulnerable populations face multiple combined environmental harms and health impacts. Of the census tracts that overlap the study area, 31% were identified as overburdened community areas. Additional details regarding environmental justice and overburdened communities can be found in the *Environmental Justice Technical Appendix* (Appendix C).

All RFFAs identified in Table 5-1 have the potential to contribute to cumulative impacts on people of color populations and low-income populations. This is mostly because if projects are sited in or near these communities, residents could be disproportionately affected by project activities. These include increased traffic, noise, air emissions, hazards, visual impacts, and land use changes. The development of new energy, industrial, commercial, and agricultural facilities and transportation and forestry activities would have a greater risk of visual changes and conversion of land uses that affect the rural character of surrounding areas. These impacts could occur disproportionately in areas with low-income populations and people of color populations. Over the 75-year timeframe of this analysis and continued development of related RFFAs, cumulative effects could result in disproportionate impacts on people of color populations or low-income populations if a facility is located near these populations. The locations and demographics of these populations are also expected to change over that time frame.

Cumulative factors for populations with environmental justice concerns are highly dependent on context but must consider the potential impacts from persistent and/or traumatic exposure to system racism/classism. Populations with environmental justice concerns are often inequitably burdened with higher rates of stress and illness, and health disparities associated with the historical and current industrial land use conditions could be exacerbated if the operation-related risks of fire and explosion spread to surrounding areas near people of color populations or low-income populations.

Construction, operation, and decommissioning of the types of green hydrogen facilities evaluated in this PEIS may have cumulatively considerable impacts on people of color populations or low-income populations from emergency response and environmental health and safety related risks. Facility activities could lead to an increased risk of fire and could result in an impact on emergency response if activities require a large emergency response in remote locations with limited response capabilities or if a fire or explosion during operations spreads rapidly or impacts large areas. The project-specific impacts from these would depend on the production and storage methods and existing and surrounding uses where the facility would be located. If a facility is located near people of color populations or low-income populations, this would potentially result in disproportionate impacts on these populations.

Green hydrogen facilities and other activities near each other could also result in cumulative impacts on other resource areas, which could result in further cumulative impacts on people of color populations or low-income populations. Potentially significant impacts on resource areas that may disproportionally affect people of color populations or low-income populations, if cumulatively considered with similar effects from other RFFAs, include the following:

- Tribal rights, interests, and resources
- EHS
- Noise and vibration
- Land use
- Aesthetics and visual quality
- Recreation
- Historic and cultural resources
- Public services and utilities

5.3.3 Earth

Earth resources include geology, like soils and topography, and geologic and seismic hazards. Details can be found in the *Earth Resources Technical Appendix* (Appendix D).

All RFFAs identified in Table 5-1 have the potential to result in impacts on earth resources. The cumulative impacts would depend on the location and number of activities and how near they are to each other. Ground-disturbing activities would impact soils. These may include grading for roads and development, clearing a site, and installing infrastructure. They could also include stockpiling and removing soils, changing the flow of water, and constructing access roads and facilities. These impacts may increase the potential for soil compaction, surface erosion and runoff, sedimentation of nearby waterways, soil contamination, slope instability, landslide risks, and changes in local drainage patterns. Grading and fill activities of multiple developments in the same area could result in an increased risk of large-scale landslides.

The addition of ground-disturbing linear features such as roads and utility corridors may also add to this cumulative impact as green hydrogen facilities and other RFFAs are developed in proximity to each other to take advantage of similar infrastructure and uses. These activities could potentially contribute to localized ground disturbance, potential changes in local drainage patterns and borrow of construction materials, potential slope stability impacts, and subsidence. When considered over the 75-year time frame covered within this analysis, these potential impacts would be compounded as similar RFFAs and multiple green hydrogen facilities are planned in increasing density and proximity to one another. Similarly, soil contamination and related remediation due to spills could be compounded over time by these developments.

Cumulative impacts to earth resources from green hydrogen facilities and other RFFAs would be expected to increase but would vary depending on the size, type, and number of activities within a given area.

5.3.4 Air quality and greenhouse gases

Air quality throughout the study area varies depending on the location. In urban surroundings, air quality is generally lower than in parts of the study area with more rural surroundings, with the exception of dust storms in central Washington. There is only one location (called a "nonattainment" area) in the state that does not meet the EPA standards for criteria pollutants: the area around the Intalco Aluminum Smelter in Whatcom County is not currently meeting the criteria for sulfur dioxide. This non-attainment area is within the PEIS geographic scope of study for green hydrogen. Additional industrial emissions at this location could contribute cumulatively to air quality impacts.

There are some areas of concern for particulate matter and ozone within the study area. Washington has requirements for reducing GHG emissions to achieve net zero emissions by 2050. Additional details regarding air quality and GHGs can be found in the *Air Quality and Greenhouse Gases Technical Appendix* (Appendix E).

While hydrogen is not a GHG, its chemical reactions can change the abundances of methane, ozone, and stratospheric water vapor, as well as aerosols if leaked. In this case, hydrogen that is leaked to the atmosphere can act as an indirect GHG. Leakage could occur during upstream production and downstream transmission, storage, and distribution. Hydrogen may react with pollutants like methane to extend their lifetime in the atmosphere. Leaked hydrogen can also impact ozone concentrations, potentially harming air quality and the recovery of the ozone layer, and it can create water vapor in the atmosphere, enhancing the GHG effect.

Green hydrogen production facility GHG life-cycle emissions would vary based on the type of production process used and amount of energy and feedstocks used by a facility and type of storage. In general, per kg of hydrogen produced, electrolysis using all renewable energy sources for electricity would have the lowest amount of life-cycle GHG emissions. Electrolysis using fossil fuel, SMR, pyrolysis, and bio-gasification methods of production would have greater life-cycle GHG emissions that could result in cumulative effects. For green hydrogen storage, anticipated sources for emissions would be from the potential use of compression equipment and gaseous storage, which would produce hydrogen emissions. Liquid tank storage and liquefaction would include emissions of criteria air pollutants, GHG emissions, and hydrogen.

Most RFFAs in Table 5-1 could contribute to cumulative impacts on air quality and GHGs. These RFFAs would use equipment and burn fossil fuels that would result in air pollutant and GHG emissions. These activities could create dust emissions from land-clearing activities and vehicle travel on paved and unpaved roadways.

State GHG emissions are expected to decrease over time to meet regulatory requirements like CETA, the Climate Commitment Act, and the Clean Fuels Standard. Clean energy sources would add to the state energy system, coal-fired power plants would be retired, and the use of electric cars would increase. However, population growth would lead to increases in urban, commercial, transportation, and industrial developments. These would emit GHGs but would need to meet regulatory requirements. More frequent and intense wildfires due to climate change could become an increasing source of particulate matter emissions and GHGs.

Cumulative impacts to air resources from green hydrogen facilities and other RFFAs may increase or decrease, depending on the size, type, and number of activities within a given area.

5.3.5 Water resources

Water resources include surface water and groundwater quantity and quality, water availability and water rights, streams and stream buffers, wetlands and wetland buffers, and floodplains. Further details on water resources can be found in the *Water Resources Technical Appendix* (Appendix F).

All RFFAs identified in Table 5-1 have the potential to result in impacts on water resources. Cumulative impacts would occur when activities are within or adjacent to streams, wetlands, and floodplains. Ground disturbance, vegetation clearing, soil compaction, and increased impervious surface area would impact surface runoff. Sedimentation and spills of hazardous materials would adversely impact water quality in wetlands and other shared waters. Multiple developments within floodplains would result in cumulative impacts on floodplain functions. New development would increase the need for water use and obtaining water rights. Some activities, such as wildlife and habitat projects, could decrease impacts on water. When siting facilities, drought conditions and water scarcity would need to be considered relative to potential water quantity needed.

Cumulative impacts to water resources from green hydrogen facilities and other RFFAs may increase or decrease, depending on the size, type, and number of activities within a given area.

5.3.6 Biological resources

Biological resources considered in this cumulative analysis include terrestrial, aquatic, and wetland wildlife species, plant species, and habitats. These resources are described in detail in the *Biological Resources Technical Appendix* (Appendix G).

All RFFAs identified in Table 5-1 have the potential to contribute to cumulative impacts on biological resources. Construction activities like land clearing, excavation, fill, and grading could affect species and habitat. Building and using roads, transmission lines, and facilities would also affect them.

Terrestrial, aquatic, and wetland habitats, including special-status habitats, would be affected by development activities. Impacts include habitat fragmentation, degradation, and loss, which could also affect landscape-scale habitat connectivity and wildlife migration corridors. Impacts may also include creating edge habitat.

Cumulative impacts would be related primarily to the disturbance, injury, and mortality of species. Wildlife would be affected by the movement of vehicles and equipment. Habitat changes across the landscape would adversely affect these species by limiting suitable habitats for cover, foraging, nesting, breeding, rearing, and migration activities. It would also result in the increased potential for invasive species to displace native species. Mobile species, like birds or larger animals, may be able to move into unaffected habitats. Special-status species may be particularly vulnerable to decreases in habitat connectivity due to their already declining populations and sensitivity to changes in their preferred habitats.

Wildlife may be affected by the movement of vehicles and equipment for green hydrogen facilities and nearby RFFAs.

Cumulative impacts on landscape-scale habitat and migration and wildlife corridors would occur if multiple RFFAs are developed in the same area, resulting in habitat degradation, fragmentation, and loss affecting landscape-scale habitat connectivity and wildlife migration corridors and the creation of edge habitat. This would restrict the movement of animals and migration paths due to increased fencing, roads, and other structures.

Migration routes and wildlife corridors provide important habitats for migrating species like birds and large animals. Cumulative impacts on landscape-scale habitat and migration and wildlife corridors would occur if multiple activities occur in the same area. Some animals and birds could be affected by activities that restrict their movements. This could be from construction, operation, or increased fencing, roads, and other structures. Many ungulates, or large hooved animals, migrate on a seasonal basis. The viability of these animals could be affected if summer and winter migration patterns are disrupted.

Cumulative impacts to biological resources from green hydrogen facilities and other RFFAs would be expected to increase but would vary depending on the size, type, and number of activities within a given area and the magnitude and extent of disturbance to terrestrial, aquatic, and wetland habitats and species.

5.3.7 Energy and natural resources

The study area contains substantial energy sources including wind, sunlight, electricity, and fuels. Mines and quarries throughout the area produce sand, gravel, and crushed stone. These resources are described in detail in the *Energy and Natural Resources Technical Appendix* (Appendix H).

Most RFFAs have the potential to contribute to cumulative impacts on energy. Clean energy projects would add electricity resources, while other energy projects, like green hydrogen projects, might use electricity. Green hydrogen production would also use resources such as RNG and biomass that could potentially create reductions in availability of or access to those resources when combined with other RFFAs. New development would use resources to grow; however, resources and energy could also be expected to increase under projects described under RFFA 1. Improved transportation infrastructure would be expected to lead to improved energy distribution. Conservation efforts could reduce the need for energy-intensive water treatment systems. Activities could increase the need for electricity and fuels for new development. There may be an increased need for aggregate to construct infrastructure, urban developments, transportation projects, and water supply projects.

Cumulative impacts to energy from green hydrogen facilities and other RFFAs may increase or decrease, depending on the size, type, and number of activities within a given area. Cumulative impacts to natural resources from green hydrogen facilities and other RFFAs would likely increase depending on the size, type, and number of activities within a given area.

5.3.8 Environmental health and safety

EHS includes hazardous materials exposure, wildfire hazards, and worker health and safety. For more information, refer to the *Environmental Health and Safety Technical Appendix* (Appendix I).

All RFFAs identified in Table 5-1 have the potential to result in impacts on EHS. Many activities are permitted to store, use, or dispose of hazardous materials. The study area contains cleanup sites on the National Priorities List under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as Superfund sites. These sites have hazardous material contamination present in the soil, surface water, or groundwater. Decommissioning for green hydrogen facilities and other energy facilities and cleanup and mining sites could involve a higher risk of releasing hazardous materials. This could be from degradation of facility components or from increased movement of hazardous materials.

Washington has experienced many extreme fire events in recent years due to climate change. Due to the relatively dry conditions, wildfires in eastern Washington occur more often than in other parts of the state, and this trend is expected to continue in the future. Based on research conducted by the University of Washington, all counties in Washington show a significant increase in the projected number of high fire days between the years 2040 and 2069. Development or land use changes could lead to increased ignition risks or create areas with elevated fire risk. Some activities, such as land management and habitat projects, could potentially reduce wildfire risk by improving the health of ecosystems and communities.

Green hydrogen production facilities would have hydrogen present on site, which is highly flammable and can be explosive. Depending on the production method, facilities could also have flammable or combustible substances on site, such as methane, oxygen, and biomass. Hydrogen and methane explosion risk can be reduced but may not be completely eliminated. Compliance with regulations requiring the proper siting, design, and operations of facilities, and appropriate planning and coordination with local emergency response would reduce these risks and avoid the potential for cumulative impacts to EHS from green hydrogen facilities.

Cumulative impacts to environmental health and safety from green hydrogen facilities and other RFFAs would likely increase depending on the size, type, and number of activities within a given area.

5.3.9 Noise and vibration

Impacts from noise and vibration are based on distance to potential sensitive human receptors. In general, noise levels are high around major transportation corridors, airports, and industrial facilities and low in rural or non-industrial areas. For more information, refer to the *Noise and Vibration Technical Appendix* (Appendix J).

Most RFFAs identified in Table 5-1 have the potential to result in noise and vibration impacts. Noise levels for activities are highest during construction when land clearing, grading, and road construction would occur. These could include heavy equipment operation, pile driving, and blasting. These would typically be temporary and of short duration.

Noise impacts during operations of activities would depend on the type, terrain, vegetation, and local weather conditions as well as distance to the nearest sensitive receptors. Sources of noise and vibration from operations of green hydrogen facilities would contribute to cumulative impacts. Urban, rural, agricultural, commercial, mining, and transportation development and use are expected to add to noise and vibration. Multiple industrial facilities and development in proximity to each other, and the development of industrial use areas, would contribute additively to noise and vibration in an area. The linear facilities such as roads and rails for transport or transmission lines for energy to support these industrial areas would similarly have additional cumulative impacts to noise and vibration. Cumulative impacts from noise and vibration from green hydrogen facilities and other RFFAs would likely increase depending on the size, type, and number of activities within a given area.

5.3.10 Land use

The study area includes industrial, agricultural, rural, residential, wildlife conservation, and recreation areas. GMA counties must develop comprehensive plans to manage their land use. Non-GMA counties must still plan for critical areas and natural resource lands. For more information, refer to the *Land Use Technical Appendix* (Appendix K).

Most RFFAs identified in Table 5-1 have the potential to result in land use impacts. Cumulative impacts on land use would occur as a result of the construction and operation of energy, urban, industrial, and transportation activities. The general trend towards conversion of land uses to urban developments combined with green hydrogen facilities and industrial-use zoned areas that are located in rural areas could lead to a cumulative loss in other land uses such as agricultural or undeveloped lands. Activities could result in increased dust, noise, traffic, and visual changes that could affect other properties.

The operation of green hydrogen facilities would also result in changes to the visual landscape from the presence of facilities, with the facility potentially visible from long distances. Other development activities would also result in changes to the visual landscape. These changes would result in changes to and/or perceptions of the existing character of the surrounding area if it is not already of an industrial nature.

The nature and extent of cumulative effects on land use in the study area would depend on whether the RFFAs resulted in changes or conversions to the same types of land uses and designations.

5.3.11 Aesthetics and visual quality

The study area for aesthetic and visual resources includes the overall green hydrogen geographic study area, as well as surrounding viewsheds. Visual resources include all objects and features that are visible on a landscape and that add or detract from its aesthetic or scenic quality. Additional details can be found in the *Aesthetics and Visual Quality Technical Appendix* (Appendix L).

Most RFFAs identified in Table 5-1 have the potential to result in impacts on aesthetics and visual quality. Development and operation would involve a range of activities with potential visual impacts. These include the removal of vegetation; dust generation; new roads; new fencing and/or landscaping; lighting; and modifying or building residential, industrial, and commercial facilities.

Typically, vegetation-clearing activities for facilities, forestry management, and roads would create visual impacts primarily by changing the color and texture of the cleared areas. Other RFFAs, such as other energy facilities, land use changes, and the development of water reservoirs or major transportation infrastructure projects, would also introduce visual contrasts and glare from artificial light sources. Siting of green hydrogen facilities or similar RFFAs in an area with surrounding non-industrial developments has the potential for cumulative impacts on that particular viewshed over time if these developments are located in proximity to each other.

Cumulative impacts to visual resources from green hydrogen facilities and other RFFAs would likely increase depending on the size, type, and number of activities within a given area.

5.3.12 Recreation

Recreation resources include parks, recreational opportunities, public lands, and public amenities such as trails. Designated recreation areas include local parks, federal lands, and state lands. Hunting and fishing seasons vary throughout the year by the species of animal. For more detailed information, see the *Recreation Technical Appendix* (Appendix M). Tribal hunting and fishing also occur throughout the state at various times during the year. For more detailed information, see the *Tribal Rights, Interests, and Resources Technical Appendix* (Appendix B).

Some RFFAs identified in Table 5-1 have the potential to result in impacts on recreational resources. Construction of green hydrogen facilities, other energy facilities, new commercial and industrial development, mining operations, transportation projects, and water supply projects would increase temporary noise, dust and visibility, and traffic, and would result in temporary changes in access to recreation resources. Larger transportation networks would also involve more vehicle traffic, resulting in more sources of noise and vibration and air pollution near recreation areas. Construction and operations could restrict access to existing recreational areas on a site or affect access to nearby areas. Increased fencing could also result in loss of recreational opportunities. As described in Section 5.3.6, activities are expected to have cumulative impacts on habitat and species, reducing opportunities for hunting and wildlife viewing. Some activities, such as wildlife and habitat projects, could improve recreational opportunities.

Cumulative impacts to recreation resources from green hydrogen facilities and other RFFAs could increase depending on the size, type, and number of activities within a given area.

5.3.13 Historic and cultural resources

Archaeological sites, historic properties, and Tribal place names exist throughout the study area. They include areas connected to spiritual practices and named places and are represented within oral tradition stories and historic documents. Historic and cultural resources include recorded and unrecorded archaeological resources, historic architectural resources listed or eligible for listing in a historic register, human remains and cemeteries, sacred sites, and documented and undocumented TCPs. Historic and cultural resources have been repeatedly affected by past and present impacts. Additional details regarding historic and cultural resources can be found in the *Historic and Cultural Resources Technical Appendix* (Appendix N).

All RFFAs identified in Table 5-1 have the potential to result in impacts on historic and cultural resources. Construction of past and present projects has included a range of ground disturbance and alterations to the landscape, some of which persist and contribute to the cumulative impacts that may result from green hydrogen facilities. The assessment of cumulative impacts on historic and cultural resources includes these considerations.

Construction and decommissioning of all green hydrogen facilities considered in this PEIS along with other activities could result in cumulative impacts on, or inadvertent discoveries of, historic and cultural resources. Construction and decommissioning activities that could impact historic and cultural resources include ground disturbance, degradation of visual quality, noise, and interruption of the landscape. Ground disturbance has the potential to impact undiscovered archaeological resources due to the presence of such sites throughout the state and the fact that portions of the study area have not been archaeologically surveyed. Other cumulative impacts that may result from green hydrogen facilities along with other activities could include degradation and interruption of culturally significant landscapes and habitats. Increased human access exposes archaeological sites and historic structures and features to greater probability of impact from a variety of stressors.

Potential cumulative impacts on historic and cultural resources during operation include disturbance of previously unrecorded archaeological sites. They also include visual degradation of settings associated with historic and cultural resources and limitation of access and travel paths traditionally utilized for cultural resources. These impacts are likely to be more significant cumulatively than on an individual project basis.

Together, past and present projects, the future activities identified here, and potential green hydrogen facilities represent changes to culturally important landscapes. Archaeological sites and TCPs are non-renewable resources; impacts on these resources would contribute to cumulative impacts from past, present, and future projects.

5.3.14 Transportation

Transportation includes roadways, railroads, airports, ports, transportation systems, traffic, parking, and movement of people and goods. For more information, refer to the *Transportation Technical Appendix* (Appendix O).

Most RFFAs identified in Table 5-1 have the potential to result in impacts on transportation. Transporting resources and workers during construction, operation, and decommissioning contribute to cumulative impacts on transportation and traffic. Activities may include road modifications or new road construction. Transportation activities would directly affect transportation resources and would be likely to result in improvements to traffic or movement. Increases in traffic from transportation infrastructure projects and urban, rural, industrial, agricultural, and commercial facilities would result in impacts.

Cumulative impacts to transportation resources from green hydrogen facilities and other RFFAs would likely increase depending on the size, type, and number of activities within a given area.

5.3.15 Public services and utilities

Public services in the study area include public schools, fire departments, EMS, and law enforcement. Public services may be provided by federal, Tribal, state, county, or local governments as well as volunteer fire departments and other volunteer groups. Utilities include telecommunications, gas and electrical, water, wastewater, and solid waste management. Depending on the area, utilities may be provided by county, city, Tribal, or private suppliers. These resources and activities are described in detail in the *Public Services and Utilities Technical Appendix* (Appendix P).

Some RFFAs identified in Table 5-1 have the potential to contribute to cumulative impacts on public services and utilities. New urban, commercial, and industrial activities and development would be expected to increase the demand and availability of public services and utilities, as would activities associated with changes in rural and agricultural activities. Increased demand from activities could exceed existing capacities of public service providers and result in the need for new or modified utilities or service systems.

Firefighting and emergency response needs would increase from changes in land management and the development and operation of energy facilities, water supply projects, and rural and urban developments. These activities could introduce ignition sources that would increase the risk of fire. Urban, commercial, industrial, rural, and agricultural development may also increase demand for potable water and wastewater treatment. If waste associated with urban, rural, commercial, agricultural, and industrial activities is not managed appropriately, it would exceed capacities for utility providers such as landfills and transfer stations.

Cumulative impacts to public services and utilities from green hydrogen facilities and other RFFAs would likely increase depending on the size, type, and number of activities within a given area.

6 Consultation and Coordination

This chapter describes how information was shared during the development of the Draft PEIS. Ecology used several methods to reach out to Tribes, local and state agencies, green hydrogen facility developers, environmental organizations, and other interested parties. These groups were provided opportunities to share information, comments, and perspectives and to engage in the development of the Draft PEIS.

6.1 PEIS scoping process

Scoping for the PEIS began on March 20, 2024. The Determination of Significance (DS) and Scoping Notice for the PEIS initiated Ecology's environmental review process. Ecology conducted an extended 30-day PEIS scoping period in accordance with SEPA requirements per WAC 197-11-408. The comment period opened on March 20, 2024, and ended April 18, 2024. It also included two online public meetings held on April 9 and April 11, 2024. Spanish interpreters were available at meetings, and materials were translated into Spanish. A separate Tribal scoping meeting was held on April 30, 2024, and Tribes were provided an additional 30 days to comment. Ecology accepted written scoping comments online and by mail, and verbally during online public scoping meetings.

A variety of scoping materials were available on Ecology's PEIS website for public review throughout the scoping period. The website provided information on scoping, including how to comment and a link to an online comment form. The *Scoping Summary Report* can be found in Appendix A. The *Scoping Summary Report* provides a summary of the scoping process and the scoping comments received.

Scoping notifications summary

- Legal notices published on the SEPA Register on March 20, 2024, and published in *The Seattle Times, The Spokesman-Review, Columbia Basin Herald, TriCity Herald, Kitsap Sun, Yakima Herald,* and *Tú Decides* (in Spanish)
- Notifications sent to Tribal Chairs, Natural and Cultural Resources Directors, and Executive Directors of Tribal organizations
- Public, agency, and media notifications through social media post on Twitter, email and listserv distributions, and news releases
- PEIS website developed and provided information and links
- Information published on Ecology's Public Input and Events

6.2 Additional public outreach and coordination with interested parties

A series of meetings were held with interested parties during development of the Draft PEIS. These meetings were designed to engage environmental organizations, the green hydrogen industry, utilities, federal and local governments, and ports. Invited parties included those that have been active in discussions about green hydrogen development in the state, expressed an interest in contributing information for the PEIS process, or are located in areas where future facilities considered in this PEIS may be proposed.

Meetings were designed to share Ecology's clean energy legislative directive and updates on the purpose of the PEIS and how it can be used, as well as the PEIS timeline. Meetings were also used to gather general input and specific information and feedback from participants.

Ecology will host three virtual public hearings to collect comments on the Draft PEIS. Ecology will respond to comments in the Final PEIS. Materials for the public hearings will be available in English and Spanish. Public hearings will take place within 30 days of the date of publication of the Draft PEIS.

6.3 Tribal engagement and consultation

Ecology provided notification of the scoping period to Tribal Chairs and Natural and Cultural Resources Directors of all federally recognized Tribes with lands and territories in Washington state, and Executive Directors of Tribal organizations. Government-to-government consultation was offered to federally recognized Tribes in Washington as an option at any time during the PEIS process.

Ecology provided opportunities where Tribes could choose to share information, comments, and perspectives on green hydrogen facilities as well as facility environmental review and permitting processes. A Tribal scoping meeting was held on April 30, 2024.

Tribal forums were held during development of the Draft PEIS, with representatives of interested Tribes and Tribal associations attending. At Tribal forums during development of this Draft PEIS, Ecology presented the geographic scope of study. The study area excludes Tribal reservation and trust lands, and Ecology asked if Tribes wanted to include their lands in the scope of study. Ecology offered Tribes an opportunity to review draft sections of the *Tribal Rights, Interests, and Resources Technical Appendix* (Appendix B) and *Historic and Cultural Resources Technical Appendix* (Appendix N). The Confederated Tribes of the Umatilla Indian Reservation and the Lummi Indian Business Council provided comments, which Ecology considered in developing this Draft PEIS.

Ecology will continue to offer Tribal forums once per quarter to provide information and discuss ideas and issues related to clean energy coordination. These forums are opportunities for Ecology to request early and continued feedback from and involvement by Tribes potentially affected by planning actions or facilities and ensure that Tribes are informed of opportunities to comment on the PEIS.

6.4 Agency coordination

Ecology worked with state agencies that have expertise in the areas evaluated in the Draft PEIS. These included the State of Washington Energy Facility Site Evaluation Council (EFSEC), WFDW, DNR, WSDOT, DAHP, and Commerce. Ecology met with state agency staff on several occasions to discuss methodologies, sources of information, potential impacts, and measures to avoid and reduce impacts. State agency staff reviewed draft technical reports and chapters of the Draft PEIS. Ecology also provided regular updates to the interagency Clean Energy Siting Council.

7 Permits and Approvals

7.1 Federal

- **Bald and Golden Eagle Protection Act (U.S. Fish and Wildlife Service [USFWS]):** This permit is required for any facility activities that may disturb or harm bald or golden eagles or their habitats, especially during construction near nesting sites.
- **Clean Water Act Section 404 Permit (U.S. Army Corps of Engineers):** This permit is required for facilities involving the discharge of dredged or fill material into U.S. waters, including wetlands.
- **Coastal Zone Management Act Consistency (Ecology):** If the project is in one of 15 coastal counties with marine shorelines, this might be required.
- **Determination of No Hazard to Air Navigation Approval (FAA):** Submission of FAA Form 7460-1 is required for any structure that exceeds certain height limits or is near airports to ensure it does not pose a hazard to air navigation.
- **Endangered Species Act (USFWS/National Oceanic and Atmospheric Administration [NOAA] Fisheries):** This consultation is required for any facility that may affect endangered or threatened species or their habitats, ensuring no jeopardy to their existence or destruction of critical habitats.
- **Fish and Wildlife Coordination Act (USFWS):** Requires equal consideration and coordination of wildlife conservation with other water resources development programs and provides authority to USFWS and NOAA Fisheries to evaluate impacts on fish and wildlife from federal actions that result in modifications to waterbodies.
- **Magnuson-Stevens Fishery Conservation and Management Act (NOAA Fisheries):** This consultation is required to protect essential fish habitats affected by the facility, particularly those near significant waterbodies.
- **Migratory Bird Treaty Act (USFWS):** This permit is required for any facility activities that may disturb or harm migratory birds, their nests, or eggs.
- **Marine Mammal Protection Act (USFWS):** National policy to prevent marine mammal species and population stocks from declining beyond the point where they cease to be significant functioning elements of the ecosystems of which they are a part. Establishes a moratorium on taking and importing marine mammals, including parts and products. Defines the federal responsibility for conservation of marine mammals. Recognizes the importance of marine mammals to the oceans and seeks to restore or maintain populations at healthy and productive levels.
- **National Environmental Policy Act (federal agency):** This environmental review is required for all federal actions including federal projects or any project requiring a federal permit, federal funding, or located on federal land.
- **National Historic Preservation Act (Advisory Council on Historic Preservation):** A Section 106 consultation is required for facilities that may affect historic properties and is typically completed as part of the federal permitting or other approval process. The process includes consultation with interested and affected Tribes, the State Historic Preservation Officer with DAHP, and other interested parties.

- **National Oceanic and Atmospheric Administration Radar Operations Center Approval (NOAA):** This approval is required to ensure the facility does not interfere with NOAA radar operations.
- **Rivers and Harbors Act:** Requires U.S. Army Corps of Engineers Section 10 authorization for the construction of any structure in or over any navigable water of the United States.
- **Section 4(f) Review (U.S. Department of Transportation):** This review is required to ensure the protection of publicly owned parks, recreation areas, wildlife refuges, and historic sites.
- **U.S. Department of Defense Clearance for Radar Interference (DoD):** This clearance is required for facilities that may interfere with military radar operations, particularly for tall structures near military installations.

7.2 Washington State

- **Access Connection Permit (WSDOT):** would be needed to allow vehicular access, and connection points of ingress to and egress from, the state highway system within unincorporated managed access areas that are under the jurisdiction of WSDOT. This requirement is based on Chapters 468-51 and 468-52 WAC and Chapter 47.50 RCW.
- **Air Quality Permits (Ecology):** These permits are required to control and manage emissions from construction and operation activities.
- **Aquatic Use Authorization (DNR):** This authorization is required for any facility activities involving the use of state-owned aquatic lands.
- **Archaeological Excavation and Removal Permit (DAHP):** This permit is required for excavating or removing archaeological resources within the facility area.
- **Clean Air Act Prevention of Significant Deterioration Permit (EFSEC, Ecology):** This permit ensures that air discharges from the facility meet state standards.
- **Clean Water Act Section 402 NPDES Construction Stormwater Permit (Ecology/EPA):** Required for construction that disturbs more than 1 acre of land and would have the potential to discharge stormwater to state surface waters, or construction disturbance of any size that would have the potential to be a significant contributor of pollutants or may be expected to cause a violation of any water quality standard (including groundwater standards).
- **Clean Water Act Section 401 Water Quality Certification (EPA, Ecology, or Tribes):** This certification is required for any facility needing a federal permit or license that may result in discharges to waters of the United States, ensuring compliance with state water quality standards.
- **Electrical Permits (Washington State Department of Labor and Industries):** These permits ensure all electrical installations meet state safety standards.
- **Overweight/Oversize Permits (WSDOT):** These permits are required for overweight/oversize loads.
- **Request for Approval of Superload Movement (WSDOT):** This approval is required for loads exceeding specific dimensions and weight.

- **Special Motor Vehicle Permit Regulations and Conditions (WSDOT)** would be required when special permit conditions, curfew hours, escort requirements, or nighttime movements are necessary.
- **State Waste Discharge Permit (Ecology):** These permits regulate discharges from municipalities or industries to groundwater and from commercial industry to a publicly owned treatment works.
- **State Refrigerant Management Program:** Requires facilities with refrigeration and air conditioning systems containing more than 50 pounds of refrigerant with a global warming potential of 150 or more to conduct and report periodic leak inspections, promptly repair leaks; and keep service records on site.
- **State Environmental Policy Act (state or local agency):** This environmental review helps state and local agencies identify environmental impacts that may result from projects and decisions.
- **Surface Mining Reclamation Permit (DNR):** Required for more than 3 acres of disturbance or when or a site has a high wall that is both higher than 30 feet and steeper than 45 degrees.
- **Utility Accommodation Permits and Franchises (WSDOT):** These permits are required for utility installations crossing state highway rights-of-way.
- **Washington Forest Practices Act (DNR):** A permit is not required for every forest practice, but the forest practices rules must be followed when conducting all forest practices activities. A permit may be required for logging or forest road construction activities.
- **Washington State Growth Management Act:** Requires fast-growing counties in the state to develop comprehensive plans to manage their population growth
- **Washington State Hydraulic Project Approval (WDFW):** This permit is required for any work that uses, diverts, obstructs, or changes the natural flow or bed of any fresh water or saltwater of the state.
- **Water Pollution Control Act (Ecology):** This is used to authorize projects that will result in the alteration or loss of non-federally regulated wetlands and other waters of the state that are not within federal jurisdiction.
- **Washington State Shoreline Management Act (Ecology):** The Shoreline Management Act requires all counties and most towns and cities with shorelines to develop and implement Shoreline Master Programs. Local governments issue shoreline substantial development, conditional use, and variance permits, as well as shoreline exemptions pursuant to the policies and use regulations in their Shoreline Master Programs. Ecology also reviews shoreline conditional use and variance permits.
- **Water Right Permit (Ecology):** This permit is necessary for new water diversions, withdrawals, or changes to existing water rights.
- **Water Right Change or Transfer Authorization (Ecology):** Required to change certain elements of a water right.

7.3 Local

- **Air Quality Permits (local air quality management authority or Ecology):** These permits are required to control and manage emissions from construction and operation activities.
- **Blasting Permits:** With the exception of unique circumstances, there would be no specific permit requirements related to noise or vibration. Permits are typically administered by the city or county in which the work is conducted. If blasting is needed for construction, a blasting permit would be required.
- **Construction Permits (local building authority):** Various permits are required for construction activities, including right-of-way access, clearing, grading, building, mechanical, and electrical permits. The local fire department would review and approve design features that pertain to fire safety (e.g., fire extinguisher placement, fire alarm system, sprinkler system, fire doors).
- **Critical Areas Codes, Shoreline, Zoning Ordinances, and Other Land Use Requirements (local planning department):** Compliance with these local regulations ensures the facility meets land use, zoning, and environmental protection standards.
- **Floodplain Development Permits (local planning department):** These permits are required for construction activities within designated floodplain areas.
- **Local utility connection permits/approvals:** Needed to connect to utility infrastructure through utility provider (local, county, PUD, water district).
- **Noise variance:** may be required to conduct nighttime construction work.
- **Shoreline Permits (local planning department):** Required for development within shorelines of the state and regulated by local jurisdictions under the Shoreline Master Program and city or county code.

8 List of Preparers and Contributors

Name	Subject matter
Agencies	
Washington State Department of Ecology	Tribal rights, interests, and resources, environmental justice and overburdened communities, earth, air quality and GHGs, water resources, biological resources, energy and natural resources, EHS, noise and vibration, land use, aesthetics/visual quality, recreation, historic and cultural resources, transportation, public services and utilities, cumulative impacts
State of Washington Energy Facility Site Evaluation Council	SEPA process, energy facility considerations
Washington Department of Fish and Wildlife	Earth, water resources, biological resources, recreation, cumulative impacts
Washington State Department of Natural Resources	Earth, water resources, biological resources, EHS, land use, recreation, transportation, cumulative impacts
Washington State Department of Transportation	Transportation, cumulative impacts
Washington State Department of Archaeology and Historic Preservation	Historic and cultural resources
Department of Defense	Military areas
Consultant team	
HDR	Air quality and GHGs, water resources, EHS, noise and vibration, aesthetics/visual quality, recreation, historic and cultural resources, transportation, public services and utilities, energy and natural resources, climate change assumptions, Tribal rights, interests, and resources, environmental justice and overburdened communities, earth, water resources (wetlands), biological resources, land use, cumulative impacts, document accessibility, and language translation
Ross Strategic	Stakeholder and public engagement
Triangle Associates	Tribal engagement

9 Distribution List

Name	Name
Governments, agencies, and regional councils	
Association of Washington Cities	U.S. Department of Defense
Bonneville Power Administration	U.S. Department of Energy
Bureau of Indian Affairs	U.S. Department of the Interior
Bureau of Land Management	U.S. Environmental Protection Agency
Bureau of Reclamation	U.S. Fish and Wildlife Service
Clean Air Agencies	U.S. Forest Service
Clean Energy Siting Coordination Council	Washington city and county planning agencies and SEPA lead agencies
State of Washington Energy Facility Site Evaluation Council	Washington Department of Fish and Wildlife
Environmental Justice Council	Washington State Department of Natural Resources
Federal Aviation Administration	Washington Emergency Management Division
Federal Emergency Management Agency	Washington State Association of Counties
Federal Energy Regulatory Commission	Washington State Conservation Commission
General Services Administration	Washington State Department of Agriculture
Governor Jay Inslee and executive and policy staff	Washington State Department of Archaeology and Historic Preservation
Governor's Office of Indian Affairs	Washington State Department of Commerce
Governor's Office for Regulatory Innovation and Assistance	Washington State Department of Health
National Marine Fisheries Service	Washington State Department of Social and Health Services
National Park Service	Washington State Department of Transportation
Northwest Power and Conservation Council	Washington State Legislators and Legislative Committees
Puget Sound Partnership	Washington State Parks and Recreation Commission
Puget Sound Regional Council	Washington State Utilities and Transportation Commission
U.S. Army Corps of Engineers	-
Tribes and Tribal representation	
Affiliated Tribes of Northwest Indians	Nooksack Indian Tribe
Columbia River Inter-Tribal Fish Commission	Port Gamble S'Klallam Tribe
Confederated Tribes and Bands of the Yakama Nation	Puyallup Tribe
Confederated Tribes of the Chehalis Reservation	Quileute Tribe
Confederated Tribes of the Colville Reservation	Quinault Indian Nation
Confederated Tribes of the Umatilla Indian Reservation	Samish Indian Nation

Name	Name
Confederated Tribes of Warm Springs	Sauk-Suiattle Indian Tribe
Cowlitz Indian Tribe	Shoalwater Bay Indian Tribe
Hoh Indian Tribe	Skokomish Indian Tribe
Jamestown S'Klallam Tribe	Snoqualmie Indian Tribe
Kalispel Tribe of Indians	Spokane Tribe of Indians
Lower Elwha Klallam Tribe	Squaxin Island Tribe
Lummi Nation	Stillaguamish Tribe of Indians
Makah Tribe	Suquamish Tribe
Muckleshoot Indian Tribe	Swinomish Indian Tribal Community
Nez Perce Tribe	Tulalip Tribes
Nisqually Indian Tribe	Upper Skagit Indian Tribe
Utilities and industry	
Green hydrogen facility developers	Utilities
Association of Washington Business	Washington Public Utility District Association
NW Energy Coalition	Washington Rural Electric Cooperative Association
Public Power Council	Washington Public Ports Association
Pacific Northwest Hydrogen Association	-
Environmental, labor, and other organizations	
Agricultural and farmland organizations	Washington State Building and Construction Trades Council
Environmental justice organizations	Washington State Labor Council
Environmental organizations	-
Other distribution	
Ecology's SEPA Register	Published legal notices and public and media notifications
Ecology's clean energy and SEPA email distribution lists	Ecology's PEIS website