Appendix Q: Cumulative Impacts Technical Appendix

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

By

HDR

For the

Shorelands and Environmental Assistance Program

Washington State Department of Ecology

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Acronyms and Abbreviations List

BESS	battery energy storage system
BLM	Bureau of Land Management
BMP	best management practice
BNSF	BNSF Railway
CCA	Climate Commitment Act
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CESA	Compatible Energy Siting Assessment
CETA	Clean Energy Transformation Act
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
Commerce	Washington State Department of Commerce
DAHP	Washington Department of Archaeology and Historic Preservation
DNR	Washington State Department of Natural Resources
DoD	U.S. Department of Defense
Ecology	Washington State Department of Ecology
EFSEC	Washington State Energy Facility Site Evaluation Council
EHS	environmental health and safety
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
GHG	greenhouse gas
GMA	Growth Management Act
HAP	hazardous air pollutant
HCP	habitat conservation Plan
I	Interstate
kg	kilogram(s)
kWh	kilowatt hour(s)
MMT	million metric tons
MTCA	Model Toxics Control Act
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
N_2O	nitrous oxide
NPDES	National Pollutant Discharge Elimination System
OFM	Washington State Office of Financial Management
PEIS	Programmatic Environmental Impact Statement
PHS	Priority Habitats and Species
PM	particulate matter
PNWH2	Pacific Northwest Hydrogen Association
PSE	Puget Sound Energy
RCO	Washington Recreation and Conservation Office

RCW	Revised Code of Washington
RFFA	Reasonably Foreseeable Future Action
RNG	renewable natural gas
SEPA	State Environmental Policy Act
SF6	sulfur hexafluoride
SMA	Shoreline Management Act
SFMO	Washington State Fire Marshal's Office
SMR	steam-methane reforming
SR	State Route
SWD	state waste discharge
TAP	toxic air pollutant
TCP	Traditional Cultural Property
TMDL	Total Maximum Daily Load
UGA	Urban Growth Area
UP	Union Pacific
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
WAC	Washington Administrative Code
WDA	workforce development area
WDFW	Washington Department of Fish and Wildlife
WSDA	Washington State Department of Agriculture
WSDOT	Washington State Department of Transportation
WSRRI	Washington Shrubsteppe Restoration and Resiliency Initiative
WUI	wildland-urban interface

Summary

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 purpose of the cumulative impacts analysis 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.

Green hydrogen facilities are anticipated to be located in areas zoned for industrial or industrial-supporting uses. Development in these locations is expected to be focused on industrial and related activities but may be located adjacent and in proximity to other uses. The scope of analysis for cumulative impacts includes a range of RFFAs that could together result in impacts. These were evaluated as trends and include the following:

- Energy projects, including clean energy development and changes to energy systems
- Urban, commercial, and industrial activities and development
- Rural and agricultural activities and development
- Federal, state, Tribal, and local wildlife and habitat projects
- Transportation infrastructure development and modification
- Contaminated site cleanup and remediation
- Mining operations
- Recreation activities
- Military use
- Water supply development and withdrawals for municipal, agricultural, industrial, and conservation uses

All RFFAs have the potential to impact resources. The cumulative impacts would depend on the location and number of activities and how near they are to each other. Due to the large geographic study area and broad trends of reasonably foreseeable actions identified and considered in this planning document, cumulative impacts for all resources would range from **less than significant to potentially significant**.

1 Introduction

The State Environmental Policy Act (SEPA) requires consideration of cumulative impacts. This technical appendix describes cumulative impacts from green hydrogen facilities and other developments in the study area over a 75-year timeframe. Cumulative impacts are effects that would result from the incremental addition of green hydrogen facilities considered in the programmatic environmental impact statement (PEIS) to the impacts from other past, present, and reasonably foreseeable future actions (RFFAs). Cumulative impacts can result from individually minor, but collectively significant, actions that occur over time.

The purpose of the cumulative impacts analysis is to make sure that decision-makers consider the full range of consequences under anticipated future conditions. This section provides an overview of the types of green hydrogen facilities in Washington state included in the PEIS and other programmatic-scale actions. The analysis of individual green hydrogen facilities and other local actions in cumulative impact assessments would be conducted as part of future project-specific environmental reviews.

The cumulative impacts assessment considered the following:

- Proximity, such as several actions that affect the study area over the 75-year timeframe of the green hydrogen facilities evaluated
- Similar effects on the same resource
- Effects that are long term and therefore likely to interact with other actions

1.1 Regulatory context

The cumulative impacts analysis was prepared in accordance with SEPA requirements (Washington Administrative Code [WAC] 197-11-060[1]). Additional guidance developed by the Council on Environmental Quality (CEQ) in the handbook titled *Considering Cumulative Effects under the National Environmental Policy Act* (CEQ 1997) was also considered where SEPA requirements are consistent with requirements of the National Environmental Policy Act (NEPA). Revised Code of Washington (RCW) 43.21C.535[2] specifically requires consideration and analysis of the following cumulative impacts in the PEIS, which are included in Section 4:

- Cultural resources
- Species designated for protection under RCW 77.12.020[3] or the federal Endangered Species Act (ESA)
- Landscape-scale habitat connectivity and wildlife migration corridors
- Environmental justice and overburdened community areas as defined in RCW 70A.02.010[4]

[1] https://app.leg.wa.gov/Wac/default.aspx?cite=197-11-060
[2] https://app.leg.wa.gov/RCW/default.aspx?cite=43.21C.535
[3] https://app.leg.wa.gov/rcw/default.aspx?cite=77.12.020
[4] https://app.leg.wa.gov/RCW/default.aspx?cite=70A.02.010

- Cultural resources and elements of the environment relevant to Tribal rights, interests, and resources, including Tribal cultural resources and fish, wildlife, and their habitat
- Land uses, including agricultural and ranching uses
- Military installations and operations

The resource technical appendices all include a section titled “Regulatory context” that reviews the resource-specific regulatory context considered in the analysis.

2 Methodology

The purpose of this section is to provide an overview of the process for evaluating potential cumulative impacts and the criteria for determining the occurrence and degree of impacts on all resource areas in the PEIS.

2.1 Study area

The study area for cumulative impacts includes the PEIS geographic scope of study for green hydrogen facilities (Figure 1) and surrounding areas to evaluate off-site cumulative impacts within a larger community or landscape, such as migration corridors.

Figure 1 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 for the affected environment.

2.2 Technical approach

The cumulative impacts analysis was prepared in accordance with SEPA requirements (WAC 197-11-060) and also considered the federal CEQ approach for analyzing cumulative impacts. 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 other RFFAs in the same geographic study area for each resource.
- Consider other RFFAs with effects during the same time period as effects from facility site characterization, construction, operation, and decommissioning.
- Analyze cumulative impacts using the best available data.

The cumulative impacts analysis builds upon information derived from the resource impact analyses. As such, consideration for the cumulative impacts analysis includes resource areas for which the future green hydrogen facilities evaluated in the PEIS could cause significant adverse impacts, or resources currently at risk even if impacts from facilities are anticipated to be relatively small. Each resource impact analysis identifies the criteria under which a significant impact would occur as a result of a green hydrogen energy facility. This cumulative impact analysis evaluates the potential for significant cumulative impacts using the same criteria considered for each of the resource areas. These criteria are identified in Section 2.3 (Impact assessment approach) of each resource area technical appendix to the PEIS. The assessment of cumulative impacts also considered the possibility of multiple green hydrogen facilities being developed in the same area and how these could amplify environmental effects.

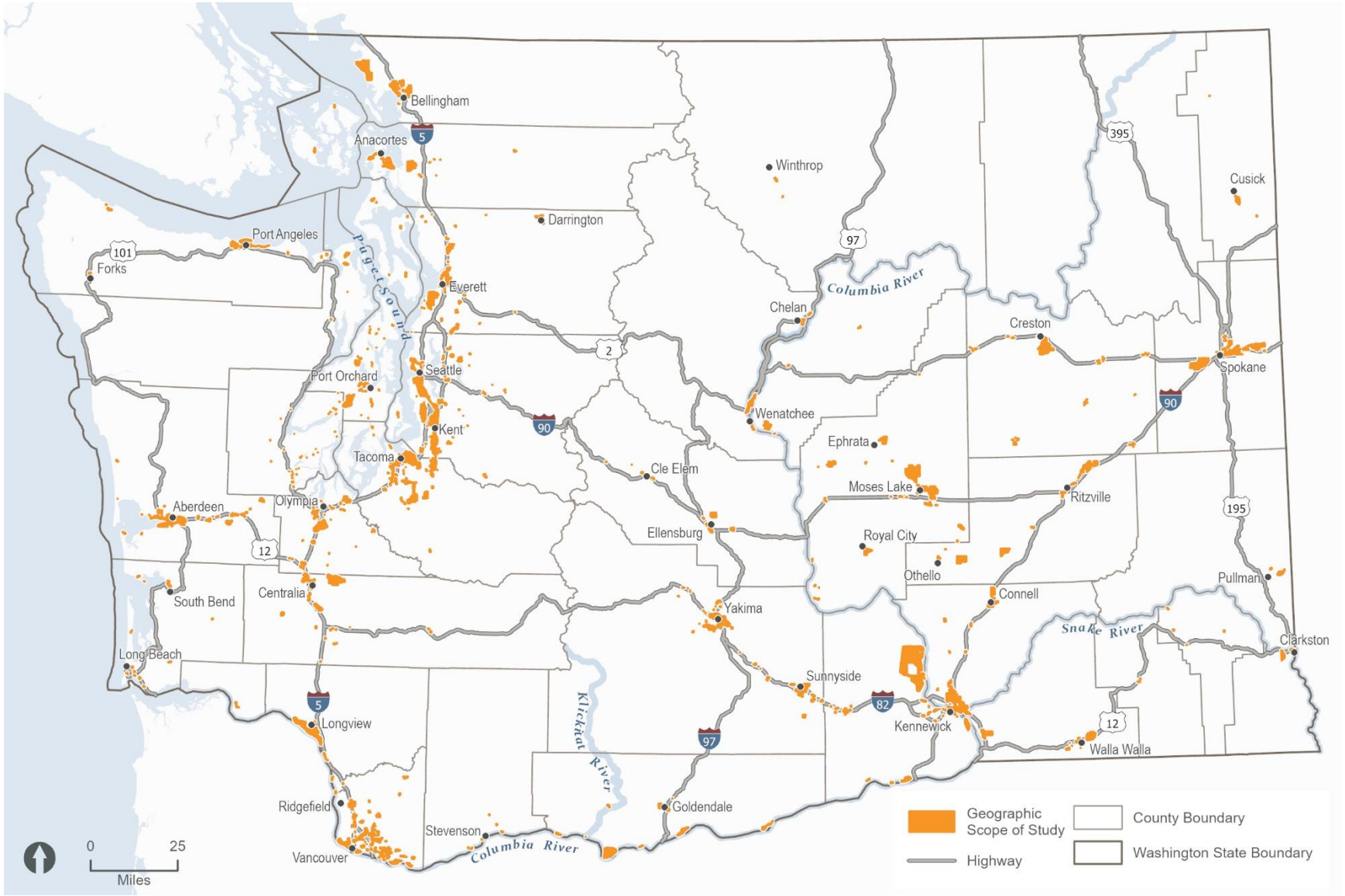

Figure 1. Green Hydrogen Energy Facilities PEIS geographic scope of study

Current conditions are a result of past and present actions. The current conditions in the study area were used as the baseline existing environmental condition for the resource analyses in the PEIS and were described as part of the affected environment for those resources. Therefore, past actions are not cumulatively considered again in this technical appendix for most resources. However, Tribes have noted that resources in the study area are part of a much larger integrated cultural network, and impacts can extend far beyond the study area in space and time. To analyze the full range of consequences of potential cumulative impacts to Tribal rights, interests, and resources as well as cultural resources, some additional past and present actions are considered in this analysis.

To identify RFFAs to be considered in the cumulative impacts analysis, the SEPA Register and other published notices and planning documents were reviewed. Scoping comments related to other actions and cumulative impacts were also considered. RFFAs identified in Section 3 (below) primarily detail future trends within the study area. The trends analysis encompassed planning efforts, programs, proposals, projects, and new legislation, and determines whether each is probable enough or too speculative to warrant further consideration. The PEIS uses information from the State Energy Strategy and information on proposed projects or trends identified by agencies (e.g., Washington Department of Fish and Wildlife [WDFW] and Washington State Energy Facility Site Evaluation Council [EFSEC]) and industry members and considers areas where clean energy development is likely or already occurring.

Once a list of RFFAs was developed, the RFFAs were evaluated to determine whether they would have an impact on the resources considered in the PEIS. The PEIS focuses on probable significant adverse impacts, with some information provided on non-significant adverse impacts. Impacts were evaluated relative to site characterization, construction, operation, and decommissioning of the types of facilities considered. Elements of the environment without significant adverse impacts were summarized more briefly than elements with significant adverse impacts. Instances where a potential beneficial cumulative impact may occur are also identified.

For most resources, the cumulative impacts analysis in Section 4 considers whether the facilities considered in the PEIS, in combination with the RFFAs, could cumulatively contribute to impacts related to the resource. The methods and conclusions underlying the analysis, and data gaps or limitations in the analysis, are described.

All RFFAs have the potential to impact resources. The cumulative impacts would depend on the location and number of activities and how near they are to each other. Due to the differences in environmental conditions across the study area and broad trends of reasonably foreseeable actions identified and considered in this planning document, cumulative impacts for all resources would range from **less than significant to potentially significant**.

3 Reasonably Foreseeable Future Actions

RFFAs are proposed activities that could cause similar effects in the same space and time as the types of facilities evaluated in the PEIS. These include trends that could affect humans and the environment within the study area and within the defined timeframe of 75 years. This trend analysis is appropriate for this planning document, as it considers impacts at a broad level. Other future actions are described in this analysis as "reasonably foreseeable" because they are ongoing, are funded for future implementation, or are included in local, state, or federal near-term plans.

Table 1 outlines the types of future actions identified as reasonably foreseeable in the study area and timeframe. Specific activities and trends for each RFFA are further described in Sections 3.1 through 3.10, following Table 1. Only the RFFAs that could impact resources considered in the PEIS were included in this analysis. Note that the facilities considered in the PEIS, and other projects or activities considered RFFAs would be required to complete project-specific environmental reviews and permitting, as appropriate and as determined by the lead agency.

Table 1. Summary of reasonably foreseeable future actions in the study area

RFFA ID	RFFA trend	Associated activities
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, renewable 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 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 ID	RFFA trend	Associated activities
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 areas available for recreation such as 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

3.1 RFFA 1 – Energy Projects including Clean Energy Developments and Changes to Existing Energy Systems

Clean energy is rapidly growing in Washington. A regionwide trend exists for ongoing and additional future development and increased use of clean energy sources with the primary goal of economy-wide reduction in greenhouse gas emissions and statewide decarbonization of energy sources. Many of these projects are being driven by multiple legislative actions, mandates, and statewide or regional initiatives designed to induce long-term changes, including the following:

- State and municipal greenhouse gas (GHG) emissions reduction limits (Chapter 70A.45 RCW[5])
- Washington State Energy Strategy (Commerce 2020)
- Washington State Clean Energy Transformation Act (CETA; Chapter 19.405 RCW[6])
- Washington State Climate Commitment Act (CCA) (Chapter 70A.65 RCW[7])
- Federal Affordable Clean Energy Rule

[5] https://app.leg.wa.gov/rcw/default.aspx?cite=70A.45
[6] https://app.leg.wa.gov/rcw/default.aspx?cite=19.405
[7] https://app.leg.wa.gov/rcw/default.aspx?cite=70A.65

- Federal Cleaner Trucks Initiative
- Electric vehicle use and government incentive programs: Chapter 173-423 WAC,[8] Clean Vehicles Program, and WAC 173-423-070,[9] Low Emission Vehicles
- Baseload Electric Generation Performance Standard, including the process for implementing the required phase-out of electricity generated by coal-fired facilities (Chapter 80.80 RCW[10])
- Pacific Northwest Electric Power Planning and Conservation Act
- U.S. Department of Energy Cleanup to Clean Energy Plan
- Energy Facility Site Evaluation *Council Draft PEIS for High-Voltage Transmission Facilities in Washington* (EFSEC 2025)
- Washington State Department of Commerce (Commerce) Rural Clean Energy Legislative Report (Commerce 2022a)
- Federal Energy Regulatory Commission Order No. 1920 for the reform of high-voltage transmission planning for projects under its jurisdiction
- Bureau of Land Management (BLM) amendments to Resource Management Plans evaluated in the NEPA *Final Programmatic Environmental Impact Statement for Utility-Scale Solar Energy Development* (BLM 2024)
- U.S. Department of Energy Regional Clean Hydrogen Hubs Program
- U.S. Department of Energy Clean Hydrogen Electrolysis Program
- U.S. Department of Energy Clean Hydrogen Manufacturing and Recycling RD&D Activities
- U.S. Department of Energy Hydrogen Shot

One of the key components of these legislative actions, mandates, and initiatives is the Washington State Energy Strategy, which is focused on providing a roadmap for the state to meet the requirements of multiple state regulations including the Energy Independence Act, CETA, and the state's GHG emission reduction limits (Commerce 2020). The state has committed to reducing GHG emission by 45% below 1990 levels by 2030, 70% below 1990 levels by 2040, and 95% below 1990 levels with net zero emissions by 2050. As part of the State Energy Strategy, five decarbonization scenarios that reflect different pathways to achieving those goals were analyzed:

- **Electrification Scenario:** Models a rapid shift to electrified end uses where total energy demand drops by 28%, but electricity demand increases 90% over 2020 levels by 2050 through the displacement of fossil fuels in buildings and transportation.
- **Transport Fuels Scenario:** Models a slower transition to electrification in transportation uses, either due to policy driving a more gradual shift or because of slower than expected electric vehicle adoption. This scenario includes a 23% drop in total energy demand, with fuels still being a significant component of transportation uses in 2050.
- **Gas in Buildings Scenario:** Models a scenario where the use of gas in the built environment continues through 2050 with the use of pipeline gas composed of natural

[8] https://app.leg.wa.gov/wac/default.aspx?cite=173-423
[9] https://app.leg.wa.gov/wac/default.aspx?cite=173-423-070
[10] https://app.leg.wa.gov/rcw/default.aspx?cite=80.80

gas mixed with a combination of cleaner alternatives such as biogas, synthetic gas, or hydrogen. Includes a 24% drop in total energy demand by 2050, largely through the replacement of existing gas-consuming appliances with more efficient gas-consuming appliances and changes in gas composition.

- **Constrained Resources Scenario:** Models the impact if the state were unable to expand electricity transmission interties to other states, requiring expansion of in-state clean energy generation capacity. This scenario includes a total energy demand reduction scenario identical to the Electrification Scenario.
- **Behavior Changes Scenario:** Models the impact of consumer choices to decrease energy consumption by driving less and reducing demand for energy services in buildings. This scenario includes a 30% drop in total energy demand through reduced use of energy services.

For all of these scenarios, the achievement of lower energy demands and reduction in associated GHG emissions would be driven by improvements in the production of clean electricity, cleaner (i.e., decarbonized) liquid fuels, and the efficiency of energy product transmission. Approximately 69% of the state's electricity supply is already provided by clean sources, primarily hydroelectricity (Commerce 2020). Additional clean energy needed to support future demands under the decarbonization scenarios is expected to be imported from other states (e.g., Montana and Wyoming wind generation) or obtained by expanding in-state clean energy generation capacity.

As indicated by the scenarios analyzed in the State Energy Strategy, expected trends for energy projects from now until 2050 include increases of in-state electricity generation via clean sources, production of decarbonized liquid fuels using electricity, and improvements in energy transmission throughout the state. RFFAs likely to occur as part of these trends include development, operation, maintenance, and decommissioning of clean energy generating facilities (including the types of green hydrogen facilities contemplated by the PEIS), energy transmission systems, and energy distribution networks, including those for electricity, renewable natural gas, coal, and other petroleum products like gasoline and oil. This RFFA also includes construction and modification of existing energy generation, transmission, and distribution infrastructure including the expansion or rehabilitation (e.g., reconductoring, pole/tower replacement/upgrade) of existing transmission and distribution lines, substations, and grid management systems.

Some of the larger future clean energy projects and initiatives that overlap with the study area for the PEIS include:

- Hanford Clean Energy Development Area
- U.S. Bipartisan Infrastructure Law and Regional Clean Hydrogen Hubs (H2Hubs) Program
- The Pacific Northwest Hydrogen Association Regional Clean Hydrogen Hub[11] Node locations in Whatcom, Benton, and Lewis Counties:

[11] https://pnwh2.com/projects/

    - Node 1 in partnership with First Mode, Puget Sound Energy, Amazon, and Centralia College, plans to produce hydrogen for clean energy and heavy-duty transportation with nearby training and workforce development facilities.
    - Node 2, led by ALA Renewable Energy LLC in partnership with Hydrogen Technology & Energy Corporation, plans to produce hydrogen for heavy-duty transportation, refineries, and power generation anticipated in Ferndale, Washington.
    - Node 4, led by Atlas Agro, plans to develop clean hydrogen for calcium ammonium nitrate fertilizer production for an expected end use by local farmers in Richland, Washington.
- Lincoln Rock Hydrogen Facility, Douglas County Public Utility District
- SkyNRG Project Wigeon sustainable aviation fuel, Wallula, Washington
- Battery energy storage facilities in industrial areas near existing transmission infrastructure
- Puget Sound Energy's (PSE) Clean Energy Implementation Plan
- PSE Renewable Natural Gas (RNG) facility at Central Wastewater Treatment Plant, Tacoma, Washington
- Augean RNG Project Facility, Yakima County
- Sunnyside RNG Project, Sunnyside, Washington
- Washington State Department of Transportation (WSDOT) ferry system electrification

These projects would require similar siting conditions; therefore, there is increased potential for multiple green hydrogen and other clean energy generation facilities to be located proximate to one another.

Hydrogen production generally involves taking primary energy from sources such as fossil fuels, wind, solar, and biomass through a series of conversion, storage, and transportation stages to delivery in the form of energy services such as heat, light, and propulsion. Hydrogen can be stored at production facilities, distribution facilities, and end-use facilities, and transported long-distance via pipeline or truck. Refining is currently the primary use of hydrogen in Washington, where it can be used in high- and low-temperature heat applications and in iron and steel production. Hydrogen can also be used as a feedstock for chemical production such as ammonia for fertilizer. Existing fuels used in industry and transportation can also be decarbonized with drop-in hydrogen derived fuels, using existing equipment and infrastructure (Commerce 2024).

Green hydrogen is also expected to be used for smaller vessels limited to ports and coastal waters in the maritime and shipping sector; direct-hydrogen uses are not currently feasible or practicable for larger ocean-going vessels (Waddell et al. 2024). Washington ports are considered potential storage hubs where hydrogen fuels can be used as shipowners and shipping customers face increasing regulatory pressures and seek to benefit from the region's economic development.

The 2024 Washington Department of Commerce report on *Green Electrolytic Hydrogen and Renewable Fuels: Recommendations for Deployment in Washington* (Commerce 2024) provides

technical analysis of the potential for developing green electrolytic hydrogen and hydrogen-derived fuels in the state; suggestions for the best uses for green hydrogen; considerations for permitting, siting, and environmental justice; and policy recommendations. The report modeled 10 scenarios that explored a range of factors that could influence how Washington might develop green electrolytic hydrogen and other renewable fuels. The report indicates that it will be critical to quickly develop new renewable energy and transmission capacity to produce green hydrogen and other types of renewable fuels derived from hydrogen. To deploy these fuels effectively and equitably, the state should prioritize the most strategic uses and focus on environmental justice and workforce considerations as part of growing a green hydrogen economy. The report also assesses present opportunities and challenges to advancing green electrolytic hydrogen and hydrogen-derived fuels in Washington and provides analysis about electricity system impacts of hydrogen and renewable fuels deployment. The strategic end uses for green hydrogen and renewable fuels identified in the report include replacing fossil-derived hydrogen in refining and other chemical production processes, such as:

- Production of renewable liquid fuels for use in on-road, maritime, and aviation transportation
- Production of ammonia
- Direct use of hydrogen in fuel cell electric vehicles, specifically heavy-duty vehicles, freight rail, and marine fuel cells
- Other direct uses of hydrogen gas in electricity production, industrial heat, and pipeline gas blends

The report lays out a roadmap for deployment of green hydrogen in the state in phases. In the near term (2023–2030), new markets for hydrogen are developed and preparation begins for large-scale hydrogen-derived drop-in fuel deployment. Early preparation is needed to handle the expected rate of development for siting and permitting of hydrogen infrastructure and renewable energy, and the report identifies that planning for new hydrogen and ammonia pipelines should start in the 2020s for operation to begin in the 2030s. Medium-term (2030–2040) and final-phase (2040–2050) goals are detailed in the report for strategies for deployment of green electrolytic hydrogen and other renewable fuels in Washington.

3.2 RFFA 2 – Urban, Commercial, and Industrial Activities and Development

Urban, commercial, and industrial activities and development are largely influenced by changes in the local and regional population, including both increases and decreases in the number of people living and working in a particular area and associated changes in population density. Population growth typically results in an increased demand for housing, employment, public services, municipal water/sewage treatment systems, and related utility infrastructure.[12]

[12] Changes in transportation infrastructure associated with such trends are included under RFFA 5.

Decreases in population often result in the abandonment of residential, urban, and industrial lands and related changes in land use.

According to the Washington State Office of Financial Management (OFM), the state's population is expected to continue growing from 7.7 million in 2020 to almost 9.9 million in 2050 (28% increase), for an annual average growth rate of approximately 0.8% (OFM 2024). Between 2020 and 2050, Washington is expected to add about 2,160,800 people, reaching 9,867,100 in 2050. Of that expected increase, OFM (2024) estimates that approximately 84% (1,819,000 people) would be due to net migration, with the other 16% (341,800 people) due to natural change (i.e., births and deaths). According to an OFM press release from June 30, 2023, the majority of state population growth between 2022 and 2023 occurred in the five largest metropolitan counties, which include King County, Pierce County, Snohomish County, Spokane County, and Clark County. The top ten cities for population change are, in descending order, Seattle, Kirkland, Redmond, Bellingham, Lynnwood, Vancouver, Spokane, Mountlake Terrace, Tacoma, and Ridgefield (OFM 2023). Percent population change in the 37 counties overlapping the study area for the PEIS ranged from over 8% (Wahkiakum, Lincoln, and Pend Oreille counties) to 0% to -2.4% (Yakima, Island, and Walla Walla counties) between 2020 and 2024.

The geographic scope of study for the PEIS is within areas zoned for industrial uses or industrial-supporting uses, where green hydrogen projects are likely to be sited. Green hydrogen is expected to be used in industrial activities, such as steel and iron production and shipping activities, and is expected to correspond with an increase in industrial activities and development. Although areas zoned as urban, commercial, or residential were not included in the geographic scope of study for the PEIS, development activities occurring in those excluded areas would still have the potential to affect both natural and built environment resources in the larger watershed or ecoregion. RFFAs considered under this category include construction of new commercial and industrial developments, expansion of existing developments, and decommissioning, decontamination, and demolition of former facilities that are no longer used.

Some areas in the study area may be seeing recent shifts in the uses of industrial use areas. The 2024 *Industrial Lands Analysis* by the Puget Sound Regional Council (Puget Sound Regional Council 2024) provides an assessment of economic activity and industry forecasts and the ability of the region to accommodate economic growth on industrial lands. The analysis identifies recent shifts in industrial activities to newer industrial sectors and the green economy that have fewer community and environmental impacts and trends moving away from use of fossil fuels. There is a shift in the Puget Sound region towards lighter industrial uses and manufacturing that is less dependent on core industrial lands, as well as a shift towards warehousing and distribution (Puget Sound Regional Council 2024).

Many of the changes in urban/suburban, commercial, and industrial activities and development would be influenced by changes in workforce concentration and location. The Washington State Employment Security Department develops employment projections for the state and for 12 regional workforce development areas (WDAs) within the state (ESD 2024). Segments of the green hydrogen study area are located in all 12 WDAs. The 10-year average annual growth rate

for total nonfarm employment in Washington for the 2020 to 2030 period is projected to be 1.7%. The largest increases by share of employment in this period are expected to be the leisure and hospitality sector and the information sector; the largest decreases are projected in the manufacturing and wholesale trade sectors (Washington State Employment Security Department 2023). The Seattle-King County WDA has the highest projected growth rate of 1.88%, the Southwest WDA has the second highest at 1.78%, and the Olympic region has the lowest at 1.37% (Washington State Employment Security Department 2023). Potential projects to support workforce growth could include urban/suburban infill development, commercial and industrial development, and conversion of previously developed land to a different use type.

3.3 RFFA 3 – Rural and Agricultural Activities and Development

The general trend relating to agricultural activities and land use in Washington is similar to that of the United States as a whole, with an ongoing decline in the number of farms and in the area of land in agricultural production as more land is converted to urban, highly developed or low-density residential land uses (Freedgood et al. 2020). The overall number of farms in Washington declined from over 40,000 in 1997 to approximately 32,000 in 2022, and farmland acreage declined from nearly 15.8 million acres to approximately 13.9 million acres between 1997 and 2022 (USDA 2024). Several industrially zoned areas within the green hydrogen study area are located adjacent to or in proximity of rural and agricultural areas, such as in Clark County, Benton County, Walla Walla County, Cowlitz County, and Grays Harbor County.

The eighth planning goal of the Growth Management Act (GMA; RCW 36.70A.020[13]) identifies agricultural lands as natural resource-based lands and encourages the preservation of designated agricultural land following the criteria established in WAC 365-190-050.[14]

In the *Washington Department of Agriculture Strategic Plan 2022-2025* (WSDA 2022), the Washington State Department of Agriculture (WSDA) identifies five priorities for the future of agriculture in the state. Those priorities include ensuring that Washington's agricultural system is equitable, resilient, and prosperous; ensuring the availability, safety, and integrity of the state's food supply for humans and animals; enforcing agricultural and environmental laws; protecting animals and plants from invasive species and diseases; and enhancing environmental justice practice within WSDA programs (WSDA 2022).

Activities associated with implementing these priorities could include modifications to existing agricultural practices and lands such as changing crop types, expanding cultivated areas, changing irrigation practices, expanding agricultural buffers, changing pesticide and herbicide use practices, and modifying livestock use, waste management, and grazing practices. Activities

[13] https://app.leg.wa.gov/rcw/default.aspx?cite=36.70a&full=true#36.70A.020
[14] https://app.leg.wa.gov/wac/default.aspx?cite=365-190-050

may also include changes in associated agricultural infrastructure (e.g., irrigation systems, fencing, drainage systems, building types/uses).

Future agricultural activities would also be affected by climate change. In the Pacific Northwest, the three main climate change effects that are expected to affect agriculture are increased air temperatures; changes in the amount, timing, and form of precipitation; and increased concentrations of carbon dioxide in the atmosphere (USDA 2024). As a result of such conditions, the productivity of some crops such as winter wheat is expected to increase with climate change (USDA 2024). Such conditions could encourage the expansion of existing wheat fields or conversion of less-productive crops to wheat.

In addition to changes in agricultural activities and practices, conversion of rural and agricultural lands to other uses could also continue to occur in the future. Ongoing activities associated with such conversions are largely driven by land values and population changes, as well as factors related to climate change. Activities associated with land use conversion could include transitioning non-designated agricultural land and undeveloped rural areas to other uses such as residential, commercial, and industrial development. Associated expansion or modification of rural road and drainage systems (e.g., culverts and storm sewers) and related infrastructure could also be included.

3.4 RFFA 4 – Federal, State, Tribal, and Local Wildlife and Habitat Projects

There are numerous public lands managed to benefit wildlife and public uses near industrial lands where green hydrogen is anticipated to be located. Development activities that occur adjacent to or abutting those areas could have effects on regional natural and built resources. These include the McNary National Wildlife Refuge near Pasco, Washington, the Umatilla National Wildlife Refuge in Umatilla County, Oregon, the Steigerwald Lake National Wildlife Refuge in Clark County, the Seashore State Park Conservation Area on the Long Beach Peninsula, and the Wiley Slough Restoration Project on the lower South Fork Skagit River, as well as others.

Activities associated with wildlife and habitat management by federal, state, local, and Tribal agencies within wildlife refuges and other public lands focus on improving habitats and ecosystem functions and on species-specific conservation projects. In addition to public lands managed for the benefit of wildlife and habitat, there are programs funded and/or managed by the federal government, state of Washington, water trust, and non-profit organizations to restore habitat on privately owned lands in the state.

Activities and programs considered under this RFFA include, but are not limited to, growth management programs, stream and riparian habitat projects, estuary restoration projects, invasive species management plans, restoration and mitigation banks, and watershed planning and implementation, fish passage improvements, and climate change adaptation, among others.

Examples include the following:

- WDFW Wildlife Area Management Plans
- Washington Shrubsteppe Restoration and Resiliency Initiative
- *Washington State Wildlife Action Plan* (WDFW 2015)
- State of Washington Natural Heritage Program
- Fish and Wildlife Habitat Conservation Areas under the GMA and Shoreline Management Act (SMA)
- Washington State Conservation Commission's Voluntary Stewardship Program
- Puget Sound Partnership's Action Agenda
- Salmon Recovery Funding Board and salmon recovery lead entity plans
- WDFW's Management Recommendations for Washington's Priority Habitats
- Washington Wildlife Habitat Connectivity Working Group
- Washington Conservation Strategy for Washington State Inland Sand Dunes
- Arid Lands Initiative

In general, the above activities and programs are building long-term strategies for habitat and wildlife conservation. The effects and extent of these activities vary across the state, depending on other influencing factors such as funding sources, changes in regulations, collaborative efforts, and interested parties. Examples of activities and programs anticipated to continue into the future are discussed below.

WDFW has a mission to preserve and perpetuate the state's fish and wildlife resources, and programs that support this mission are planned as funding or partnership resources become available (WDFW 2024a). WDFW manages 33 wildlife areas across the state, and each area is guided by a management plan that addresses the status of wildlife species and their habitat, habitat restoration, public recreation, weed management, and other activities to meet the department's mission (WDFW 2024a). The Washington Wildlife Habitat Connectivity Working Group's Washington Connected Landscapes Project is providing a series of scientific analyses and tools that use the best available science to identify important wildlife habitat linkage areas and inform decisions that can impact habitat connectivity in Washington. The 2015 *Washington State Wildlife Action Plan* objectively assesses the status of the state's wildlife and habitats, identifies key problems, and outlines the actions needed to conserve wildlife and habitats over the long term (WDFW 2024b).

The Washington Shrubsteppe Restoration and Resiliency Initiative (WSRRI) strategy is set for a 30-year period and includes five key elements focused on community engagement, habitat protection, habitat restoration, species management, and fire management (WDFW 2024d). The Natural Heritage Program issued a 2022 *State of Washington Natural Heritage Plan* that identifies a number of programs to identify and conserve the state's biodiversity such as developing a map and database of sites of biodiversity significance, referred to as "Essential Conservation Areas," to guide landscape and site-scale conservation (DNR 2024).

To guide where on the landscape WSRRI and its partners should invest proactively and implement specific actions, WSRRI partners mapped habitat quality and connectivity across the landscape. They identified the following:

- Core areas have the highest-quality habitat, and actions targeted here should include protection, threat prevention and abatement, and restoration where disturbances occur despite protection measures.
- Growth Opportunity Areas still have significant amounts of habitat but are more degraded than habitat in core areas, and strategic restoration here could increase habitat quality and result in more core area.
- Corridors are relatively free of wildlife movement barriers and connect core areas and growth opportunity areas across the landscape; further barrier development (e.g., road construction or habitat conversion) should be avoided in corridors.
- Other Habitat is more degraded than the other three categories but is still important to retain and, if resources allow, its condition should be improved over time.

Spatial priority maps were developed for two WSRRI conservation targets: dry (xeric) ecosystems and wet (mesic) ecosystems. Further discussion of these maps is in the *Biological Resources Technical Appendix*.

3.5 RFFA 5 – Transportation Infrastructure Development and Modification

The trend for transportation RFFAs includes activities to maintain, expand, and improve Washington's road and rail transportation systems and increase air cargo and shipping within navigable waterways. An example trend influencing RFFAs in this category includes the Joint Transportation Committee's projections that air cargo will experience an average annual growth rate of 4.4% between 2016 and 2026 (JTC 2018).

Transportation infrastructure development and modification includes efforts to increase the resiliency of the transportation network and expanding options to reduce reliance on single-occupancy vehicles. These efforts are typically driven by federal, state, and local transportation programs and plans such as the following:

- Federal and state highways corridor programs and improvements
- Washington Transportation Plan (WSDOT 2015, 2018)
- Washington State Rail Plan 2019-2040 (WSDOT 2020)
- Local transportation plans
- Freight and passenger rail plans
- Highway system plans
- Lower Columbia River Channel Maintenance Plan (USACE 2024a)

Focus areas for the state's transportation system are identified in Phase 2 of the WSDOT transportation plan and include maintaining and preserving assets, managing growth and traffic

congestion, enhancing multimodal (e.g., road, rail, waterway, bicycle, pedestrian) connections and choices, and aligning funding structures with the multimodal vision (WSDOT 2018). Based on these focus areas, transportation-related activities are likely to include the following:

- Improving, rehabilitating, and reconstructing existing infrastructure (e.g., roadways, intersections, bridges, ferries, rail lines)
- Expanding and realigning transportation routes to accommodate growth and reduce traffic congestion
- Restructuring existing or building new transportation systems that better support integrated use for multiple modes of transportation
- Improving or expanding existing rail systems to improve safety, freight mobility and connectivity, better support the use of both manifest and unit trains, and address expected changes in rail traffic
- Expanding non-motorized transportation infrastructure (e.g., bikeways, pedestrian trails).

Washington's freight transportation system handles approximately $707 billion of cargo annually, and industrially zoned areas in the green hydrogen study area are expected to use this network and be located in proximity to it. The Freight and Goods Transportation System is a classification system of multimodal freight corridors specific to Washington and classifies freight corridors for truck, rail, and waterway based on annual tonnage carried. A total of 76% of truck freight corridors are identified as state highways, 17% are city streets, and 7% are county roads. A total of 2,870 miles of rail system and 792 miles of waterways are identified as moving freight in Washington (WSDOT 2023).

The 2022 WSDOT *Washington State Freight System Plan* identifies a freight plan for the state and also identifies changing trends and forecasts in the region. Between 2022 and 2050, freight movements are forecasted to increase 45% across the state, with the greatest upward tonnage increases in air cargo. Relatively steady changes are forecasted in truck, rail, and multiple-mode freight tonnage. The pipeline system and maritime freight tonnages are also expected to steadily increase over time. Energy is identified as the largest top commodity in freight tonnage between 2022 and 2050. Freight tonnage is expected to grow the fastest by percent in Okanogan, Snohomish, King, Mason, Stevens, and Garfield Counties (WSDOT 2022a).

Residential and commercial zones of major urban areas may begin to expand into areas formerly dedicated to industrial or freight handling uses as Washington's population grows. It is common to see industrially zoned areas converted into other uses as populations increase, creating increasing opportunities for conflict between freight activity and other transportation users. Alternately, relocating freight facilities away from urban centers can increase travel distances, which adds to congestion, emissions, and conflicts with other transportation users. Additionally, vulnerable and overburdened communities tend to be located disproportionately in proximity to industrial areas and freight facilities and are more vulnerable to the negative community health impacts associated with those areas (WSDOT 2022a).

3.6 RFFA 6 – Contaminated Site Cleanup and Remediation

Green hydrogen facility developers may site projects at or adjacent to cleanup sites where environmental remediation activities either have been completed or are ongoing. Activities in this category include ongoing activities and reasonably foreseeable future cleanup activities at sites known to be contaminated by hazardous or dangerous substances including petroleum, heavy metals, pesticides, persistent organic pollutants, and other types of toxic substances under the Washington Model Toxics Control Act (MTCA) and federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

Contaminated site cleanup and remediation activities that could occur at these and other sites include initial and remedial site investigations involving excavation, soil borings, and monitoring well installation; contaminated soil and sediment removal via excavation and dredging; capping of contaminated soils and sediments; water treatment facility construction; and leachate and gas collection system installation.

Industrial zoned land use areas may have areas that have been contaminated from previous industrial activities. The geographic scope of study for green hydrogen contains 19 cleanup sites currently on the National Priorities List under CERCLA, also known as Superfund sites. Many of the cleanup sites that are within the study area are located in western Washington. Two Superfund sites are located adjacent to industrially zoned land where green hydrogen facilities are anticipated to be located. These sites have hazardous material contamination present in the soil, surface water, or groundwater.

3.7 RFFA 7 – Mining Operations

There are approximately 875 active permitted sand, gravel, rock, and stone mining operations within the state and it is possible that green hydrogen facilities could be sited near or adjacent to existing or proposed mining operations. Activities from the other RFFAs could result in increased demand for aggregate and increased mining operations.

Ongoing activities related to those mining operations that could contribute to cumulative effects on the environment, when considered with effects of construction and operation of green hydrogen facilities, include mining and processing area expansions, new mine and processing facility development, modifications of mining processes and procedures (e.g., dewatering/drainage system alterations), and mine reclamation activities. Potential impacts from those activities could include vegetation removal, soil excavation, fill placement, road development, increased diesel emissions from mining equipment, drainage alterations, utility expansion, erosion, and fugitive dust generation.

3.8 RFFA 8 – Recreation Activities

This trend covers ongoing and reasonably foreseeable future changes in recreation activities and programs on public lands, including increases in recreational uses reported by the

Washington State Recreation and Conservation Office (RCO) and WDFW. Green hydrogen facilities could be sited near or adjacent to existing or proposed recreation areas.

In RCO's 2023 Washington Recreation and Conservation Plan (RCO 2023), a review of participation trends in 45 outdoor activity categories found that participation had increased in all but two categories since a previous survey in 2017 (RCO 2023). Outdoor activities that showed the greatest increases in participation included wildlife and nature viewing, paddle sports, visiting outdoor cultural and historic sites, tent camping, backpacking, playing yard games in parks, snowshoeing, hanging out in parks, and mountain biking. WDFW's wildlife area management plans also document continued and increased use of their lands for hunting, fishing, wildlife viewing, camping, horseback riding, mountain biking, and motorized recreation (WDFW 2024e).

Potential activities associated with these trends include increased access to waterways; development, expansion, or closure of hiking, biking, and equestrian trails and trail systems; expansion of winter recreation areas; rehabilitation of existing and development of new camping and RV sites; and increased access to areas for hunting, fishing, and off-road motor vehicle use. Maintenance and repairs of recreation amenities and infrastructure (e.g., restrooms, roads, parking areas) are also included in the consideration of potential activities.

3.9 RFFA 9 – Military Use

Several military testing, training, and operating areas occur adjacent to or surrounding areas where green hydrogen facilities may be located. To address the potential for clean energy facility development to affect the military's ability to operate or conduct training, the Compatible Energy Siting Assessment (CESA) was jointly developed by the Washington Department of Commerce, EFSEC, and the U.S. Department of Defense (DoD) to assess state energy trends, developers' practices, community requirements, and military missions in Washington (DOC 2024). The outcome of CESA is a framework that promotes early and ongoing civilian and military consultation to coordinate the siting of clean energy facilities that could affect military use and/or pose a safety risk to military personnel. It includes a civilian-military compatibility needs and trends assessment, a review of energy siting policies and procedures, and a prototype web-mapping tool to support the further development of consulting tools and applications.

Primary military installations or areas near or adjacent to the PEIS study area include:

- Fairchild Air Force Base
- Joint Base Lewis-McChord and Yakima Training Center
- Naval Air Station Whidbey Island and Naval Outlying Field-Coupeville
- Naval Base Kitsap-Bangor, Keyport and Puget Sound Naval Shipyard and Intermediate Maintenance Facility
- Naval Station Everett
- U.S. Coast Guard-District 13, under the Department of Homeland Security

- Washington Military Department headquarters at Camp Murray
- Military training centers, various counties
- Military air training routes with floor elevations ranging from 200 feet to 1,500 feet, multiple contiguous counties
- Special use airspace areas with floor elevation ranging from 0 feet (surface) to greater than 1,000 feet, multiple contiguous counties

Activities associated with this RFFA in those areas that could contribute to cumulative impacts on the natural and built environment when combined with impacts from the construction and operation of green hydrogen facilities include runway resurfacing; construction, rehabilitation, and maintenance projects; expansion of exclusion areas; changes in land use and management; and changes in surface and air training routes and activities.

3.10 RFFA 10 – Water Supply Development and Withdrawals for Municipal, Agricultural, Industrial, and Conservation Uses

With the general increases in annual average and maximum summertime air temperatures, reduction of winter snowpack and summer stream flows, and increase in freshwater water temperatures predicted to occur as a result of climate change, there is greater potential for the occurrence of drought and subsequent water shortages. Such conditions could limit the amount of water available for municipal, industrial, agricultural, and conservation uses.

This RFFA includes ongoing activities related to the development, modification, and use of water supply systems to address future water supply issues include the expansion and development of reservoirs, well fields, water distribution systems, water treatment plants, and pump stations for municipal, agricultural, and industrial uses. This RFFA also includes projects that encourage water conservation, water storage, and flood risk reduction and that support streamflow for aquatic species, including dam removal projects and changes in water rights policy and availability. Examples of activities contributing to this trend in the study area include:

- Cold Water Connection, Olympic Peninsula
- Columbia River Basin projects, various counties
- Columbia River Water Management Program
- Icicle Creek strategy, Chelan County
- Lake Whatcom Management Program, Whatcom County
- Lones Levee Setback and Floodplain Restoration Project, King County
- Lower Dungeness and River's Edge Floodplain Restoration Projects, Clallam County
- Pilchuck River Diversion Dam Removal, Snohomish County
- Puget Sound National Estuary Program
- Seattle Public Utilities Cedar River Watershed Habitat Conservation Plan (HCP)
- Seattle Public Utilities Water System Plan
- Skagit River Basin Mitigation Program

- Switzler Reservoir Project, Klickitat County
- U.S. Army Corps of Engineers (USACE) Howard Hanson Dam Management (Green River), HCP, & Fish Passage Project
- Walla Walla Water 2050 Strategic Plan, Walla Walla County
- Yakima Basin Integrated Water Management Plan, Yakima and Kittitas Counties
- Yakima River Basin Projects, Yakima and Kittitas Counties

4 Cumulative Impacts by Resource Area

This section provides an overview of potential cumulative effects from the types of facilities considered in the PEIS and a qualitative assessment of adverse impacts as relevant to each of the resource areas analyzed in the PEIS.

The extent and magnitude of impacts on resources would vary depending on the geographical region and size of the facility relative to other RFFAs in the area. In general, when considering the contribution of future effects, 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. Conversely, smaller facilities are likely to result in fewer cumulative impacts on resources because they have a smaller footprint and require less supporting infrastructure. Cumulative impacts would also vary depending on the production and storage method of green hydrogen and the inputs and outputs required of the facility. There is increased potential for multiple green hydrogen and other clean energy generation facilities to be located proximate to one another. An example of this is the nodes being proposed as part of the green hydrogen hub process. As a result, the combined impacts from construction, operation, and decommissioning of one or more of these facilities could result in cumulative impacts on the natural and built environment. Developers should consider the increasing challenges that result from multiple green hydrogen facilities and other RFFAs being proposed in the same area that may amplify the cumulative effects on resource areas.

4.1 Tribal rights, interests, and resources

This section summarizes the resources evaluated within the study area in the *Tribal Rights, Interests, and Resources Technical Appendix* and analyzes impacts on this resource resulting from the types of facilities considered and other RFFAs in the green hydrogen study area. The study area for Tribal rights, interests, and resources encompasses the overall green hydrogen geographic scope of study for the PEIS.

Tribes are recognized as unique sovereign people that exercise self-government rights that are guaranteed under treaties and federal laws. Each Tribal reservation in the state constitutes a bordering sovereign jurisdiction subject to federal and Tribal environmental laws. Green hydrogen facilities and RFFAs could affect Tribal rights, interests, and resources in and around the areas where facilities are built, or the affected resources could extend well beyond future proposed facility footprints. Additional details can be found in the *Tribal Rights, Interests, and Resources Technical Appendix*.

4.1.1 Current conditions

Indigenous Tribes and populations have been in the Northwest since time immemorial. There are 32 federally recognized Tribes with lands and territories in Washington state. Each of these Tribes continues to have close connections to its aboriginal territories. Tribes in Washington

have reserved rights to fish and harvest natural resources throughout much of the state. Treaty fishing may occur in small and large rivers and marine areas.

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. In addition, Tribal resources include areas important to traditional cultural practices and the natural and cultural resources associated with those practices including plants, wildlife, or fish used for commercial, subsistence, and ceremonial purposes.

Resources may also include archaeological or historic sites or Traditional Cultural Properties (TCPs) associated with Tribal use and sites considered sacred by Tribes. Tribal resources, archaeological sites, historic and cultural sites, TCPs, and natural resources often can be interconnected and overlapping as Tribal resources.

All areas of Washington state are within the traditional homelands of Tribes. Prior to non-native settlement, these areas were and continue to be places of daily living, subsistence, ceremonial, and burial uses. Lands were subject to treaties, unilateral appropriation by the federal government, or negotiation between the federal government and Tribes. Tribal rights, interests, and resources exist throughout this homeland. Additional details regarding Tribal rights, interests, and resources can be found in the *Tribal Rights, Interests, and Resources Technical Appendix*.

4.1.2 Past and present actions

The analysis of cumulative impacts on Tribal rights, interests, and resources differs in its approach when compared to the cumulative impact analyses for other resources. As noted in Section 2.2, the current conditions in the study area were used as the baseline existing environmental condition for the resource analyses in the PEIS; therefore, past actions are not cumulatively considered again in this report for most resources. However, Tribes have noted that resources in the study area are part of a much larger integrated cultural network, and impacts can extend in space and time beyond the study area or a specific project. To analyze the full range of consequences of potential cumulative impacts to Tribal rights, interests, and resources, some additional past and present actions are considered in this section.

Tribal communities have been connected to the places and resources of the study area since time immemorial, and Tribal and cultural resources have been repeatedly affected by past and present actions. This includes changes to the environment, modifications of waterbodies, and building of dams and reservoirs that inundated, exposed, destroyed, or otherwise affected Tribal resources throughout Washington. Reservoir level fluctuations and flow modifications associated with dams continue to affect cultural and archaeological sites, as well as areas important to traditional cultural practices and the natural and cultural resources associated with those practices including plants, wildlife, or fish used for commercial, subsistence, and ceremonial purposes.

The building of dams and associated reservoirs have historically affected Tribal resources by inundating villages and important fishing, trading, and cultural sites. Today, reservoir level fluctuations and flow modifications associated with operation of dams can increase the risk of exposure, erosion, and looting of remaining cultural sites. Dams also continue to impede native fish and aquatic species migrations, alter water temperature and quality, and form reservoirs that can allow invasive species to prey on native species. Salmon in particular is a native species that is an important aspect of Tribal culture. Salmon and their habitat continue to be affected by human development.

Additionally, during the turn of the nineteenth century, agriculture and urban commerce began to be the major drivers of the growth in population and economy of the state. While agriculture and logging continued to be important industries through the early and mid-1900s, the economy has since diversified to include airplane production, hydropower, and technology. These activities changed the landscape within the study area, along with urbanization, to create industrialized land uses and areas for activities such as manufacturing, refineries, and port activities.

The assessment of past and present human impacts on Tribal rights, interests, and resources includes these considerations as well as a variety of other past development projects that have limited Tribal access to sites for cultural practices and gathering of natural resources, contributed to visual changes in the natural state of the landscape that can interrupt Tribal cultural practices and impact the expression of Tribal spirituality, or resulted in ground disturbance that could increase the chances of exposure, erosion, and looting of Tribal resources.

4.1.3 Reasonably foreseeable future actions

RFFAs with potential to affect the Tribal rights, interests, and resources are listed in Table 2 along with a summary of the potential effects of these actions.

Table 2. Reasonably foreseeable future actions relevant to Tribal rights, interests, and resources

RFFA ID	RFFA trend	Impact description
RFFA 1	Energy Projects including Clean Energy Developments and Changes to Existing Energy Systems	• Potential impacts from activities that result in ground disturbance (including inadvertent discovery of cultural resources), noise impacts, degradation of visual quality, or interruption of the landscape, habitats, and species. • Potential impacts on sacred sites or TCPs from visual changes and noise. • Transmission line projects that require clearing near streams have the potential to degrade fisheries and other Tribal resources.
RFFA 2	Urban, Commercial, and Industrial Activities and Development	• Impacts would be similar to those described for RFFA 1.

RFFA ID	RFFA trend	Impact description
RFFA 3	Rural and Agricultural Activities and Development	• Impacts would be similar to those described for RFFA 1. • Potential impacts from land use changes in rural areas on species and habitats especially if the land was previously undeveloped. Impacts to habitats and species could adversely impact Tribal rights, interests, and resources. • New rural and agricultural facilities have the potential to impact Tribal resources.
RFFA 4	Federal, State, Tribal, and Local Wildlife and Habitat Projects	• Habitat restoration projects could occur on sites with previously undiscovered cultural resources, resulting in potential impacts from ground-disturbing activities. • Proper management can potentially result in beneficial effects on Tribal rights, interests, and resources from projects that maintain, enhance, restore, or create habitats including wetlands.
RFFA 5	Transportation Infrastructure Development and Modification	• Impacts would be similar to those described for RFFA 1.
RFFA 6	Contaminated Site Cleanup and Remediation	• Impacts would be similar to those described for RFFA 1. • Projects would likely result in long-term beneficial impacts on the environment but could result in short-term impacts from risk from spills or leaks during cleanup and remediation.
RFFA 7	Mining Operations	• Impacts would be similar to those described for RFFA 1.
RFFA8	Recreation Activities	• Recreational activities could potentially disrupt, alter, or degrade habitats and species and thus adversely impact Tribal rights, interests, and resources.
RFFA 9	Military Use	• Impacts would be similar to those described for RFFA 1.
RFFA 10	Water Supply Development and Withdrawals for Municipal, Agricultural, Industrial, and Conservation Uses	• Impacts would be similar to those described for RFFA 1. • Projects have a high likelihood of encountering cultural resources as waterways play an important role in the histories and traditions of Tribes. Waterways are also identified as high-risk areas for encountering archaeological sites due to known settlement patterns near water sources. • Projects that result in recreational opportunities, improvements to water resources, and energy provision can benefit Tribal communities. Other projects, such as dam construction or removal, can potentially disrupt, alter, or degrade habitats and species and thus impact Tribal rights, interests, and resources.

4.1.4 Cumulative impacts from the types of facilities evaluated in the PEIS and other reasonably foreseeable future actions

The following sections summarize the cumulative impacts on Tribal rights, interests, and resources when considering the RFFAs in combination with the different types of facilities considered in the PEIS.

4.1.4.1 Impacts from construction and decommissioning

Construction and decommissioning of green hydrogen facilities considered in the PEIS along with other activities could result in cumulative impacts on Tribal rights, interests, and resources. Construction and decommissioning activities that could impact Tribal resources include ground disturbance, restrictions to access, degradation of visual quality, noise, and interruption 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. Projects that are being constructed simultaneously in close proximity to each other could intensify impacts.

Impacts on traditional access and travel paths for resources could impact Tribes' spiritual practices. 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's significance. This type of impact is likely to increase based on the amount of the landscape or resource that is no longer freely accessible. This can also impact Tribes through changes in access to areas where traditional hunting, fishing, gathering, or other traditional practices occur.

Construction and decommissioning impacts to plant and animal species that are of importance to Tribes and cumulative impacts to biological resources, described in Section 4.6 of this appendix, could also result in cumulative impacts to Tribal resources. 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, resulting in increased alteration of vegetation, fragmentation of habitats, degradation of fisheries, or additional restricted movement of animals and migration paths due to increased fencing, roads, and other structures.

Impacts to Tribal gathering areas may affect other Tribes and surrounding non-Tribal communities with which the resource is shared. Tribes have stated that impacts to Tribal members' ability to participate in, teach, learn, and share cultural practices affect the mental, spiritual, and physical health of Tribal members. Restrictions to access and removal of areas used for cultural practices could affect entire Tribal communities and multiple generations.

Sensitive viewers of some areas or sensitive receptors of noise impacts could include members of Tribes, and some landscapes can have special meaning because of Tribal connections or

values. Multiple facilities and other activities developed in close proximity to each other could intensify disruption to sacred religious and ceremonial practices.

Together, past and present projects, the RFFAs identified above, and potential green hydrogen facilities represent substantial changes to culturally important landscapes, visual changes in the natural state of the landscape that can interrupt Tribal cultural practices and impact the expression of Tribal spirituality, as well as physical barriers to areas where cultural activities take place.

4.1.4.2 Impacts from operation

Operational activities that could affect Tribal rights, interests, and resources include those identified as impacts under construction, as well as changes in access to natural and cultural resources and increased human activity with associated noise, light, dust, and human presence.

Potential cumulative impacts to Tribal rights, interests, and resources during operation include disturbance of previously unrecorded archaeological sites, visual degradation of settings associated with Tribal resources, and limiting access and travel paths traditionally utilized for hunting, fishing, gathering, and other ritual and cultural activities. Multiple green hydrogen facilities and other RFFAs developed in close proximity to each other could intensify impacts on Tribal resources.

4.2 Environmental justice

This section summarizes the environmental justice and overburdened community areas evaluated within the study area in the *Environmental Justice Technical Appendix* and analyzes impacts resulting from the types of facilities and other RFFAs. The study area for environmental justice and overburdened community areas includes all census tracts that overlap the geographic scope of study. Additional details can be found in the *Environmental Justice Technical Appendix*.

4.2.1 Current conditions

People of color populations and low-income populations were identified using the U.S. Census Bureau American Community Survey 2018–2022 5-year estimate data at the census tract level. Of the 692 census tracts that overlap the study area for green hydrogen facilities, 275 census tracts (40%) are identified as populations of people of color and 373 census tracts (54%) are identified as low-income populations.

Census tracts were also evaluated for whether or not they meet the criteria to be identified as an overburdened community area based on the Washington Environmental Health Disparities layer of the Washington Tracking Network Map, the federal Climate and Economic Justice Screening Tool, and maps of Tribal lands as recognized by the Bureau of Indian Affairs. Of the 692 census tracts that overlap the study area, 214 (31%) were identified as overburdened community areas.

4.2.2 Reasonably foreseeable future actions

RFFAs with potential to affect the people of color populations or low-income populations are listed in Table 3 along with a summary of the potential effects of these actions.

Table 3. Reasonably foreseeable future actions relevant to environmental justice

RFFA ID	RFFA trend	Impact description
RFFA 1	Energy Projects including Clean Energy Developments and Changes to Existing Energy Systems	• If projects are sited in or near an area with people of color populations or low-income populations, residents could be disproportionately affected by project activities including but not limited to increased traffic, noise, air emissions, hazards, visual impacts, and land use changes.
RFFA 2	Urban, Commercial, and Industrial Activities and Development	• Similar to impacts described under RFFA 1.
RFFA 3	Rural and Agricultural Activities and Development	• Similar to impacts described under RFFA 1. • Projects would have a greater risk of disproportionate aesthetic and land use impacts on people of color populations or low-income populations if they degrade the visual character of a rural area or result in a conversion of land use.
RFFA 4	Federal, State, Tribal, and Local Wildlife and Habitat Projects	• Projects would likely result in improvements to the environment, such as increased tree canopy cover and green spaces, but could result in short-term impacts on people of color populations or low-income populations as described under RFFA 1.
RFFA 5	Transportation Infrastructure Development and Modification	• Similar to impacts described under RFFA 1.
RFFA 6	Contaminated Site Cleanup and Remediation	• Projects would likely result in long-term beneficial impacts on the environment but could result in short-term impacts on people of color populations or low-income populations as described under RFFA 1.
RFFA 7	Mining Operations	• Similar to impacts described under RFFA 1. • Mining operations are also likely to result in environmental health and safety risks and adverse environmental impacts from the use of hazardous materials that could disproportionately impact people of color populations or low-income populations.
RFFA 8	Recreation Activities	• Potential beneficial impacts if they improve access to recreational activities for people of color populations or low-income populations.
RFFA 9	Military Use	• Similar to impacts described under RFFA 1.
RFFA 10	Water Supply Development and Withdrawals for Municipal, Agricultural, Industrial, and Conservation Uses	• Similar to impacts described under RFFA 1.

4.2.3 Cumulative impacts from the types of facilities evaluated in the PEIS and other reasonably foreseeable future actions

The following sections summarize the cumulative impacts on people of color populations or low-income populations when considering the RFFAs in combination with the different types of facilities considered in the PEIS.

4.2.3.1 Green hydrogen production facility

Green hydrogen production facilities may have disproportionate impacts on historic and cultural resources, Tribes and Tribal communities, biological resources, public services and utilities, vibration, and environmental health and safety. These potential impacts on people of color populations or low-income populations could be exacerbated when considered with similar effects from other RFFAs.

Construction and decommissioning of these facilities and similar RFFAs 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. 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. Depending on the location, scale, and timing of other RFFAs, these could represent a cumulative impact on biological resources and to Tribal communities and resources.

Vibration impacts from construction of these types of facilities and similar RFFAs have the potential to impact conventional and historic structures and could be a potential impact with respect to human annoyance, depending on the duration and severity of vibration during construction. Environmental justice populations are more likely to be located in proximity to the industrial-use areas and facilities where these projects would be expected to be located and impacts from vibration could represent a cumulative impact on these populations.

There is a potential that construction, operation, and decommissioning would have potentially significant adverse impacts on public services and utilities and environmental health and safety if activities required a large fire response in remote locations with limited response capabilities or if a fire or explosion during operations spreads rapidly or impacts large areas. The potential project-specific impacts would depend on the production and storage methods and existing and surrounding uses where the facility and other RFFAs would be located. These impacts could exacerbate health disparities associated with the historical and current industrial land use conditions experienced by overburdened communities.

Pacific Northwest Hydrogen Association (PNWH2) Hub locations in Ferndale, Richland, and Centralia are located in census tracts with between 10 to 20% (Richland), 0 to 10% (Centralia), and 20 to 30% (Ferndale) populations of people of color (U.S. Census Bureau 2022b, 2022). The PNHW2 Hub projects are proposed in industrial-zoned locations adjacent to existing industrial

uses, including the Northwest Advanced Clean Energy Park in Richland, a coal plant in Centralia, and an oil refinery in Ferndale. Land use codes are expected to maintain a buffer from non-industrial uses; however, low-income populations and people of color populations have been disproportionately impacted by the adverse effects of industrial development due to their proximity to industrial sites. An increased demand for emergency response at these locations due green hydrogen projects and/or other RFFAs, if those projects are in locations with limited response capabilities, could also result in cumulative impacts to environmental justice populations.

4.2.3.2 Green hydrogen production facility with co-located battery energy storage system (BESS)

Cumulative impacts from green hydrogen production facilities with a co-located BESS when considering other RFFAs in the area would be similar to the impacts discussed above for green hydrogen production facilities. The addition of BESS components could result in additional risks from fire and hazardous air emissions if a fire were to occur. Because of the additional fire risks of BESSs, specialized advanced 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 and to reduce risks of BESS fire ignition and spread. 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 urban areas near people of color populations or low-income populations.

4.2.3.3 Green hydrogen storage facility

Cumulative impacts to environmental justice communities from green hydrogen storage facilities when considering other RFFAs in the area would be similar to the impacts discussed above for green hydrogen production facilities.

4.2.3.4 No Action Alternative

Under the 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. Potential cumulative impacts on environmental justice communities would be similar to the impacts for the types of facilities described above, depending on facility size and design.

4.3 Earth resources

This section summarizes the earth resources evaluated within the study area in the *Earth Resources Technical Appendix* and analyzes impacts on these resources resulting from the types of facilities considered and other RFFAs in the green hydrogen study area. The study area for earth resources includes the PEIS study area. Additional details can be found in the *Earth Resources Technical Appendix*.

4.3.1 Current conditions

The key features of earth resources for the cumulative analysis are as follows:

- Geomorphology and geology
- Topography
- Soil resources (erosion and accretion)
- Geologic hazards

Factors relating to earth resources encompass both aboveground, surficial features (topography, soils, rock and other biomass, water resources) and belowground features (geologic units, seismic and landslide hazards). Aboveground, buffer zones may be applied to certain hazard types, such as fault lines or landslide-prone areas, to capture potential impacts to adjacent areas related to these types of hazards. Belowground, the study area extends to the depth of the construction work activity types for facilities.

Washington's geology is deeply connected with the themes of continental tectonic forces, volcanism, uplift, and glaciation. Sedimentary, metamorphic, and igneous rock deposits and emplacements are found across the state. Surface soils derived from these rock deposits often form in common groupings or horizons, as a relative function of the environs in which they are present. Other soil structures such as biological crusts or desert pavements may also be sensitive to disturbance and play an important role in local ecology; both are unique biological and physiological conditions that are specific to the environment in which they form and may take very long periods to recover.

Geologic hazards have the potential to affect environmental quality and change topography, habitat, vegetation, drainage patterns, and other attributes. Understanding geologic hazards such as liquefaction, fault ruptures, tsunamis and seiches, volcanic areas, landslides, subsidence and sea level rise is important because risks of these hazards can impact the safety and feasibility of facility construction, operation, and decommissioning

4.3.2 Reasonably foreseeable future actions

RFFAs with potential to affect the earth resources are listed in Table 4 along with a summary of the potential effects of these actions.

Table 4. Reasonably foreseeable future actions relevant to earth resources

RFFA ID	RFFA trend	Impact description
RFFA 1	Energy Projects including Clean Energy Developments and Changes to Existing Energy Systems	• Potential adverse impacts from an increase in soil compaction, mixing of soil horizons, vegetation removal, surface erosion and runoff, sedimentation of nearby waterways, soil contamination, slope instability, changes in local drainage patterns to support development infrastructure, subsidence related to tapping and withdrawal of groundwater reserves, and borrow of local

RFFA ID	RFFA trend	Impact description
		earth resources for construction, operations, and maintenance activities.
RFFA 2	Urban, Commercial, and Industrial Activities and Development	• Similar to impacts described under RFFA 1.
RFFA 3	Rural and Agricultural Activities and Development	• Similar to impacts described under RFFA 1. Potential adverse impacts from pollution and degradation of soil from agricultural and rural activities.
RFFA 4	Federal, State, Tribal, and Local Wildlife and Habitat Projects	• Potential benefits to earth resources through conservation projects that stabilize soils and reduce surface erosion and runoff.
RFFA 5	Transportation Infrastructure Development and Modification	• Similar to impacts described under RFFA 1.
RFFA 6	Contaminated Site Cleanup and Remediation	• Potential long-term improvements to the environment but could result in short-term impacts from risk of polluting soil from spills or leaks during cleanup and remediation, land subsidence related to withdrawal of contaminated groundwater for treatment, and the borrow of local earth resources for use as fill at remediation sites.
RFFA 7	Mining Operations	• Potential adverse impacts from an increase in surface erosion and runoff, sedimentation of nearby waterways, soil contamination, mixing of soil horizons, and borrow of local earth resources for reclamation work.
RFFA 8	Recreation Activities	• Potential adverse impacts from an increase in soil compaction, surface erosion and runoff, and sedimentation of nearby waterways from increased use of public lands and human presence.
RFFA 9	Military Operations	• Similar to impacts described under RFFA 1.
RFFA 10	Water Supply Development and Withdrawals for Municipal, Agricultural, Industrial, and Conservation Uses	• Similar to impacts described under RFFA 1.

4.3.3 Cumulative impacts from the types of facilities evaluated in the PEIS and other reasonably foreseeable future actions

The following sections summarize the cumulative impacts to earth resources when considering the RFFAs in combination with the different types of facilities evaluated in the PEIS.

4.3.3.1 Green hydrogen production facility

Cumulative impacts on soil and geological resources associated with the construction, operation, and decommissioning of green hydrogen production facilities would primarily occur when green hydrogen facilities and future developments in a given area involve elements that

result in ground-disturbing activities. These activities may include grading, clearing and grubbing, installation of subsurface infrastructure (e.g., foundations, pilings, utility trenches), borrow and stockpiling of site soils, importing of off-site soils, placement and compaction of low-permeability materials, and the use of aggregate resources and structural concrete. Other activities such as construction of site access and foundations, and subsurface utility installation could include excavation of soil and rock materials and importing aggregate (concrete and/or gravel) for concrete or hard-pack gravel equipment pads.

Impacts associated with these activities would include the increased potential for soil compaction, mixing of different layers of soil, surface erosion and runoff, sedimentation of nearby waterways, and soil contamination. 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.

Construction activities would increase the potential for improper 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. 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.

Facility construction activities in combination with adjacent future developments could cumulatively increase the risk of erosion, soil loss, and disruption in soil formation resulting in long-term changes in overall soil quality, soil stability, and regional drainage patterns. While one green hydrogen facility may be up to 10 acres in size, siting several developments within a given area would magnify the risk of multiple different types of hazardous chemicals contaminating soils, which can leach toxins into groundwater and waterways. Grading, cut, and fill activities associated with facility development in combination with other nearby future developments could result in an increased risk of large-scale landslides and greater susceptibility of slope failure due to other potential geologic hazards (e.g., earthquakes).

Cumulative impacts associated with decommissioning activities are anticipated to be similar to those generated during construction; however, they would be of lesser intensity and duration because the use of previously developed access routes and staging areas would be available, and site restoration activities would include re-establishing native vegetation.

The level of contributions from green hydrogen production facilities would vary depending on the size and number of other individual future actions within a given area, as well as their relative location and timing. Multiple green hydrogen production facilities and other RFFAs occurring in the same area may result in greater cumulative impacts to soil and geologic resources compared to facilities and RFFAs that are more dispersed. 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, 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.

PNWH2 Hub locations in Ferndale, Centralia, and Richland, Washington, are located in the South Cascades (Centralia), Puget Lowland (Centralia), and Columbia Basin (Richland) geologic provinces, respectively (DNR 2024). The Centralia Hub location is within an area of high liquefaction susceptibility; the Richland and Ferndale Hub locations are within areas of very low to moderate liquefaction susceptibility (USGS 2024).

Cumulative impacts on soil and geologic resources could be avoided or minimized through careful siting and design considerations, permitting, and implementation of mitigation measures and best management practices (BMPs) as described in the *Earth Resources Technical Appendix*.

4.3.3.2 Green hydrogen production facility with co-located BESS

When considering other RFFAs in the area, cumulative impacts for green hydrogen production facilities with BESSs would be similar to the impacts discussed for green hydrogen production facilities. The BESS would require storage facilities, spill containment, additional electrical infrastructure and operational management systems; additional soil testing may be required to determine if failure or contamination has occurred. An increase could be seen in remediation efforts related to similar developments. Adverse cumulative impacts would be magnified by the presence of multiple facilities affecting the study area in combination with the RFFAs.

4.3.3.3 Green hydrogen storage facility

Cumulative impacts to soil and geological resources from green hydrogen storage facilities when considering other RFFAs in the area would be similar to the impacts discussed for green hydrogen production facilities.

4.3.3.4 No Action Alternative

Under the 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. The potential cumulative impacts on soil and geological resources would be similar to the impacts for the types of facilities described above, depending on facility size and design.

4.4 Air quality and greenhouse gases

This section summarizes air quality and greenhouse gases evaluated within the study area in the *Air Quality and Greenhouse Gases Technical Appendix* and analyzes impacts on this resource resulting from the types of facilities considered and other RFFAs in the green

hydrogen study area. The study area for air quality and GHGs includes the PEIS study area, and surrounding areas, which could include facilities and activities with air emissions. Additional details regarding air quality and GHGs can be found in the *Air Quality and Greenhouse Gases Technical Appendix*.

4.4.1 Current conditions

4.4.1.1 Air quality

Air quality throughout the study area varies depending on the location. In parts of the study area with urban surroundings, air quality is generally lower than in parts with more rural surroundings.

To protect public health and welfare nationwide, the federal Clean Air Act requires that the U.S. Environmental Protection Agency (EPA) establish National Ambient Air Quality Standards (NAAQS) for certain common and widespread pollutants based on the latest science. EPA has set NAAQS for seven common "criteria pollutants." The NAAQS represent maximum ambient (outdoor air) concentration levels of the criteria pollutants with the aim of protecting public health with an adequate margin of safety. Washington state has adopted its own set of Washington Ambient Air Quality Standards, which are equal to the NAAQS for nearly all the criteria pollutants.

After EPA sets a new or revises an existing NAAQS, it must review available air quality data and designate each area of the state as meeting or not meeting the standard. Areas that failed to meet the new or revised NAAQS are designated as "nonattainment" areas. There are no current nonattainment areas in Washington state at the time of writing this PEIS. Since EPA recently lowered the particulate matter $(PM)_{2.5}$ standard, some counties may soon enter nonattainment status for $PM_{2.5}$.

At the time of this PEIS, all areas in Washington State meet the NAAQS set by EPA for criteria pollutants. There are 15 former nonattainment areas in Washington. Each area has an approved maintenance plan for air quality that includes specific requirements for the area. Most of the 15 areas have demonstrated attainment of the standard for which they were designated nonattainment for more than 20 years. This is an important threshold signifying successful maintenance strategies so there is no longer need to review or revise them. At the end of 2025, there will be only two maintenance areas that are still within the 20-year planning period: Tacoma $PM_{2.5}$ and Ferndale SO_2. Those areas and their associated maintenance pollutants are (EPA 2024a):

- **Carbon monoxide (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
- **SO_2:** Ferndale-Intalco in Whatcom County

There are some areas of concern for particulate matter and ozone within the study area. The Tri-Cities area (Kennewick, Pasco, and Richland) is an area of concern for ozone. Sunnyside, Toppenish, and Yakima to the west are areas of concern for particulate matter, along with Omak in the north and Colville in the northeast. To make sure the air continues to meet air quality standards, Ecology and its partners monitor the air using Washington's Air Monitoring Network.

Any location in the study area may experience occasional severe deterioration of air quality due to wildfires (usually July–September), depending on wind patterns and the location of the fire(s).

4.4.1.2 Greenhouse gas emissions

In 2021, the United States generated roughly 6,340 million metric tons (MMT) of carbon dioxide equivalents (CO_2e) (EPA 2023). In 2019, Washington produced about 102.1 MMT of CO_2e (Ecology 2022). Ecology found that 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 (both in-state and out-of-state) at 21%.[15] The sources of the remaining 8% of emissions are agriculture, waste management, and industrial processes.[16]

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 (Derwent et al. 2020). 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.

4.4.2 Reasonably foreseeable future actions

RFFAs with potential to affect air quality and GHGs are listed in Table 5 along with a summary of the potential effects of these actions.

[15] Transportation sources include on-road vehicles, marine vessels, jet fuel and aviation gasoline, rail operations, and natural gas for transportation. Washington GHG emissions from the transportation sector have been fairly constant for several years, with on-road gasoline continuing to contribute over 50% of transportation sector emissions. Marine vessel emissions include emissions from recreational, commercial, and ocean-going vessels, but exclude marine bunker fuels consumed in international waters.

[16] The industrial sector includes fugitive GHG emissions that are released during the production, processing, transmission, and distribution of fossil fuels. These emissions are typically fugitive methane due to leakage and venting from natural gas pipelines, and petroleum systems.

Table 5. Reasonably foreseeable future actions relevant to air quality and greenhouse gases

RFFA ID	RFFA trend	Impact description
RFFA 1	Energy Projects including Clean Energy Developments and Changes to Existing Energy Systems	• Likely beneficial impacts from the likelihood of reduced GHG and air pollutant emissions for clean energy development.
RFFA 2	Urban, Commercial, and Industrial Activities and Development	• Potential adverse impacts from population growth and development that could result in increased GHG and air pollutant emissions.
RFFA 3	Rural and Agricultural Activities and Development	• Potential adverse impacts from expansion and development of rural activities and developments that would likely result in increased GHG and air pollutant emissions.
RFFA 4	Federal, State, Tribal, and Local Wildlife and Habitat Projects	• May result in potential adverse impacts or potential beneficial impacts depending on how management actions influence population growth density and locations as they relate to the prioritization of wildlife and habitat projects.
RFFA 5	Transportation Infrastructure Development and Modification	• Potential beneficial impacts resulting from efforts to decrease the reliance on single-occupancy vehicles, likely resulting in a decrease in GHG emissions.
RFFA 6	Contaminated Site Cleanup and Remediation	• Potential adverse effects from activities including initial remediation, site investigations, clean up, and monitoring that may all require operation of vehicles and machinery that would emit air pollutants and GHGs.
RFFA 7	Mining Operations	• Potential adverse impacts from conducting mining activities, requiring the use of machinery using fossil fuels that that would result in increased emissions.
RFFA 9	Military Operations	• Potential adverse impacts from military infrastructure development and modification activities that would result in increased emissions. • Potential beneficial impacts from military infrastructure development and modification activities that would result in decreased emissions.
RFFA 10	Water Supply Development and Withdrawals for Municipal, Agricultural, Industrial, and Conservation Use	• Potential adverse effects from activities including development of water treatment plants and distribution systems that may require operation of vehicles and machinery that would emit air pollutants and GHGs.

4.4.3 Cumulative impacts from the types of facilities evaluated in the PEIS and other reasonably foreseeable future actions

The following sections summarize the cumulative impacts on air quality and GHGs when considering the RFFAs in combination with the different types of facilities considered in the PEIS.

4.4.3.1 Green hydrogen production facility

Site characterization, construction and decommissioning of green hydrogen facilities would require the use of on-road equipment construction machinery and on-site generators that would result in air pollutant and GHG emissions from the combustion of fuel in internal combustion engines, as well as particulate dust emissions from land-clearing activities and vehicle travel on paved and unpaved roadways.

During operation, stationary sources of air emissions (e.g., boilers, generators) and mobile sources of air emissions (e.g., combustion engines in vehicles, non-road equipment, and machinery) at the green hydrogen production facility would produce GHG emissions. The types of GHG emissions from vehicles, non-road equipment, and machinery would be similar to those discussed for construction but in a much lesser volume. The number of onsite employees and vehicles/equipment during operation of green hydrogen production facilities would be on a smaller scale than during construction; one to three employees would be onsite as needed, and the majority of operations would be performed remotely. Therefore, GHG emissions from mobile sources would be less than those estimated for construction. Stationary sources of GHGs would likely be produced from boilers used to heat administrative, storage, and other indoor areas.

During operation, building heating and cooling systems could generate air quality and GHG emissions. If electric-powered heat transfer systems are used, no criteria air pollutant, hazardous air pollutant (HAP), toxic air pollutant (TAP), or GHG emissions would be expected from the heating system. If renewable natural gas heating systems are used, then various criteria air pollutants, HAPs, and toxic air pollutants would be expected, as well as emissions of GHGs such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) (EPA 2023). For cooling systems, chlorofluorocarbons, hydrofluorocarbons, perfluorocarbons, or sulfur hexafluoride (SF6) could be emitted if refrigerants are leaked. The amount of emissions from building heating and cooling would depend on the size of the buildings and the heating/cooling capacity at the facility, as well as the heating and cooling technology used. Estimated annual emissions would be similar to those of other industrial facilities and would be required to comply with BMPs to be below criteria pollutant thresholds.

Emissions from green hydrogen production depend on the production method, as described below:

- **Electrolysis:** Producing hydrogen via electrolysis does not directly emit any criteria air pollutants, HAPs, TAPs, or GHGs. Oxygen is the only byproduct.
- **Steam-methane reforming (SMR) of RNG:** Emissions from the SMR process occur from the combustion of methane to produce hydrogen, resulting in the release of CO_2, CO, CH_4, NO_X, and potential sulfur compounds and particulate matter. Types and quantities of air emissions from the SMR process depend on the source and chemical composition of the RNG feedstock (i.e., proportion of CH_4, CO_2, and other trace gases), operational conditions, and hydrogen production capacity of the facility.

- **Pyrolysis of RNG or biomass:** The primary byproduct of hydrogen production via pyrolysis is solid carbon, but the process also produces some air emissions, which may be produced from the thermal decomposition of organic materials. Types and quantities of air emissions from the pyrolysis process depend on the source and chemical composition of the renewable natural gas or biomass feedstock (i.e., proportion of CH_4, CO_2, and other trace gases), operational conditions, and hydrogen production capacity of the facility.
- **Gasification of biomass:** Emissions from the biomass gasification process occur from the incomplete combustion of biomass, which can result in emissions of CO, CO_2, CH_4, and volatile organic compounds. Emissions can also include particulate matter, sulfur compounds, and NO_X. Types and quantities of air emissions from the bio-gasification process depend on the feedstock, operational conditions, and capacity of the facility.

Impacts from increased emissions of air pollutants are typically greatest at the emissions source, with changes to concentrations of pollutants decreasing as the distance from the emitting source increases. For this reason, pollutant emissions may not contribute to a cumulative impact on air quality unless the emissions occur relatively close to a pollutant-emitting RFFA activity, both in terms of time and location. Greater GHG emissions are anticipated from bio-gasification methods of green hydrogen production and would subsequently contribute to greater adverse cumulative effects if those types of facilities are co-located or located in the same geography and timespan as other GHG-producing RFFAs. LCA studies for utility-scale electricity generation technologies indicate the median life-cycle CO_2e emissions factors for coal-generated electricity is 1,001 grams CO_2e per kilowatt-hour (kWh) produced and for renewable natural gas-generated electricity is 486 grams CO_2e per kWh produced.

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 kilogram (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 GHG emissions that could result in cumulative effects.

While hydrogen itself is not a GHG, its chemical reactions can change the abundances of methane, ozone, and stratospheric water vapor, as well as aerosols if leaked. Leakage could occur during upstream production and downstream transmission, storage, and distribution. The potential for GHG emissions and effects from green hydrogen production on climate change could be reduced by siting and design considerations at the project level, potentially avoiding cumulative impacts to GHG emissions.

An overall cumulative reduction in air emissions from RFFAs and green hydrogen facilities—including particulates and other air pollutants—as well as a cumulative reduction in GHG emissions would be anticipated as regulatory requirements like CETA, CCA, and Clean Fuel Standard are implemented. These would mean clean energy sources would be added to the

power mix, coal-fired power plants would be retired and decommissioned, and the use of electric cars would increase. Likewise, as transportation infrastructure developments are implemented that decrease the reliance on single-passenger vehicle trips, air pollution and GHG would also decrease. This could also include further adoption of electric vehicles, which would also contribute to a further net reduction in GHG emissions.

Urban, commercial, and industrial developments driven by population change trends are likely to result in a cumulative increase in air pollution and GHG emissions as new developments are built, or existing developments are expanded. This may include the conversion of vegetated land to non-vegetated land and the conversion of agricultural land use to residential, commercial, or industrial uses with the associated expansion of road and utility systems. Mining operations and military facility development or expansion are likely to require operation of machinery that result in increases in air pollution and GHG emissions. The beneficial or adverse effect could depend on the degree to which new or expanded developments minimize air pollutant emissions and GHGs depending on industry practices, regulatory requirements, and local and state government planning. Green hydrogen production facilities would represent a beneficial cumulative impact to air quality as a replacement to a reliance on fossil fuel consumption and subsequent decrease in GHG emissions, depending on the degree to which the life-cycle carbon intensity of the green hydrogen reduces compared to the energy resource it replaces.

In addition, increased wildland fires due to climate change from GHG emissions could continue to become an increasing source of particulate matter emissions, contributing to a degradation of air quality.

PNWH2 Hub locations in Ferndale, Centralia, and Richland, Washington, are located in existing and historic industrial-use areas. These areas may include associated air emissions from industrial activities, including power plants and refineries.

Because many of the RFFA activities identified in Table 5 have the potential to be located relatively close to each other and the green hydrogen energy facilities evaluated the PEIS, their air pollutant emissions would have the potential to contribute to a cumulative impact on local air quality. The RFFA activities would also be anticipated to contribute to new increases in GHG emissions. The GHG emissions for green hydrogen energy facilities are expected to be able to be reduced through a mitigation plan.

4.4.3.2 Green hydrogen production facility with co-located BESS

Cumulative impacts from green hydrogen production facilities with co-located BESSs when considering other RFFAs in the area would be similar to the impacts discussed for green hydrogen facilities alone but with some differences. However, the overall contribution of facilities with BESS to GHG emissions when combined with the RFFAs is not likely to be meaningfully different than that for facilities without BESS.

4.4.3.3 Green hydrogen storage facility

Cumulative impacts from green hydrogen storage facilities when considering other RFFAs in the area would be similar to the impacts discussed for green hydrogen facilities but with some differences. There would not be the sources of emissions associated with green hydrogen production. Instead, 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.

Effects to air quality would depend on the size and scale of the facility, the presence of multiple such facilities, and effects of other RFFAs, and could represent a potential cumulative impact.

4.4.3.4 No Action Alternative

Under the No Action Alternative, agencies would continue to conduct environmental review and permitting for green hydrogen development under existing laws on a project-by-project basis. Potential cumulative impacts on air quality would be similar to the impacts for the types of facilities described above, depending on facility size and design.

4.5 Water resources

This section describes the water resources evaluated within the study area in the *Water Resources Technical Appendix* and analyzes impacts on this resource resulting from the types of facilities considered and other RFFAs. The study area for water resources encompasses the overall green hydrogen geographic scope of study for the PEIS, which covers large areas of land spread across Washington, including all of the state's major hydrologic basins. Water resources include surface water and groundwater quantity and quality, wetlands, floodplains and frequently flooded areas, and water availability and water rights. Further details on water resources can be found in the *Water Resources Technical Appendix*.

4.5.1 Current conditions

The key features of water resources in the cumulative analysis discussions are as follows:

- Surface water quantity and quality
- Groundwater quantity and quality
- Streams and wetlands and associated regulatory buffers
- Floodplains
- Water availability and water rights

4.5.1.1 Surface water quantity and quality

Surface waters in the study area vary considerably in size and flow. The study area encompasses surface waters ranging in magnitude 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 drainageways with only seasonal flow.

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 within the study area include the following:

- Elevated temperatures from land clearing and development (reduced shading), point source discharges, and dams
- Low dissolved oxygen from elevated water temperatures and excessive organic material decay
- High total suspended solids and turbidity from land disturbance and erosion, and in-water construction
- Bacteria from livestock and failing septic systems
- Elevated nutrients and pesticides from agricultural activities
- Toxics from industrial activities
- Pollutants, including metals and petroleum hydrocarbons, in stormwater runoff from roads and other impervious surfaces

4.5.1.2 Groundwater

Groundwater is the water found underground in the spaces of saturated soil and rock that recharges when water from the surface (e.g., rain or snowmelt or surface waterbodies) seeps downward into the ground. Groundwater quality is managed and monitored through several programs in Washington. Hazardous materials may be present and interact with groundwater within the study area. Ecology and EPA track formal and independent cleanups, hazardous sites, and underground storage tank sites. Given the study area's relationship to industrial areas, hazardous materials may be present that have not been historically identified in the Ecology database or other sources.

Aquifers in the study area are regionally extensive, with potential to be used as a source of drinking water. Most of the study area in eastern Washington is on lands with Columbia Plateau basaltic-rock and Columbia Plateau basin-fill aquifers. Most of the study area in western Washington is on lands with Puget Sound aquifers. Smaller portions of the study area include areas with the Pacific Northwest basin-fill aquifer and Pacific Northwest basaltic-rock aquifer.

4.5.1.3 Wetlands

Wetlands 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 in the study area 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 and marine waters, and on slopes. There are no comprehensive sources that identify and map the presence, extent, and condition of all wetlands.

4.5.1.4 Water availability

Across the study area, water availability varies by location and is dependent on many factors such as local hydrology and climate conditions (precipitation, air temperature, snowpack), land uses, waterbody closures, and existing water rights including minimum instream flows. While irrigation and public supply comprise nearly 80% of the state's water use overall, water use differs substantially between western and eastern Washington. The dominant water use in the western part of the state, where most of the state's population resides, is municipal supply. In the drier and more sparsely populated eastern portions of the state, where much of the state's agricultural production is based, crop irrigation is by far the dominant water use category. The areas of highest water use in the state are in central Washington, for crop irrigation (USGS 2018).

4.5.1.5 Floodplains

Federal Emergency Management Agency Flood Insurance Rate Maps identify flood hazard areas regulated under the National Flood Insurance Program. Special flood hazard areas are defined as areas that would be inundated by the flood event having a 1% chance of being equaled or exceeded in any given year (i.e., the "100-year" flood) and generally form the basis for state and local floodplain management regulations. Channel migration zones are areas within a floodplain where a stream or river channel can be expected to move naturally over time; for existing and planned developments near rivers and streams, it is important to know where channel migration zones exist.

4.5.2 Reasonably foreseeable future actions

RFFAs with potential to affect the water resources are listed in Table 6 along with a summary of the potential effects of these actions.

Table 6. Reasonably foreseeable future actions relevant to water resources

RFFA ID	RFFA trend	Impact description
RFFA 1	Energy Projects including Clean Energy Developments and Changes to Existing Energy Systems	• Potential adverse impacts from increased alterations to surface water flow and quality and groundwater recharge capabilities, and from greater demand for water availability or water rights. • Potential adverse impacts on wetland boundaries and functions and reduced floodplain functions from placement or removal of material or structures to support energy development access and infrastructure and from potential alteration of surface drainage patterns.
RFFA 2	Urban, Commercial, and Industrial Activities and Development	• Similar to impacts described under RFFA 1. • Potential adverse impacts on water quality in wetlands and other water bodies from construction activity, operation, and increases in impervious surfaces and stormwater runoff.
RFFA 3	Rural and Agricultural Activities and Development	• Potential adverse impacts from pollution and degradation of water from agricultural and rural activities, and from a greater demand for water availability or water rights.

RFFA ID	RFFA trend	Impact description
		• Transition to urban, commercial, and industrial development would adversely impact water resources similar to impacts described under RFFA 1 and RFFA 2. • Potential adverse impacts on wetland boundaries and functions and floodplains from drainage activities, fill placement, and the use of herbicides and fertilizers associated with agricultural activities.
RFFA 4	Federal, State, Tribal, and Local Wildlife and Habitat Projects	• Potential beneficial effects on water resources from projects that reduce pollution, flood damage and erosion and improve overall water flow and quality.
RFFA 5	Transportation Infrastructure Development and Modification	• Similar to impacts described under RFFA 2. • Potential adverse impacts from an increase in alterations to surface water flow and quality and groundwater recharge capabilities.
RFFA 6	Contaminated Site Cleanup and Remediation	• Projects under RFFA 6 would likely result in long-term improvements to the environment but could result in short- term adverse impacts on water resources from risk of pollution entering waterways and wetlands from spills or leaks during cleanup and remediation.
RFFA 7	Mining Operations	• Potential adverse impacts on water resources from pollution and changes in local drainage patterns from expansion of mining facilities.
RFFA 8	Recreation Activities	• Potential adverse impacts on water resources from sedimentation of nearby waterways and wetlands from an increase in recreation activities. • Potential adverse impacts on wetland boundaries and functions and floodplains from increased erosion potential.
RFFA 9	Military Operations	• Potential adverse impacts on water resources from a greater demand for water availability or water rights from expansion of military facilities. • Potential adverse impacts on wetland boundaries and functions from placement of fill for infrastructure improvements, alteration of surface drainage patterns, increases in impervious surfaces and stormwater runoff.
RFFA 10	Water Supply Development and Withdrawals for Municipal, Agricultural, Industrial, and Conservation Uses	• Potential adverse impacts on water resources from a greater demand for water availability or water rights from construction of new water storage facilities and associated infrastructure. • Potential adverse impacts on wetland boundaries and functions from placement of fill and alteration of surface drainage patterns.

4.5.3 Cumulative impacts from the types of facilities evaluated in the PEIS and other reasonably foreseeable future actions

The following sections summarize the cumulative impacts to water resources when considering the RFFAs combination with the different types of facilities evaluated in the PEIS.

4.5.3.1 Green hydrogen production facility

Cumulative impacts on water resources associated with the construction, operation, and decommissioning of green hydrogen production facilities could occur when these types of facilities and future developments in a given area involve elements within or adjacent to streams, wetlands, and floodplains (e.g., stream crossings, culvert installations, removal, fill). Ground disturbance, vegetation clearing, soil compaction, and increased impervious surface area could impact discharge patterns, flow rates, and volumes of surface runoff. Spills of pesticides, fuel, vehicle fluids, or other hazardous materials used or stored on a site could adversely impact water quality in wetlands and other waters that are adjacent to facility or transportation infrastructure and other developments. Multiple developments within floodplains could result in cumulative impacts on floodplain functions for flood storage, water quality, habitat, and water velocity attenuation.

Similarly, subsurface construction could locally affect shallow groundwater flows, to approximately the depth of the excavation and/or fill. An increase in impervious surfaces would prevent infiltration of rainfall and snowmelt, resulting in a reduction in groundwater recharge capability. Groundwater extraction for construction and operation uses could result in localized water table drawdown. Construction within or near an existing groundwater pollution plume could cause contaminants to move between aquifers and result in substantial disruption to groundwater beyond the development footprint.

Impacts to surface water quantity during operations would vary by production facility type due differences in the types of chemicals and pollutants uses and stored on-site, and differences in production processes. Compared to electrolysis and bio-gasification, SMR would have the highest water needs for production and would need approximately 6 to 8 gallons of water per kg of hydrogen produced water (steam). Electrolysis would require approximately 2 to 3 gallons of water and bio-gasification methods would require approximately 1.3 gallons of water per 1 kg of hydrogen produced. Pyrolysis methods of hydrogen production would not require water. Other industries that produce fuels, like gasoline, require approximately 1–11 gallons to produce 1 kg of gasoline (EPA 2024b). Water needs during operation of green hydrogen production facilities would be like other industries that produce fuels. When siting facilities, drought conditions and water scarcity would need to be considered relative to potential water quantity needed.

Storage and treatment of wastewater from reverse osmosis could create the potential for pollutants to enter surface waters and degrade water quality. BMPs and regulatory requirements for storage of hazardous materials would reduce the risk of impacts to surface waters. Any release of liquid or gaseous hydrogen would become gaseous and would not impact water resources. Multiple green hydrogen facilities and other RFFAs occurring in the same area may result in greater cumulative impacts to water resources compared to facilities and RFFAs that are more dispersed. It is anticipated that the energy projects included in RFFA 1 are likely to be located relatively near each other and near green hydrogen facilities evaluated in the PEIS, to take advantage of the same infrastructure.

Electrolysis, SMR, and bio-gasification processes would generate industrial wastewater as part of hydrogen production. Projects would be required to comply with National Pollutant Discharge Elimination System (NPDES) and state waste discharge (SWD) standards and requirements. If an NPDES or SWD permit is not required, developers would still be required to manage projects to prevent pollutants from reaching groundwater. Wastewater would be treated on site to NPDES 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 multiple facilities are in proximity to each other and combined with other similar RFFAs in the same location and timeframe, there could be cumulative impacts to water quality from discharges or to wastewater treatment facilities. Impacts to wastewater treatment facilities are discussed in Section 4.15, Public services and utilities.

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. For projects involving unavoidable impacts to wetlands, compensatory mitigation would generally be required to ensure that there is no net loss of wetland functions for wetlands and wetland buffers. A facility would require a project-specific wetland mitigation plan before permits are issued. Compliance with these requirements for mitigation would offset the accumulation of cumulative effects to wetlands over the 75-year timeframe of this study and other RFFAs.

If required, the operation and maintenance of in-water intake and discharge pipes for facility types could lead to impacts to water quality. Operation of these pipes involves water intake and water discharge. Discharges could erode sediment, leading to turbidity. Discharged water could be a different temperature as well, depending on the production method and discharge location. If proper BMPs and handling and spill prevention are not followed, these discharges could result in impacts on water quality. If these impacts occur on a large scale and repeatedly over time, they would represent a cumulative impact.

PNWH2 Hub locations in Ferndale, Centralia, and Richland are located in existing and historical industrial-use areas located in proximity to surface waterbodies. The Richland Hub is located on the west side of the Columbia River; the Centralia Hub is located on the south side of Hanford Creek; and the Ferndale Hub is located on the Strait of Georgia. All locations would use municipal water sources and discharge to local wastewater treatment facilities and stormwater systems.

4.5.3.2 Green hydrogen production facility with co-located BESS

When considering other RFFAs in the study area, cumulative impacts on water resources from green hydrogen production facilities with BESSs would be similar to the impacts discussed for green hydrogen production facilities. The addition of BESS components is not expected to result in more ground disturbance from the overall facility footprint, or in larger impacts to water resources such as wetlands and additional stream crossings, or increased risk of sedimentation and hazardous materials release into a nearby waterway in the event of a BESS failure. Emergency response actions are to allow the fire to burn to prevent water contaminated with

pollutants to affect surface water and groundwater quality. However, firefighting water may be used on adjacent facility components to prevent fire spread. Firefighting water and post-fire runoff may be contaminated with hazardous materials such as lithium, cobalt, and electrolytes. Spill response measures would be included in the project's Stormwater Pollution Prevention Plan, Emergency Response Plan, and the BESS operations and safety manual as required by NFPA 855.

4.5.3.3 Green hydrogen storage facility

When considering other RFFAs in the area, cumulative impacts on water resources from green hydrogen storage facility construction and decommissioning would be similar to the impacts discussed for green hydrogen production facilities. However, a stand-alone green hydrogen storage facility would have lower operational water resource requirements as a green hydrogen production facility.

4.5.3.4 No Action Alternative

Under the No Action Alternative, agencies would continue to conduct environmental review and permitting for green hydrogen development under existing laws on a project-by-project basis. Potential cumulative impacts on water resources would be similar to the impacts for the types of facilities described above, depending on facility size and design.

4.6 Biological resources

This section summarizes the biological resources evaluated within the study area in the *Biological Resources Technical Appendix* and analyzes impacts on this resource resulting from the types of facilities considered and other RFFAs in the green hydrogen study area. The study area for biological resources encompasses the overall green hydrogen geographic scope of study for the PEIS. Biological resources include terrestrial, aquatic, and wetland wildlife species, plant species, and habitats. Additional details can be found in the *Biological Resources Technical Appendix*.

4.6.1 Current conditions

The key features of biological resources in the study area for the cumulative analysis discussions are as follows:

- Terrestrial and aquatic species listed under the ESA, Washington state species of concern (listed and candidate species), and those potentially identified by county-specific codes as sensitive species, species of local importance, and species of concern
- Unique, priority, and culturally important species and habitats
- Terrestrial habitat, including U.S. Fish and Wildlife Service (USFWS) critical habitats; WDFW Priority Habitats and Species (PHS) priority habitats (e.g., Aspen Stands, Riparian, Biodiversity Areas and Corridors, Shrubsteppe); habitat features such as caves, cliffs, snags and logs, and talus; and other terrestrial habitats that support priority species such as agricultural lands or disturbed grounds

- Non-wetland terrestrial and riparian habitat regulatory buffers required by counties and municipalities for the protection of critical areas as required by the GMA and SMA
- Vertical air space aboveground that is typically used by bird, bat, and other flying species, and vertical depths belowground that may be used by burrowing species
- Wildlife migration corridors and landscape-scale habitat connectivity within extensive geographic areas encompassing various ecosystems, landforms, and habitats, and considering the multiple species and the interactions between different habitats within a landscape
- Any freshwater or marine aquatic habitat, including critical habitat determined by the National Oceanic and Atmospheric Administration Fisheries and USFWS, and the following PHS priority habitats identified by WDFW: Instream, Freshwater Wetlands and Fresh Deepwater, Open Coast Nearshore, and Puget Sound Nearshore habitat types
- Salmonid and other fish migration routes
- Wetland habitats including any wetlands, and their associated regulatory buffers required by counties and municipalities for the protection of critical areas under the GMA and SMA
- Any Waters of the United States and their associated regulatory buffers required by counties and cities for the protection of critical areas under the GMA

4.6.1.1 Terrestrial species and habitats

The study area occurs within eight Level III Ecoregions of Washington. These Level III Ecoregions are delineated based on a general similarity in ecosystems, and throughout the state they are further characterized by a number of ecological systems or habitat types and vegetation communities (Level IV Ecoregions; EPA 2016). For further discussion of Ecoregions and terrestrial species and habitats within the study area, see the *Biological Resources Technical Appendix*.

The industrial zones in the study area may already be developed or cleared, and therefore habitats of interest may not be present within those zones. However, even if not present within the study area, special status habitats may be adjacent and warrant consideration. Furthermore, climate change is anticipated to cause changes in both species and habitat ranges (Thomas 2010). Range boundaries that are currently outside of the study may alter over time as the climate regime shifts.

The habitats at highest potential risk of impacts from green hydrogen facilities may include shrubsteppe habitat, forest habitat (including old-growth forests), marine shorelines, westside prairie, and riparian areas. Marine shorelines are discussed in the aquatic habitat section, although many terrestrial species use them for habitat and forage.

4.6.1.2 Aquatic species and habitats

The study area contains a variety of aquatic habitats, including habitats for freshwater and anadromous fish; amphibians; turtles; mollusks; urchins; crustaceans; shore and seabirds; and aquatic macroinvertebrates that could be affected by the proposed action. The WDFW Priority

Habitat types within the study area include instream habitat, freshwater wetlands, and fresh deepwater habitats (WDFW 2023). For further discussion of aquatic species and habitats within the study area, see the *Biological Resources Technical Appendix.*

4.6.1.3 Wetlands

Wetlands occur throughout the study area. However, unlike many streams, rivers, lakes, and marine waters whose locations and boundaries are often evident and relatively well mapped, there are no comprehensive sources that identify and map the presence, extent, and condition of wetlands. Wetlands provide a number of important ecosystem functions, including habitat for terrestrial, aquatic, and amphibious species; water quality improvement; flood flow reduction/protection; shoreline stabilization; groundwater recharge; and streamflow maintenance (Ecology 2023). Many of these functions such as flood flow reduction and shoreline stabilization are particularly valuable to humans.

This cumulative analysis focuses on impacts on wetland functions and values associated with the provision of habitat for aquatic and terrestrial species. As part of state and local regulation of wetlands in Washington, wetlands are rated and categorized using Ecology's Washington State Rating System. The rating system includes specific regional methods for the western (Hruby and Yahnke 2023) and eastern (Hruby 2014) portions of the state. The wetland categories derived using the rating system are characterized by the following criteria:

- **Category I wetlands** represent a unique or rare wetland type, are more sensitive to disturbance, or are relatively undisturbed and contain ecological attributes that are impossible to replace within a human lifetime.
- **Category II wetlands** are difficult, although not impossible, to replace, and provide high levels of some functions.
- **Category III wetlands** have moderate levels of functions. They have been disturbed in some ways and are often less diverse or more isolated from other natural resources in the landscape than Category II wetlands.
- **Category IV wetlands** have the lowest levels of functions and are often heavily disturbed.

For further discussion of aquatic wetlands within the study area, see the *Biological Resources Technical Appendix.*

4.6.2 Reasonably foreseeable future actions

RFFAs with potential to affect the biological resources are listed in Table 7 along with a summary of the potential effects of these actions.

Table 7. Reasonably foreseeable future actions relevant to biological resources

RFFA ID	RFFA trend	Impact description
RFFA 1	Energy Projects including Clean Energy Developments	• Potential adverse impacts on landscape-scale habitat connectivity and wildlife migration corridors from the fragmentation, degradation, or loss of

RFFA ID	RFFA trend	Impact description
	and Changes to Existing Energy Systems	vegetation and habitat from construction and operation of new energy facilities and associated infrastructure, transmission lines, and distribution networks, and from decommissioning of facilities. • Edge habitat creation from facility construction may adversely impact species. • Habitat alterations and increased use of resources (e.g., water) may affect species viability and migratory pathways. • Facility construction, operation, and decommissioning activities, including facility components, noise, and vehicle traffic that may disturb, injure, or kill species. • Potential adverse impacts on habitats from erosion, sedimentation, and risk of contamination. • Potential adverse impacts on wetland boundaries and functions from placement or removal of material or construction of facilities to support energy development infrastructure and from potential alteration of surface drainage patterns. • Potential adverse impacts on water quality in wetlands and other water bodies from increases in impervious surfaces and stormwater runoff. • Potential adverse impacts on water quality in wetlands and other waterbodies from increased land disturbance from overhead, underground, and/or submarine utility transmission. • Potential adverse impacts on water quality in wetlands and other waterbodies from runoff from transportation associated with projects. • Potential adverse impacts associated with impingement or entrainment on aquatic species if developments require surface water intake structures.
RFFA 2	Urban, Commercial, and Industrial Activities and Development	• Similar to impacts described under RFFA 1.
RFFA 3	Rural and Agricultural Activities and Development	• Potential adverse impacts from pollution and degradation of soil, water, and air from agricultural and rural activities. • Transition to urban, commercial, and industrial development would adversely impact biological resources similar to impacts described under RFFA 1. • Potential adverse impacts on wetland boundaries and functions from drainage activities, fill placement, and the use of herbicides and fertilizers associated with agricultural activities.
RFFA 4	Federal, State, Tribal, and Local Wildlife and Habitat Projects	• Potential beneficial effects on biological resources from projects that maintain, enhance, restore, or create native habitats including wetlands.

RFFA ID	RFFA trend	Impact description
RFFA 5	Transportation Infrastructure Development and Modification	• Similar to impacts described under RFFA 1.
RFFA 6	Contaminated Site Cleanup and Remediation	• Projects under RFFA 6 would likely result in long-term improvements to the environment but could result in short-term impacts from the risk of polluting terrestrial and aquatic habitats from spills or leaks during cleanup and remediation.
RFFA 7	Mining Operations	• Similar to impacts described under RFFA 1. • Potential adverse impacts on wetland boundaries and functions from large-scale alteration of surface elevations, fill placement, and drainage pattern alterations.
RFFA 8	Recreation Activities	• Similar to impacts described under RFFA 1.
RFFA 9	Military Operations	• Similar to impacts described under RFFA 1.
RFFA 10	Water Supply Development and Withdrawals for Municipal, Agricultural, Industrial, and Conservation Uses	• Similar to impacts described under RFFA 1.

4.6.3 Cumulative impacts from the types of facilities evaluated in the PEIS and other reasonably foreseeable future actions

The following sections summarize the cumulative impacts to biological resources when considering the RFFAs in combination with types of green hydrogen facilities considered in the PEIS.

4.6.3.1 Green hydrogen production facility

The site characterization, construction, operation, and decommissioning of green hydrogen production facilities could contribute to cumulative impacts on terrestrial, aquatic, and wetland habitats, including special-status habitats, when increased residential, commercial, and industrial development occurs in adjacent or nearby areas. Increased development includes the types of actions associated with new energy facilities, additional water and wastewater treatment plants, extension of road and rail transportation systems, construction of new, expanded, and/or improved utility corridors, and construction of new water storage facilities (e.g., reservoirs). The energy projects included in RFFA 1 may be located relatively near each other and near green hydrogen facilities included in the PEIS, to take advantage of the same infrastructure.

Impacts on biological resources from those actions include habitat fragmentation, degradation, and loss affecting landscape-scale habitat connectivity and wildlife migration corridors and creating edge habitat. Habitat restoration following decommission activities could take several years, and for some habitat types such as sagebrush-dominated shrubsteppe, restoration could take decades. Land development that decreases habitat connectivity can restrict wildlife movement and alter daily, seasonal, and life cycle needs including hunting, foraging, sheltering,

breeding, rearing, and migrating. Adjoining habitats may also be affected by habitat fragmentation, degradation, or loss. The impacts on wildlife would vary based on geography, habitat, existing level of land disturbance, species presence and their assemblages, and land use and management policies.

The effects of habitat fragmentation, degradation, or loss are more readily observed in vegetation communities and wildlife but can also impact ecological processes. The construction of roads, staging areas, new structures, buildings, and other infrastructure disrupts the connectivity between formally contiguous habitats resulting in a reduction in habitat interspersion and complexity. While these impacts are expected to be minor for green hydrogen projects, they may have adverse cumulative effects when combined with other RFFAs in the same area.

Flying species, such as birds and bats, may better tolerate habitat fragmentation by moving into unaffected habitats. Other more mobile species (e.g., ungulates) may also better adapt to habitat fragmentation by dispersing into adjacent unaffected areas; however, human-caused barriers, such as facilities, fencing, and roads may impede their movement across the landscape, which can adversely affect species viability and migration. Special-status species may be particularly vulnerable to decreases in habitat connectivity, due to their already declining populations and sensitivity to adverse alterations in their preferred habitats.

The removal of riparian vegetation during site clearing could adversely affect aquatic and wetland habitats by reducing the area of shading over the water, leading to higher water temperatures and less dissolved oxygen. Development of green hydrogen and other RFFAs within a given area would further increase the potential risk of erosion, fugitive dust, spills, soil compaction, or sedimentation, as well as an increase in human presence. An increase in sediment loads resulting from construction or decommissioning activities could affect fish and amphibian feeding, breeding, and incubating efficiency in aquatic and wetland habitats.

Habitat-related functions (e.g., biotic and abiotic functions) would also be adversely affected by the additive effects of adjacent developments. Cumulative impacts on biotic functions may include changes in the interactions between producers, consumers, and decomposers and associated food web dynamics, as well as changes to the overall flow of energy. Cumulative impacts on abiotic functions may include changes to hydrologic regimes, moisture and temperature regulation, nutrient cycling, and soil formation.

Cumulative impacts on terrestrial, aquatic, and wetland species, including special-status species, associated with the RFFAs and construction and operation of these types of facilities, would primarily be associated with the disturbance, injury, and mortality of species. Habitat loss, degradation, or fragmentation across the landscape would adversely affect wildlife species by limiting habitats for cover, foraging, nesting, breeding, rearing, and migration activities. Cumulative impacts on landscape-scale habitat and migration and wildlife corridors would occur if multiple facilities and other RFFAs are in the same area, resulting in increased fragmentation or alteration of habitats that restrict the movement of animals and migration paths due to increased fencing, roads, and other structures. Ungulate summer and winter

migration patterns may become disrupted and affect herd viability. Habitat alterations could also result in the increased potential for invasive species colonization which could displace native species. The potential for green hydrogen projects to cause landscape-scale habitat and migration and wildlife corridors is unlikely due to the footprint of the facilities—up to 10 acres in size—and their location in areas zoned for industrial or industrial-supporting uses. However, when combined with other RFFAs in the same region and associated developments such as transmission lines and roads, there is the potential for impacts to landscape-scale habitat fragmentation.

The level of contributions from green hydrogen production facilities would vary depending on the size and number of other individual future actions within a given area, as well as their location and timing relative to construction and operation of such facilities and related access and infrastructure. Multiple green hydrogen production facilities and other RFFAs occurring in the same area may result in greater cumulative impacts to biological resources compared to facilities and RFFAs that are more dispersed. Over the 75-year timeframe of this analysis, cumulative impacts could be magnified and compounded if project-level effects are not avoided and mitigated. The status and presence of biological resources would also be expected to change and shift somewhat during that time depending on the location and resource. This potential for cumulative impacts depends greatly on actions taken locally and state-wide, both at the planning level and at the project level, to avoid and mitigate effects in a coordinated way. The effects of cumulative actions would depend in part on the magnitude and extent of disturbance to terrestrial, aquatic, and wetland habitats. Cumulative impacts would be greater if facilities are sited on undeveloped lands compared to lands already converted to industrial use.

PNWH2 Hub locations in Ferndale, Centralia, and Richland, Washington, are located in existing and historical industrial-use areas where there would be limited habitats or species present due to the developed industrial uses of these locations.

Cumulative impacts on some biological resources could be avoided or minimized through careful siting and design, permitting, and implementation of mitigation measures and BMPs, as described in the *Biological Resources Technical Appendix*. Cumulative impacts on special-status species may not be able to be mitigated.

4.6.3.2 Green hydrogen production facility with co-located BESS

Cumulative impacts from green hydrogen production facilities with co-located BESSs when considering other RFFAs in the area would be similar to the impacts discussed for green hydrogen production facilities alone. Co-locating BESSs with a green hydrogen production facility could minimally increase the overall footprint of the facility; otherwise, potential impacts would be similar to the same green hydrogen production facilities without co-located BESSs. As such, the potential cumulative contribution of facilities with co-located BESSs would be similar to those of green hydrogen production facilities alone.

4.6.3.3 Green hydrogen storage facility

A green hydrogen storage facility would not have the same operational water resource requirements as a green hydrogen production facility (specifically those relying on electrolysis, SMR, or bio-gasification) and would therefore have less potential for water use to cumulatively impact aquatic habitat and species. The storage facility footprints would be 1 acre or less and would have decreased hazardous materials that are used on site for production, therefore reducing the potential for spills. Thus, fewer cumulative effects would occur to aquatic biological resources from green hydrogen storage facilities than those described for green hydrogen production. Potential cumulative impacts from green hydrogen storage facilities on terrestrial habitats and species would be the same as those described for green hydrogen production facilities.

4.6.3.4 No Action Alternative

Under the No Action Alternative, agencies would continue to conduct environmental review and permitting for green hydrogen development under existing laws on a project-by-project basis. Potential cumulative impacts on biological resources would be similar to the impacts for the types of facilities described above, depending on facility size and design.

4.7 Energy and natural resources

This section summarizes the energy and natural resources evaluated in the *Energy and Natural Resources Technical Appendix* and analyzes impacts on this resource resulting from the types of facilities considered and other RFFAs in the green hydrogen study area. It analyzes primary and secondary sources of energy, and non-energy natural resources that may be used during the construction, operation, and decommissioning of the different types of facilities considered in the PEIS.

4.7.1 Current conditions

Washington is a net exporter of electricity, generating 98,726 million kWh of electricity in 2023. Washington is also a net exporter of fuels for transportation and equipment, with five refineries that can process approximately 648,000 barrels of crude oil per day (EIA 2024), producing 4,200 million gallons of gasoline and 2,500 million gallons of diesel each year. Washington consumed approximately 294,613 million cubic feet of renewable natural gas in 2018 (Find Energy 2024).

Washington currently has two biofuel manufacturing facilities. 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.

There are few RNG facilities currently located in Washington. These facilities include the Cedar Hills Landfill in King County, the Roosevelt Landfill in Klickitat County, and the South Treatment Plant in King County. As of 2018, these three facilities were capable of producing enough RNG

to offset approximately 1.3% of fossil natural gas consumption in Washington, or about 4,002,400 metric million British thermal units per year.

Wood fuels are the main source of biomass in Washington. In early 2024, about 86% of the state's biomass generating capacity for electricity was from wood-fueled electrical power facilities. Crop residues from agricultural areas in the east and those from western forests provide additional biomass resources (EIA 2024).

Construction aggregate is the collective term for sand, gravel, and crushed stone. Though it is a non-renewable resource, construction aggregate is readily available in Washington. In 2023, Washington produced 30.9 MMT of sand and gravel from 544 active permitted surface mines, and 14.4 MMT of crushed stone from 298 active permitted surface mines (USGS 2022; DNR 2023).

For more information on energy and natural resources, see the *Earth Resources Technical Appendix*. For more information on utility capacity and public utilities, please see the *Public Services and Utilities Technical Appendix.*

4.7.2 Reasonably foreseeable future actions

RFFAs with the potential to affect energy and natural resources are listed in Table 8 along with a summary of the potential effects of these actions.

Table 8. Reasonably foreseeable future actions relevant to energy and natural resources

RFFA ID	RFFA trend	Impact description
RFFA 1	Energy Projects including Clean Energy Developments and Changes to Existing Energy Systems	• An increased demand, generation, and delivery of energy from clean energy sources would be expected with the development of clean energy projects, including clean energy developments and changes to the existing energy system (transmission lines). • Clean energy projects are expected to add energy to the state electrical grid system.
RFFA 2	Urban, Commercial, and Industrial Activities and Development	• The upward trend in population growth and density would be expected to increase demand for energy and natural resources to accommodate the needs of growing urban, commercial, and industrial activities and development in the study area.
RFFA 4	Federal, State, Tribal, and Local Wildlife and Habitat Projects	• Changes in land management and habitat projects would be expected to affect new energy facility siting and development if new land designations make a site suitable or unsuitable for development. • Proper management would be expected to minimize environmental impacts and promote the development and utilization of clean energy sources.

RFFA ID	RFFA trend	Impact description
RFFA 5	Transportation Infrastructure Development and Modification	• Improved transportation infrastructure would be expected to lead to cost savings in energy transportation, distribution, and storage. The trend would be expected to potentially improve access to energy resources. • Improved road access would be expected to reduce energy consumption during construction, operation, and decommissioning. This trend can also increase the demand in energy-efficient technologies.
RFFA 7	Mining Operations	• Mining operations in the study area have the potential to adversely affect sand and gravel resources. Siting of new and expanded areas of mining could affect the range of potential sites available for other projects.
RFFA 10	Water Supply Development and Withdrawals for Municipal, Agricultural, Industrial, and Conservation Uses	• Increases in water demand, and development of water treatment and distribution facilities, would require energy inputs. • Irrigation systems for agricultural uses could increase energy consumption. • Water treatment and pumping for industrial use (e.g. cooling, steam generation, and cleaning) would contribute to energy consumption. • Conservation efforts would be expected to improve energy resources because they reduce the energy needed for extensive water treatment.

4.7.3 Cumulative impacts from the types of facilities evaluated in the PEIS and other reasonably foreseeable future actions

The following sections summarize the cumulative impacts to energy and natural resources when considering the RFFAs in combination with the different types of green hydrogen facilities evaluated in the PEIS.

4.7.3.1 Green hydrogen production facility

Green hydrogen production facilities would consume transportation fuels during site characterization, construction, and decommissioning for three broad purposes: on-road fuels (diesel and gasoline) for worker commuting, on-road fuels for haul-truck trips, and off-road fuels (diesel and dyed diesel) for site equipment. Construction for this type of facility would use aggregate for concrete foundations for the building and equipment foundations and pads, and building would require aggregate and other raw materials for constructing access roads. Gravel would likely be used for parking areas and equipment storage areas.

Impacts during construction and decommissioning of this type of facility, and reasonably foreseeable infrastructure projects, also include the electricity that would be needed to power construction tools and equipment and to power construction lighting, and on-road diesel fuels and gasoline would be used for construction equipment. Construction workers are also likely to drive to work, which would have additive effects in the consumption of fossil fuels during the construction period. Additionally, consumption of fuels is likely to increase during the

transportation of components for green hydrogen facilities and other construction materials for future infrastructure projects, which are often transported by air, water, or rail, and during the transport of aggregate resources.

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, including 2,908 to 48,434 gallons of diesel and2,166 to 55,682 gallons of gasoline. Relative to the total annual fuel production in Washington, this represents 0.0001% to 0.002% of the total available diesel fuel and 0.00005% to 0.001% of the gasoline fuel resources produced in the state. RNG and biomass would not be needed during site characterization, construction, and decommissioning activities.

Cumulative impacts to aggregate sources would increase depending on the number of projects from other RFFAs occurring in proximity to each other. Impacts to aggregate resources during the construction of this type of facility would be cumulative if aggregate required for the construction of energy infrastructure and transmission systems, urban developments, transportation projects, and water supply projects is extracted from the same source as the resources extracted for green hydrogen production facilities. It is anticipated that the energy projects included in RFFA 1 are likely to be located relatively near each other and near green hydrogen facilities evaluated in the PEIS, to take advantage of the same infrastructure. This may lead to more aggregate extraction from the same sources.

Operation includes maintenance activities that would likely require fuel for maintenance vehicles and tools. Electricity would be needed to produce hydrogen, and for lighting, heating, and other purposes at buildings. Electricity would also be required to produce hydrogen using any of the production types. RNG and/or biomass would be required to produce hydrogen using SMR, pyrolysis, or bio-gasification methods.

Electricity is required to produce hydrogen using any of the production types included in the PEIS with electrolysis requiring the most electricity (kWh) to produce 1 kg of hydrogen. Overall, electricity requirements would not result in a reduction in access to or create a substantial reduction in availability of electricity. Combined with other RFFAs, these types of facilities are not expected to contribute to overall cumulative impacts for electricity availability. Additionally, electricity accessibility and capacity would be expected to increase over the 75-year timeframe of this analysis under projects described under RFFA 1.

RNG may be used during operation of facilities relying on the SMR and pyrolysis methods of production. RNG requirements for large SMR facilities may exceed 143% of statewide RNG supply, and RNG requirements for large pyrolysis facilities may exceed 19% of statewide RNG supply. This 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. Combined with other RFFAs that would use RNG, this could represent cumulative impacts to RNG availability, depending on the type and scale of the RFFAs.

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. New demands for biomass may be met in the open market. However, additional demand for biomass during operations of large bio-gasification facilities could result in a reduction in access or create a substantial reduction in availability of biomass feedstocks. Combined with other RFFAs that would use biomass, this could represent cumulative impacts to biomass availability, depending on the type and scale of the RFFAs.

The combined transportation fuel consumed by worker commuting (up to three full-time staff), delivery, and site equipment at green hydrogen production facilities during construction would be up to 232,335 gallons over the lifespan of construction, 1 to 3 years. Relative to the total annual fuel production in Washington, this represents approximately 0.02% of the total available transportation fuel resource produced in the state.

Gravel would be needed for upkeep of access roads and other rocked surfaces. It is assumed that up to 45% of a site could be permeable surface (gravel, dirt, or grass). 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.

RFFAs leading to operation of new energy facilities, urban and rural development projects, transportation infrastructure projects, and water development facilities would include maintenance activities that would likely require fuel for maintenance vehicles and tools; electricity for lighting, heating, and other domestic purposes at buildings; and gravel for upkeep of access roads. These impacts, although minor compared to those during the construction period, would have additive effects to the impacts of other RFFAs during the timeframe of these projects.

4.7.3.2 Green hydrogen production facility with co-located BESS

Cumulative impacts for green hydrogen production facilities with co-located BESS would be the same as for green hydrogen production facilities alone and would not materially add to the overall footprint or energy usage of the facility. No additional cumulative impacts are anticipated.

4.7.3.3 Green hydrogen storage facility

Cumulative impacts for green hydrogen storage facilities would be similar to those for green hydrogen production facilities during construction and decommissioning.

During operation, green hydrogen storage facilities would require electricity to enable gas compression and liquefaction for gas storage and to compress hydrogen gas to liquid form for liquid storage. Upper-bound kWh requirements for each storage type were based on electricity required to produce 1 kg of hydrogen. Gas storage would require approximately 2–3 kWh per kg of hydrogen stored. Liquid storage would require 7–12 kWh per kg of hydrogen stored.

Compared to green hydrogen production methods, these requirements are the same or less than a 1-acre production facility. 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 and would not represent additional cumulative impacts compared to green hydrogen production facilities.

4.7.3.4 No Action Alternative

Under the No Action Alternative, agencies would continue to conduct environmental review and permitting for green hydrogen development under existing laws on a project-by-project basis. Potential energy and natural resources impacts would be similar to the impacts for the types of facilities described above, depending on facility size and design.

4.8 Environmental health and safety

This section summarizes environmental health and safety (EHS) evaluated within the study area in the *Environmental Health and Safety Technical Appendix* and analyzes impacts on this resource resulting from the types of facilities considered and other RFFAs in the green hydrogen study area. EHS includes hazardous materials; fire and explosion risk including wildfire risk; and worker health and safety risks.

4.8.1 Current conditions

The presence of EHS hazards in the study area is associated mainly with former or existing industrial development or other development, while wildfire may be more prominent in less-developed areas.

Hazardous materials currently present in the study area are primarily associated with human activity and development. Large concentrations of hazardous materials can be present at industrial sites, 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 (such as gasoline, diesel, or oil); heavy metals (such as lead, cadmium, mercury, or arsenic); pesticides; solvents; compressed gases; and batteries. The quantities and use of hazardous materials vary greatly by land use. Small concentrations of hazardous materials may also be present along roads as a result of vehicular activity. This could include heavy metals, petroleum products, or hydraulic fluids.

The study area contains 19 cleanup sites currently on or previously on the National Priorities List under CERCLA, also known as Superfund sites. The study area contains approximately 14,145 MTCA sites with known or suspected contaminants.

Fires could occur throughout the study area from a wide range of factors including but not limited to vehicle malfunctions, industrial accidents, cooking accidents, fireworks, cigarettes, lightning, electrical malfunctions, transportation, and arson. Generally, fires are not the most common emergencies that fire departments respond to, but they are by far the costliest

incidents. The three most common types of fire in Washington in 2022 were outside rubbish, structure, and natural vegetation fires, including wildfires. In 2022, 81 fire fatalities were reported in Washington (Washington State Fire Marshal's Office [SFMO] 2023). Structure fires accounted for 58.9% and vehicle fires accounted for 9.3% of fire fatalities that year (USFA 2024). Between 2018 and 2019, smoking and/or smoking materials were the leading cause of fire deaths in Washington, accounting for 17% of fatal fires (SFMO 2023).

The study area includes areas zoned for industrial or industrial-supporting uses. Fires in industrial areas generally make up a small proportion of total fires but are typically much more impactful than general fires. Between 2011 and 2015, an average of 37,910 fires annually were reported in industrial and production facilities in the United States (Alkış et al. 2021). Industrial and production facilities accounted for only about 3% of all fires in the United States between 2011 and 2015 but caused approximately 10% of all fire-related damages in that period (USFA 2019). These fires caused an average of 0.01% of fire deaths and 0.01% of fire injuries in the United States annually in that timeframe (McGree 2023; USFA 2024). See further discussion in the *Environmental Health and Safety Technical Appendix* for fire response capabilities.

General health and safety risks can occur anywhere accidents or hazards occur. Falls, vehicle accidents, earthquakes, volcanic eruption, floods, and structural failure are some of the risks that occur to general environmental health and safety. Distance from emergency services is also a factor in considering environmental health and safety.

The health and safety risks of hydrogen production are comparable to those of oil refineries and food processing, both of which use renewable natural gas and gasoline vapor in their production.

Industrial areas commonly include flammable 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 (OSHA 2014). Explosions can also occur when fires are exposed to flammable gases or dusts. 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 renewable natural gas or gasoline in their respective flammable ranges. Hydrogen burns with a colorless flame, making it difficult to detect that it is burning (DOE 2004).

Wildland fires affect grasslands, forests, and brushlands, as well as structures. They carry the potential for injury, loss of life (human and wildlife), and property damage. Such fires can occur from either human-generated factors or natural causes. 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. The combination of these factors can fuel or arrest the spread of wildfire if it occurs. Much of the study area occurs in western Washington where development is denser, and risk of wildfire is lower. The study area overlaps with areas that are transitions between land and human development, known as wildland-urban interface (WUI) areas. WUI

areas are transitions between land and human development and have greater risk of wildfire than developed areas (USFA 2022).

4.8.2 Reasonably foreseeable future actions

RFFAs with the potential to affect EHS are listed in Table 9 along with a summary of the potential effects of these actions.

Table 9. Reasonably foreseeable future actions relevant to environmental health and safety

RFFA ID	RFFA trend	Impact description
RFFA 1	Energy Projects including Clean Energy Developments and Changes to Existing Energy Systems	• Construction, operation, or decommissioning of new energy projects and existing energy systems could have potential adverse effects to EHS resulting from mishandling debris and hazardous materials from construction and operations. • Solid waste generated from decommissioned facilities would be expected to have potential adverse effects if not disposed appropriately. • Construction, operation, and decommissioning of energy facilities would be expected to have increased risks of occupational hazards to workers.
RFFA 2	Urban, Commercial, and Industrial Activities and Development	• Construction and expansion of infrastructure to meet urban, commercial, and industrial activities and development would be expected to increase the risk to occupational hazards to workers and community exposure to hazardous materials to air, water, and soils.
RFFA 3	Rural and Agricultural Activities and Development	• Changes in rural and agricultural activities and development would be expected to increase the risk to occupational hazards to workers and community exposure to hazardous materials to air, water, and soils from the use of chemicals and pesticides. • Expansion of activities could limit firebreaks and increase the risk of fires.
RFFA 4	Federal, State, Tribal, and Local Wildlife and Habitat Projects	• Overall, RFFAs in this trend would be expected to improve the health of ecosystems adjacent to habitat projects by restoring natural processes and supporting healthy ecosystems. • These impacts from these projects could potentially reduce wildfire risk.
RFFA 5	Transportation Infrastructure Development and Modification	• The development or modification of transportation infrastructure would be expected to have adverse effects to EHS resulting from mishandling debris and hazardous materials from construction, and increased concentration of hazardous materials from vehicle traffic. • Better infrastructure would be expected to increase accessibility to rural areas and increase the service provided by emergency responders.

RFFA ID	RFFA trend	Impact description
		• Construction, operation and decommissioning of transportation infrastructure could have increased risks of occupational hazards to workers.
RFFA 6	Contaminated Site Cleanup and Remediation	• Ongoing cleanup activities at sites known to be contaminated by hazardous or dangerous substances reduce risks to EHS. • There are potential increased temporary risks from occupational hazards to workers and waste disposal.
RFFA 7	Mining Operations	• Ongoing cleanup activities at sites known to be contaminated by hazardous or dangerous substances reduce risks to EHS. • There are potential increased temporary risks from occupational hazards to workers and waste disposal.
RFFA 8	Recreation Activities	• Construction, expansion, and decommissioning of mines has the potential to adversely affect the health of workers, ecosystems, and adjacent communities due to the exposure to mining-related pollution.
RFFA 9	Military Operations	• Military activity could adversely affect air, soil, noise, and water quality in the study area, increasing exposure to hazardous materials.
RFFA 10	Water Supply Development and Withdrawals for Municipal, Agricultural, Industrial, and Conservation Uses	• Water supply development and withdrawal has the potential to adversely affect water resources through exposure to hazardous materials and debris during construction, operation, and decommissioning. • Construction, operation and decommissioning of water facilities could have increased risks to occupational hazards to workers.

4.8.3 Cumulative impacts from the types of facilities evaluated in the PEIS and other reasonably foreseeable future actions

The following sections summarize the cumulative impacts to EHS when considering the RFFAs in combination with the different types of facilities evaluated in the PEIS.

4.8.3.1 Green hydrogen production facility

Cumulative impacts from construction, operation, and decommissioning of green hydrogen production facilities and other RFFAs could increase the risks of hazardous material spills or contamination in the study area. This can be from materials present in vehicles, construction equipment, and construction materials. Accidents or failures 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. However, cumulative impacts from hazardous materials during construction, operation, and decommissioning could be additive and adverse when combined with impacts from multiple infrastructure projects from other RFFAs in a similar timeframe or geographic location. It is anticipated that the energy projects included in RFFA 1 are likely to be located

relatively near each other and near green hydrogen facilities evaluated in the PEIS, to take advantage of the same infrastructure.

Construction activities may encounter contaminated sites that have previous hazardous materials such as underground chemical storage tanks and asbestos-containing materials. If not handled carefully, these hazardous materials could lead to negative health impacts to construction workers. Damaging an underground storage tank could cause leaks that could contaminate soil, groundwater, and surface water. Depending on the location and other RFFAs, these could result in adverse cumulative impacts to EHS.

Operating a green hydrogen facility would involve the transportation, production, use, and storage of hazardous materials. Different hazardous materials could be present, depending on the production method. Proper safety features during production operations are designed to prevent adverse impacts from these types of facilities. Accidents or failures during operation that could result in the release of hazardous materials for this type of facilities 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.

Degradation over time could also increase the risk of damage or failure of infrastructure and equipment. Decommissioning of these types of facilities, other energy facilities, and water infrastructure development, in addition to other RFFAs such as cleanup sites, could involve a higher risk of releasing hazardous materials due to degradation of facility components or dismantling facility components. Decommissioning also creates challenges for the storage, transport, recycling, and disposal of waste, increasing potentially adverse cumulative impacts to EHS if green hydrogen production facilities and other RFFAs are occurring in a similar timescale and geographic location.

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. Fires caused from any of these fuel sources could ignite hazardous materials, and burning these materials would release hazardous fumes and/or particulate matter into the air that would be hazardous to workers, the general public, and the surrounding environment. Due to hydrogen's low density, it is nearly impossible for hydrogen explosions to occur in an open-air environment. Providing proper setbacks between flammable materials and maintaining gas leak and flame detectors are the easiest ways to prevent unnecessary destruction and loss of life from explosions.

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 to reduce risk. Properly storing flammable materials would reduce the risk of explosion and the potential for cumulative impacts related to fire and explosions. Explosions are much more likely if an oxidizer such as oxygen is present when a fire starts. Coordination with local fire departments would help emergency responders properly assess and fight fires, should they need to mobilize.

Proper containment, safety features, and design features during production and operations would help prevent adverse impacts from these types of facilities; however, the presence of multiple facilities and RFFAs could contribute to adverse cumulative impacts.

PNWH2 Hub locations in Ferndale, Centralia, and Richland, Washington, are located in existing and historical industrial-use areas that have the potential for environmental health and safety considerations associated with industrial developments. In particular, the Richland Hub location is located within a previous location of the Hanford EPA Superfund Site, a U.S. Department of Energy decommissioned nuclear production complex that includes buildings, disposal sites, contaminated groundwater, a national monument and other vacant land totaling about 586 square miles. Formerly a part of the Hanford Nuclear Reservation, the land was transferred from the Department of Energy to the Tri-City Development Council and eventually to Energy Northwest, the Port of Benton, and the City of Richland for community benefit through development. The non-industrial zoned areas around the Richland Northwest Clean Energy Park remain within the boundaries of the Superfund Site.

These types of facilities, and other RFFAs in the study area involving construction, operation, and decommissioning activities, would have similar EHS risks as those that are present on other industrial construction sites. Construction, operation, and decommissioning of green hydrogen facilities could generate ignition risks that require careful management, if combined with other RFFAs that lead to and create areas with elevated fire risk. Examples of the latter include projects that require equipment for the development or decommissioning of infrastructure, and changes in land use resulting from population increases. Local wildlife and habitat projects could potentially reduce wildfire risk by improving the health of ecosystems adjacent to the habitat projects and wildlife. The study area is likely to experience additional climate change effects by the time of decommissioning, with a projected increase in the number of high fire danger days.

4.8.3.2 Green hydrogen production facility with co-located BESS

Green hydrogen production facilities with co-located BESSs would have the same cumulative impacts as those described for green hydrogen production facilities, with the addition of impacts that could occur from the BESSs, which contain hazardous materials, could cause fires, and can present challenges for emergency responders. While thermal events are very rare for BESSs, if a thermal runaway event due to damage or battery management system failure were to occur, a lithium-ion BESS would represent additional hazards to workers and emergency responders.

A BESS 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. The risk of hazardous materials leaks from batteries in the BESS could increase during operation compared to construction, due to the increased potential for batteries to leak or ignite when overheating from energy storage.

Should a thermal runaway event occur, it can result in release of toxic materials. Battery incidents can be difficult to extinguish, and some battery types can reignite above certain temperatures after being put out. Once a fire has self-extinguished, there may be releases of flammable or toxic gases including hydrogen fluoride, hydrogen chloride, hydrogen cyanide, and carbon monoxide. Spraying water on smoke or vapor released from the battery, whether burning or not, may cause skin or lung irritation.

Specialized advance planning and procedures for enhanced fire 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. Occurring on a large scale consistently across project level actions, these measures would help avoid cumulative impacts to EHS from BESS.

If multiple facilities and other RFFAs affect the study area, there is a potential for adverse cumulative impacts from the BESSs, depending on the scale and location of the facilities, the local emergency response capacity, and the planning and compliance actions taken at each facility.

4.8.3.3 Green hydrogen storage facility

Cumulative impacts to EHS during construction, operation, and decommissioning of green hydrogen storage facilities would be similar to those identified for green hydrogen production facilities. 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.

4.8.3.4 No Action Alternative

Under the No Action Alternative, agencies would continue to conduct environmental review and permitting for green hydrogen development under existing laws on a project-by-project basis. Potential EHS cumulative impacts would be similar to the impacts for the types of facilities described above, depending on facility size and design.

4.9 Noise and vibration

This section summarizes the noise and vibration conditions evaluated within the study area in the *Noise and Vibration Technical Appendix* and analyzes impacts on this resource resulting from the types of facilities considered and other RFFAs in the green hydrogen study area. For more information regarding the fundamentals of noise and vibration and the common range of noise and vibration levels per land use, refer to the *Noise and Vibration Technical Appendix*.

4.9.1 Current conditions

The study area for assessment of noise and vibration impacts associated with construction, operation, and decommissioning of the potential green hydrogen facilities includes consideration of potential sensitive human receptor locations surrounding green hydrogen

facility sites and along access roads associated with truck hauling of materials and supplies. Ambient noise in the industrial-use areas would vary depending on the existing development and use of the site. Additionally, noise levels vary with location and time. In general, noise levels are high around major transportation corridors (highways and railways), airports, industrial facilities, and construction activities.

The geographic extent of the study area varies from more densely populated areas and cities to more remote and less populated locations. The existing acoustic environment in these areas could include existing industrial uses, motor vehicle traffic, railroad and train activities, local roadways, periodic aircraft flyovers and airport activity, as well as natural sounds. Sound levels in industrial areas may be typically quieter during the night than during the daytime, depending on the location and adjacent uses.

Sound propagating 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 alter noise levels. Industrial areas may possess a range of topographical and built features that can serve to reduce the propagation of noise.

Some land uses are considered more sensitive to noise than others due to the amount of noise exposure (in terms of both exposure duration and insulation from noise) 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 commercial and industrial land uses. While the lands where green hydrogen facilities are anticipated to be located are zoned for industrial or industrial-supporting uses, adjacent land uses could contain noise-sensitive receptors. Recreational uses are also sensitive to noises; refer to the *Recreation Technical Appendix* for an analysis of noise impacts on recreationists.

Environmental justice populations and overburdened community areas may be at increased risk to adverse impacts from noise. Urban noise pollution is generally found to be greater in minority and low-income neighborhoods. Refer to the *Environmental Justice Technical Appendix* for analysis of noise impacts on environmental justice populations and overburdened community areas.

4.9.2 Reasonably foreseeable future actions

RFFAs with potential to affect noise and vibration are listed in Table 10 along with a summary of the potential effects of these actions.

Table 10. Reasonably foreseeable future actions relevant to noise and vibration

RFFA ID	RFFA trend	Impact description
RFFA 1	Energy Projects including Clean Energy Developments and Changes to Existing Energy Systems	• There would be possible adverse effects from increased volumes of noise due to construction, operation, and decommissioning of new and existing energy infrastructure. Adverse effects would depend on the location of the actions and mitigation for noise impacts.

RFFA ID	RFFA trend	Impact description
RFFA 2	Urban, Commercial, and Industrial Activities and Development	• Similar to impacts described under RFFA 1. • Impacts would be expected as increased population brings potential increases in background noise from residential, commercial, industrial, and transportation development and activities.
RFFA 3	Rural and Agricultural Activities and Development	• Impacts would be expected from ongoing agricultural activities and changes to land use on non-designated agricultural land, and machinery required for tilling, harvesting, livestock grazing development and expansion, and irrigation system maintenance and upgrades.
RFFA 4	Federal, State, Tribal, and Local Wildlife and Habitat Projects	• Reduced noise levels would be expected with the implementation of local wildlife and habitat projects that create natural buffers that absorb and dampen noise and vibration from surrounding human activities. • Impacts would be expected from construction activities and increased human activities in those areas.
RFFA 5	Transportation Infrastructure Development and Modification	• There would be potential adverse effects from increased noise and vibration during the construction, modification, and operation of new or improved roads and highways, mass transit projects, and rail transportation systems.
RFFA 7	Mining Operations	• There would be potential adverse effects due to development, operations, and reclamation of new and existing mining and processing area expansions.
RFFA 9	Military Operations	• There would be potential additive effects from the development or modification projects at military facilities and military aircraft operations.
RFFA 10	Water Supply Development and Withdrawals for Municipal, Agricultural, Industrial, and Conservation Uses	• There would be potential additive effects from the development and operation of reservoirs, well fields, water distribution systems, water treatment plants, and pump stations for municipal, agricultural, and industrial uses. • There would be potential adverse effects from the construction and maintenance of new water storage and flood risk reduction projects.

4.9.3 Cumulative impacts from the types of facilities evaluated in the PEIS and other reasonably foreseeable future actions

The following sections summarize the cumulative impacts from noise and vibration when considering the RFFAs in combination with different types of facilities evaluated in the PEIS.

4.9.3.1 Green hydrogen production facility

Typically, noise levels for green hydrogen production facilities and other RFFAs are highest during site characterization and construction when land clearing, grading, and road construction would occur. These construction activities would typically be temporary and of

short duration and would include operation of off-road equipment and operation of haul trucks to bring in equipment and materials and remove soil or demolition debris.

Vibration from specific construction activities for all RFFAs occurring at distances closer than 350 feet from residential land uses could contribute to a potential cumulative impact with respect to human annoyance. Construction-related vibration also has the potential to result in architectural damage to nearby structures. There is the potential for cumulative effects from vibration if construction of a green hydrogen facility or similar RFFA occurs within 350 feet from residential land uses or in proximity to conventional or historic structures during construction.

The potential for the construction, operation, or decommissioning noise that a green hydrogen production facility or any other RFFAs would depend on the existing ambient noise level at any given receptor and the distance to the noise-sensitive receptor. The existing ambient noise levels are expected to be louder in industrial-use zoned areas where siting of facilities would likely occur, and quieter in more rural areas.

Potential cumulative impacts during operations of these facilities and other RFFAs would depend on the activities, terrain, vegetation, and local weather conditions as well as distance to the nearest sensitive receptors. Sources of noise and vibration from operations of this type of facility are expected to attenuate to noise levels within WAC EDNA thresholds for Class A receptors and are not expected to contribute to cumulative impacts, depending on the location and topography and type of facility. However, impacts from other RFFAs in the vicinity from urban, rural, agricultural, and commercial activities could be additive to the operation impacts of larger transportation networks close to green hydrogen facilities (which would also involve more vehicle traffic), resulting in adverse cumulative impacts from noise and vibration from transportation and shipping locations. These cumulative impacts could be additive over the timeframe of these facilities if appropriate levels of planning, mitigation, and BMPs do not occur. Future facility developers would need to consider project-specific study areas for assessing cumulative impacts of noise and vibration for specific facilities and other RFFAs within their site footprint, including sensitive receptors for the proposed work.

Changes in land management and the development of habitat projects could create natural buffers that absorb and dampen noise and vibration during construction and decommissioning of this type of facility and from surrounding human activities. Noise-mitigating actions from other RFFAs could also result in limiting adverse impacts to noise if noise-mitigating actions include elements like walls and enclosures that limit the propagation of noise within a landscape.

PNWH2 Hub locations in Ferndale, Centralia, and Richland, Washington, are located in existing and historical industrial-use areas that are zoned for higher levels of industrial noise and at a distance from noise-sensitive receptors.

4.9.3.2 Green hydrogen production facility with co-located BESS

Cumulative impacts on noise and vibration from construction and decommissioning of green hydrogen production facilities with co-located BESSs and other RFFAs would be similar to the

impacts discussed for green hydrogen production facilities but with some differences. In addition to the operational noise sources described for facilities without BESSs, sources of noise include battery storage liquid cooling units and battery storage inverters, which would likely operate 24 hours per day. Only one or two units would be used at a green hydrogen facility to balance electrical loads, and the impacts of the co-located BESSs when combined with other RFFAs, are not expected to have additive effects on cumulative impacts to sensitive receptors in the vicinity.

4.9.3.3 Green hydrogen storage facility

Cumulative impacts from noise and vibration during construction, operation, and decommissioning of green hydrogen storage facilities would be similar to those identified for green hydrogen production facilities for construction, depending upon scale and location of the facility and other RFFAs in the same geographic area and timeframe. Impacts during operation would be of a lesser nature, as noise-producing equipment for storage facilities would be of a lesser quantity compared to production facilities.

4.9.3.4 No Action Alternative

Under the No Action Alternative, agencies would continue to conduct environmental review and permitting for green hydrogen development under existing laws on a project-by-project basis. Potential noise and vibration cumulative impacts would be similar to the impacts for the types of facilities described above, depending on facility size and design.

4.10 Land use

This section summarizes the land uses evaluated within the study area in the *Land Use Technical Appendix* and analyzes impacts on this resource resulting from the types of green hydrogen facilities considered and other RFFAs. The study area for land use encompasses the overall green hydrogen geographic study area. Further details on land uses can be found in the *Land Use Technical Appendix*.

4.10.1 Current conditions

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 the cities and UGAs, land uses tend more toward agricultural, rural residential, forestry, wildlife conservation, and undeveloped recreation areas. This land use pattern reflects historic settlement of the state, resource extraction uses and associated transportation routes, and, since its enactment in 1990, the GMA.

The GMA seeks to focus growth in areas that have adequate public services, protect natural resource lands and critical areas, and generally discourage urban spawl. This requires fast-growing counties in the state to develop Comprehensive Plans to manage their population growth. The cities and counties with lower population levels and/or growth that are not required to "fully plan" must still plan for critical areas and natural resource lands under the

GMA (MSRC 2024). Under the SMA, local governments are also required to establish shoreline environmental designations and development standards.

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. Land adjacent to the study area can include residential or commercial parcels, emergency services, rural and agricultural uses, offices, and recreational areas.

Under the GMA, fully planning counties and cities are required to provide sufficient capacity of industrial lands suitable for development within their jurisdictions. Land uses that support industrial activity contribute to the region's economy. Industrial land uses include various land-intensive activities, often involving atypical patterns of noise, light, and hours of operation. Industrial uses can generally include refineries, manufacturing, transportation (airports, rail, ports), warehousing, freight terminals, and laboratories (Puget Sound Regional Council 2024). Areas zoned for industrial and industrial-supporting uses may expand through local jurisdiction zoning changes to accommodate future industrial development needs and economic growth priorities and needs of the region.

During the process of identifying industrial lands, counties and cities consult with local economic development organizations to identify sites that are particularly well suited for industry. Suitable site characteristics often include 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 needed infrastructure and surrounding land use compatibility.

The study area includes locations where industrial uses are compatible with existing land use and also where transportation and infrastructure currently exist to support green hydrogen facilities such as ports, airports, and refineries. Port districts play an integral role in preparing land for industrial and commercial development, and generally create industrial and commercial business parks to cluster similar use developments that require similar resources. Washington's GMA requires jurisdictions to discourage development of incompatible land uses adjacent to airports; many jurisdictions subsequently allow industrial uses within their airport overlay zones. Refineries are industrial facilities used to produce motor fuel from crude oil, unfinished oils, natural gas liquids, or other hydrocarbons and from which motor fuel may be transported from the refinery by pipeline, marine vessel, rail, or truck; these locations are in areas zoned for industrial use and may be strategic locations for green hydrogen projects.

Large areas of land, water, and air outside of military installations in Washington are used for military testing, operations, and training under the DoD, Washington Military Department, and U.S. Coast Guard. 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[17]). Development that is incompatible with this priority poses risks to operational efficiency and the safety of military personnel and the public.

4.10.2 Reasonably foreseeable future actions

RFFAs with potential to affect land use are listed in Table 11 along with a description of the effects of these actions.

Table 11. Reasonably foreseeable future actions relevant to land use

RFFA ID	RFFA trend	Impact description
RFFA 1	Energy Projects including Clean Energy Developments and Changes to Existing Energy Systems	• The development of new energy projects, including new energy facilities, transmission systems, and distribution networks, could lead to the conversion of existing land not already in use for energy facilities, including the conversion of land for easements and right-of-way for transmission lines and roads. Anticipated retirement, decommissioning, and demolition of existing coal-fired power plants may result in the availability of land previously used for energy facilities to be converted for other uses (e.g., recreational or agricultural).
RFFA 2	Urban, Commercial, and Industrial Activities and Development	• Higher population growth in urban/suburban areas and increased demands on housing, municipal water/sewage treatment systems, mass transit systems, urban/suburban transportation infrastructure, and related utility infrastructure may lead to changes in land uses associated with construction of new commercial and industrial developments, expansion of existing developments, and decommissioning, decontamination, and demolition of former facilities that are no longer used.
RFFA 3	Rural and Agricultural Activities and Development	• Land values, population changes, and factors related to climate change may result in transitioning non-designated agricultural land and undeveloped rural areas to other uses such as residential, commercial, and industrial development.
RFFA 4	Federal, State, Tribal, and Local Wildlife and Habitat Projects	• Wildlife and habitat projects may contribute to dedicated areas in comprehensive plans and zoning districts that focus on natural areas, species, and habitats and unavailable for industrial uses.
RFFA 5	Transportation Infrastructure Development and Modification	• Projects aiming to improve Washington state's road network may potentially induce growth by easing traffic congestion around urban centers, thereby facilitating the movement of populations into areas not otherwise used for residential developments and changing land use patterns.
RFFA 6	Contaminated Site Cleanup and Remediation	• Contaminated site cleanup and remediation may contribute to increased availability of land for development, particularly historically industrial-use lands that may be redeveloped.
RFFA 7	Mining Operations	• Mine expansions and new mine and processing facility developments may require a change in the underlying land

[17] https://app.leg.wa.gov/RCW/default.aspx?cite=36.70A.530

RFFA ID	RFFA trend	Impact description
		use if occurring in areas not already designated for such activities and facilities.
RFFA 8	Recreation Activities	• Expansions, closures, and establishment of new recreational trails, facilities, and sites may require changes to the underlying land use in the area of the activity.
RFFA 9	Military Operations	• Infrastructure development or modification at military areas occurring adjacent to the study area could result in temporary disturbances that are conflicting with nearby land uses or conversion of existing land uses for military use in the case of expansion projects. However, the CESA study is intended to include tools and resources that encourage information-exchange between developers, permitting authorities, and military representatives, which could promote early and ongoing civilian-military consultation in energy siting and reduce the potential for military use to result in land use conflicts
RFFA 10	Water Supply Development and Withdrawals for Municipal, Agricultural, Industrial, and Conservation Uses	• Land use plans and policies, particularly those focused around future development, will impact water usage patterns and associated plans for water resources and conservation.

4.10.3 Cumulative impacts from the types of facilities evaluated in the PEIS and other reasonably foreseeable future actions

The following sections summarize the cumulative impacts on land use when considering the RFFAs in combination with the different types of facilities evaluated in the PEIS.

4.10.3.1 Green hydrogen production facility

As described in the *Land Use Technical Appendix*, construction of green hydrogen production facilities has the potential to result in proximity impacts such as increased dust, noise, traffic, and visual changes that could temporarily affect other properties in the facility vicinity.

Green hydrogen facilities are anticipated to be sited in areas that are already of an industrial-use nature. Green hydrogen production facilities operating on industrial lands are not expected to result in changes to the character or use of the area or cause land use conflicts, as the facilities would be consistent with the industrial land uses. However, in locations where industrial facilities and uses have not yet been extensively established within industrial zoned areas, and adjacent lands include other use types such as agricultural, rural, or recreational uses, green hydrogen facilities may contribute to a cumulative impact on the character of non-industrial lands adjacent to the facilities.

Industrial development adjacent to non-industrial land uses could result in effects to the existing character of the built environment but would not change existing use. Green hydrogen production facilities could be constructed in more undeveloped areas, including industrial sites within limited areas of more intense rural development, or adjacent to waterfronts, parks,

commercial areas, or residential areas. These areas could experience more intense impacts from construction, as construction would introduce a change in the character of the existing built environment, which would be compounded by the presence of other RFFAs and/or co-located green hydrogen facilities.

Cumulative land use effects may also include the conversion of land for utility use such as easements and right-of-way for utility corridors or roads that might support green hydrogen infrastructure development. Cumulative effects for land use would depend on the scale of the facility, the presence of multiple such facilities, and/or the presence of other RFFAs in the area. These impacts to land use would be additive over the timeframe of these facilities as additional related RFFAs.

PNWH2 Hub locations in Ferndale, Centralia, and Richland, Washington, are located in areas zoned for heavy industrial uses.

4.10.3.2 Green hydrogen production facility with co-located BESS

Cumulative impacts to land use from green hydrogen production facilities with co-located BESSs, when considering other RFFAs in the area, would be similar to the impacts discussed for green hydrogen production facilities.

4.10.3.3 Green hydrogen storage facility

Cumulative impacts to land use from green hydrogen storage facilities, when considering other RFFAs in the area, would be similar to the impacts discussed for green hydrogen production facilities.

4.10.3.4 No Action Alternative

Under the No Action Alternative, agencies would continue to conduct environmental review and permitting for green hydrogen development under existing laws on a project-by-project basis. Potential cumulative impacts on land use would be similar to the impacts for types of facilities described above, depending on facility size and design.

4.11 Aesthetics and visual quality

This section summarizes the aesthetics and visual quality evaluated within the study area in the *Aesthetics and Visual Quality Technical Appendix* and analyzes impacts on this resource resulting from the types of facilities considered and other RFFAs in the green hydrogen study area. Additional details can be found in the *Aesthetics and Visual Quality Technical Appendix*.

4.11.1 Current conditions

The study area for aesthetic and visual resources includes the PEIS geographic scope of study as well as surrounding viewsheds and scenic resources. Visual resources include all objects and features that are visible on a landscape and that add or detract from its aesthetic or scenic quality.

The geographic scope of study for green hydrogen consists of areas zoned to be compatible with industrial uses, which generally have level terrain and are not located on ridgelines. Industrial areas are often closer to urban areas; however, portions of the study are located in more rural areas. Industrial areas typically include large buildings, visible infrastructure like pipelines or electrical lines, and wide paved roads for parking and moving equipment. Industrial land uses include various land-intensive activities, often involving atypical patterns of noise, light, and hours of operation.

The level of development and population in the study area varies widely from large urban areas to smaller cities, to towns or rural areas. Human influences have altered much of the visual landscape of the study area, especially with respect to land use and land cover, and will continue to do so over the 75-year timeframe of this PEIS study. The geographic scope of study includes areas that have not yet been developed for industrial-type uses and are not currently of an industrial visual nature.

Interstates have multiple traffic lanes that take over large swaths of land and dominate the landscape, which increases movement of people and goods that accommodate motor traffic. Areas without major interstates often have developments (buildings, structures) or other elements in the environment dominating the landscape with only single- or double-lane roadways supporting the development. Ports also alter the visual landscape of an area, as they consist of large asphalt-surfaced land typically adjacent to a waterbody. 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 dramatic visual impact than those closer to urban areas.

There are extensive scenic resources, such as the Pacific Ocean and Puget Sound; mountain ranges such as the Olympic Mountains, Cascade Mountains, or Kettle River Range; national and state parks, monuments, and recreation areas; historic sites, parks, memorials, and landmarks; National Wild and Scenic Rivers, national historic trails, scenic highways, undeveloped open plains or rolling hills, and national wildlife refuges; marine parks and sanctuaries; state and national forests; and other designated scenic resources that occur in the region where green hydrogen facilities may be located. In addition, many other scenic resources exist on federal, state, and other non-federal lands, 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 that could be scenic resources where green hydrogen facilities and other RFFAs are constructed.

There are National Scenic Byways, designated by the Federal Highway Administration, including Mountains to Sound, Coulee Corridor, and International Selkirk Loop (USDOT 2024). There are also more than 100 state-designated Scenic Byways distributed across every region of the state, including the study area.

Small parts of the study area are adjacent to three National Wild and Scenic Rivers: the Klickitat, Skagit, and Snake Rivers. Additionally, about 2% of the industrial lands in the study area is within the Columbia River Gorge National Scenic Area.

4.11.2 Reasonably foreseeable future actions

RFFAs with potential to affect aesthetics and visual quality are listed in Table 12 along with a summary of the potential effects of these actions.

Table 12. Reasonably foreseeable future actions relevant to aesthetics and visual quality

RFFA ID	RFFA trend	Impact description
RFFA 1	Energy Projects including Clean Energy Developments and Changes to Existing Energy Systems	• Visual effects due to the permanent change in the viewshed from construction or decommission of energy infrastructure (e.g. wind turbines, photovoltaic arrays, transmission lines, facility and storage structures) would be expected. • Temporary adverse effects would be expected from machinery during construction, operation, and decommissioning activities.
RFFA 2	Urban, Commercial, and Industrial Activities and Development	• Cumulative viewshed effects would be expected due to population changes, which brings potential permanent modifications to residential, commercial, and industrial activities and development. • Impacts include glare from artificial light sources and from the reflective quality of glass used in commercial, industrial, and residential buildings and infrastructure.
RFFA 3	Rural and Agricultural Activities and Development	• There could be effects resulting from changes in land use, and expansion or modification of rural roads and utility systems.
RFFA 5	Transportation Infrastructure Development and Modification	• There could be visual impacts due to the permanent change in the viewshed from the development or modification of transportation infrastructure projects. • Temporary adverse effects would be expected during construction activities.
RFFA 7	Mining Operations	• Impacts to viewshed would be expected from expansion or decommission of active mining sites. • Temporary additive effects to viewsheds would be expected during construction, operation, and decommissioning activities.
RFFA 9	Military Operations	• There could be potential adverse effects from aerial military exercises in the study area.
RFFA 10	Water Supply Development and Withdrawals for Municipal, Agricultural, Industrial, and Conservation Uses	• There could be potential permanent visual effects due to the permanent change in the viewshed from development or decommission of reservoirs, well fields, and water treatment plants. • Temporary adverse effects would be expected during construction and maintenance of below-surface infrastructure.

4.11.3 Cumulative impacts from the types of facilities evaluated in the PEIS and other reasonably foreseeable future actions

The following sections summarize the cumulative impacts on aesthetics and visual quality when considering the RFFAs in combination with the different types of facilities evaluated in the PEIS.

4.11.3.1 Green hydrogen production facility

Construction and operation of green hydrogen production facilities and other RFFAs could involve a range of activities associated with potential cumulative visual impacts on existing landscape and landscape features, including the removal of vegetation; dust generation; the introduction of buildings or roads; modifying or installing residential, industrial, or commercial facilities; and increasing human and vehicular activities from construction crews in the landscape. Typically, vegetation-clearing activities for green hydrogen production facilities and other RFFAs would create cumulative visual impacts primarily by changing the color and texture of the cleared areas. The presence of materials and equipment in these areas would introduce temporary changes in form, line, color, and texture to the visible landscape, and additional visual contrasts could be introduced by any vegetation clearing or grading required.

The various construction, decommissioning or site modification activities described previously require work crews, vehicles, and equipment that would add to the temporary visual impacts of construction. Small-vehicle traffic for worker access and large-equipment traffic (e.g., trucks, graders, excavators, and cranes) for road and building construction, site preparation, and installation would be expected. Additionally, any lighting used during construction for any of the RFFAs in the vicinity have potential additive effects to the aesthetics and visual resources in the area. Cumulative impacts from construction or decommissioning would be greater if multiple green hydrogen facilities and other RFFAs are occurring in the study area.

Generally, these types of facilities would be sited in areas zoned for industrial development and uses where visual impacts would be limited during construction and operation. However, depending on the timing and location of other RFFAs, or if multiple green hydrogen facilities were co-located, there could be cumulative visual impacts if facilities are located near scenic resources. The construction of new or expansion of existing utility corridors and associated infrastructure would also represent a cumulative visual impact if they change the visual character of a landscape. Lighting from the operation of green hydrogen production facilities and similar RFFAs would contribute cumulatively to light pollution, which would be more noticeable in rural areas. Additionally, depending on the location, construction and operation could contrast with the topography that makes up existing viewsheds. Siting of facilities or RFFAs like other green energy projects in an industrial area with surrounding non-industrial developments have the potential for cumulative impacts on that particular viewshed over time if these developments are located in proximity to each other. If facilities or similar RFFAs are sited in a rural area, the likelihood of contrast with the topography of viewsheds would increase.

PNWH2 Hub locations in Ferndale, Centralia, and Richland, Washington, are located in existing and historical industrial-use areas that have industrial facilities and activities on the geography

and existing viewsheds. The cumulative impacts to aesthetics and visual quality described in this section are the same for green hydrogen projects and other RFFAs at these locations.

4.11.3.2 Green hydrogen production facility with co-located BESS

Visual cumulative impacts from facilities with co-located BESSs and other RFFAs are expected to be similar to those for facilities without BESSs for construction, operation, and decommissioning. BESS would be similar visually to other industrial equipment on a green hydrogen facility site and would be of a similar scale and size to other equipment.

4.11.3.3 Green hydrogen storage facility

Visual cumulative impacts from green hydrogen storage facilities and other RFFAs are expected to be similar to those for green hydrogen production facilities for construction, operation, and decommissioning.

4.11.3.4 No Action Alternative

Under the No Action Alternative, agencies would continue to conduct environmental review and permitting for green hydrogen development under existing laws on a project-by-project basis. Potential visual and aesthetics cumulative impacts would be similar to the impacts for the types of facilities described above, depending on facility size and design.

4.12 Recreation

This section summarizes the recreation resources evaluated within the study area in the *Recreation Technical Appendix* and analyzes impacts on this resource resulting from the types of facilities considered and other RFFAs. The study area for recreation includes the PEIS study area.

4.12.1 Current conditions

Recreational areas provide opportunities for people to enjoy and engage with the natural and built environment. Recreational opportunities within the geographic scope of study are somewhat limited, given the focus on properties zoned for industrial uses; however, varied recreational opportunities exist within the study area. Designated recreational areas within the recreational study area include local parks, public schools, water access points, golf courses, swimming pools, and other lands open to public use, including WDFW lands. Additional recreational lands, including rivers, lakes, and marine waters, are likely present in the study area but may not be included in currently available recreational databases.

Recreational activities vary with terrain, season, and land use. Activities during the summer months typically include more hiking, biking, camping, and water activities, while the winter typically includes more snow-based activities such as skiing, snowboarding, and snowshoeing. Fishing seasons vary throughout the year by the species of animal (WDFW 2024a). Tribal fishing also occurs throughout the state at various times during the year. For more detailed information on Tribal fishing, see the *Tribal Rights, Interests, and Resources Technical Appendix*.

To protect the natural environment and prevent overcrowding, some recreational activities require permits or licenses issued from the managing agency such as the U.S. Forest Service, WDFW, Washington State Department of Natural Resources (DNR), or the landowner.

Recreational opportunities are also present on private lands. Landowners engage in recreational activities on their own property and can provide access to the public at their discretion (WDFW 2024c). Recreational sporting complexes provide a space for people to enjoy a variety of activities in one location. Many recreational sporting complexes include space for soccer, football, baseball, softball, basketball and other sporting activities.

Informal recreation on public lands also occurs throughout the study area. Informal recreation refers to activities that take place on public lands without a formal designation. Many schools are identified in the study area that provide recreational opportunities. Often, youth sports organizations use school facilities for practices and games. Playgrounds at elementary schools are used by the neighborhood residents after school hours, and swimming facilities at schools are also open to the public. Water-based recreation is prevalent throughout the state at rivers, reservoirs, lakes, and swimming pools Similar to the recreational activities described above, opportunities for water-based recreation are available in designated areas, on private property, and on public lands. The study area includes boat launches, trails, and community parks along waterways that provide opportunities for water-related recreation.

Outdoor recreation has become increasingly popular in recent years. The RCO reports that between 2017 and 2023, 20 different outdoor recreational activities in Washington have seen a double-digit increase in participation rates (RCO 2023). Interest and participation in recreational activities will likely continue to increase in the future with population growth. Changes in land use could alter some recreational opportunities in the future; however, the recreation study area is expected to continue to provide a diverse array of recreational opportunities.

4.12.2 Reasonably foreseeable future actions

RFFAs with potential to affect recreation are listed in Table 13 along with a summary of the potential effects of these actions.

Table 13. Reasonably foreseeable future actions relevant to recreation

RFFA ID	RFFA trend	Impact description
RFFA 1	Energy Projects including Clean Energy Developments and Changes to Existing Energy Systems	• Increased demand for power could result in additional development of facilities that have the potential to degrade recreation sites. • Development of energy projects and changes to existing energy systems could alter existing recreational opportunities in the study area. • There could be potential for new recreational opportunities from the decommissioning of existing energy facilities.

RFFA ID	RFFA trend	Impact description
RFFA 2	Urban, Commercial, and Industrial Activities and Development	• Interest and participation in recreation activities would likely continue to increase in the future with urban population growth. • Increased population in the region may result in increased demand for recreational sites and increased overall visitation and associated regional economic activity. • Residential, commercial, and industrial development have the potential to degrade the quality of recreation areas and/or cause congestion at recreation areas.
RFFA 3	Rural and Agricultural Activities and Development	• Increased demands for agricultural production could result in additional development of facilities that have the potential to degrade recreation sites due to habitat loss and fragmentation, and soil erosion and degradation from stressed agricultural lands. • Development of rural and agricultural activities are emerging recreational opportunities in agricultural land, such as agrotourism.
RFFA 4	Federal, State, Tribal, and Local Wildlife and Habitat Projects	• Changes in land use could alter some recreational opportunities in the future. • New federal, Tribal, state, and local fish and wildlife improvement projects would be expected to restore, maintain, create, or enhance fish and wildlife habitat and could have the potential to increase recreational fishing opportunities and improve recreational experiences where recreation is allowed.
RFFA 5	Transportation Infrastructure Development and Modification	• Transportation infrastructure development could provide better accessibility to recreation resources, which has the potential to cause overcrowding. • Transportation infrastructure development projects could have potential adverse effects to existing recreational areas resulting from habitat fragmentation or destruction, noise, air and water pollution, and disruption of already existing recreation areas.
RFFA 7	Mining Operations	• Potential adverse effects from the expansion of mining operations include land use changes, impacts on visual resources, and noise and vibration that could affect the recreational experience
RFFA 8	Recreation Activities	• Expansion or closure of multi-modal trails, camping sites, and areas available for hunting or fishing could affect recreation in the project area. Land use change in public lands could have the potential to adversely affect recreation activities.
RFFA 7	Water Supply Development and Withdrawals for Municipal, Agricultural, Industrial, and Conservation Uses	• Water supply development and withdrawals for municipal, agricultural, industrial, and conservation uses would be expected to affect recreational opportunities through increased opportunity for reservoir-based recreation or by disrupting existing recreational opportunities. • Water withdrawal projects can also have possible adverse effects through reduction of recreation practices in areas where withdrawals for water supply reduce water levels.

4.12.3 Cumulative impacts from the types of facilities evaluated in the PEIS and other reasonably foreseeable future actions

The following sections summarize the cumulative impacts to recreation when considering the RFFAs in combination with the different types of facilities evaluated in the PEIS.

4.12.3.1 Green hydrogen production facility

Generally, the industrial nature and limited geographic scope of sites zoned for industrial uses would result in a lesser contribution to recreation of cumulative impacts from green hydrogen facilities; however, cumulative effects could be greater when combined with other RFFAs in the area and timeframe and depending on their location in relation to recreational opportunities.

Potential construction and decommissioning cumulative impacts from other RFFAs could increase noise, dust and visibility, and traffic, and could result in temporary changes in access to recreation resources. Recreationists within sight and sound of the construction or decommissioning area for a green hydrogen facility or other RFFAs could experience disruption or impairment of their recreational experience because of noise and dust. The magnitude of these impacts would be related to the distance from the facility construction area and local conditions. Impacts to traffic could create longer travel times for recreationists. In addition, access to recreational sites could be restricted or limited during construction, operation, and decommissioning. Perimeter fencing for the RFFAs could also result in loss of recreational opportunities. Generally, the industrial nature and limited geographic scope to industrial-use-zoned sites would result in a lesser contribution of cumulative impacts from green hydrogen facilities; however, cumulative effects could be greater when combined with other RFFAs in the area and timeframe and depending on their location in relation to recreational opportunities. Recreational resources would also be expected to be added, removed, or modified during the 75-year timeframe of this analysis; additional cumulative impacts during this time could occur if actions do not consider access to and availability of recreational resources.

If multiple green hydrogen facilities and other RFFAs are sited nearby in an area used and valued for its recreational opportunities, operations of such facilities could adversely impact those recreational opportunities due to access limitations, noise, and visual cumulative impacts, resulting in impairment or loss of recreational opportunities. Operation of larger transportation networks associated with RFFAs would also involve more vehicle traffic, resulting in more sources of noise and vibration and air pollution near recreation areas. Elimination of recreational opportunities may result in higher use of similar recreation opportunities or segmentation from overcrowding or overuse of resources, adversely affecting the recreational experience. In addition, operations of green hydrogen facilities and other RFFAs could result in cumulative impacts on vegetation, displacement of wildlife species, and changes in wildlife habitats, reducing opportunities for hunting and wildlife viewing.

It is anticipated that the energy projects included in RFFA 1 are likely to be located relatively near each other and near green hydrogen facilities evaluated in the PEIS, to take advantage of the same infrastructure. This may lead to the cumulative effects described above on the same recreational resources and activities located in those areas.

PNWH2 Hub locations in Ferndale, Centralia, and Richland, Washington, are located in existing and historical industrial-use areas that do not contain recreation opportunities on site.

4.12.3.2 Green hydrogen production facility with co-located BESS

Cumulative impacts to recreation opportunities from construction, operation, and decommissioning of green hydrogen production facilities co-located with a BESS would be similar to those discussed for green hydrogen production facilities. Up to two BESS units would be contained within the facility footprint and enclosure of the green hydrogen production facility and would be of a similar industrial visual nature and scale to other equipment at the green hydrogen production facility.

4.12.3.3 Green hydrogen storage facility

Cumulative impacts to recreation opportunities from construction, operation, and decommissioning of green hydrogen storage facilities would be similar to those discussed for green hydrogen production facilities. Equipment at green hydrogen storage facilities would be of a similar industrial visual nature to those at green hydrogen production facilities and would be of a similar scale.

4.12.3.4 No Action Alternative

Under the No Action Alternative, agencies would continue to conduct environmental review and permitting for green hydrogen development under existing laws on a project-by-project basis. Potential cumulative impacts on recreation would be similar to the impacts for the types of facilities described above, depending on facility size and design.

4.13 Historic and cultural resources

This section summarizes the historic and cultural resources evaluated in the *Historic and Cultural Resources Technical Appendix* and analyzes impacts on this resource resulting from the types of facilities considered and other RFFAs. The study area for cultural resources includes the PEIS study area. Additional details regarding cultural resources can be found in the *Historic and Cultural Resources Technical Appendix*.

4.13.1 Current conditions

Throughout the study area there are lands, shorelines of major waterways, and their tributaries where Tribes have lived for thousands of years before present and continue to live and utilize these areas. 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.

Cultural resources addressed in the cumulative impact analysis include:

- Archaeological resources, both recorded and unrecorded

- Historic architectural buildings and structures listed or eligible for listing in a historic register
- Human remains and cemeteries
- Sacred sites
- Documented and undocumented TCPs

Archaeological resources are typically identified through archaeological survey work. Although many archaeological and ethnographic studies have been conducted across the state and have inventoried archaeological sites and TCPs, the Washington Department of Archaeology and Historic Preservation (DAHP) points out that only a small percent of the state (approximately 5%; DAHP 2020) has been surveyed for cultural resources at any level. Therefore, it should not be assumed that sites have been intensively surveyed. Additionally, past surveys and studies that have taken place are often developed with project-specific research designs that may not account for all cultural resources that may be present within a particular area. Ethnographic studies may provide information on specific types of traditional practices or on practices and locations consideration.

Historic architectural resources include buildings, sites, structures, objects, or districts that have reached a particular age threshold to be considered eligible for listing in the National Register of Historic Places (NRHP) or the Washington Heritage Register.

In Washington state, non-forensic human remains and cemeteries on private and state land are recorded as archaeological sites. Human remains may be encountered in a variety of contexts and landforms and are under the jurisdiction of federal or state agencies. Sites with human remains are most often considered to be NRHP eligible. Lands with these types of resources typically cannot be developed without an adverse effect determination requiring additional mitigation. Sacred sites can be considered cultural resources when a historic property is also considered a sacred site by a Tribe. Sacred sites are also discussed in the *Tribal Rights, Interests, and Resources Technical Appendix*. The treatment of impacts on sacred sites is guided by federal policy.

A TCP is a property or a place that is inventoried or determined to be eligible for inclusion on the NRHP or the Washington Heritage Register because of its association with cultural practices and beliefs that are (1) rooted in the community's history and (2) important to maintaining the continuing cultural identity of the community's traditional beliefs and practices. DAHP maintains a database of TCPs within Washington state, 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. TCPs are often associated with cultural practices that groups may not wish to become widely known, such as spiritual practices.

4.13.2 Past and present actions

The analysis of cumulative impacts on cultural resources differs in its approach when compared to the cumulative impact analyses for other resources. As noted in Section 2.2, the current

conditions in the study area were used as the existing environmental condition for the resource analyses in the PEIS; therefore, past actions are not cumulatively considered again in this report for most resources. However, Tribes have noted that cultural resources in the study area are part of a much larger integrated cultural network, and impacts can extend in space and time beyond the study area or a specific facility. To analyze the full range of consequences of potential cumulative impacts to cultural resources, this assessment includes consideration of past developments that have changed the culturally important landscape or resulted in ground disturbance that could increase the chances of exposure, erosion, and looting of archaeological sites.

Cultural resources have been repeatedly affected by past and present impacts associated with all the RFFA trends in the study area. For example, these actions include the modification of waterbodies and building of dams and reservoirs that inundated, exposed, destroyed, or otherwise affected cultural resources throughout Washington. They also include the urban, commercial, and industrial developments that resulted in visual and noise impacts on TCPs and sacred sites and the development of agricultural land to other uses that may lead to encounters with previously undiscovered cultural resources.

4.13.3 Reasonably foreseeable future actions

RFFAs with potential to affect cultural resources are listed in Table 14 along with a description of the effects of these actions.

Table 14. Reasonably foreseeable future actions relevant to cultural resources

RFFA ID	RFFA trend	Impact description
RFFA 1	Energy Projects including Clean Energy Developments and Changes to Existing Energy Systems	• Potential impacts from ground-disturbing activities that could result in damage or destruction of cultural resources. • Potential impacts from the alteration of topography, alteration of hydrologic patterns, removal of soils, erosion of soils, runoff into and sedimentation of adjacent areas, and oil or other contaminant spills. • Potential adverse impacts on sacred sites or TCPs from visual changes and noise.
RFFA 2	Urban, Commercial, and Industrial Activities and Development	• Similar to impacts described under RFFA 1.
RFFA 3	Rural and Agricultural Activities and Development	• Similar to impacts described under RFFA 1. • Transition of rural and agricultural land to other uses such as residential, commercial, and industrial development could increase risk of encountering previously undiscovered cultural resources.
RFFA 4	Federal, State, Tribal, and Local Wildlife and Habitat Projects	• Habitat restoration projects could occur on sites with previously undiscovered cultural resources, resulting in potential impacts from ground-disturbing activities.

RFFA ID	RFFA trend	Impact description
RFFA 5	Transportation Infrastructure Development and Modification	• Similar to impacts described under RFFA 1.
RFFA 6	Contaminated Site Cleanup and Remediation	• Similar to impacts described under RFFA 1.
RFFA 7	Mining Operations	• Similar to impacts described under RFFA 1.
RFFA 8	Recreation Activities	• Similar to impacts described under RFFA 1.
RFFA 9	Military Operations	• Similar to impacts described under RFFA 1.
RFFA 10	Water Supply Development and Withdrawals for Municipal, Agricultural, Industrial, and Conservation Uses	• Similar to impacts described under RFFA 1. • Projects have a high likelihood of encountering cultural resources as waterways play an important role in the histories and traditions of Tribes. Waterways are also identified as high-risk areas for encountering archaeological sites due to known settlement patterns near water sources.

4.13.4 Cumulative impacts from the types of facilities evaluated in the PEIS and other reasonably foreseeable future actions

The following sections summarize the cumulative impacts on cultural resources when considering the RFFAs in combination with the different types of facilities evaluated in the PEIS.

4.13.4.1 Impacts from construction and decommissioning

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. Construction and decommissioning of the green hydrogen facilities considered in the PEIS along with other activities could result in cumulative impacts on, or inadvertent discoveries of, cultural resources. Construction and decommissioning activities that could impact cultural resources include ground disturbance, degradation of visual quality, noise, and interruption of the landscape. Tribes' spiritual practices could be interrupted by impacts on land areas and cultural or sacred sites, including degradation of visual quality, noise, and interruption of access (Tribes' sacred sites and spiritual practices are also discussed in Section 4.1).

Ground disturbance has the potential to impact unrecorded archaeological resources due to the prevalence of such sites throughout the state. Decommissioning activities would include the dismantling and removal of all aboveground structures, as well as some underground structures.

Degradation and destruction of cultural properties could result from the alteration of topography, alteration of hydrologic patterns, removal of soils, erosion of soils, runoff into and sedimentation of adjacent areas, and oil or other contaminant spills.

Other cumulative impacts that may result from green hydrogen facilities along with the activities identified above 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.

Development of multiple green hydrogen facilities and other activities within a given area could further increase the risk of impacts to cultural resources. Together, past and present projects, the RFFAs identified above, and potential green hydrogen facilities could result in changes to culturally important landscapes. Archaeological sites and TCPs are non-renewable resources; impacts to these resources could contribute to substantial cumulative impacts from past and future projects.

4.13.4.2 Impacts from operation

Operational activities that could affect cultural resources include those ongoing from construction, as well as changes in access to cultural resources, increased human activity, and potential ongoing ground disturbance.

Potential cumulative impacts to cultural resources during operation include disturbance of previously unrecorded archaeological sites, visual degradation of settings associated with cultural resources, and limiting of access and travel paths traditionally utilized for cultural resources. Additional facilities in areas that already have clean energy facilities would likely contribute to cumulative impacts because there would be increased likelihood of seeing multiple facilities from one location or in succession when traveling on area trails or roads. Multiple green hydrogen facilities and other RFFAs developed close to each other could intensify impacts on cultural resources.

4.14 Transportation

This section summarizes the transportation resources evaluated within the study area in the *Transportation Technical Appendix* and analyzes impacts on this resource resulting from the types of facilities considered and other RFFAs in the green hydrogen study area.

Transportation resources include transportation systems (roads, rail, vessels, and commercial airports), traffic, public transit, and non-motorized or other transportation system conflicts and movement of trucks, trains, or vessels to transport equipment for construction, operation, or decommissioning of green hydrogen facilities.

4.14.1 Current conditions

The *Transportation Technical Appendix* presents detailed information about existing transportation in the study area, including roadways, railways, commercial airports, navigable waterways, existing travel and commuting patterns, and movement of goods and services.

Washington's road network spans more than 80,000 miles, with 764 interstate miles and 1,602 miles of U.S. highways connected by state routes, county roads, city streets, and other

roadways (WSDOT 2022a). Interstate (I-)5 is the major north-south route through the state in western Washington. I-90 is the major east-west route and primary transportation corridor through Washington state. I-82 begins at I-90 near Ellensburg and extends south/southeast to Oregon. These corridors are principal freight arterials for regional and international cargo, as well as commute and recreation routes, providing access to nearby cities, employment centers, rural towns, and outdoor recreational areas.

Approximately 7,000 miles of Washington's road network are designated as Truck Freight Economic Corridors. The majority of routes in the study area are classified as high-volume truck corridors T-2, which are high-volume truck corridors; followed by T-3 routes, which are a combination of first- and last-mile connector routes and alternative freight routes.

State highways that are identified as key high truck volume freight routes and within the study area include State Route (SR) 18, SR 167, SR 512, and SR 599. Particularly high concentrations of truck freight routes occur near and connecting to Seattle and Tacoma along these state routes.

The freight rail network across the United States is operated by Class I, II, and III railroads, which are classified by annual operating revenue. Class I railroads have the highest operating revenue, operating in multiple states over thousands of miles of track. In Washington, Class I railroads are operated by only BNSF Railway (BNSF) and Union Pacific Railroad (UP), which are also in the study area. Facilities within the study area could also utilize rail transport both in and outside of the study area. There are 39 intermodal facilities in Washington allowing for the transfer of cargo between rail and other methods of transport. Transload of cargo between rail and trucks or semitrailers takes place at 22 facilities statewide operated by BNSF, UP, Cascade and Columbia River Railroad, and Tacoma Municipal Belt Railway. In addition, cargo is transferred between ships and rail at seven facilities statewide (WSDOT 2022b). All intermodal facilities are in or connected to the study area.

The majority of the industrial lands on which green hydrogen is anticipated to be located are close to highly populated counties and their urban areas (King County, Pierce County, Snohomish County, Spokane County, and Clark County), which are connected to a nearby Class I rail freight corridor and major interstates. A few parts of the study area in smaller jurisdictions are connected to only non-Class I railroads, which may require transfers to Class I railroads or require transportation by truck before being on rail. In the study area, this includes areas west of the Puget Sound in western Washington and areas east and south of Spokane closer to the borders of Idaho and Oregon in eastern Washington.

USACE plans, constructs, operates, and maintains navigation channels, locks, and dams to maintain authorized channel depths in harbors and inland waterways. The USACE Seattle District's regulatory jurisdiction covers the entire state of Washington. The civil works boundaries of the Seattle district encompass 99,000 square miles and contains 4,700 miles of shoreline, with boundaries including the Columbia River system upstream of the mouth of the Yakima River, much of eastern Washington, Northern Idaho, and western Montana to the Continental Divide (USACE 2018). Within Washington, USACE provides navigation along the Columbia River that follows the Oregon-Washington border and extends 106.5 miles from the

mouth of the Columbia River to Vancouver, Washington, as well as along the lower 11.6 miles of the Willamette River. Columbia River navigation accommodates the current fleet of international bulk cargo and container ships as part of the Columbia and Lower Willamette Federal Navigation Channel, which in 2017 was used to transport 47.5 million tons of cargo (USACE 2024b).

Additionally, the U.S. Department of Transportation has designated two marine highways that serve Washington. There are 18 public ports, 158 marine terminals, 11 deepwater marine ports, and 57 inland ports in Washington.

4.14.2 Reasonably foreseeable future actions

RFFAs with the potential to affect transportation are listed in Table 15 along with a summary of the potential effects of these actions.

Table 15. Reasonably foreseeable future actions relevant to transportation

RFFA ID	RFFA trend	Impact description
RFFA 1	Energy Projects including Clean Energy Developments and Changes to Existing Energy Systems	• There would be expected impacts from truck, rail, and barge delivery of equipment, materials, and project components during the construction, operation, and decommissioning of clean energy facilities. • There could be impacts to traffic patterns, volumes, hazards, or risks to other users resulting from road closures during development and maintenance of transmission lines.
RFFA 2	Urban, Commercial, and Industrial Activities and Development	• There could be impacts to traffic patterns, volumes, hazards, or risks to other users resulting from changes in population growth patterns and in urban, commercial, and industrial activities and development, including expansion of areas designated for parking.
RFFA 3	Rural and Agricultural Activities and Development	• There could be impacts to traffic patterns, volumes, hazards, or risks to other users resulting from changes in population growth and in rural and agricultural activities and development, including expansion of areas designated for parking. • • Increased demands for agricultural production could result in additional development of facilities and transport of products
RFFA 4	Federal, State, Tribal, and Local Wildlife and Habitat Projects	• There could be impacts to traffic patterns, volumes, hazards, or risks to other users resulting from changes to land ownership and road use by federal, state, Tribal, and local wildlife and habitat projects that may create more opportunities for recreation or limit public access to existing roads.
RFFA 5	Transportation Infrastructure Development and Modification	• There could be adverse impacts to traffic patterns, volumes, hazards, or risks to other users resulting from long-term road closures or interruptions to traffic patterns or volumes during construction and maintenance of transportation infrastructure projects in

RFFA ID	RFFA trend	Impact description
		the study area, including culverts, bridges, highways, rail, and transit, among others. • There could be improvements to traffic patterns resulting from the development of transportation plans and projects.
RFFA 7	Mining Operations	• There could be impacts to traffic patterns, volumes, hazards, or risks to other users resulting from changes in the expansion of mining sites, including road closures and the production and transport of aggregate and other minerals required to develop major infrastructure projects in the region.
RFFA 9	Military Operations	• There could be impacts on air traffic in the navigable airspace from military use.

4.14.3 Cumulative impacts from the types of facilities evaluated in the PEIS and other reasonably foreseeable future actions

The following sections summarize the cumulative impacts to transportation when considering the RFFAs in combination with the different types of facilities evaluated in the PEIS.

4.14.3.1 Green hydrogen production facility

Transporting equipment and supplies during construction, operation, and decommissioning of green hydrogen facilities, in combination with other RFFAs, could contribute to cumulative impacts on transportation and traffic. Transportation resources are expected to change over the 75-year timeframe of this analysis as transportation agencies maintain, expand, or neglect transportation infrastructure. Traffic is similarly expected to change over time as infrastructure changes and adapts to changes in population, development, and transportation.

Cumulative impacts from RFFAs include construction and decommissioning worker trips from in the study area. Given the proximity of the green hydrogen study area to urban areas, there could also be conflicts between heavy truck haul routes and public transportation and non-motorized routes during construction. Transportation of green hydrogen facility components and large equipment for construction and decommissioning activities during infrastructure development projects would use transportation modes for shipping components, supplies, and materials would only be temporary; hence, any impacts would also be temporary.

Cumulative impacts from facility construction and decommissioning for RFFAs may also include fortifying local road bridges, road and rail improvements, port modifications, reconstructing turning radii, adding acceleration or deceleration lanes on highways, or removal of obstructions to move the shipments. Such modifications would be determined on a site-specific basis. Depending on the number and complexity of required road modifications or new roads at a particular site, construction can be temporarily but potentially highly disruptive to communities.

Operation of facilities would include an increase in vehicle trips due to employee travel, maintenance, and deliveries traveling to and from the facility site. This could also cause an increase in shipments by train or barge. The increase in vehicle, train, and barge trips during operation are not anticipated to result in substantial damage or change to roads, rail, or marine freight corridors to the extent that major repairs or replacement would be required to return to pre-impact conditions.

However, the increase in vehicle, train, and barge trips could have cumulative effects if combined with impacts of other RFFAs, depending on their timing and location. An increase in traffic from transportation infrastructure projects or urban, rural, agricultural, and commercial facilities near the green hydrogen facilities could increase the potential of cumulative impacts. Alternatively, there could be potential improvements to traffic patterns resulting from projects increasing the need to develop regional or comprehensive transportation plans.

PNWH2 Hub locations in Ferndale, Centralia, and Richland, Washington, are located in existing and historical industrial-use areas that have existing infrastructure for industrial-use transportation.

4.14.3.2 Green hydrogen production facility with co-located BESS

Cumulative impacts for green hydrogen production facilities with co-located BESSs would be similar to those described for green hydrogen production facilities alone, with the addition that more truck trips would be required to transport the BESS storage container and equipment during construction and decommissioning. Construction worker travel times would likely be similar, but facilities may require slightly more workers or a longer construction period. A one-time oversized or overweight transportation shipment for construction of up to two BESS storage containers and equipment would be required. As such, the potential cumulative contribution of co-located BESSs would be greater than that of green hydrogen facilities alone, depending on the size and scale of the facility, and the timing and location of other RFFAs.

4.14.3.3 Green hydrogen storage facility

When considering other RFFAs in the area, cumulative impacts on transportation from green hydrogen storage facilities would be similar to those described for green hydrogen production facilities, with the addition that accommodation of additional oversized or overweight shipments and land for siting could interfere with local traffic and transportation networks. Impacts to transportation infrastructure could occur during construction or decommissioning if storage tanks are located at transportation terminals or at an end-use location such as an industrial or fueling facility, as regular operational activities in those areas could be disrupted. Depending on the number of storage tanks, truck, rail, or vessel count could increase during construction and operations.

4.14.3.4 No Action Alternative

Under the No Action Alternative, agencies would continue to conduct environmental review and permitting for green hydrogen development under existing laws on a project-by-project

basis. Potential cumulative impacts on transportation would be similar to the impacts for types of facilities described above, depending on facility size and design.

4.15 Public services and utilities

This section summarizes the public services and utilities resources evaluated within the study area in the *Public Services and Utilities Technical Appendix* and analyzes impacts on this resource resulting from the types of facilities considered and other RFFAs in the PEIS study area.

4.15.1 Current conditions

The green hydrogen facility study area is served by a variety of public service providers. Depending on the local conditions, public services may be provided by federal, Tribal, state, county, or local governments as well as volunteer groups including volunteer fire departments. Public services addressed in this section include emergency response in the form of fire prevention and response, emergency medical services, wildfire response, law enforcement, and health care facilities, as well as public schools and utilities.

Public services in the study area include public schools, fire departments, emergency medical services, and law enforcement, described in additional detail in the *Public Services and Utilities Technical Appendix*. Coordination and emergency alert communication are conveyed to the public through subscriber-based text alerts via cell phone and email; radio and other media such as sirens in flooding or tsunami areas are used to communicate with the public about hazardous conditions and natural disasters. Emergency management services are generally provided at the county level and consist of various divisions that carry out dispatch services to all law enforcement, fire, and emergency management and response services (including 9-1-1 response) through centers within their respective divisions.

Utilities in the study area, as described in the *Public Services and Utilities Technical Appendix*, include solid waste management, wastewater and stormwater, water supply, electrical service, telecommunications systems, and renewable natural gas. Depending on the area, utilities may be provided by county, city, Tribal, or private suppliers. In general, utility infrastructure often correlates to the size of the population it serves. As a result, population levels, coupled with any topographic or other constraints on where utilities can be provided, often dictate how well a community is served by utility systems. Because much of the study area is developed with existing industrial and industrial-supporting uses, existing utility services are anticipated to be available within the study area or nearby.

4.15.2 Reasonably foreseeable future actions

RFFAs with potential to affect public services and utilities are listed in Table 16 along with a description of the effects of these actions.

Table 16. Reasonably foreseeable future actions relevant to public services and utilities

RFFA ID	RFFA trend	Impact description
RFFA 1	Energy Projects including Clean Energy Developments and Changes to Existing Energy Systems	• Development and operation of new energy projects and decommissioning of existing energy systems could increase the demand of public services and utilities associated with labor force movements and relocation, and utility lines needed to support operation of construction and maintenance equipment. • Potential increase in emergency service needs due to injury or fire. • Water used for activities could adversely affect water quality and could require wastewater treatment prior to disposal. • Increased needs for energy and natural resources such as water, electricity, biomass and renewable natural gas. • Disposal of recyclable equipment that can be to reuse or recycle other materials.
RFFA 2	Urban, Commercial, and Industrial Activities and Development	• Public service and utility infrastructure often correlates to the size of the population it serves. Changes in urban, commercial, and industrial activities and development could increase the demand and availability of public services and utilities. • Water use for industrial activities could adversely affect water quality and require wastewater treatment prior to disposal.
RFFA 3	Rural and Agricultural Activities and Development	• Like RFFA 2, changes in population and rural and agricultural development would be expected to affect the demand and availability of public services and utilities. • Water use for agricultural activities could adversely affect water quality and require wastewater treatment prior to disposal.
RFFA 5	Transportation Infrastructure Development and Modification	• There could be a potential increase in demand for public services and utilities during construction activities of transportation infrastructure development and modification. • Water used to support construction activities could temporarily adversely affect water quality and require wastewater treatment prior to disposal. • Operations of transportation infrastructure actions could potentially increase accessibility to public services and utilities statewide.
RFFA 10	Water Supply Development and Withdrawals for Municipal, Agricultural, Industrial, and Conservation Uses	• Water withdrawals for conservation purposes would be expected to limit availability of the resources for other uses. • Increase in industrial use could adversely affect water resources by limiting alternative use and requiring wastewater treatment prior to disposal.

RFFA ID	RFFA trend	Impact description
		• Agricultural and municipal water use could place additional demands on existing utility infrastructure. • Operations of water supply development projects would be expected to increase overall resource availability and accessibility for various use types.

4.15.3 Cumulative impacts from the types of facilities evaluated in the PEIS and other reasonably foreseeable future actions

The following sections summarize the cumulative impacts to public services and utilities when considering the RFFAs in combination with green hydrogen facilities.

4.15.3.1 Green hydrogen production facility

Cumulative impacts would occur if a facility and any of the RFFAs would result in increased demand for public services during construction, operation, or decommissioning that would exceed existing capacities of public service providers, significantly increased demand for public services during operations, the relocation of new or modified utilities or service systems, or the obstruction of aerial emergency response capabilities. The availability and accessibility to public services are expected to change over the 75-year timeframe of this analysis, depending on the location, as jurisdictions and agencies develop those resources in response to changes in populations and development. It is anticipated that the energy projects included in RFFA 1 are likely to be located relatively near each other and near green hydrogen facilities evaluated in the PEIS, to take advantage of the same infrastructure. This may lead to increasing demands on some of the same public service and utility resources.

Construction and decommissioning of green hydrogen facilities and other RFFAs would entail employment of a temporary workforce that could result in an increased demand for public services including law enforcement, fire departments (including wildfire response capabilities), solid waste providers, and the availability of emergency medical services, healthcare facilities, and public schools. If developments of green hydrogen production facilities and other RFFAs occur in the same districts for public service providers, there would be higher potential for cumulative impacts to public services and utilities during that period.

If a fire were to occur during operations, facilities proposed in more-populated and urban developed areas would have faster response times and more fire-fighting resources available than facilities proposed in less-populated areas. Additionally, the industrial land in the study area has had or currently has similar types of industrial operations occurring.

If a fire during operation is not contained, it could spread outside of the operation perimeter and spread, leading to a wildfire. Green hydrogen production 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 fire response demand in the event of an operation-related wildfire could limit fire response resources needed to address other fires in the vicinity. Providing proper training and proper personal protective equipment, following International Building Code and International Fire Code standards, and having first aid readily available as well as trained emergency response personnel on staff would all reduce impacts on emergency medical services, especially for facilities in more remote areas.

Cumulative impacts to public schools are expected to be temporary, as few out-of-area construction workers would 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. Further discussion regarding green hydrogen production facilities and impacts to public schools are discussed in the *Public Services and Utilities Technical Appendix.*

All types of green hydrogen production facilities 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. Demand for potable water is expected to change based on changes in urban, commercial, and industrial development, rural and agricultural development, and during construction and operation of RFFAs that may need water supply.

Discharge of construction wastewater could increase flow rates, temperature, or turbidity of receiving surface waters. Storage and treatment of wastewater from reverse osmosis could create the potential for pollutants to enter surface waters and degrade water quality. BMPs and regulatory requirements for storage of hazardous materials would reduce the risk of inadvertent impacts to surface waters. Any release of liquid or gaseous hydrogen would become gaseous and would not impact water resources.

Operations wastewater would be treated on site or routed to a wastewater treatment plant. Developers would need to coordinate with regional wastewater treatment programs to ensure that the local wastewater treatment system has the capacity to treat industrial wastewater associated with the facility. If multiple facilities are in proximity to each other and combined with other similar RFFAs in the same location and timeframe, and if the local wastewater treatment system did not have the appropriate capacity to treat industrial wastewater associated with the facilities, then there would be a cumulative impact related to wastewater.

Facilities would be required to obtain water quality permits for construction, and BMPs would be implemented to manage stormwater and wastewater discharges. All production facilities would include small volumes of sanitary wastewater from other operations and maintenance activities such as office building kitchens and restroom facilities. Sanitary water usage in industrial settings is approximately 10 gallons per person per shift where there are just 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) (EPA 2024c).

PNWH2 Hub locations in Ferndale, Centralia, and Richland, Washington, are located in existing and historical industrial-use areas that use existing local public services and utilities.

4.15.3.2 Green hydrogen production facility with co-located BESS

Cumulative impacts for green hydrogen production facilities with co-located BESSs would be similar to those identified for the same types of facilities but with some key differences. Co-location of the BESSs introduces additional fire risk management, emergency response, and solid waste considerations when compared to facilities without a BESS. Although rare, battery storage may pose a risk of fire and explosion if the batteries or their systems were to overheat. Depending on the technology selected, lithium-ion batteries and lead acid batteries contain hazardous materials, which pose potential risks for environmental release if not handled correctly and could introduce hazards for first responders (ACP 2023). Additionally, the operator or decommissioner would need to coordinate with local solid waste providers for recycling or disposal of zinc-hybrid batteries. For detailed discussion regarding public health and safety related to BESSs, refer to the *Environmental Health and Safety Technical Appendix.* When combined with other RFFAs in the same district, facilities with BESS would be expected to have cumulative effects to first responders if multiple incidents occur at the same time.

4.15.3.3 Green hydrogen storage facility

Cumulative impacts for green hydrogen storage facilities would be similar to those identified for green hydrogen production facilities, with the added risk of the pressure required to store green hydrogen. The pressure required to store green hydrogen could create hazards for staff, firefighters, and emergency responders. The severity of these impacts could be wide ranging, depending on the type and quantity of hydrogen exposure, and would depend on the size and scale of the facility combined with the timing and location of other RFFAs.

4.15.3.4 No Action Alternative

Under the No Action Alternative, agencies would continue to conduct environmental review and permitting for green hydrogen development under existing laws on a project-by-project basis. Potential cumulative impacts on public services and utilities would be similar to the impacts for the types of facilities described above, depending on facility size and design.

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