Board of Pilotage Commissioners Tug Escort Rulemaking (Chapter 363-116 WAC)
State Environmental Policy Act Draft Environmental Impact Statement

Air Quality and Greenhouse Gases Discipline Report

Washington State Board of Pilotage Commissioners

Washington State Department of Ecology

Olympia, WA

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Acronyms and Abbreviations

AIS	automatic identification system
ASIL	acceptable source impact level
ATB	articulated tug barge
BPC	Board of Pilotage Commissioners
CAA	Clean Air Act
CFR	Code of Federal Regulations
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
Ecology	Washington Department of Ecology
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESHB	Engrossed Substitute House Bill
FOR	functional and operational requirement
GHG	greenhouse gas
HAP	hazardous air pollutant
hp	horsepower
km	kilometer
min/yr	minutes per year
MMT	million metric ton
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NOx	nitrogen oxides
NO_2	nitrogen dioxide
NWCAA	Northwest Clean Air Agency
O_3	ozone
ORCAA	Olympic Region Clean Air Agency
OTSC	Oil Transportation Safety Committee
PM	particulate matter
$PM_{2.5}$	particulate matter with a diameter of 2.5 micrometers or less
PM_{10}	particulate matter with a diameter of 10 micrometers or less
ppm	parts per million
PSCAA	Puget Sound Clean Air Agency

RCW	Revised Code of Washington
SEPA	State Environmental Policy Act
SIL	significant impact level
SIP	State Implementation Plan
SO_2	sulfur dioxide
TAP	toxic air pollutant
TAS	Treatment in a Similar Manner as States
tpy	tons per year
$\mu g/m^3$	micrograms per cubic meter
VOC	volatile organic compound
WAC	Washington Administrative Code
WSDOT	Washington State Department of Transportation

Summary

This discipline report is produced by the Washington State Department of Ecology (Ecology) as part of the development of an Environmental Impact Statement (EIS) as required pursuant to the State Environmental Policy Act (SEPA).

The Board of Pilotage Commissioners (BPC), in consultation with Ecology, is conducting a rulemaking to amend Chapter 363-116 of the Washington Administrative Code (WAC), Pilotage Rules. The rulemaking will consider 2019 legislative changes made to Chapter 88.16 of the Revised Code of Washington (RCW) (Pilotage Act) through the passage of Engrossed Substitute House Bill (ESHB) 1578. The rules will be designed to achieve best achievable protection, as defined in RCW 88.46.010, and will be informed by other considerations in ESHB 1578. The BPC and Ecology determined that the rulemaking may have significant adverse impacts on the environment and are developing an EIS.

This Air Quality and Greenhouse Gases Discipline Report describes the existing conditions and potential impacts to air quality resulting from the four rulemaking alternatives: No Action (Alternative A), Addition of Functional and Operational Requirements (FORs) (Alternative B), Expansion of Tug Escort Requirements (Alternative C), and Removal of Tug Escort Requirements (Alternative D). The study area for the air quality resource analysis includes the EIS Study Area which encompasses the rulemaking alternative boundaries and potential areas for escort tug commute to and from the alternative boundaries.

The following air quality-related topics were analyzed:

- Impacts on air quality and human health risk in the EIS Study Area due to escort tug emissions.
- Impacts on air quality and associated human health risk in the EIS Study Area due to oil spills.
- Impacts on climate change due to escort tug greenhouse gas (GHG) emissions.

No significant and unavoidable adverse impacts to air quality were identified under any of the four rulemaking alternatives. Table 1 summarizes the changes in escort tug activity under each alternative, the resulting impacts on air quality, mitigation measures identified, and determinations of significance.

Table 1. Air quality impact summary.

Change in Activity	Resulting Impact on Air Quality	Comparison to Alternative A	Mitigation	Significant and Unavoidable Adverse Impact?
Alternative A: No Action				
Continued operation of escort tugs throughout EIS Study Area, resulting in continued emissions of criteria pollutants and their precursors, air toxics, and GHGs.	Continued potential for minor, localized air quality impacts where emissions occur.	N/A	Continued adherence to regulations (e.g., regarding vessel speed, relating to traffic safety and oil pollution prevention) and laws (e.g., Emissions Control Area fuel sulfur content restriction). Participation in voluntary slowdown programs.	No
	Probability of any hazard incident from an escort tug is low: probability of 0.86 per year. Potential air quality impact from diesel fuel spill and response is likely to be small. This risk level would continue.	N/A	Continued adherence to requirements of existing vessel traffic and oil pollution safety regime.	No

Change in Activity	Resulting Impact on Air Quality	Comparison to Alternative A	Mitigation	Significant and Unavoidable Adverse Impact?
Target vessels continue to have tug escorts within rulemaking area.	Probability of a drift grounding from a target vessel is low: a 186-year event in the EIS Study Area. Potential air quality impact from drift grounding spill and response could be substantial. This risk level would continue.	N/A	Continued adherence to requirements of existing vessel traffic and oil pollution safety regime.	No
Alternative B: Addition of Functional and Operational Requirements				
Continued operation of escort tugs throughout EIS Study Area, resulting in continued emissions of criteria pollutants and their precursors, air toxics, and GHGs from escort tugs.	Continued potential for minor, localized air quality impacts where emissions occur.	Same as for Alternative A.	Same as for Alternative A.	No
	Probability of any hazard incident from an escort tug is low: probability of 0.86 per year. Potential air quality impact from diesel fuel spill and response is likely to be small.	Same as for Alternative A.	Same as for Alternative A.	No

Change in Activity	Resulting Impact on Air Quality	Comparison to Alternative A	Mitigation	Significant and Unavoidable Adverse Impact?
Target vessels continue to have tug escorts within rulemaking area, with added FORs.	Probability of a drift grounding from a target vessel is low: a 186-year event in the EIS Study Area. Potential air quality impact from drift grounding spill and response could be substantial. This risk level would continue.	Some minor and unquantified reduction in risk due to standardization of FORs, resulting in slightly lower risk of air quality impacts.	Same as for Alternative A.	No
Alternative C: Expansion of Tug Escort Requirements				
Increase in escort tug underway time (by 2.41%) and shift in escort tug commute and escort locations, with continued routine criteria pollutant, air toxics, GHG emissions from escort tugs.	Continued potential for minor, localized air quality impacts where emissions occur.	Minor increase in quantities of emissions and minor changes to locations of emissions.	Same as for Alternative A.	No
	Probability of any hazard incident from an escort tug increases but remains low: probability of 0.88 per year. Potential air quality impact from diesel fuel spill and response is likely to be small.	2.41% increase in risk of a hazard incident from an escort tug (risks concentrated in the expansion area), resulting in higher risk of air quality impacts.	Same as for Alternative A.	No

Change in Activity	Resulting Impact on Air Quality	Comparison to Alternative A	Mitigation	Significant and Unavoidable Adverse Impact?
Target vessels have tug escorts within expanded rulemaking area, with added FORs.	Probability of a drift grounding from a target vessel is a 189-year event in the EIS Study Area. Potential air quality impact from drift grounding spill and response could be substantial.	1.6% reduction in risk of drift grounding across the EIS Study Area (benefits concentrated in the expansion area), resulting in lower risk of air quality impacts.	Same as for Alternative A.	No
Alternative D: Removal of Tug Escort Requirements				
Elimination of escort tug activity throughout EIS Study Area, resulting in the elimination of criteria pollutant, air toxics, and GHG emissions from escort tugs.	Potential for minor, localized air quality improvements where existing routine emissions occur.	Minor reduction in air quality impacts.	None	No
	Risk of any hazard incident from an escort tug associated with this rule is eliminated (0 per year).	Risk associated with tugs escorting target vessels is eliminated, resulting in lower risk of air quality impacts.	None	No
Target vessels no longer have tug escorts within rulemaking area.	Probability of a drift grounding from a target vessel is a 167-year event in the EIS Study Area. Potential air quality impact from drift grounding spill and response could be substantial.	11.84% increase in risk of drift grounding across the EIS Study Area (increases in risk concentrated in the rulemaking area), resulting in higher risk of air quality impacts.	Same as for Alternative A.	No

1.0 Introduction

1.1 Background

The Board of Pilotage Commissioners (BPC), in consultation with the Washington Department of Ecology (Ecology), is conducting a rulemaking to amend Chapter 363-116 of the Washington Administrative Code (WAC), Pilotage Rules. The rulemaking will consider 2019 legislative changes made to Chapter 88.16 of the Revised Code of Washington (RCW) (Pilotage Act) through the passage of Engrossed Substitute House Bill (ESHB) 1578. The rules will be designed to achieve best achievable protection, as defined in RCW 88.46.010, and will be informed by other considerations in ESHB 1578.

The rulemaking will:

- Describe tug escort requirements for the following vessels (referred to as "target vessels" throughout this report) operating in the waters east of the line extending from Discovery Island light south to New Dungeness light and all points in the Puget Sound area:
    - Oil tankers of between 5,000 and 40,000 deadweight tons.
    - Articulated tug barges (ATB) and towed waterborne vessels or barges greater than 5,000 deadweight tons that are designed to transport oil in bulk internal to the hull.
- Specify operational requirements for tug escorts, where they are required.
- Specify functionality requirements for tug escorts, where they are required.
- Consider the existing tug escort requirements applicable to Rosario Strait and connected waterways to the east, established in RCW 88.16.190(2)(a)(ii), including adjusting or suspending those requirements, as needed.
- Describe exemptions to tug escort requirements, including whether certain vessel types or geographic zones should be precluded from the escort requirements.
- Make other changes to clarify language and make any corrections needed.

This rulemaking could potentially increase or decrease tug escort activity and the risk of oil spills in Puget Sound. The BPC and Ecology therefore determined that the rulemaking may have significant adverse impacts on the environment. The BPC and Ecology issued a Determination of Significance on February 22, 2023, which initiated development of an Environmental Impact Statement (EIS) as required under RCW 43.21C.030 (2)(c) pursuant to the State Environmental Policy Act (SEPA). At the same time, Ecology also issued a formal scoping notice as required through the SEPA process. Ecology conducted an EIS Scoping Meeting on March 21, 2023 to invite comments

> **Note:** Unless specified otherwise, the following terminology applies throughout this discipline report:
>
> - **"Tug escort"** refers to the act of a tug escorting a target vessel that is specifically affected by this rulemaking.
> - **"Escort tug"** refers to the tug that conducts escorts of target vessels. Underway time for an escort tug includes active escort time and time spent commuting to and from an escort job.

on the scope of the EIS and a comment period was open from February 22 through April 8, 2023.

The BPC and Ecology have agreed to act as co-lead agencies under SEPA and share lead agency responsibility for the EIS. The elements of the environment to be included in the EIS were preliminarily identified in the scoping notice. This discipline report serves as the detailed analysis of an element identified for inclusion in the EIS and will serve as supporting documentation to the EIS.

The BPC is conducting the rulemaking process concurrently with the EIS development and works closely with Ecology to coordinate the public involvement process. The rulemaking effort includes regular public involvement workshops that are designed to share information with stakeholders, Tribal Government representatives, and interested parties. The BPC also appointed the Oil Transportation Safety Committee (OTSC) as an advisory committee of subject matter experts representing different areas like the regulated industry, Tribal Governments, and environmental groups. The OTSC meets regularly to develop recommendations for the BPC, and the BPC makes the final decisions related to this rulemaking.

1.2 Rulemaking Alternatives

Through the rulemaking public involvement process, the BPC developed rulemaking alternatives for consideration in the EIS. The BPC has proposed four reasonable[1] rulemaking alternatives to be analyzed in the EIS. This discipline report analyzes the impacts associated with the four proposed rulemaking alternatives: No Action (Alternative A), Addition of Functional and Operational Requirements (FORs) (Alternative B), Expansion of Tug Escort Requirements (Alternative C), and Removal of Tug Escort Requirements (Alternative D). The proposed rulemaking alternatives are summarized below and are shown on Figure 1.

Alternative A. No Action. Under Alternative A, the existing tug escort regulations would continue in effect with no changes.

Alternative B. Addition of Functional and Operational Requirements. The existing tug escort regulations would continue with the addition that escort tugs operating under the rule would need to meet the following three functional and operational requirements:

1. Pre-escort conference: Prior to beginning the escort, the escort tug and the target vessel need to coordinate and discuss safety measures and other standard requirements.
2. Minimum horsepower: Escort tugs must meet minimum horsepower (hp) requirements based on the DWT of the escorted vessel:
    - Escort tugs must have 2,000 hp for vessels greater than 5,000 and less than 18,000 DWT
    - Escort tugs must have 3,000 hp for vessels equal to or greater than 18,000 DWT and less than 40,000 DWT.

[1] As defined in Chapter 197-11-786 WAC.

3. Propulsion specifications: To ensure sufficient propulsion, escort tugs must have a minimum of twin-screw propulsion.

Alternative C. Expansion of Tug Escort Requirements. This alternative would maintain the geographic scope of the current tug escort regulations and extend them to the northwest (See Figure 1 below). This alternative would add 28.9 square miles (74.9 square kilometers) to the existing geographic extent where tug escort requirements apply. The expansion area would be located at the northern boundary of the existing tug escort requirement. This alternative would include the above-mentioned three functional and operational requirements set forth under Alternative B.

Alternative D. Removal of Tug Escort Requirements. This alternative would remove the current tug escort requirement for the target vessels within the rulemaking boundaries.

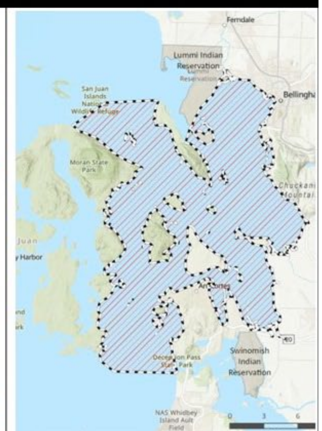
Alternative A (No Action)	Alternative B (Add FORs)	Alternative C (Expansion)	Alternative D (Removal)
 No change to geographic scope of requirements	 No change to geographic scope of requirements	 Expand current requirements north to Patos Island	 Remove requirements within current boundary
No change to existing functional and operational requirements (FORs)	Add pre-escort conference, minimum horsepower, and propulsion requirements	Add pre-escort conference, minimum horsepower, and propulsion requirements	N/A – tug escort requirements for target vessels are removed

Figure 1. Proposed rulemaking alternatives.

Under ESHB 1578, Ecology developed a model to simulate vessel traffic patterns and oil spill risk, including tug escort activity. The model was based on historical automatic identification system (AIS) data from 2015-2019 and was used to inform the 2023 Analysis of Tug Escorts for Tank Vessels. For the current EIS effort, Ecology used the model to 1) simulate the tracks of escort and assist[2] tug traffic, based on 2015-2019 historical AIS data, and 2) simulate the current volumes of escort and assist tug traffic along these tracks while accounting for tug escort requirements that went into effect in 2020.

[2] Escort tugs are sometimes referred to as "escort/assist tugs" in this analysis because the same vessels typically perform both escorting and assisting work. Ecology used the model to simulate traffic for both escorting and assisting work; however, only escorting work would be affected by the rulemaking alternatives.

The model produced 1,000 annual simulations of escort and assist tug traffic. To represent current conditions and Alternative A, Ecology selected the simulation output with the highest amount of escort tug traffic (i.e., the "worst case scenario") to ensure that the EIS does not undercount potential environmental impacts and to account for other potential near-term growth in vessel traffic (e.g., traffic from the Trans Mountain Expansion). For Alternative C, Ecology modified the Alternative A simulated traffic outputs to account for the proposed changes in tug escort requirements under that alternative.

Ecology used 2023 historical AIS data (i.e., not simulated) to represent all vessel categories other than escort and assist tugs, with some adjustments to account for recreational and fishing vessels that are not equipped with AIS. Traffic for these other vessel categories did not require simulation because it would not change based on the rulemaking alternatives.

The simulation outputs are used here to show the differences in underway time for escort tugs under Alternative A and Alternative C. Figure 2 and Figure 3 show the results of these simulations, compiled to indicate the total minutes per year (min/yr) of escort tug underway time within each one-square-kilometer grid cell. Figure 4 depicts the change in escort tug underway time between Alternatives A and C. Escort tug activity under Alternative B would not be expected to be meaningfully different than under Alternative A, while Alternative D would result in zero tug escorts. Refer to Appendix B Transportation: Vessel Traffic Discipline Report for details regarding the vessels activity simulation methodology and results.

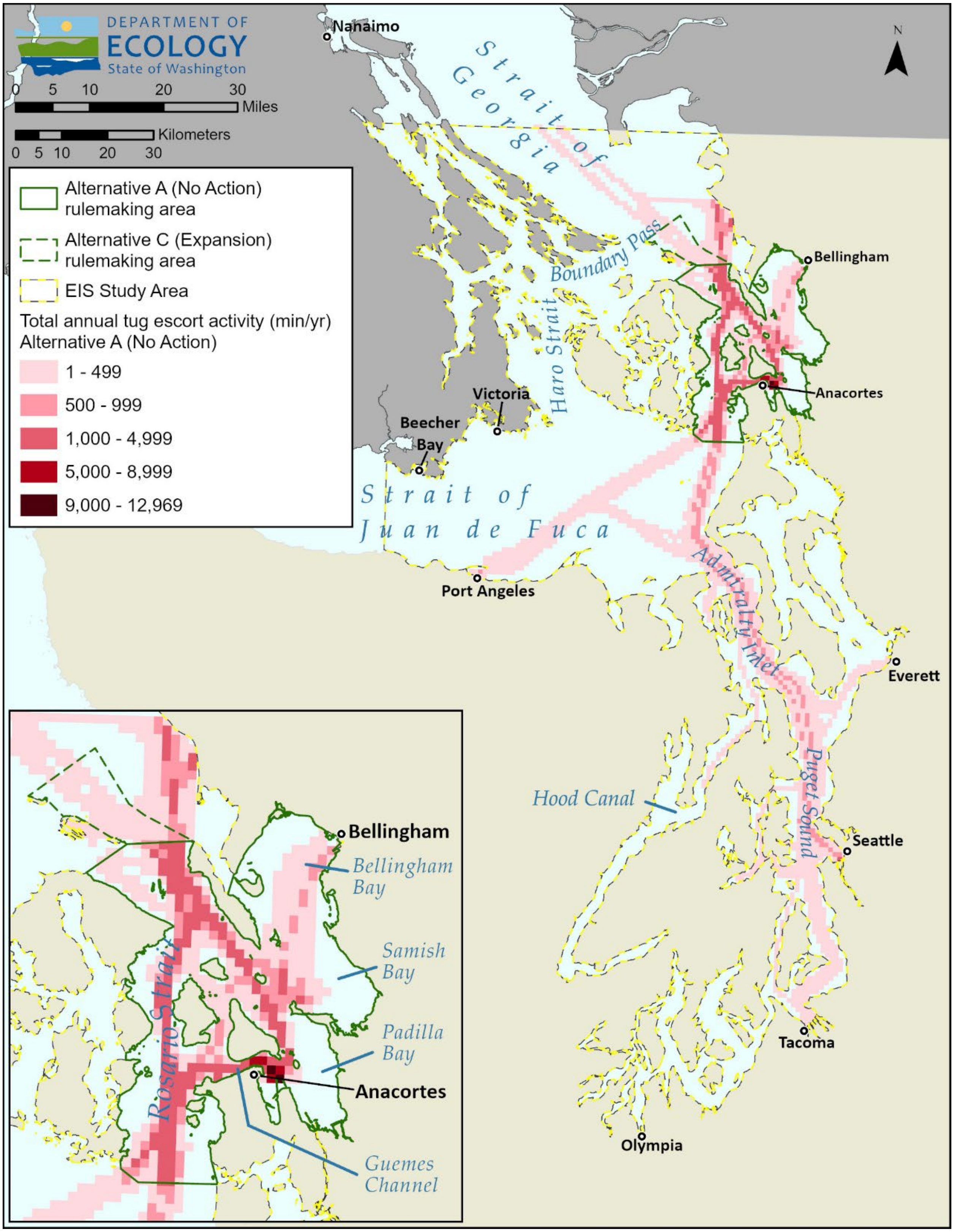


Figure 2. Simulated escort tug underway time under Alternative A and B.

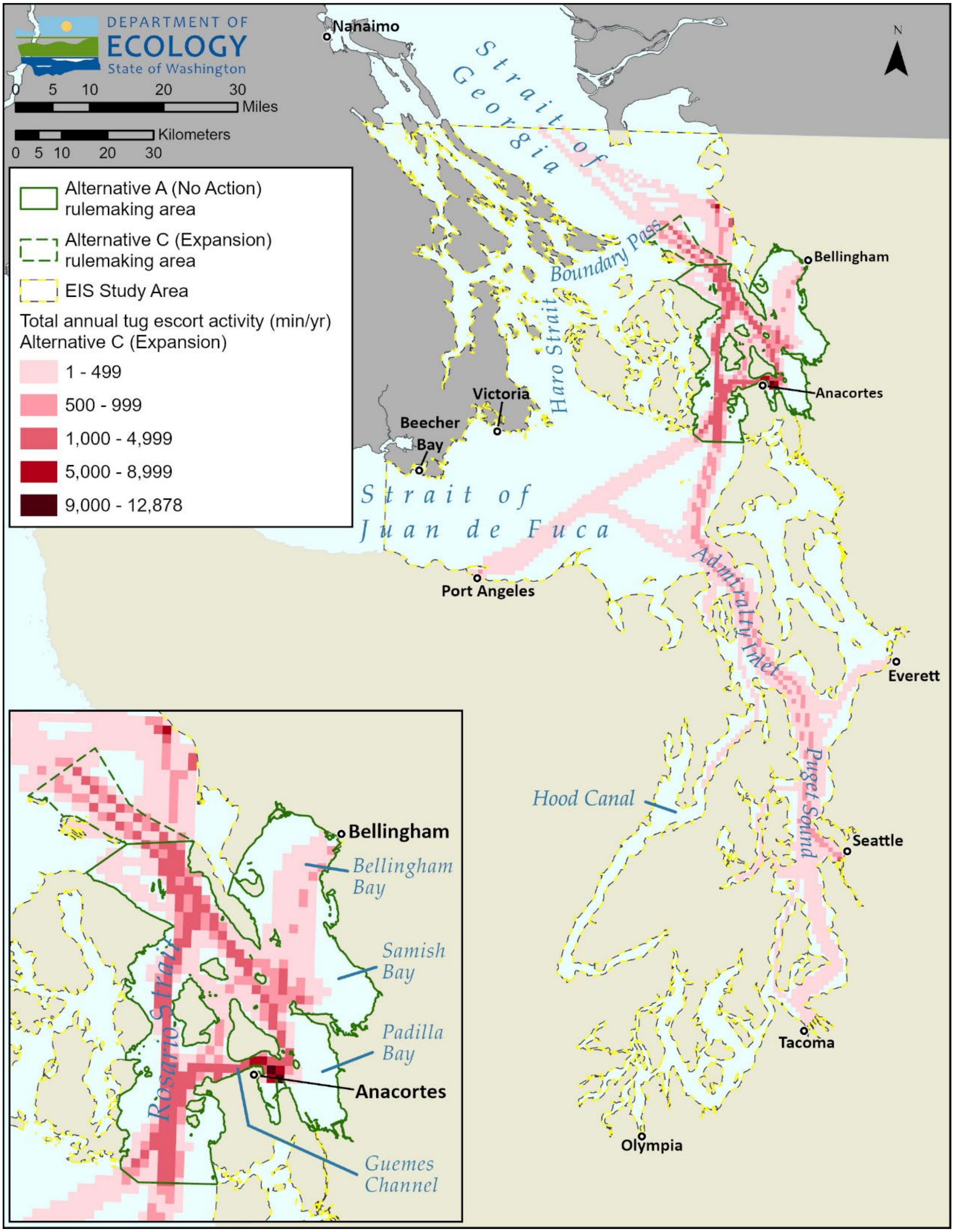


Figure 3. Simulated escort tug underway time under Alternative C.

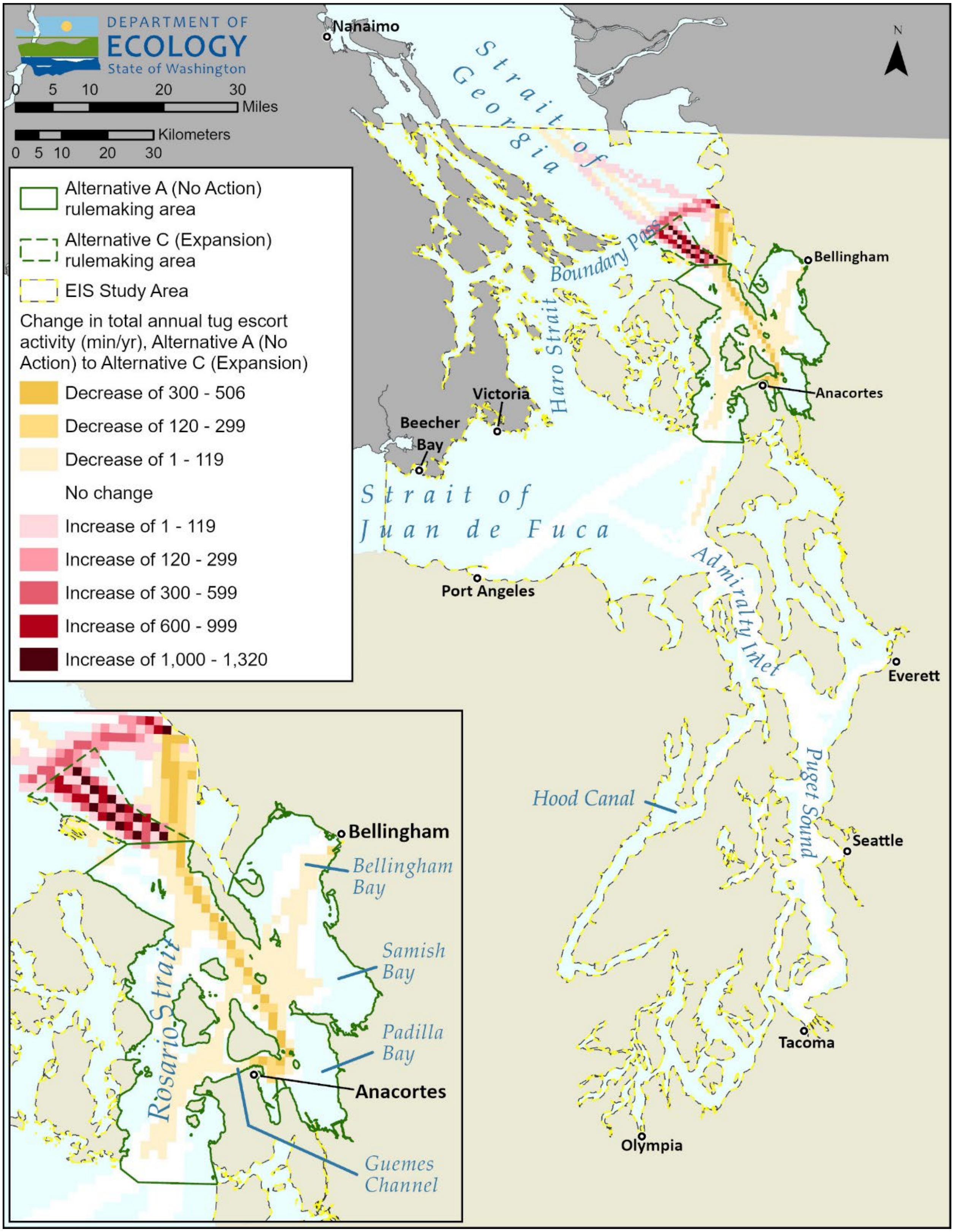


Figure 4. Simulated change in escort tug underway time between Alternative A and Alternative C. An additional accessible version of this map is available in Appendix M.

1.3 Resource Study Area

The EIS Study Area includes the rulemaking alternative boundaries and potential areas for escort tug commutes to and from the alternative boundaries. Specifically, the EIS Study Area includes all connected marine waters in the Salish Sea[3] network of coastal waterways (including Puget Sound), bounded to the north by the 49th Parallel and bounded to the west by a line extending across the Strait of Juan de Fuca from Pike Point to Tongue Point (see Figure 5).

The study area for air quality and GHG is the EIS Study Area shown in Figure 5 below, plus immediately adjacent land with communities potentially affected by escort tug air pollution. The EIS Study Area includes the rulemaking alternative boundaries and all potential areas for escort tug commute routes to and from the alternative boundaries.

[3] The term "Salish Sea" is used here to describe the transboundary waters of the Strait of Juan de Fuca, the Puget Sound, and the Georgia Strait. The name for this waterbody was proposed in 1989 by a marine science professor at Western Washington University to emphasize the region as a single ecosystem. It has since been formally adopted by the Washington State Committee on Geographic Names (Chapter 237-990 WAC) and the British Columbia Geographical Names Office (BC Geographical Names, n.d.). It was named for the Coast Salish Tribes who live on or near the Salish Sea on both sides of the U.S.-Canadian border. However, the defined geographic boundary of the Salish Sea also extends into the lands and waters of Tribes that are not Coast Salish, including the Makah Tribe (Nuu-Chah-Nulth). We use the term "Salish Sea" in this analysis, but recognize the diversity of native peoples that have lived in and used these waters since time immemorial.

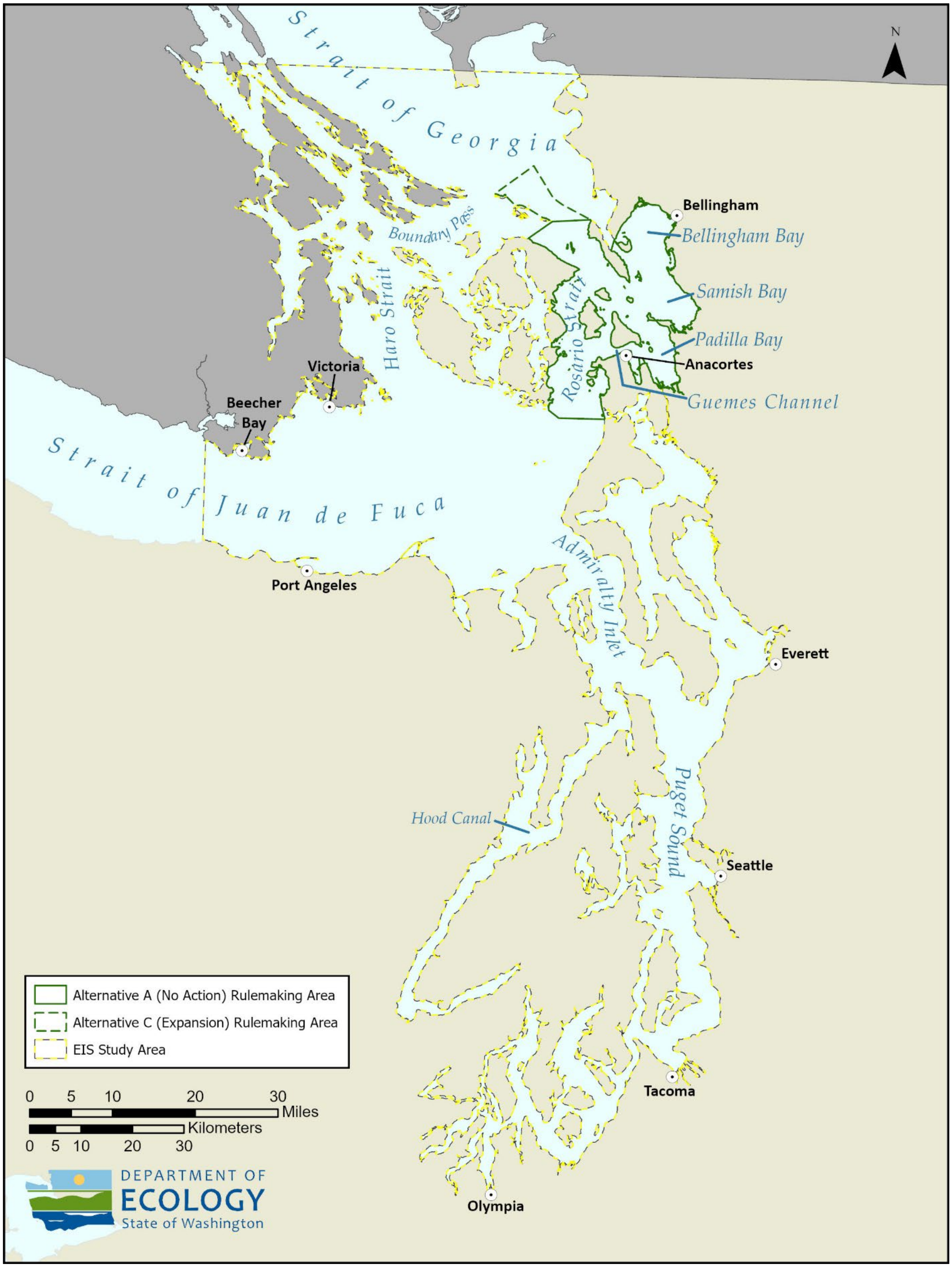


Figure 5. Boundary of the EIS Study Area.

1.4 Resource Description

This Air Quality and Greenhouse Gases Discipline Report describes the existing air quality in the EIS Study Area and evaluates the potential air quality impacts of each rulemaking alternative. The assessment focuses on escort tug air pollutant emissions. The analysis relies on the results of focused air modeling as well as literature reviews to inform existing conditions and expected impacts from each alternative. In this discipline report, Ecology examines the following air pollutants that are emitted by oil spills and/or the combustion of fossil fuels and can cause or contribute to human health impacts: nitrogen oxides (NOx), particulate matter (PM), sulfur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs), and air toxics. Ecology also examines the emissions of greenhouse gases (GHG) by escort tugs and the climate change implications.

1.5 Regulatory Framework

Table 2 describes the Clean Air Act (CAA), which is the federal regulatory program applicable to air quality and GHG impacts in the EIS Study Area. Table 3 summarizes relevant federal, state, local, and Tribal laws, plans, and policies pursuant to sections of the CAA, and these laws and policies are discussed later in this section. Section 3.0 (Technical Analysis and Results) further discusses these laws, plans, and policies as they relate to the EIS Study Area and impacts potentially resulting from the rulemaking alternatives. Discussion of these laws, plans, and policies related to air quality is intended to provide a framework for the overall regulatory context of the action but is not necessarily intended to imply applicability or compliance requirements for the four regulatory alternatives evaluated in the EIS.

Table 2. Relevant federal laws related to air quality.

Regulatory Program	Lead Agency or Entity	Description
Clean Air Act of 1970 (CAA), as amended	Ecology or Respective Tribe Authorized by U.S. Environmental Protection Agency (EPA) [a]	Establishes legislation for the regulation of air emissions and establishment of the National Ambient Air Quality Standards (NAAQS)

[a] Under the CAA, certain federally recognized Tribes are authorized by the EPA to be treated in a similar manner as a state (TAS). These Tribes have independent authority for setting air quality standards and implementing regulations for air on reservation lands.

Table 3. Statues, regulations, and policies related to the implementation of the Clean Air Act.

Statute, Regulation, Policy	Description
International	
International Convention for the Prevention of Pollution from Ships (MARPOL), Annex VI	• Designates areas around the North American coast as "Emission Control Areas" for nitrous oxides, sulfur oxides, and PM.

Statute, Regulation, Policy	Description
Federal	
CAA, Section 109	• Requires EPA to set NAAQS for air pollutants with a potential risk to public health and/or welfare.
CAA, Section 110	• Authorizes states to develop and adopt State Implementation Plans (SIPs) to implement, maintain, and enforce NAAQS.
CAA, Section 112	• Requires EPA establish hazardous air pollutant emission standards.
CAA, Section 301(d)	• Establishes the Tribal Authority Rule, which authorizes the EPA to treat an Indian Tribe as a state for purposes of administering air quality standards under nearly all CAA programs.
State	
Washington Clean Air Act (RCW 70A.15)	• Declares protection of air quality, including for public health and welfare, as a state priority. • Authorizes seven clean air agencies to enforce federal, state, and local clean air policies, regulations, and laws.
Chapter 173-476 WAC, Washington State Ambient Air Quality Standards	• Establishes state ambient air quality standards for PM_{10}, $PM_{2.5}$, lead, sulfur oxides, nitrogen oxides, ozone, and carbon monoxide.
Chapter 173-460 WAC, Controls for New Sources of Toxic Air Pollutants	• Institutes limits for new or modified toxic air pollutant (TAP) sources to protect air quality and human health and safety • Sets acceptable source impact levels (ASILs), small quantity emission rates, and *de minimis* emission values for TAPs.
Washington Climate Commitment Act (RCW 70A.65)	• Establishes GHG emission caps and requires facilities (stationary sources) with emissions above 25,000 metric tons carbon dioxide equivalents (CO_2e) to join the cap-and-trade program.
Limiting GHG Emissions (RCW 70A.45)	• Establishes statewide and state agency GHG emission reduction goals for 2030, 2040, and 2050.
Washington State Department of Transportation (WSDOT) Air Quality, Energy, and Greenhouse Gas Emissions Guidance	• Recommendations from WSDOT on evaluating NAAQS conformity, mobile source air toxics, GHG emissions, and other air quality analyses relevant to SEPA and CAA.

Statute, Regulation, Policy	Description
Washington SIP	• Sets specific actions to achieve attainment after a region does not meet NAAQS for any criteria pollutant • Washington's SIP includes attainment plans, maintenance plans, infrastructure plans, rules, and state air quality programs. • The Regional Haze Plan is one air quality program under the SIP and aims to help the state improve visibility.
Tribal	
Federal Air Rules for Reservations air quality standards (40 CFR Part 49)	• Tribes that are designated under Treatment in a Similar Manner as States may implement and manage CAA programs under select Sections and provisions of the Act. Exceptions are listed in 40 CFR § 49.4. • Confederated Tribes and Bands of Yakama Nation, Confederated Tribes of the Colville Reservation, Confederated Tribes of the Chehalis Reservation, Hoh Indian Tribe, Jamestown S'Klallam Tribe, Kalispel Tribe of Indians, Lower Elwha Klallam, Lummi Nation, Makah Tribe, Muckleshoot Indian Tribe, Nisqually Indian Tribe, Nooksack Tribe, Port Gamble S'Klallam Tribe, Puyallup Tribe, Quileute Tribe, Quinault Indian Nation, Sauk-Suiattle Indian Tribe, Shoalwater Bay Indian Tribe, Skokomish Indian Tribe, Spokane Tribe of Indians, Squaxin Island Tribe, Stillaguamish Tribe of Indians, Suquamish Tribe, Swinomish Indian Tribal Community, Tulalip Tribes, and Upper Skagit Indian Tribe are all Tribes approved for TAS within or adjacent to the EIS Study Area.
Local	

Puget Sound Clean Air Agency (PSCAA) 2030 Strategic Plan	• Establishes PSCAA's air quality goals for 2030. The three main goals are:
	  ○ Protect and improve air quality and public health.
	  ○ Protect the climate by reducing contributions to GHG emissions.
	  ○ Reduce air pollution disparities.

Northwest Clean Air Agency (NWCAA) Strategic Plan	• Sets NWCAA's overall air quality goals. The overall goal of the plan is to achieve clean air for everyone in Island, Skagit, and Whatcom counties, and an economy and environment that are enhanced as a result.

Federal and Washington Air Quality Standards

First enacted in 1970 and most recently amended in 1990, the federal CAA established air quality criteria called National Ambient Air Quality Standards (NAAQS), which are benchmark air pollutant quantities over a defined time period for a region. National primary standards protect public health, especially for sensitive populations such as children, the older individuals, and those with preexisting respiratory health issues. Secondary standards protect other aspects of public welfare, including protections for animal and vegetation health as well as protection against haze (EPA, 2024b). The NAAQS are regularly updated, with the most recent revision in February 2024. See Table 4 for the current NAAQS.

Areas where air pollutant levels exceed the NAAQS are designated as nonattainment areas for the specific pollutant(s) in question. Once a nonattainment area regularly complies with the NAAQS and has a maintenance State Implementation Plan (SIP) approved by the U.S. Environmental Protection Agency (EPA), it can be designated as a maintenance area for the pollutant. The EPA redesignates a maintenance area as fully in attainment for a pollutant when the area consistently meets the NAAQS and has successfully implemented the SIPs for at least 20 years (EPA, 2024e).

While EPA implements the CAA and establishes the NAAQS, states are responsible for meeting the NAAQS and establishing SIPs (Congressional Research Service, 2022). The Washington State General Regulations for Air Pollution Sources (WAC 173-400) and the Washington State Clean Air Act (RCW 70.94) establish state air quality policy and air quality standards. See Table 4 for Washington's ambient air quality standards.

Table 4. Federal and Washington State Ambient Air Quality Standards.

Pollutant	Averaging Time	National Standard[a]		Washington State Standard[b]
		Primary	Secondary	
Ozone (O_3)	8-hour	0.070 parts per million (ppm) (137 μg/m^3)	Same as primary	0.070 ppm
Respirable particulate matter (PM_{10})	24-hour	150 μg/m^3	Same as primary	150 μg/m^3
Fine particulate matter ($PM_{2.5}$)	24-hour	35 μg/m^3	Same as primary	35 μg/m3
	Annual	9.0 μg/m^3	15.0 μg/m^3	12.0 μg/m3
Carbon monoxide (CO)	1-hour	35 ppm (40 mg/m^3)	—	35 ppm (40 mg/m^3)
	8-hour	9 ppm (10 mg/m^3)	—	9 ppm (10 mg/m^3)
Nitrogen dioxide (NO_2)	1-hour	100 ppb (188 μg/m^3)	—	100 ppb (188 μg/m^3)
	Annual	53 ppb (100 μg/m^3)	Same as primary	53 ppb (100 μg/m^3)
Sulfur dioxide (SO_2)	1-hour	75 ppb (196 μg/m^3)	—	75 ppm
	3-hour	—	0.5 ppm (1300 μg/m^3)	0.5 ppm
	24-hour	—	—	0.14 ppm
	Annual	—	—	0.02 ppm
Lead	3-month	0.15 μg/m^3	Same as primary	0.15 μg/m^3

Source: a – (EPA, 2024b); b – WAC 173-476

Authorized under the Washington State Clean Air Act, seven regional clean air agencies alongside four Ecology regional offices implement air quality standards throughout Washington. Tribal governments work with EPA Region 10 to manage air quality on Tribal lands. The three clean air agencies and one Ecology regional office managing air quality within the EIS

Study Area include: the Northwest Clean Air Agency (NWCAA), which covers Island, Skagit, and Whatcom counties; Puget Sound Clean Air Agency (PSCAA), which manages Snohomish, King, Pierce, and Kitsap counties; Olympic Region Clean Air Agency (ORCAA) covering Clallam, Jefferson, Mason, Thurston, Grays Harbor, and Pacific counties; and Ecology Northwest Regional Office, which manages air quality in San Juan County. Clean air agencies monitor air quality in their regions, enforce air quality regulations, and educate the public on air pollution and its health effects (Ecology, 2024d; Puget Sound Clean Air Agency, 2023a).

Port-Specific Air Quality Plan

The Northwest Ports Clean Air Strategy is a collaboration between the Northwest Seaport Alliance, Port of Seattle, Port of Tacoma, and Vancouver Fraser Port Authority with the ultimate goal of supporting clean air in local communities and helping to limit the sector's contributions to climate change. While the Strategy is not legally binding, it provides a vision for reducing port-related air emissions. In fact, the Northwest Ports Clean Air Strategy seeks to completely phase out all emissions from their seaport-related activities by 2050, which in part involves replacing current equipment with zero-emissions technology (Northwest Ports Clean Air Strategy, 2020).

Recognizing that tug boats (including all assist and escort activities, a far larger scope than the escort tugs evaluated in this EIS) are the primary emissions source out of all harbor vessel types in the region, the Northwest Ports Clean Air Strategy includes three harbor vessel-specific objectives:

- Continually increase vessel efficiency and decrease emissions from existing vessels.
- By 2030, sufficient infrastructure is in place to enable adoption of zero-emissions harbor vessels.
- By 2050, zero-emissions harbor vessels are adopted.

The Strategy recognizes that zero-emissions technology is not yet available for marine vessels, but emphasizes the need to support research and development efforts to move the reality of zero-emissions harbor activities forward (Northwest Ports Clean Air Strategy, 2020).

2.0 Methodology Summary

Ecology identified and reviewed scientific literature, technical reports, and data regarding air quality within the EIS Study Area, focusing primarily on pollutants related to escort tug activity associated with this proposed rulemaking. Ecology also reviewed Tribal and stakeholder input received from the scoping and workshop phases. During scoping, the public identified increased emissions from increased transits and idling time and the public health impact as primary concerns. At our workshops, the public also highlighted locations of various sensitive receptors (e.g., hospitals, community centers).

Ecology reviewed available literature and data from previous air quality reports, GHG inventories, and other technical sources to examine existing air quality trends. Ecology also identified the main air pollutants emitted from escort tugs that may be impacting air quality, including criteria air pollutants, air toxics, and GHGs. Ecology then quantified estimates of pollutant emissions and subsequently used these calculations to inform dispersion modeling at eight receptor areas. The goals of this analysis were the following:

1) Assess whether emissions from existing escort tug activities are potentially causing or contributing to any existing air quality concerns.
2) Assess whether the proposed changes in tug escort requirements under the four rulemaking alternatives would be expected to worsen or alleviate any such existing air quality concerns and/or cause any new air quality concerns.

The quantification and dispersion modeling methods are summarized below, and further details can be found in Attachment A (Technical Memorandum: Air Quality and Greenhouse Gases).

2.1 Quantification of Escort tug Emissions

Using coordinate locations, reported speed over ground, and duration data from simulated escort tug underway activity (see Section 1.2 (Rulemaking Alternatives) and Appendix B Transportation: Vessel Traffic Discipline Report), Ecology calculated the estimated emissions from escort tugs under Alternative A and Alternative C. Escort tug activity under Alternative B would not be expected to be meaningfully different than under Alternative A; therefore, Ecology did not perform any emissions estimates specifically for Alternative B. Similarly, Alternative D did not require any emissions estimates because it would result in zero tug escort activity and thus zero associated emissions.

Ecology considered real-life idling and dockside power usage practices of escort and assist tugs to inform the calculations, finding that operators minimize idling time and utilize shore power to reduce dockside engine usage. With this, dockside idling was not included in the emissions calculations.

Ecology used propulsion engine power, service speed,[4] auxiliary engine power, and build year from 18 tugs known to perform escort duties in the Pacific Northwest, as identified in

[4] Service speed is a vessel's typical speed given normal engine load and typical weather conditions.

Appendices P and Q of the 2021 Vessel Traffic Trend Study, to further inform the emissions calculations.

Emissions were then calculated for criteria pollutants, VOCs, hazardous air pollutants (HAPs), and GHGs. See Attachment A for the specific equations and emission factors used.

2.2 Dispersion Modeling

2.2.1 Overview

Ecology performed air dispersion modeling using AERMOD[5] (American Meteorological Society & EPA, 2023) to predict the air quality impacts of several escort tug -emitted criteria pollutants (CO, NO_2, $PM_{2.5}$, PM_{10}, and SO_2) under Alternatives A (No Action) and C (Expansion). Ecology did not perform air dispersion modeling for either Alternative B or Alternative D for the same reasons it did not perform emissions estimates. Dispersion modeling efforts assessed only escort tug emissions and the associated changes in airborne pollutant concentrations from those tug emissions. The modeling did not attempt to account for background pollutant levels or contributions from other sources. The goal of the dispersion modeling effort was to determine whether escort tug pollutant contributions were high enough to warrant further analysis related to air quality impacts.

Because of the large size of the EIS Study Area, modeling potential emissions dispersion over the entire EIS Study Area was not feasible. Ecology focused the modeling efforts around the rulemaking area, where changes in the concentration of escort tug underway time from the proposed rulemaking are the largest. Ecology chose to conduct focused modeling to estimate escort tug pollutant concentrations at the following eight receptor areas of concern, which we are calling: Buckhorn, Cherry Point, Neptune Beach, Lummi, Bellingham, James Island, Anacortes, and Swinomish (see Figure 6). Ecology selected these areas as receptors because they meet at least one of the following characteristics: relatively high escort tug activity under Alternative A and/or Alternative C, sensitivity to changes in air quality (e.g., presence of Environmental Justice communities and/or areas experiencing air quality-related health impacts such as asthma), Tribal reservations, areas of public interest, or availability of monitoring data.

Ecology conducted the dispersion modeling at two different timescales, depending on the pollutant and impact threshold: 1) annual average, for comparison against thresholds with an annual averaging period; and 2) peak day, for comparison against thresholds with an averaging period of 24 hours or less. See Attachment A for further details.

[5] AERMOD is the American Meteorological Society/Environmental Protection Agency's recommended dispersion model for this type of analysis.

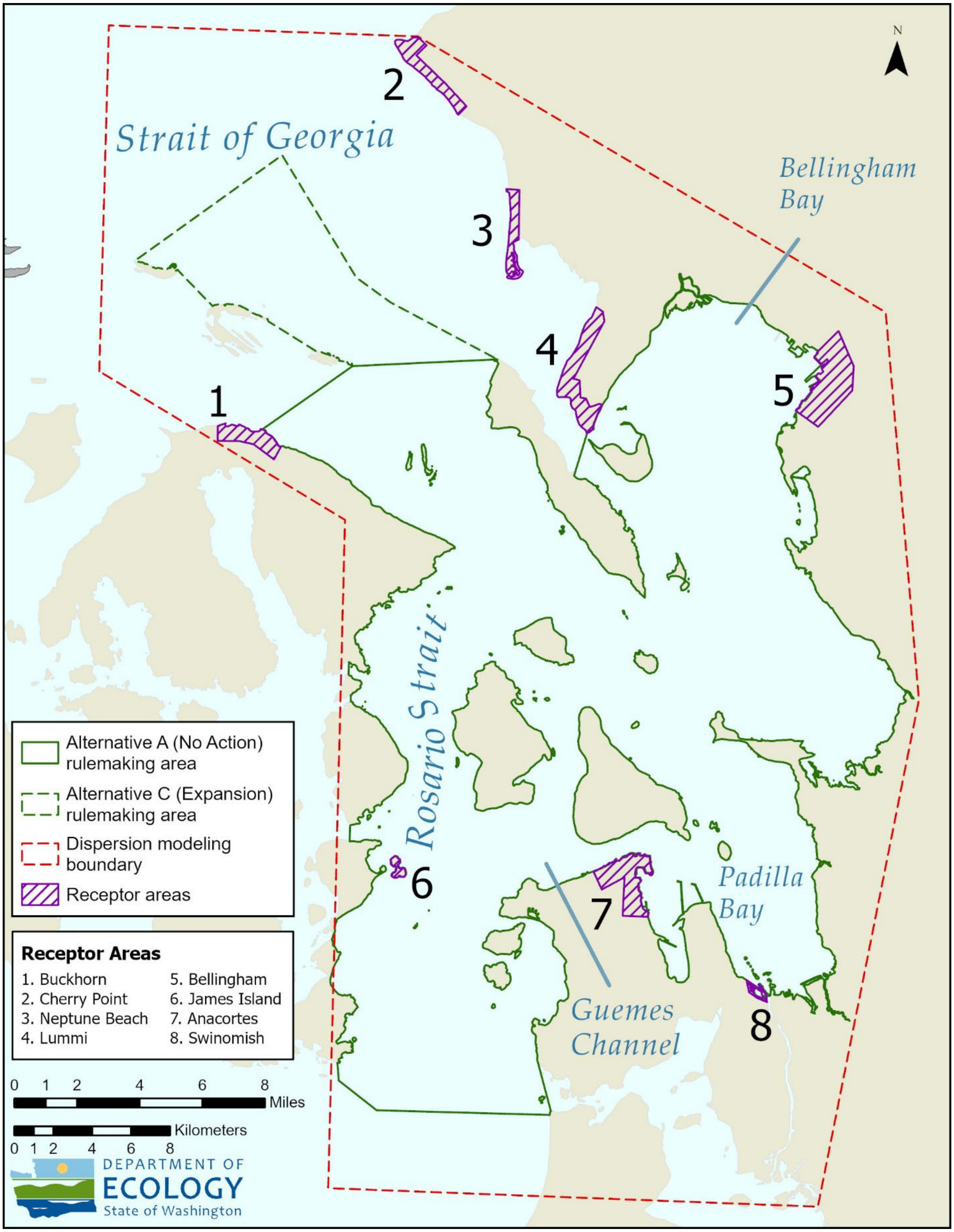


Figure 6. Receptor areas for dispersion modeling.

2.2.2 Impact Thresholds

Ecology used EPA's NAAQS significant impact levels (SILs) to assess whether escort tug emissions could adversely affect air quality in the form of a NAAQS violation. The SILs, which are listed in Table 5, can help to assess the potential air quality impacts from a proposed stationary source. If dispersion modeling determines that the source's emissions would result in criteria pollutant concentrations below the corresponding SIL, this would indicate that the source has no potential to cause or contribute to a NAAQS violation. However, modeled concentrations exceeding the SIL could indicate that additional analysis (e.g., review of ambient air quality monitoring data) may be warranted.

The SILs and corresponding regulations only apply to the permitting of stationary sources and have no regulatory applicability to mobile sources or this rulemaking. Ecology nonetheless considered the SILs to be reasonable screening-level indicators of potential air quality impacts from escort tug emissions because the impacts of criteria pollutants are presumed to be identical, regardless of whether they were emitted from a stationary or mobile source (e.g., escort tug).

Table 5. Modeled air pollutants and corresponding NAAQS SILs.

Pollutant	Averaging Period	SIL ($\mu g/m^3$)
CO	1-hr	2000
	8-hr	500
NO_2	1-hr	7.5*
	Annual	1
PM_{10}	24-hr	5
$PM_{2.5}$	24-hr	1.2
	Annual	0.13
SO_2	1-hr	7.8*
	3-hr	25

* Interim SIL

2.2.3 Human Health Impact Assessment

Ecology used its acceptable source impact levels (ASILs) to assess whether escort tug emissions could result in an unacceptable human health risk from exposure to toxic air pollutants (TAPs). ASILs, which are listed in WAC 173-460-150, are screening-level thresholds used to assess the potential health risk of a new or modified stationary air pollution source undergoing review for a Notice of Construction permit. ASILs indicate the TAP concentration that would result in an increased lifetime cancer risk of more than one per one million, assuming continuous lifetime exposure.[6] If a screening-level review, such as the one conducted for this rulemaking, determines that the stationary source's emissions would result in TAP concentrations below the ASIL, the health risks would be considered acceptable. If the TAP concentrations exceed the ASIL, the stationary source would require a more in-depth second tier review and health impact

[6] Continuous lifetime exposure assumes that someone is constantly exposed to a TAP for 70 years (Ecology, 2019).

assessment, per the Air Toxics Rule (WAC 173-460-090). If this second assessment indicates that the stationary source's TAP emissions are not likely to result in an increased lifetime cancer risk of more than ten per one million (i.e., ten times greater risk than is represented by the ASIL), the health risks would be considered acceptable.

For this analysis—which is not subject to the air toxics regulations—Ecology chose a simplified version of the stationary source risk assessment described above. Specifically, Ecology assumed that the air toxics emissions would be considered "acceptable" if the modeled air toxics concentrations were less than 10 times the ASIL.

Because escort tugs emit PM from the combustion of diesel fuel, Ecology selected diesel PM (a TAP) as the representative pollutant for this air toxics analysis. Ecology conservatively assumed that all modeled $PM_{2.5}$ would be considered diesel PM and compared the modeled $PM_{2.5}$ concentrations at each receptor area against the diesel PM ASIL of 0.0033 micrograms per cubic meter ($\mu g/m^3$). As described above, if the modeled $PM_{2.5}$ concentrations were less than 10 times the ASIL, Ecology concluded that the increased lifetime cancer risk would not be more than ten per million (and would therefore be considered "acceptable").

The ASILs and air toxics regulations only apply to the permitting of stationary sources and have no regulatory applicability to mobile sources or this rulemaking. Ecology nonetheless considered the ASILs to be reasonable screening-level indicators of potential human health impacts from exposure to escort tug emissions because the impacts of TAPs are presumed to be identical, regardless of whether they were emitted from a stationary or mobile source (e.g., escort tug).

2.3 Assessment of Significance

Last, Ecology assessed whether the emissions and air quality or health impacts would be likely to result in significant adverse environmental impacts, per the significance thresholds outlined below in Table 6. Per WAC 197-11-794, significant "means a reasonable likelihood of more than a moderate adverse impact on environmental quality" and should rely on context (e.g., physical setting) and intensity (e.g., magnitude and duration of impact). Findings of significance were reported for each alternative, where identified.

Table 6. Significance thresholds for air quality and GHGs.

Indicator	Significance Thresholds
Washington State emissions reductions goals	• Substantially inconsistent with State emissions reductions plans or goals for criteria pollutants and/or GHGs.
Ambient air quality standards	• Reasonable likelihood of a chronic and recurring increase in the frequency, severity, and/or extent of numeric or narrative air quality standard exceedances.
Human health risk	• Emissions would result in TAP concentrations that could result in an increased lifetime cancer risk of more than ten per million.

3.0 Technical Analysis and Results

This section describes the affected environment for air quality within the EIS Study Area. It also describes the anticipated, qualitative impacts on air quality from the four alternatives: No Action (Alternative A), Addition of FORs (Alternative B), Expansion of Tug Escort Requirements (Alternative C), and Removal of Tug Escort Requirements (Alternative D). Finally, this section identifies mitigation measures that could avoid, minimize, or reduce the potential impacts and determines if there would be significant and unavoidable adverse environmental impacts.

3.1 Affected Environment

The EIS Study Area includes all connected marine waters in the Salish Sea network of coastal waterways (including Puget Sound), bounded to the north by the 49th Parallel and bounded to the west by a line extending across the Strait of Juan de Fuca from Pike Point to Tongue Point (see Figure 5). The Salish Sea is a geographic area encompassing land and water bodies of southern British Columbia, Canada, and northern Washington State.

The rulemaking areas include marine waters of San Juan, Skagit, and Whatcom counties, and a small portion of Island County, Washington. Specific waters include Bellingham Bay, Samish Bay, Rosario Strait, Thatcher Pass, Burrows Bay, and smaller areas such as Boat Harbor, Deepwater Bay, Strawberry Bay, Secret Harbor, and Cooks Cove.

The study area for evaluating air quality and GHG emissions includes the EIS Study Area and the surrounding communities where escort tug emissions may impact air quality and/or health.

Vessels that utilize the EIS Study Area include recreational boaters as well as commercial vessels such as container ships, tank barges, ATBs, ferries, cruise ships, and commercial and factory fishing vessels. For the purposes of this analysis and consistent with previous analyses, Ecology is considering the escort tug population of this EIS to be the 18 escort tugs identified in Appendices P and Q of the 2021 Vessel Traffic Trend Study (BPC & Ecology, 2021). Ecology assumes that, while the fleet conducting tug escort activity may have changed since the 2021 study (and may continue to change), the fleet will remain generally similar in composition and characteristics (e.g., length) to those identified in the 2021 study. See the Transportation: Vessel Traffic Discipline Report (Appendix B) for details.

3.1.1 Overview of Air Quality in the EIS Study Area

Air quality is influenced in part by weather conditions that dictate whether and where pollutants travel. Wind direction in the EIS Study Area varies by season. In the winter, the wind primarily blows to the south or southwest, while in the summer it typically blows to the northwest (Western Regional Climate Center, 2024). Air pollution is most apparent during days in the late fall or winter with open skies, little to no wind, and a distinct temperature inversion (i.e., conditions where warm air sits on top of cooler air preventing any mixing, moving, or dispersing of the air and any pollutants) (Western Regional Climate Center, 2024).

Air pollution in Washington State comes from both naturally occurring and anthropogenic sources. With peaks in summer and early fall, wildfires originating both within and outside of

Washington are a significant source of various air pollutants in the state. Major anthropogenic sources of air pollution in the area include emissions from industries as well as on-road (e.g., cars and trucks) and non-road (e.g., trains, planes, and ships) vehicles. While many air pollutants are invisible, some of these emissions also contribute to haze levels and reduce overall visibility.

Although air quality in the state generally meets federal and state ambient air quality standards, air pollution at concentrations lower than these standards could still cause adverse human health impacts (Dominici et al., 2022), especially for vulnerable populations such as older individuals (Di et al., 2017; EPA, 2024k). Washington State has informally designated several areas in the State as areas of concern for criteria pollutants if their air quality index reaches above 70 or if they often exceed federal standards. Nearly the entire EIS Study Area except for the northernmost section (north of Lummi Island) is considered an area of concern for ozone. Additionally, monitoring stations show elevated $PM_{2.5}$ levels near the cities of Everett and Tacoma (Ecology, 2023b).

Washington State and its clean air agencies set and regularly update objectives to further improve air quality. For example, Ecology's Regional Haze Plan (2018-2028) sets long- and short-term goals to reduce air pollutants contributing to haze (Ecology, 2022). Additionally, clean air agencies working within the EIS Study Area have set specific goals for air quality in their respective regions. For example, PSCAA's goals include reducing overall air pollution by 20 percent from 2022 to 2030; PSCAA is measuring non-wildfire-related $PM_{2.5}$ as a proxy to track this goal. PSCAA estimates that these air quality improvements could reduce the annual economic impact of air pollution health effects by $500 million to $1 billion. The PSCAA also aims to reduce cancer risk from TAPs by 50 percent by 2030, highlighting this need particularly for communities overburdened by air pollution (Puget Sound Clean Air Agency, 2023a).

The state and regional clean air agencies also seek to reduce GHGs. For example, PSCAA strives to see a 50 percent drop in GHGs in the region compared to 1990 levels. GHGs and state and regional goals are discussed more below.

3.1.2 Overview of Escort Tug Air Pollutants

The Salish Sea, including the EIS Study Area, is a high traffic area for both commercial and recreational marine vessels (MacGillivray et al. 2024). Busy marine shipping routes pass through this area, including local and international shipping lanes to the Ports of Seattle, Tacoma, and Vancouver, British Columbia, as well as numerous passenger and cargo ferry routes. These inland waters are also popular for recreational, ecotourism, and fishing vessels. Tugs support maritime operations throughout the waterway, including but not limited to escorting laden tank ships, assisting commercial vessels into port, towing barges, and other harbor operations. Escort tugs make up only a small fraction of total vessel activity in the Salish Sea. Specifically, Ecology estimates that escort tug underway time currently represents approximately 0.96 percent of overall marine vessel activity with AIS in the EIS Study Area (see Appendix B Transportation: Vessel Traffic Discipline Report for more details).

While escort tugs constitute only a small portion of marine vessel activity, their pollutant emissions can be substantial. Despite their compact size, their duties require sufficient speed and power to assist much larger vessels. For example, while a typical semi-truck engine has around 400-600 hp, Ecology estimates that escort tugs working in the EIS Study Area have propulsion engines with an average of 6,100 hp. In addition to their powerful propulsion engines, tugs operate auxiliary engines to support onboard equipment during operations. Large engines and high activity levels lead to greater fuel consumption and resulting emissions.

Air pollution can impact marine mammals that come up for air in close proximity to marine vessels. However, escort tugs do not operate in gatherings intentionally near marine mammals, do not idle in place, and are not allowed within a certain distance of some marine mammals. Therefore, impacts to marine mammals due to escort tug emissions are expected to be negligible, if any, and are not discussed in this report. See Appendix F Plants and Animals Discipline Report for further discussion of impacts to marine wildlife.

In this section, Ecology describes the main air pollutants emitted by escort tugs and their associated potential impacts to human health.

NOx

NOx are a group of naturally occurring and anthropogenically produced reactive gases. Nitrogen dioxide (NO_2) often serves as an indicator to monitor overall NOx pollution because it is the most common anthropogenically emitted NOx in the atmosphere (EPA, 1999, 2016). Large industries and the transportation sector, specifically on-road vehicles, contribute the majority of NOx pollution in the region (Ecology, 2022; Puget Sound Clean Air Agency, 2024c).

The precise health effects caused by NOx pollution exposure are not fully understood, as NOx are just one of many products from fossil fuel combustion, and therefore exposure to NOx occurs concurrently with exposure to other air pollutants (Costa et al., 2014). Studies link exposure to NO_2 to increased respiratory-related hospital admissions, short-and long-term respiratory ailments, and reduced immune system function (Costa et al., 2014; Wang et al., 2024). Long-term NO_2 exposure has also been linked with increased mortality. Vulnerable populations, such as older individuals, children, and people who are immunocompromised are at particular risk of adverse health effects, such as limited lung development (California Air Resources Board, 2024b; EPA, 2016; Wang et al., 2024).

The entire area surrounding the EIS Study Area is in attainment with the NAAQS for NO_2. Air quality in Washington State has never violated NO_2 national standards (Ecology, 2024b).

$PM_{2.5}$ and PM_{10}

Particulate matter (PM) is typically divided into two categories: PM_{10}, consisting of small particles up to 10 micrometers in diameter, and $PM_{2.5}$, consisting of particles up to 2.5 micrometers in diameter. Sources of PM can vary from natural sources, such as tree pollen and wildfires, to anthropogenic emissions from fossil fuel combustion and other activities. In the EIS Study Area, primary sources of $PM_{2.5}$ include wildfires, fugitive dust (e.g., from agriculture and construction vehicles), and industrial complexes (Ecology, 2022; EPA, 2021b; Puget Sound Clean Air Agency, 2023a). The PSCAA identifies $PM_{2.5}$ as the biggest air quality challenge in the region (Puget Sound Clean Air Agency, 2024a).

Exposure to PM can lead to short- and long-term health impacts. Both PM_{10} and $PM_{2.5}$ are small enough to accumulate in the lungs, and $PM_{2.5}$ can even be absorbed into the bloodstream. Exposure to excessive $PM_{2.5}$ levels can lead to shortness of breath, coughing, and wheezing. Short-term exposure has been linked with increased hospitalizations and exacerbation of existing respiratory and cardiovascular condition (Kim et al., 2015). These symptoms and conditions worsen with long-term exposure, and vulnerable populations including older individuals, children, and populations with preexisting health conditions are disproportionately affected by PM pollution. For example, PM exposure has been correlated with reduced lung development and function (Gauderman et al., 2004, 2015). Long-term exposure to PM increases the risk of developing respiratory and cardiovascular conditions and also increases mortality rates, including at levels below NAAQS (Anderson et al., 2012; Orellano et al., 2020).

No cities or counties within the EIS Study Area are in nonattainment for PM. However, several urban areas within the EIS Study Area are maintenance areas for PM_{10}. This includes Thurston County (specifically the cities of Olympia, Tumwater, and Lacey), Tacoma, Kent, and Seattle. The Tacoma region is also a maintenance area for 24-hour $PM_{2.5}$. While the EIS Study Area generally meets EPA's NAAQS for PM, it is important to note that exposure to $PM_{2.5}$ levels below the NAAQS can still impact health (Di et al., 2017; Dominici et al., 2019; Puget Sound Clean Air Agency, 2024b).

SO_2

SO_2 is an odorous, colorless gas emitted when sulfur, often present in fuels, is burned. Alongside PM, high SO_2 levels in the air contribute to visually hazy conditions. Primary sources of SO_2 in Washington include emissions from industrial facilities, fossil fuel power plants, oil refineries, and the transportation sector, particularly ship and locomotive diesel engines (Ecology, 2022, 2024c).

Short-term SO_2 exposure may damage the human respiratory system and make breathing difficult. These impacts are exacerbated for those with preexisting respiratory conditions such as asthma (EPA, 2024a). Short-term increases in SO_2 levels have also been linked with increased mortality rates (Orellano et al., 2021). Long-term exposure multiplies health risks and reduces overall lung function (American Lung Association, 2023).

SO_2 levels in Washington have declined drastically in the past several decades in response to mandatory pollution controls on the industry and transport sectors (Ecology, 2024c). Until recently, a small portion of Whatcom County near a former aluminum smelter in Mountain View was a designated nonattainment area for 1-hour SO_2 (Ecology, 2024c; EPA, 2024i). However, as of a ruling in effect as of January 16, 2025, all areas in Washington State are in attainment for SO_2.

CO

CO is an odorless gas often released during incomplete combustion, which occurs when there is not enough oxygen to fully burn the fuel source (i.e., carbon). Vehicles and other fossil fuel-burning machinery are primary sources of outdoor CO pollution (EPA, 2024d; Washington State Department of Health, 2024). Even in low concentrations, exposure to CO can cause fatigue in healthy populations and chest pain for people with heart conditions. At higher concentrations, exposure to CO may result in headaches, impaired vision, dizziness, confusion, and nausea, as breathing in excessive CO reduces the body's ability to transport oxygen to the heart and brain (California Air Resources Board, 2024a; EPA, 2024d). High concentrations of CO are more likely to occur in indoor settings.

Near the EIS Study Area, the Seattle-Tacoma area is a maintenance area for CO, while all other areas are attainment areas (EPA, 2024i).

VOC

VOCs are a class of organic chemicals that easily evaporate under typical temperature and pressure atmospheric conditions and that are photochemically reactive in the atmosphere (EPA, 2024c; US EPA, 2024). Because VOCs constitute a wide range of compounds, sources vary significantly. A majority of VOCs are emitted from natural sources such as forest vegetation (Ecology, 2022). However, like for many other air pollutants, fossil fuel combustion is also a major source of VOCs (Chauhan et al., 2014). Solvents and on-road vehicles are the greatest anthropogenic VOC emitters in Washington (Ecology, 2022). All crude oil contains VOCs, which are acutely toxic when inhaled. In the event of an oil spill, this can be a concern for responders, nearby residents, and marine animals that breathe air. Emitted VOCs can react with oxygen in the air to form secondary organic aerosols, contributing to hazy conditions (Ecology, 2022). While VOCs are not a criteria pollutant under the CAA, they are precursors to the criteria pollutant ground-level ozone (O_3).

Health impacts of excessive exposure to VOCs can vary significantly based on the specific gases and compounds. The Agency for Toxic Substances and Disease Registry maintains an online portal detailing the health impacts from exposure to specific VOCs. Exposure to high levels of some VOCs may result in immediate effects like headaches, nausea, and an irregular heartbeat (Chauhan et al., 2014). However, long-term exposure increases risk of more severe health impacts, including damage to the central nervous system, liver, kidney, and other organs (Chauhan et al., 2014). VOCs associated with petroleum combustion can also severely aggravate asthma symptoms in children (Delfino et al., 2003). EPA classifies several VOCs as hazardous air pollutants (HAPs), also called air toxics, which are known to cause serious health effects, including cancer (EPA, 2024h).

Alongside other gases and pollutants such as NOx and CO, VOCs react with sunlight to form ground-level ozone (referred to in this report as just ozone or O_3), which is different from the naturally occurring atmospheric ozone layer that protects the planet from the sun's ultraviolet rays. Exposure to elevated ozone levels can trigger and aggravate respiratory issues and even permanently damage lung tissue (Kampa & Castanas, 2008; Puget Sound Clean Air Agency, 2024a). Because their lungs are still developing, children are at greatest risk for health impacts from ozone (EPA, 2024g).

All areas surrounding the EIS Study Area are in attainment for ozone. Despite meeting national standards, PSCAA identifies ozone as a pollutant of concern for the region. Using data from 2015 and 2016, the Northwest Ports Clean Air Strategy reports that harbor vessels contribute over 10 percent of all VOC emissions at participating ports[7] (Northwest Ports Clean Air Strategy, 2020).

Air Toxics

Air toxics are air pollutants that pose threats to human health and welfare. Air toxics include pollutants categorized as HAPs by the EPA and/or as TAPs by Ecology. These lists include a broad range of pollutants; the EPA labels 188 specific chemicals as HAPs and Ecology identifies 430 chemicals as TAPs (Ecology, 2025a). Health issues arising from exposure can be life threatening and include cancer, reproductive harm, and damage to the respiratory, cardiovascular, immune, and nervous systems. Additionally, some air toxics can bioaccumulate to higher levels throughout the food chain (Puget Sound Clean Air Agency, 2011). Off- and on-road vehicles, such as trucks, marine vessels, and trains, are the primary sources of air toxics in Washington, contributing a combined 72 percent the state's total air toxics-related cancer risk in 2019 (Ecology, 2025a).

Diesel exhaust emits a wide range of air toxics, including diesel PM (California Air Resources Board, 2024c). Contributing 66 percent of cancer risk from air pollutants, diesel PM poses a major health risk in Washington State (Ecology, 2024a). Diesel PM exposure can also cause asthma, worsen heart and lung diseases, and increase mortality rates (EPA, 2024f; Koutros et al., 2023).

While air toxics, including diesel PM, are not criteria pollutants, Ecology actively works to control air toxics emissions under its Clean Air Act (70A.15 RCW) and associated WAC at 173-460 (in-part referred to as the Air Toxics Rule). Note, however, that the Air Toxics Rule only applies to stationary sources.

GHGs

GHGs are naturally occurring atmospheric gases that increase surface temperatures on Earth by absorbing heat that otherwise would have been radiated out to space. Fossil fuel burning and other human activities are increasing the Earth's atmospheric GHG concentration, therefore amplifying the atmosphere's heat trapping effect and driving climate change.

GHGs include but are not limited to carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Every GHG has a different potency, or warming potential, that is expressed in terms of CO_2 equivalents (CO_2e). CO_2 comprises nearly 80 percent of GHG emissions in the U.S., making it the most commonly emitted GHG by far (EPA, 2025). The transportation, electricity, and industrial sectors are the three largest contributors to CO_2 emissions in the U.S., contributing a combined total of 81 percent of CO_2 emissions in 2022 (EPA, 2025). Due to the carbon content in fossil fuels, CO_2 is an inevitable byproduct of fossil fuel combustion.

CH_4, with a CO_2e of approximately 28, is 28 times more potent than CO_2 (EPA, 2025). While natural processes such as wildfires and decomposing bacteria in wetlands naturally release CH_4, anthropogenic CH_4 emissions in the U.S. largely come from oil and natural gas industry

[7] Participating ports include the Northwest Seaport Alliance, Port of Seattle, Port of Tacoma, and Port of Vancouver.

activities, livestock digestive systems, and landfills; these contribute a combined 69 percent of the nation's CH_4 emissions (EPA, 2025). CH_4 lingers in the atmosphere for approximately 12 years before it transforms into water vapor and CO_2 (Mayerfeld et al., 2025).

While N_2O accounted for only 6 percent of the nation's GHG emissions in 2022, N_2O has a CO_2e of approximately 265 and is therefore a major concern for climate change (EPA, 2025). While agricultural soil management activities (e.g., application of fertilizers) contributed three-fourths of the nation's N_2O emissions in 2022, fossil fuel combustion is a notable source as well (EPA, 2025).

Overall, fossil fuel combustion is the primary source of anthropogenic GHGs (EPA, 2025). Followed closely by industry and electric power, the transportation sector is the greatest contributor to the U.S.'s total GHG emissions, accounting for over a quarter of U.S. emissions (EPA, 2025). A similar trend occurs at the state and regional level, with the transportation sector responsible for nearly 40 percent of GHG emissions in Washington State (Ecology, 2025b) and in the Puget Sound region (Puget Sound Clean Air Agency, 2023b).

In 2019, total GHG emissions in the U.S. and Washington State were 6,558 million metric tons (MMT) CO_2e and 102.4 MMT CO_2e, respectively (EPA, 2021a; Puget Sound Clean Air Agency, 2023b). Washington's total 2019 emissions are the equivalent of emissions from burning over 11.5 billion gallons of gasoline (EPA, 2024j). While missing its goal to meet 1990 GHG emission levels by 2020, Washington State still aims to achieve the other goals set in its Limiting Greenhouse Gas Emissions Act (70A.45 RCW). This Act includes goals to reduce statewide emissions to 45 percent below 1990 levels by 2030, 70 percent by 2040, and 95 percent by 2050. Clean Air Agencies have also set goals to reduce regional GHG. For example, one goal outlined in the PSCAA's 2030 Strategic Plan includes reducing regional GHG emissions to 50 percent below 1990 levels by 2030 and also achieving the state's goal of 95 percent below 1990 levels by 2050 (Puget Sound Clean Air Agency, 2023a).

In 2021, marine vessels (ocean-going vessels, harbor vessels, and recreational vessels) emitted approximately 1.22 million tons of CO_2e in the Puget Sound Air Basin, which encompasses all U.S. portions of the EIS Study Area in addition to surrounding land areas (Puget Sound Maritime Air Forum, 2024). The marine vessel sector also sets goals to reduce its climate impact. Participating ports of the Northwest Ports Clean Air Strategy met a goal to reduce GHG emissions per metric ton of cargo moved by 15 percent relative to 2005 levels well before the 2020 target year (Northwest Ports Clean Air Strategy, 2020). Additionally, the participating ports are aiming to surpass the United Nations' goal of a 50 percent GHG emissions reduction relative to 2008 levels by 2050 (Northwest Ports Clean Air Strategy, 2020).

3.1.3 Assessment of Current Emissions from Escort tugs

Ecology estimated the annual emissions from escort tugs under existing conditions, following the methodology summarized in Section 2.1 (Quantification of Escort tug Emissions) and described in more detail in Attachment A. Table 7 shows the calculated annual emissions of criteria pollutants, VOCs, GHGs, and HAPs from escort tugs within the EIS Study Area under existing conditions and compares these to recent estimates of total emissions from all marine vessels in the Puget Sound air basin.

Table 7. Annual escort tug emissions associated with the rulemaking in the EIS Study Area (existing conditions) and comparison to total marine vessel emissions in Puget Sound air basin.

Pollutant	Existing (Alternative A) Escort tug Emissions (tons/yr)	2021 Marine Vessel Emissions in Puget Sound Air Basin (tons/yr)[a]	Escort tug % of Marine Vessel Emissions
Criteria Pollutants			
CO	28.2	13,015	0.217%
NOx	187	18,159	1.03%
PM_{10}	4.84	331	1.46%
$PM_{2.5}$	4.70	312	1.51%
SO_2	0.109	369	0.0295%
VOCs			
VOCs	6.29	1,970	0.319%
GHGs			
CH_4	0.120	N/A	N/A
CO_2	11,900	N/A	N/A
N_2O	0.604	N/A	N/A
CO_2e	12,100	1,218,437	0.993%
HAPs			
HAPs	0.787	N/A	N/A

Source: a – (Puget Sound Maritime Air Forum, 2024)

Figure 7 illustrates the locations and estimated amounts of annual NOx emissions from existing escort tug activity. As is to be expected, areas with the most escort tug activity (e.g., Rosario Strait and Guemes Channel) have the highest emissions. While this figure specifically depicts NOx emissions and the amounts of emissions vary across pollutants, the spatial distribution and relative intensity of escort tug emissions throughout the EIS Study Area are very similar across all pollutant categories. The majority of these emissions are within the ozone “area of concern” defined by Ecology, which encompasses all of Puget Sound and extends north to Lummi Island.

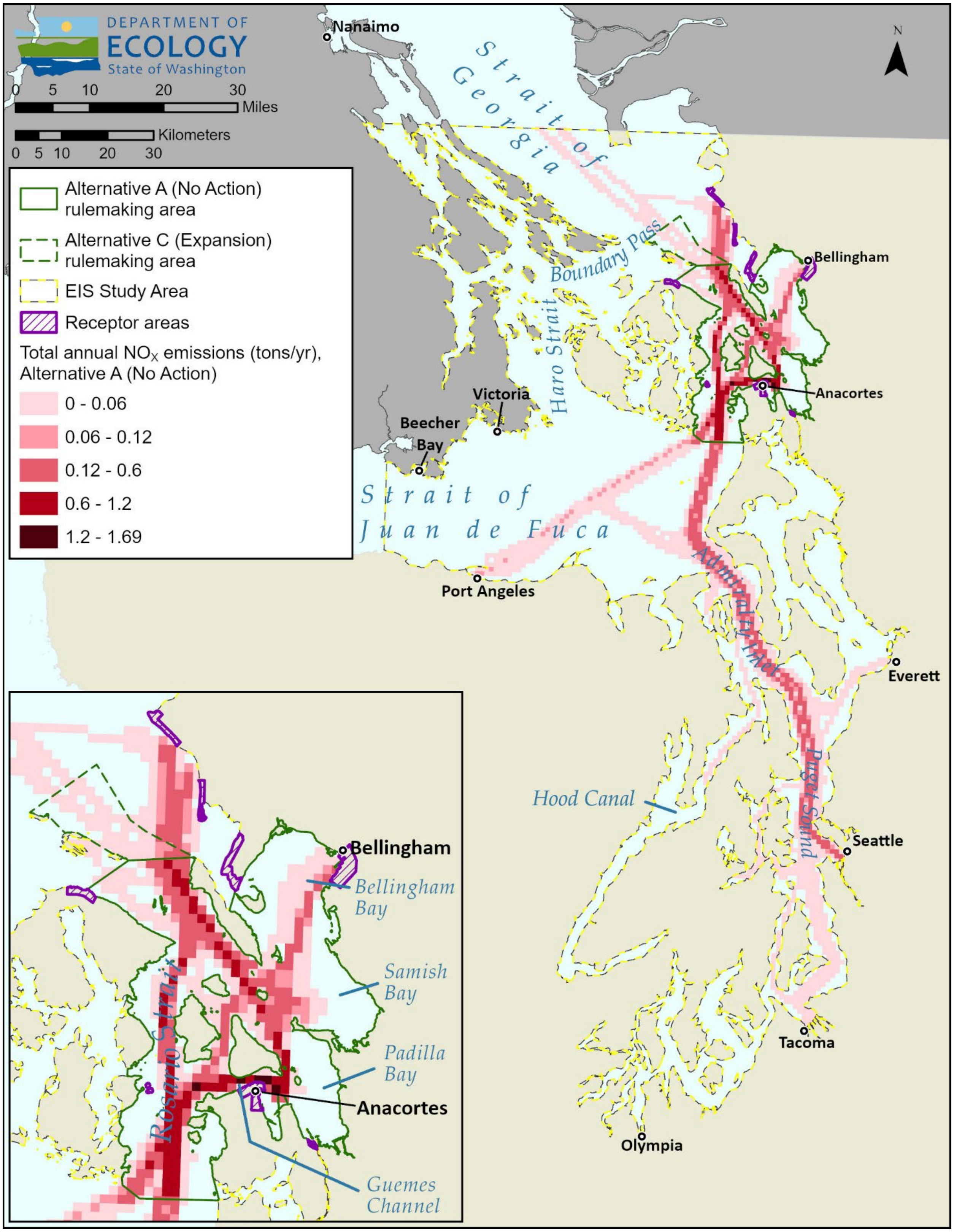


Figure 7. Annual escort tug NOx emissions in the EIS Study Area (existing conditions).

Table 8 presents the estimated annual escort tug emissions in tons per year (tpy) released within 5 kilometers (km) of each of the eight selected receptor areas under existing conditions. *(Note: The dispersion modeling effort included all escort tug emissions associated with the proposed rulemaking, not just those emitted within 5 km of receptor areas. This table is for illustrative and comparative purposes.)* Among the eight receptor areas, nearby emissions are generally highest at Anacortes and James Island. The 5-km radius around Buckhorn has very low emissions for all air pollutants, while all escort tug emissions are at least 5 km away from the Swinomish receptor area.

Table 8. Annual escort tug emissions (tpy) within 5 km of each receptor area (existing conditions).

Receptor Area	CO	NOx	$PM_{2.5}$	PM_{10}	SO_2	VOC	$CO2_e$
Anacortes	3.02	22.1	0.593	0.611	0.012	1.02	1,290
Bellingham	0.281	1.92	0.049	0.05	0.001	0.071	120
Buckhorn	0.015	0.102	0.003	0.003	0	0.004	6.22
Cherry Point	0.419	3.35	0.094	0.097	0.002	0.184	180
James Island	2.47	16.2	0.406	0.419	0.01	0.534	1,050
Lummi	1.02	6.62	0.164	0.169	0.004	0.204	437
Neptune Beach	1.26	8.67	0.223	0.23	0.005	0.331	539
Swinomish	0	0	0	0	0	0	0

3.1.4 Assessment of Current Air Quality Impacts from Escort tugs

Ecology then conducted dispersion modeling to estimate the airborne pollutant concentrations resulting from escort tug emissions under existing conditions, following the methodology summarized in Section 2.2 (Dispersion Modeling) and described in more detail in Attachment A.

Modeled concentrations for CO, $PM_{2.5}$, PM_{10}, and SO_2 are well below their corresponding SILs at all eight receptor areas, indicating that, under existing conditions, escort tug emissions have no potential to cause or contribute to a violation of the NAAQS for these pollutants. Among the eight receptor areas, modeled concentrations under existing conditions are generally highest at Anacortes, James Island, and Cherry Point, though the concentrations vary among individual receptor points in each receptor area (e.g., lower concentrations farther from the shoreline). Annual average concentrations are lowest at Bellingham, while peak day concentrations are generally lowest at Buckhorn. Refer to Attachment A for additional information.

Figure 8 illustrates the average peak day NO_2 concentrations from escort tug emissions at each receptor area. While annual average modeled concentrations for NO_2 were all well below the corresponding SIL, hourly peak-day NO_2 concentrations exceed the corresponding SIL (7.5 $\mu g/m^3$) in some or all of all eight receptor areas. Bellingham and Buckhorn are the only receptor areas where some individual receptor points do not exceed the hourly NO_2 SIL.

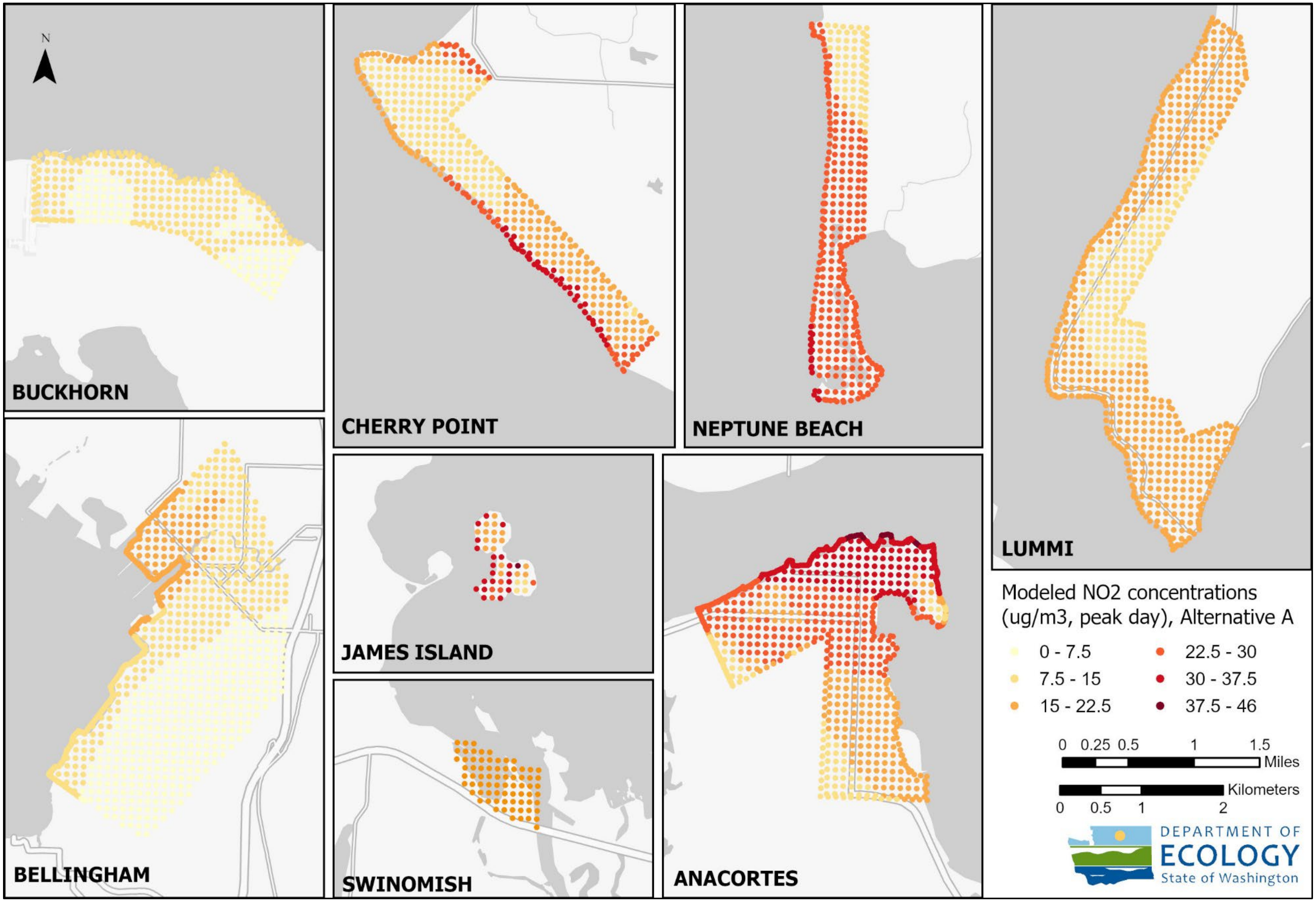


Figure 8. Modeled NO_2 concentrations ($\mu g/m^3$, peak day) resulting from escort tug emissions – Alternative A.

Because of these SIL exceedances, Ecology reviewed available air quality monitoring data and reports for NO_2 to provide further context on whether these existing escort tug emissions could potentially be causing or contributing to a violation of the hourly NO_2 NAAQS. Review of real-world air quality monitoring data in the region shows that air quality in the Puget Sound region continues to meet the NO_2 NAAQS by a wide margin (Puget Sound Clean Air Agency, 2024a). Additionally, NO_2 monitoring locations throughout the state exceeded the annual NAAQS less than 0.1 percent of the time from 2021-2023.

The highest value recorded in this time period was 78.5 parts per billion in downtown Seattle near the harbor and an interstate highway interchange. While the NO_2 monitoring network does not include full coverage of all areas or all potential sources of NO_2 in the state or EIS Study Area, it targets the most common sources of NOx and NO_2 (i.e., mobile sources) and is designed to capture peak hourly emissions events. While some locations are designated near-road monitors, they also represent urban conditions with nearby maritime-related activity. The Puget Sound area is home to significant marine vessel activity; current monitoring data already show that emissions from numerous vessel activities (including tug operations) do not currently cause exceedances of the NO_2 air quality standards. In fact, maritime-related NOx emissions have been steadily decreasing due to improvements in fuel efficiency and changes in operations (Northwest Seaport Alliance, 2024).

Annual average modeled $PM_{2.5}$ concentrations were compared to the $PM_{2.5}$ SIL and the diesel PM ASIL to understand the likelihood of NAAQS exceedance and TAP human health risk, respectively. The modeled $PM_{2.5}$ values are all well below the annual SIL (0.13 μg/m^3), indicating that existing escort tug activity has no potential to cause or contribute to a violation of the annual $PM_{2.5}$ NAAQS.

To understand the human health impact potential related to TAPs—and to recognize that human health impacts can occur even if pollutant levels are below the NAAQS—Ecology is using the $PM_{2.5}$ modeled results as a proxy for diesel particulate matter health impacts from escort tug emissions under the proposed rule.. Approximately 39 times lower than the SIL, the diesel PM ASIL (0.0033 μg/m^3) is a much more protective threshold. As a result, the majority of receptor areas have modeled $PM_{2.5}$ values exceeding the diesel PM ASIL. The highest annual average modeled $PM_{2.5}$ concentration, for any receptor area under existing conditions, is 0.01269 μg/m^3—approximately 3.8 times greater than the diesel PM ASIL.

As discussed in Section 2.2.3 (Human Health Impact Assessment), the ASIL is based on a very low risk threshold (one-per-million increased lifetime cancer risk) and assumes continuous lifetime exposure to the pollutant (i.e., 24 hours per day for 70 years). Because of the highly conservative nature of the ASIL, Ecology is considering the magnitude of ASIL exceedance to understand the relative likelihood of adverse human health impacts related to diesel PM. Because $PM_{2.5}$ calculations exceed the diesel PM ASIL by a factor less than ten, Ecology determined it is very likely that a more in-depth second tier review and health impact assessment (a requirement that does not apply to mobile sources under the Air Toxics Rule) would conclude that the escort tug emissions under existing conditions represent an "acceptable" health risk.

3.1.5 Air Pollutants from Oil Spills

Major oil spills in the EIS Study Area are rare events; however, a catastrophic oil spill is a high-impact risk to the many resources and recreational and commercial opportunities relied on by humans, wildlife, and flora of the area (Puget Sound Partnership, 2024). While impacts to water quality and marine health are major concerns, oil spills can have notable air quality impacts as well.

During an oil spill, air pollution can result from evaporated oil and occasionally from the spill cleanup response methods. In addition to weather and other outside factors, oil evaporation rates depend on the type, density, and even geographic origin of the oil. With VOCs comprising up to 75 percent of their weights, light diesel oil and gasoline spills evaporate quickly, and small spills may dissipate into the air within one day (BOEM, 2021; ITOPF, 2024; NOAA, 2006). Gasoline accounts for nearly 47 percent of all oil transferred by ATBs in Washington State. Heavy and sinking oils, including heavy crude oils and bunker fuels, are very slow to evaporate and are more likely to sink into the water column. While quick evaporation can lessen the net environmental impacts of the spill such as those to water quality and marine and shoreline species, the resulting vapors may increase human exposure to air pollutants, especially for spill response workers and nearby, downwind communities. Short-term impacts from exposure may include headaches, lightheadedness, difficulty concentrating, numbness, blurred vision, and/or memory loss (Krishnamurthy et al., 2019). 99 percent of the oil on escort tugs is diesel carried as fuel (the remaining 1 percent is primarily hydraulic oil) (Ecology, 2023a). Diesel and other persistent light oils are slower to evaporate than gasoline, but quicker than heavy and sinking oils, and may evaporate within a few days.

Response options to spills are dependent on a variety of factors, such as the type and amount of oil, proximity to the shoreline and sensitive areas, timing of the response, environmental conditions, and authorizations to use certain response methods. Examples range from physical containment (e.g., booms) to direct extraction (e.g., skimmers) and chemical dispersants. While deployment of dispersing chemicals can help reduce aerosolized VOCs, their use has been linked to an increase in PM (Afshar-Mohajer et al., 2018). Another spill response method that could have air quality impacts is in-situ burning, which involves setting the spilled oil on fire to minimize the water-based spread of oil. It is very rarely deployed in the marine environment and has never been used in Washington State. In-situ burning in the state would require approval from the Region 10 Regional Response Team before deployment in most areas. No Regional Response Team approval is required for areas more than 3 miles away from human population. In-situ burning provides clear benefits to wildlife, water quality, and coastal environments by reducing buildup and direct exposure to oil. However, it also poses air quality and associated health risks by releasing criteria pollutants and air toxics into the air. Health risks are greatest for site workers directly exposed to the vapor (Chen, Sandler, et al., 2023; Chen, Werder, et al., 2023). See Appendix C Environmental Health: Releases Discipline Report for more details on these and other oil spill response methods.

Studies on past marine oil spills, such as the over 130-million-gallon 2010 Deep Water Horizon (DWH) oil spill in the Gulf of Mexico, may provide some insights on the potential air quality and associated health-related impacts of oil spills. The DWH event involved a slow-evaporating and heavy crude oil. Chemical dispersants and in-situ burning methods were used to partially clean the spill, and approximately 40 percent of the oil ended up evaporating (French-McCay et al., 2021). Even though it constituted only a small portion of the cleanup efforts, in-situ burning for the DWH spill likely resulted in $PM_{2.5}$ concentrations well above the $PM_{2.5}$ NAAQS (Pratt et al., 2022). Also present in diesel oil, one of the DWH's most prevalent air toxics was naphthalene, a human carcinogen that damages the liver, kidney, and central nervous system (Montas et al., 2022). Studies focusing on long-term neurobehavior changes in DWH workers and first responders suggest there may be a direct relationship between high exposure to oil spill sites and decreased neurobehavioral functions such as attention span and memory (Chen, Werder, et al., 2023; Krishnamurthy et al., 2019). In the event of a spill in Washington State, regional response teams must follow the existing air quality monitoring and response worker safety protocols detailed within the Northwest Area Contingency Plan (Northwest Area Committee, 2024).

Large spills could result from incidents involving target vessels or escort tugs. Oil spills from target vessels, such as those carrying crude oil, would likely have a greater impact on air quality than spills from escort tugs due to the larger quantity that could be released. A spill from escort tugs would release diesel fuel in a smaller quantity than target vessels. Any release of oils or diesel fuel from target vessels and/or escort tugs would have a negative impact on air quality. However, many factors must be taken into account to predict the severity and extent of air quality impacts, including oil type. Additionally, factors such as the location and timing of a spill highly influence the trajectory of oil (and therefore the associated air pollutants).

Ecology performed oil spill trajectory modeling, which simulated the trajectory of worst case spills in locations where target vessel drift groundings have a relatively high likelihood of occurrence and where escort tug traffic is most concentrated. These simulations suggest that communities near a target vessel spill by Clark Island are at an elevated risk of being affected by air pollution, as target vessels are not required to have tug escorts in this area. Affected communities may include Lummi Island, Cherry Point, and Birch Point. Based on trajectory modeling of a target vessel spill at Matia Island, communities on the Southern Gulf Islands, parts of Victoria, the San Juan Islands, Lummi Island, and north of Neptune beach would be at an elevated risk of oil spill-related impacts. Looking at areas where tug escorts are currently required, the trajectory models also suggest that a major escort tug spill near Anacortes could impact air quality in shoreline communities of Guemes Island, Saddlebag Island, Hat Island, areas around Shamish Island, Chuckanut Bay, and other nearby communities. Finally, a simulated oil spill at Southern Rendezvous Point would potentially affect communities near Anacortes, Alexander Beach, and sparsely populated areas along the southern coast of Lopez Island. Oil spill risk is considered in detail in Appendix C Environmental Health: Releases Discipline Report.

3.2 Alternative A: No Action

3.2.1 Impacts from Implementation

Alternative A represents the most likely future conditions if we make no changes to existing tug escort requirements for target vessels. Tug escort requirements for target vessels would remain in place in the current rulemaking area as established by RCW 88.16.190(2)(a)(ii). As discussed above in Section 3.1.2 (Overview of Escort Tug Air Pollutants), existing escort tugs currently emit criteria pollutants (NOx, $PM_{2.5}$, PM_{10}, SO_2, and CO), VOCs, and HAPs throughout the EIS Study Area, including within a large region identified as an area of concern for ozone. These emissions would continue to occur under Alternative A, potentially resulting in continued minor impacts to air quality and haze levels in the EIS Study Area. Because escort tug emissions would remain stable, Alternative A would not advance State, regional, or port-specific criteria pollutant or air quality-related health goals.

Ecology's dispersion modeling analysis (see Section 2.2 (Dispersion Modeling)) concluded that existing escort tug emissions of criteria pollutants are not causing or contributing to any NAAQS violations, and that emissions of air toxics do not pose an unacceptable risk to human health. That would continue to be the case under Alternative A.

As discussed above in Section 3.1.2 (Overview of Escort Tug Air Pollutants), existing escort tugs currently emit approximately 12,000 TPY CO_2e of GHGs during operations. This is equivalent to the emissions from burning approximately 1,235,000 gallons of gasoline (EPA, 2024j) and represents approximately 0.99 percent of GHG emissions from marine vessels in the Puget Sound air basin (see Table 7). This would continue under Alternative A. With no changes to GHG emission quantities, Alternative A would not be inconsistent with Washington State's GHG reduction goals. Ecology acknowledges that climate change is actively impacting Washington's communities and ecosystems, and that steady GHG emissions contribute to climate change causes. Therefore, Alternative A would continue to contribute to the climate crisis by not decreasing escort tug GHG emissions.

Escort tug activity under Alternative A would continue to have beneficial impacts related to oil spill risks, compared to the risks associated with removing tug escort requirements under Alternative D. Under Alternative A, a target vessel drift grounding in the EIS Study Area would be a 186-year event. An oil spill from that drift grounding would be a 25,546-year event and could be a catastrophic oil spill that would negatively impact air quality. In this alternative, escort tugs have an incident rate of 0.86 per year. Potential incident types included in this rate range from equipment malfunctions and small fueling spills to collisions and groundings. These incidents generally have a lower spill potential than a catastrophic target vessel spill because the volume of oil on tugs (fuel) is much less than the volume carried by target vessels (fuel and cargo).

Under Alternative A, the existing spill risks and possible resulting air quality impacts discussed above in Section 3.1.5 (Air Pollutants from Oil Spills) would continue.

3.2.2 Proposed Mitigation Measures

Escort tugs under Alternative B are required to adhere to the required mitigation measures described in Section 3.2.2 for Alternative A. Ecology also recommends that they continue to implement the voluntary measures identified for Alternative A in Section 3.2.2.

Required Mitigation (Rulemaking or Other Existing Regulations)

Because the entire EIS Study Area is located within the Emissions Control Area under MARPOL, vessels operating in the region (including escort tugs) must use fuels with sulfur content not exceeding 0.10 percent mass-by-mass. This mandatory restriction is already followed by all escort tugs and other marine vessels operating within the EIS Study Area and reduces emissions of sulfur oxides and PM. The only marine diesel available in the U.S. for escort tugs is ultra-low sulfur diesel, which has 0.00015 percent sulfur, far lower than the ECA cap. Escort tugs are required to adhere to all applicable requirements regarding vessel speeds, which helps control air-related impacts to receptors. Escort tugs must also comply with all relevant federal and state vessel traffic safety and oil pollution prevention, preparedness, and response measures as well as with existing vessel traffic safety measures outlined in Appendix B Transportation: Vessel Traffic Discipline Report and requirements outlined under 46 Code of Federal Regulations Chapter I, Subchapter M.

Recommended Mitigation Measures

Ecology recommends that escort tug operators consider adopting lower and/or zero-emission propulsion for escort tugs to reduce GHG emissions, when the technological readiness and cost make this safe and feasible. Unlike for on-road vehicles, zero-emission alternatives may not be technologically feasible for marine vessels for several years (Northwest Ports Clean Air Strategy, 2020). Escort tugs and target vessels are recommended to implement any marina/port-specific measures aimed at reducing GHG emissions.

Additional mitigation measures and BMPs include vessel slowdowns, when safe and appropriate to do so. A recent study by the ECHO Program concluded that voluntary slowdowns could reduce criteria pollutant (NOx, PM, and SO_2) and GHG emissions from marine vessels by between 11 percent and 25 percent, depending on the pollutant and location (Vancouver Fraser Port Authority, 2023). Ecology recommends that escort tug operators continue their participation in voluntary slowdowns, including those led by the ECHO Program and Quiet Sound.

3.2.3 Significant and Unavoidable Adverse Impacts

Although existing escort tugs emit criteria pollutants (or their precursors), Ecology's analysis demonstrates that continued emissions under Alternative A would have no potential to cause a chronic or recurring increase in the frequency, severity, and/or extent of exceedances of any NAAQS. As discussed in Section 3.2.1 (Impacts), Alternative A would not be inconsistent with State, regional, or port-specific criteria pollutant or GHG emissions reduction plans. Ecology also determined that continuing escort tug TAP emissions under Alternative A would not result in TAP concentrations that could result in an increased lifetime cancer risk of more than ten per million. Given the above analysis, Alternative A would not result in significant and adverse impacts to air quality in the EIS Study Area.

3.3 Alternative B: Addition of Functional and Operational Requirements

3.3.1 Impacts from Implementation

Alternative B adds functional and operational requirements intended to increase safety and formalize existing best practices. It makes no change to the geographic boundaries described in Alternative A. These functional and operational requirements include 1) minimum either 2,000 or 3,000 hp requirements for the escort tugs based on the DWT of the escorted vessel, 2) minimum of twin-screw propulsion, and 3) a pre-escort conference between the tug and the escorted vessel.

Of the 18 tugs identified in the 2021 Vessel Traffic Trend Study (BPC & Ecology, 2021) as performing target vessel escort work, two are between 2,000 and 3,000 hp. Ecology reviewed the data used in this report and found that the escort tugs between 2,000 and 3,000 hp were only escorting target vessels under 18,000 DWT. The horsepower requirement codifies existing industry practices and ensures that tugs have sufficient power to intervene to prevent a drift grounding (and potential subsequent spill). Additionally, all 18 of the identified tugs meet the minimum twin screw propulsion requirement. These two requirements reflect today’s industry practices and are therefore unlikely to result in changes to the distribution of escort tugs and their associated impacts.

The addition of FORs would not be anticipated to have any meaningful changes in air pollutant emissions from escort tugs compared to Alternative A, since all escort tugs in the existing fleet already meet the proposed horsepower and propulsion requirements.

The addition of FORs could result in a minor but unquantified decrease in the risk of target vessel oil spills due to drift groundings but would not be expected to change the existing risk of a diesel fuel spill (and associated air quality impacts) from escort tug incidents.

3.3.2 Mitigation Measures

No additional mitigation measures outside of those included for Alternative A in Section 3.2.2 (Mitigation Measures) have been identified under Alternative B. Escort tugs and target vessels would adhere to required existing mitigation measures and requirements. Additionally, escort tugs and target vessels are encouraged to implement the recommended mitigation measures described in Section 3.2.2 (Mitigation Measures).

3.3.3 Significant and Unavoidable Adverse Impacts

As stated in 3.3.1 (Impacts), the addition of the FORs would not meaningfully change the anticipated types or quantities of air emissions relative to Alternative A. Additionally, Alternative B would not meaningfully change the predicted frequency or volume of spills from escort tugs and target vessels relative to Alternative A. Therefore, Alternative B would not have significant or unavoidable adverse environmental impacts on air quality.

3.4 Alternative C: Expansion of Tug Escort Requirements

3.4.1 Impacts from Implementation

Alternative C maintains the tug escort requirements outlined in Alternative A and expands them northwest towards Patos Island. Alternative C would result in a 2.41 percent increase in escort tug underway time. To put this into perspective of the change in overall marine vessel activity, escort tug underway time would represent approximately 0.99 percent of overall marine vessel activity with AIS in the EIS Study Area (up from 0.96 percent in Alternative A). The net increase in escort tug underway time would occur primarily within and near the expansion area (i.e., in the Strait of Georgia and the Strait of Georgia South Zones). Escort tug underway time in the rest of the EIS Study Area would decrease slightly or remain the same (see Figure 4). Alternative C also includes the FORs included in Alternative B.

As discussed in Section 3.3 (Alternative B: Addition of Functional and Operational Requirements (FORs)), FORs would not have any meaningful impact on the type, quantity, or frequency of escort tug-related emissions relative to Alternative A. However, the total quantities of emissions would change. Ecology estimated the annual emissions of criteria pollutants, VOCs, GHGs, and HAPs from escort tugs under Alternative C, following the methodology summarized in Section 2.1 (Quantification of Escort tug Emissions) and described in more detail in Attachment A. The results are presented in Table 9 along with the increase in emissions compared to Alternative A.

Overall, total annual quantities of emissions under Alternative C would be approximately 2.5 percent greater than emissions under Alternative A, with minor differences across pollutants. As expected, this increase is generally consistent with the 2.41 percent increase in escort tug underway time relative to Alternative A. This increase in emissions, while minor, would not further state and regional efforts to reach emissions reduction goals. Additionally, the increase would result in slight increases of escort tug contributions to haze-forming pollutants.

The GHG emissions from escort tugs under Alternative C (12,400 TPY CO_2e) would represent approximately 1.02 percent of GHG emissions from marine vessels in the Puget Sound air basin. The 317 TPY CO_2e (2.63 percent) increase in CO_2e emissions under Alternative C would be equivalent to burning an additional 32,360 gallons of gasoline (EPA, 2024j). Although this minor increase in emissions doesn't contribute to state emissions reduction goals, it does not significantly hinder state efforts to reach GHG emissions reduction goals. For perspective, the Washington State Climate Commitment Act includes reporting and cap-and-investment requirements for stationary facilities with annual emissions exceeding 10,000 metric tons CO_2e and 25,000 metric tons CO_2e, respectively. The increase in escort tug GHG emissions under Alternative C would be far below those thresholds (which do not apply to mobile sources).

Table 9. Annual escort tug emissions totals in the EIS Study Area from the proposed rulemaking (Alternative C) and comparison to total marine vessel emissions in Puget Sound air basin.

Pollutant	Alternative C Escort Tug Emissions (tons/yr)	Percent Increase Compared to Alternative A	2021 Marine Vessel Emissions in Puget Sound Air Basin (tons/yr)[a]	Escort tug % of Marine Vessel Emissions
Criteria Pollutants				
CO	29.0	2.63%	13,015	0.220%
NOx	192	2.59%	18,159	1.06%
PM_{10}	4.96	2.57%	331	1.50%
$PM_{2.5}$	4.81	2.57%	312	1.54%
SO_2	0.122	2.63%	369	0.03%
VOCs				
VOC	6.44	2.46%	1,970	0.33%
GHGs				
CH_4	0.122	2.46%	N/A	N/A
CO_2	12,200	2.63%	N/A	N/A
N_2O	0.620	2.59%	N/A	N/A
CO_2e	12,400	2.63%	1,218,437	1.02%
HAPs				
HAPs	0.806	2.48%	N/A	N/A

Source: a – (Puget Sound Maritime Air Forum, 2024)

Figure 9 and Figure 10 illustrate the locations and estimated annual NOx emissions from escort tug activity throughout the EIS Study Area under Alternative A and the change in these emissions between Alternatives A and C, respectively. While Figure 9 specifically depicts NOx emissions and the amounts of emissions would vary across the other pollutants, the spatial distribution and relative intensity of escort tug emissions throughout the EIS Study Area would be very similar across all pollutant categories. As shown in Figure 10, net increases in NOx emissions would occur north and west of Lummi Island, which is outside of the ozone area of concern. Alternative C would slightly decrease emissions of ozone precursors within the ozone area of concern. While the amounts of emissions vary across pollutants, the spatial distribution and relative intensity of emissions throughout the EIS Study Area would be very similar across all pollutant categories.

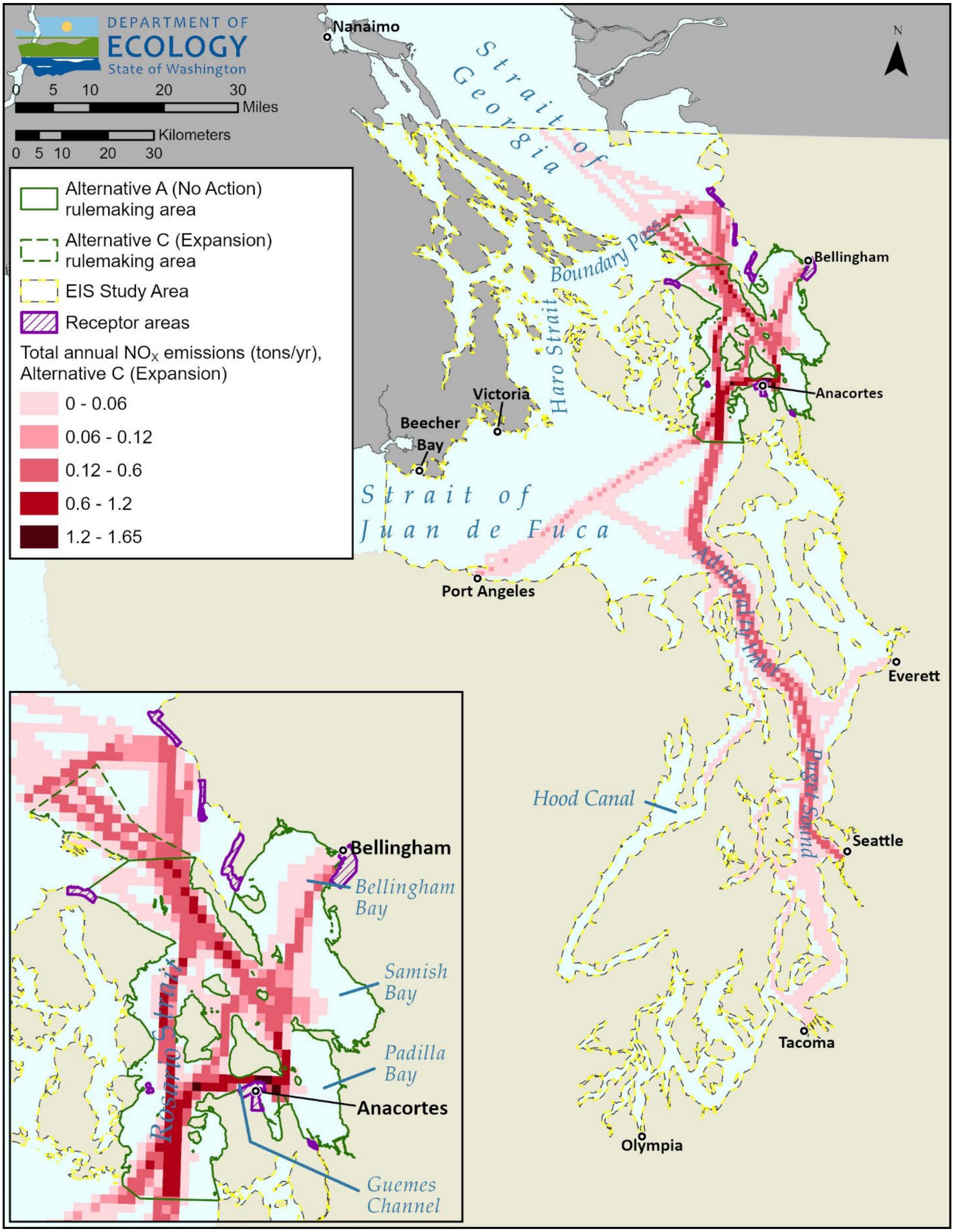


Figure 9. Annual escort tug NOx emissions in the EIS Study Area (Alternative C).

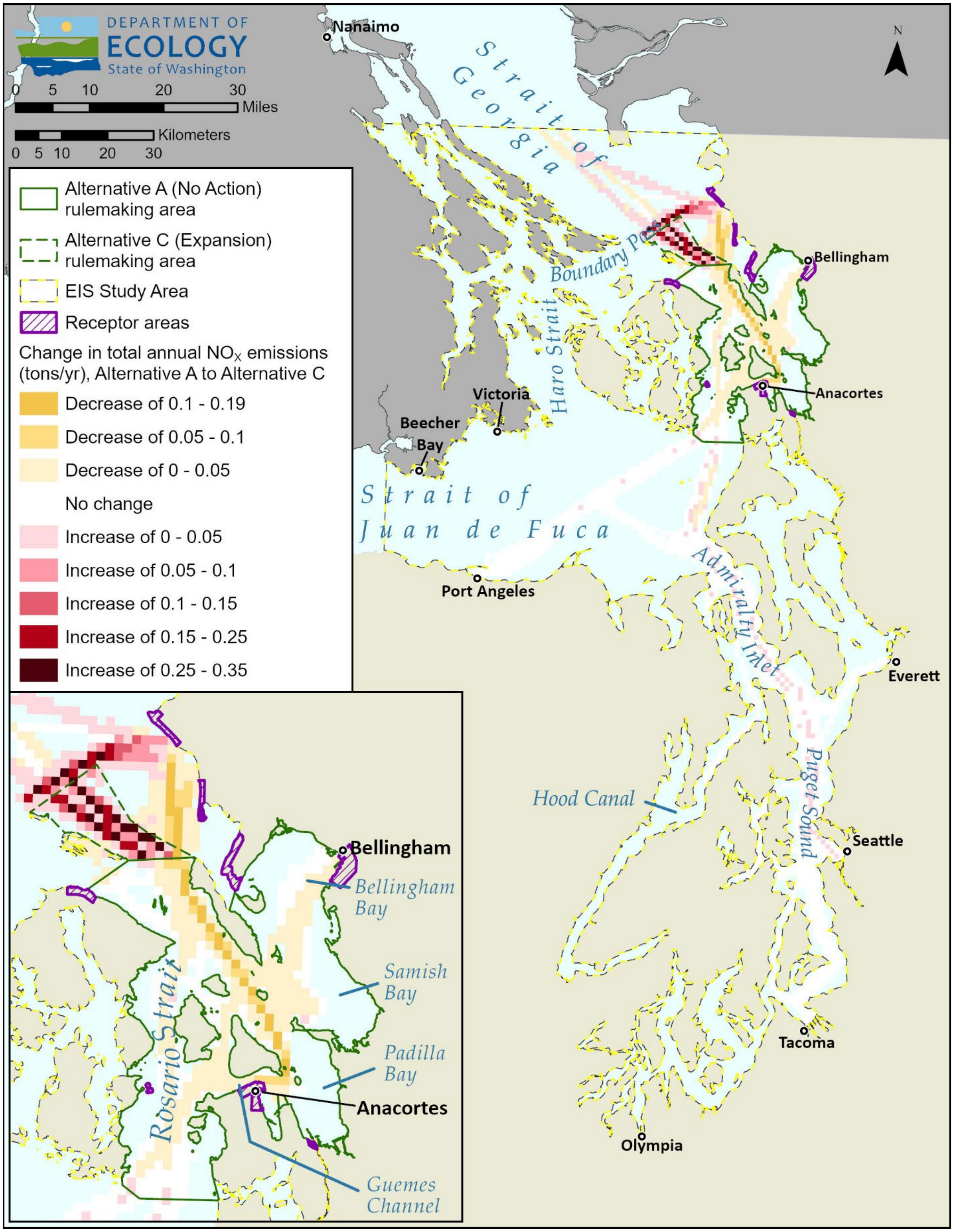


Figure 10. Change in annual escort tug NOx emissions between Alternative A and Alternative C. An additional accessible version of this map is available in Appendix M.

Table 10 presents estimated annual emissions that would be released within 5 km of each receptor area under Alternative C as well as the percent change from Alternative A to Alternative C. These “nearby” annual emissions would decrease under Alternative C for all receptor areas except Cherry Point, where the nearby emissions would increase by approximately 10 percent to 22 percent. There would be a substantial decrease in emissions near the Lummi and Neptune Beach receptor areas under Alternative C, because much of the nearby simulated escort tug activity under Alternative A would move further offshore under Alternative C.

Table 10. Annual emissions (tpy) within 5 km of each receptor area (Alternative C).

Receptor Area	CO	NOx	$PM_{2.5}$	PM_{10}	SO_2	VOC	CO_2e
Alternative C							
Anacortes	2.87	21.1	0.567	0.584	0.011	0.980	1,226
Bellingham	0.240	1.65	0.042	0.044	0.001	0.062	103
Buckhorn	0.013	0.093	0.002	0.002	0.000	0.004	5.75
Cherry Point	0.511	3.94	0.108	0.112	0.002	0.202	219
James Island	2.45	16.2	0.404	0.416	0.010	0.532	1,050
Lummi	0.799	5.19	0.128	0.132	0.003	0.161	341
Neptune Beach	0.844	5.84	0.151	0.155	0.003	0.227	361
Swinomish	0	0	0	0	0	0	0
Change from Alternative A to Alternative C							
Anacortes	-5.0%	-4.6%	-4.4%	-4.4%	-5.0%	-3.6%	-5.0%
Bellingham	-14.6%	-14.1%	-13.7%	-13.7%	-14.6%	-12.3%	-14.6%
Buckhorn	-7.6%	-8.6%	-9.2%	-9.2%	-7.6%	-11.5%	-7.7%
Cherry Point	21.8%	17.6%	15.5%	15.5%	21.8%	9.6%	21.8%
James Island	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%
Lummi	-21.8%	-21.6%	-21.5%	-21.5%	-21.8%	-20.7%	-21.8%
Neptune Beach	-33.1%	-32.7%	-32.4%	-32.4%	-33.1%	-31.3%	-33.1%
Swinomish	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Meanwhile, similarly to Alternative A, modeled concentrations for CO, $PM_{2.5}$, PM_{10}, and SO_2 under Alternative C would be all well below their corresponding SILs. This means that escort tug emissions would have no potential to cause or contribute to a NAAQS violation for these pollutants under Alternative C. Among the eight receptor areas, modeled concentrations under Alternative C are generally highest at Anacortes and James Island, though the concentrations vary among individual receptor points in each receptor area. The 5-km radius around Buckhorn has very low emissions for all air pollutants, while all escort tug emissions are at least 5 km away from the Swinomish receptor area. These results mirror the relative concentrations under Alternative A. Refer to Attachment A for additional information.

While annual average modeled concentrations for NO_2 under Alternative C were all well below the corresponding SIL, hourly peak-day NO_2 concentrations exceed the corresponding SIL (7.5

μg/m^3) in some or all of all eight receptor areas. As under Alternative A, Bellingham and Buckhorn are the only receptor areas where some individual receptor points do not exceed the hourly NO_2 SIL. Peak day NO_2 concentrations under Alternative C decrease by approximately 10 percent to 20 percent at Buckhorn and by approximately 10 percent at Lummi and Neptune Beach relative to Alternative A. Peak day NO_2 concentrations at Cherry Point increase slightly (by approximately 1 percent) and are unchanged at all other receptor areas under Alternative C. Ecology determined that, because the region currently meets the NO_2 NAAQS by a wide margin and modeled peak day NO_2 concentrations under Alternative C increase only slightly at one receptor area (Cherry Point) and decrease or are unchanged at all other receptor areas, Alternative C would not be expected to cause or contribute to a violation of the hourly NO_2 NAAQS.

Average annual concentrations for NO_2 and $PM_{2.5}$, which are the only two criteria pollutants with annual SILs, increase under Alternative C by approximately 10 percent at Buckhorn, 3 percent at Cherry Point, and 0.5 percent at James Island relative to Alternative A. Annual average concentrations of NO_2 and $PM_{2.5}$ at the other five receptor areas decrease under Alternative C by approximately 2 percent to 4 percent. Even with these changes, under Alternative C, the modeled $PM_{2.5}$ values were all well below the respective SIL. This indicates that, like under Alternative A, Alternative C escort tug activity has no potential to cause or contribute to a violation of the annual $PM_{2.5}$ NAAQS.

Like under Alternative A, modeled $PM_{2.5}$ emissions under Alternative C exceed the diesel PM ASIL by less than a factor of ten. Therefore, Ecology determined that a more in-depth second tier review and health impact assessment (that is not required for mobile sources) would conclude that escort tug emissions under Alternative C represent an “acceptable” health risk.

The rulemaking expansion under Alternative C would increase the geographic range of the existing tug escort requirements and therefore potentially decrease the risk of drift groundings. Under Alternative C, a target vessel drift grounding in the EIS Study Area would be a 189-year event and an oil spill from that drift grounding would be a 25,830-year event. These decreased risks, relative to existing conditions, thereby minimize the potential to adversely affect air quality due to oil spills.

Conversely, the expanded range of tug escort requirements and increase in escort tug activity would slightly increase the escort tug incident rate. In this alternative, escort tugs have an incident rate of 0.88 per year. Potential incident types included in this rate range from equipment malfunctions and small fueling spills to collisions and groundings. These incidents generally have a lower spill potential than a catastrophic target vessel spill because the volume of oil on tugs (fuel) is much less than the volume carried by target vessels (fuel and cargo).r. Ecology’s worst case discharge trajectory modeling suggests that a spill from an escort tug within the expanded rulemaking area could affect areas near Point Roberts, the Southern Gulf Islands, Strait of Georgia, Boundary Bay, Rosario Strait, Patos Island, Sucia Island, San Juan Islands, Waldron Island, and Orca Island, and therefore air quality around these areas.

3.4.2 Mitigation Measures

Escort tugs under Alternative C are required to adhere to the required mitigation measures described in Section 4.7.3.2 for Alternative A. Ecology also recommends that they continue to implement the voluntary measures identified for Alternative A in Section 4.7.3.2.

3.4.3 Significant and Unavoidable Adverse Impacts

Although escort tug activities emit criteria pollutants (or their precursors), these emissions under Alternative C would not be likely to cause a chronic or recurring increase in the frequency, severity, and/or extent of exceedances of any NAAQS. The increases in criteria pollutants and GHG emissions from escort tugs would be very minor compared to long-term trends showing substantial reductions in pollutant emissions from maritime activity since 2005 (Puget Sound Maritime Air Forum, 2024). These minor increases would not be substantially inconsistent with State emissions reductions plans or goals for criteria pollutants or GHGs. Similarly, increases in TAP concentrations would not be expected to result in an increased lifetime cancer risk of more than ten per million. Therefore, Alternative C would not have significant or unavoidable adverse environmental impacts on air quality.

3.5 Alternative D: Removal of Tug Escort Requirements

3.5.1 Impacts from Implementation

Alternative D removes the existing tug escort requirements for target vessels, eliminating escort tug underway time (and therefore emissions) associated with this proposed rule. We can reasonably assume that most or all of the 18 identified escort tugs would remain within the EIS Study Area but shift to other assisting and/or escort work for larger vessels. While the individual tugs may continue to have emit criteria air pollutants, air toxics, and GHGs, they would be unrelated to this rulemaking and are not considered in this EIS.

Alternative D would therefore support state, regional, and port-specific initiatives relating to reducing criteria pollutant and GHG emissions and would reduce ozone precursor emissions within Ecology's ozone area of concern. However, as discussed in Sections 3.1.3 (Assessment of Current Emissions from Escort tugs) and 3.1.4 (Assessment of Current Air Quality Impacts from Escort tugs), current escort tug activity does not cause or contribute to air quality concerns relating to exceeding national standards or causing human health impacts. Therefore, Alternative D would not be expected to result in a significant improvement in air quality in the EIS Study Area.

Under Alternative D, the probability of a target vessel drift grounding would increase by 11.84 percent within the EIS Study Area (relative to Alternative A) and by 90.50 percent within the rulemaking area. This would result in an increased risk of air pollution for communities near the EIS Study Area and particularly near the rulemaking area. Ecology's trajectory modeling suggests that a spill from a target vessel grounding would be more likely to affect areas such as Lummi Island, San Juan Islands, Rosario Strait, Eastern Strait of Juan de Fuca, Cherry Point, Strait of Georgia, Boundary Bay, Anacortes, Samish Island, Guemes Island, Guemes Channel and Saddlebags, Waters East, and Chuckanut Bay. Therefore, communities in and near these areas would be at an elevated risk for exposure to oil spill-based air pollutants, as would oil spill response workers. Further discussion of modeled spills and resulting environmental impacts are presented in Appendix C Environmental Health: Releases Discipline Report.

While the risk of major spills from target vessels would increase under Alternative D, the elimination of tug escort activity under Alternative D would also result in an eliminated risk of escort tug spill risk associated with this proposed rule.

3.5.2 Mitigation Measures

No additional mitigation measures for target vessels, other than the required and recommended measures included for Alternative A in Section 3.2.3 (Significant and Unavoidable Adverse Impacts), have been identified for Alternative D.

3.5.3 Significant and Unavoidable Adverse Impacts

Alternative D would result in an increased risk of catastrophic oil spills from target vessels and the air quality impacts from a spill and its response could be substantial. However, these impacts would be fairly short term and would be unlikely to substantially affect regional emissions reductions goals or cause chronic or recurring NAAQS exceedances. Also, the short-term exposure would be unlikely to meaningfully influence a cancer risk analysis, which is based on lifetime exposure to TAPs. Therefore, Alternative D would not have significant or unavoidable adverse environmental impacts on air quality.

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Attachment A: Technical Memorandum – Air Quality and Greenhouse Gases

Final

Technical Memorandum: Air Quality and Greenhouse Gases

Tug Escort Rulemaking Environmental Impact Statement

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

AERCOARE	American Meteorological Society/Environmental Protection Agency Coupled Atmosphere Response Experiment
AERMOD	American Mereological Society/Environmental Protection Agency Regulatory Model
AIS	Automatic Identification System
ASIL	acceptable source impact level
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalents
DWT	deadweight tonnage
EF	emission factor
EIS	Environmental Impact Statement
EPA	United States Environmental Protection Agency
GHG	greenhouse gas
g/kWhr	grams per kilowatt hour
HAP	hazardous air pollutant
hp	horsepower
hr	hour
IMO	International Maritime Organization
km	kilometer
kn	knot
kW	kilowatt
MERP	Modeled Emission Rate of Precursors
MMIF	Mesoscale Model Interface Program
MMSI	Maritime Mobile Service Identity
NAAQS	National Ambient Air Quality Standards
N_2O	nitrous oxide
NAD	North American Datum
NO_2	nitrogen dioxide
NOx	nitrogen oxides

(Continued)

PM	particulate matter
$PM_{2.5}$	particulate matter with a diameter of 2.5 micrometers or less
PM_{10}	particulate matter with a diameter of 10 micrometers or less
ppb	parts per billion
SIL	significant impact level
SO_2	sulfur dioxide
TAP	toxic air pollutant
tpy	tons per year
UTM	Universal Transverse Mercator
$\mu g/m^3$	micrograms per cubic meter
VOC	volatile organic compound
WRF	Weather Research and Forecasting

EXECUTIVE SUMMARY

The Washington State Department of Ecology (Ecology) has contracted ERG to develop an Environmental Impact Statement to evaluate the effects of changing tug escort requirements for certain "target vessels" in the Puget Sound. Target vessels include oil tankers of between 5,000 and 40,000 deadweight tons; and articulated tug barges (ATB) and towed waterborne vessels or barges greater than 5,000 deadweight tons that are designed to transport oil in bulk internal to the hull. ERG estimated and analyzed how changes in vessel operations, including number of tug escort trips and geographic distribution of escort tug underway time, would result in different air emissions from the escort tugs and, subsequently, how emissions changes would impact local air quality. Two regulatory alternatives were examined: Alternative A: No Action (current requirement in statute) and Alternative C: Expansion of Tug Escort Requirements, which includes an additional 28.9 square miles to the northwest boundary of the current tug escort requirement.

Using the modeled vessel activity from Ecology's risk model, ERG used the most recent U.S. Environmental Protection Agency (EPA) guidance to estimate air emissions for select criteria pollutants, greenhouse gases, and hazardous air pollutants for activities associated with Alternatives A and C. Then, AS1MET used the **A**merican Meteorological Society/**E**PA **R**egulatory **Mod**el (AERMOD) (American Meteorological Society & EPA, 2023) to estimate how these emissions would impact air concentrations of pollutants within and near several areas of particular interest. Annual emissions increase under Alternative C consistent with the 2.41 percent increase in escort tug underway time in Alternative C relative to Alternative A. Among the eight receptor areas, modeled concentrations are generally highest at Anacortes, James Island, and Cherry Point. Annual average concentrations are lowest at Bellingham, while peak day concentrations are generally lowest at Buckhorn.

ERG used EPA's National Ambient Air Quality Standards (NAAQS) significant impact levels (SILs) to assess whether emissions from tug escort requirements could adversely affect air quality in the form of a NAAQS violation. Modeled concentrations of carbon monoxide, particulate matter (PM) with a diameter of 2.5 micrometers or less ($PM_{2.5}$), PM with a diameter of 10 micrometers or less (PM_{10}), and sulfur dioxide are all well below their corresponding SILs, indicating that escort tug emissions have no potential to cause or contribute to a violation of the NAAQS for these pollutants under either alternative.

Hourly nitrogen dioxide (NO_2) concentrations modeled on the peak day exceed the corresponding SIL under both alternatives. However, a review of Ecology-managed air quality monitoring data indicates that NO_2 concentrations throughout the Puget Sound region are well below the NAAQS and are declining, despite nitrogen oxide emissions from extensive marine vessel activity (including tug escort activities). This suggests that continued escort tug emissions under Alternative A, and the modeled changes in those emissions under Alternative C, would not be expected to cause or contribute to a violation of the hourly NO_2 NAAQS.

The majority of receptors under both alternatives have annual average modeled $PM_{2.5}$ values exceeding the acceptable source impact level (ASIL) for diesel PM. ASILs are screening-level thresholds used under the Air Toxics Rule (WAC 173-460-090 to assess the potential health risk of air toxics emissions from a new or modified stationary air pollution source. However, the exceedances of this very conservative screening-level threshold are small enough to suggest that, if a second-tier health impact assessment were to be conducted pursuant to the Air Toxics Rule, it would conclude that the escort tug emissions represent an "acceptable" health risk under both alternatives. (Note: The Air Toxics Rule applies to the permitting of stationary sources and has no regulatory applicability to mobile sources or this rulemaking.)

1. INTRODUCTION

The Washington State Department of Ecology (Ecology) has contracted ERG to develop an Environmental Impact Statement to evaluate the effects of changing tug escort requirements for certain "target vessels" in the Puget Sound. Target vessels include oil tankers of between 5,000 and 40,000 deadweight tons; and articulated tug barges (ATB) and towed waterborne vessels or barges greater than 5,000 deadweight tons that are designed to transport oil in bulk internal to the hull. ERG used data from Ecology's risk model to evaluate how changes in tug escort requirements could impact escort tug underway time and distribution in the EIS Study Area. ERG expanded upon this foundation by estimating and analyzing how changes in escort tug operations, including number of tug escort trips and geographic distribution of escort tug underway time, would result in different air emissions from these vessels and, subsequently, how emissions changes would impact local air quality.

To examine air quality impacts, ERG estimated pollutant emissions from escort tugs[1] within the EIS Study Area for the following two rulemaking alternatives:

- Alternative A (No Action): Alternative A represents the most likely future conditions if we make no changes to existing tug escort requirements for target vessels. Tug escort requirements for target vessels would remain in place in the current rulemaking area as established by RCW 88.16.190(2)(a)(ii). Alternative A maintains current tug escort requirements for laden tank barges and articulated tug barges over 5,000 deadweight tonnage (DWT) and oil tankers between 5,000 and 40,000 DWT (hereafter referred to as the "target vessels") in Rosario Strait and connected waters east. This is the No Action Alternative and the current requirement in statute.

- Alternative C: Alternative C maintains the tug escort requirements outlined in Alternative A and expands them northwest towards Patos Island (approximately 28.9 square miles). Alternative C would result in a 2.41 percent increase in escort tug underway time. The net increase in escort tug underway time would occur primarily within and near the expansion area (i.e., in the Strait of Georgia and the Strait of Georgia South Zones), while escort tug underway time in the rest of the EIS Study Area would decrease slightly or remain the same (see Figure 6). Alternative C also includes the FORs outlined in Alternative B.

This analysis did not require estimation of pollutant emissions for tug escort requirements for the following two rulemaking alternatives:

- Alternative B (Addition of Functional and Operational Requirements (FORs)): Alternative B adds functional and operational requirements intended to increase safety and formalize existing best practices. It makes no change to the geographic boundaries of the RCW 88.16.190(2)(a)(ii) or the vessels to which it applies. The FORs include a pre-escort conference, minimum horsepower (hp), and propulsion specifications. ERG assumed that escort tug emissions under this alternative would be essentially identical to those under Alternative A. Ecology reviewed the existing escort tug fleet and found that for horsepower

[1] "Tug escort" herein refers to the act of a tug escorting a target vessel, inclusive of the act of commuting to and from the escort job. Unless specified otherwise, the terms "escort tug" and "tug escort" refer to the subset of overall tug escort activity or underway time for target vessels that are specifically affected by this rulemaking.

and propulsion specifications, the FORs are codifying existing industry practices. The pre-escort conference is not expected to affect emissions.

- Alternative D (Removal of Tug Escort Requirements): Alternative D removes the existing tug escort requirements for target vessels within the rulemaking area, eliminating escort tug underway time associated with this proposed rule. Escort tug emissions under this alternative would be zero. We can reasonably assume that most or all of the 18 identified escort tugs would remain within the EIS Study Area but shift to other assisting and/or escort work for larger vessels. While the individual tugs would continue to emit pollutants, they would be unrelated to this rulemaking and are not considered in this EIS.

Using the modeled vessel activity from Ecology's risk model, ERG used the most recent U.S. Environmental Protection Agency (EPA) guidance to estimate air emissions for select criteria pollutants, greenhouse gases (GHGs), and hazardous air pollutants (HAPs) for activities associated with Alternatives A and C. Then, AS1MET used the emissions data in a dispersion model to estimate how these emissions would impact air concentrations of pollutants within and near several areas of particular interest.

Section 2 of this report presents the methodology and assumptions used in estimating the pollutant emissions, conducting the dispersion modeling analysis, and comparing the results to various impact thresholds. Section 3 presents the results of the analysis, while Section 4 summarizes some brief conclusions.

2. METHODS

2.1 Study Area

The study area is the EIS Study Area shown in Figure 2-1. This study area encompasses the entirety of the rulemaking alternative boundaries and potential areas for escort tug commute routes to and from the alternative boundaries as well as immediately adjacent areas with potentially affected receptors. ERG estimated escort tug emissions within the entire EIS Study Area for Alternatives A and C. For the emissions dispersion modeling analysis, ERG and AS1MET modeled emissions from tug escort requirements within the dispersion modeling study area (a subset of the overall EIS Study Area) and evaluated the resulting air quality impacts at eight selected receptor areas of concern. These locations are shown in Figure 2-2.

ERG and AS1MET identified these eight receptor areas based on a review of factors including existing and/or projected tug escort operations, areas with relatively high levels of escort tug underway time under Alternative A and/or Alternative C, sensitivity to changes in air quality (e.g., presence of Environmental Justice communities and/or areas experiencing air quality-related health overburdens), Tribal reservations, areas of public interest, and availability of monitoring data to assist with characterizing existing air quality conditions.

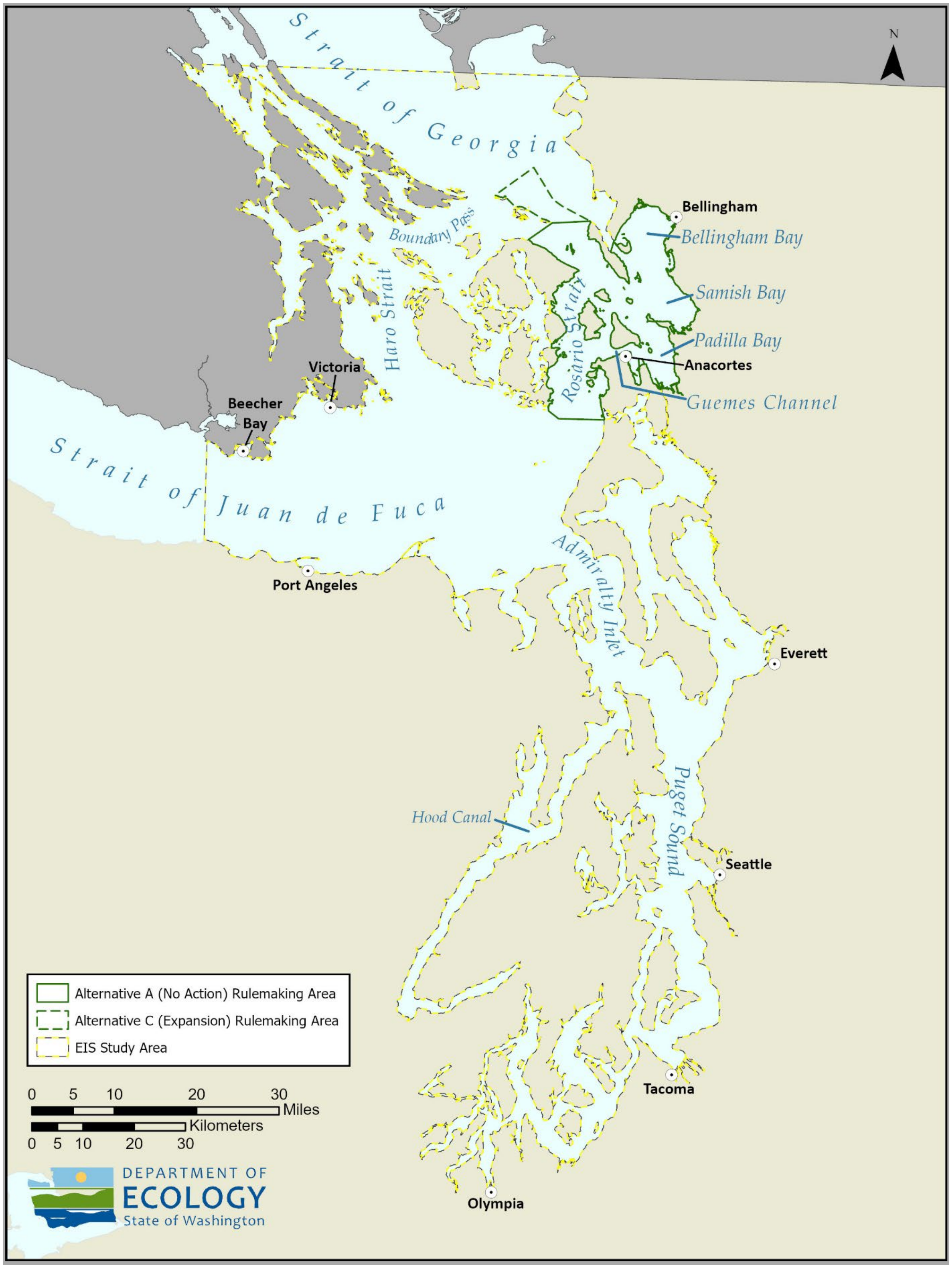


Figure 2-1. EIS Study Area

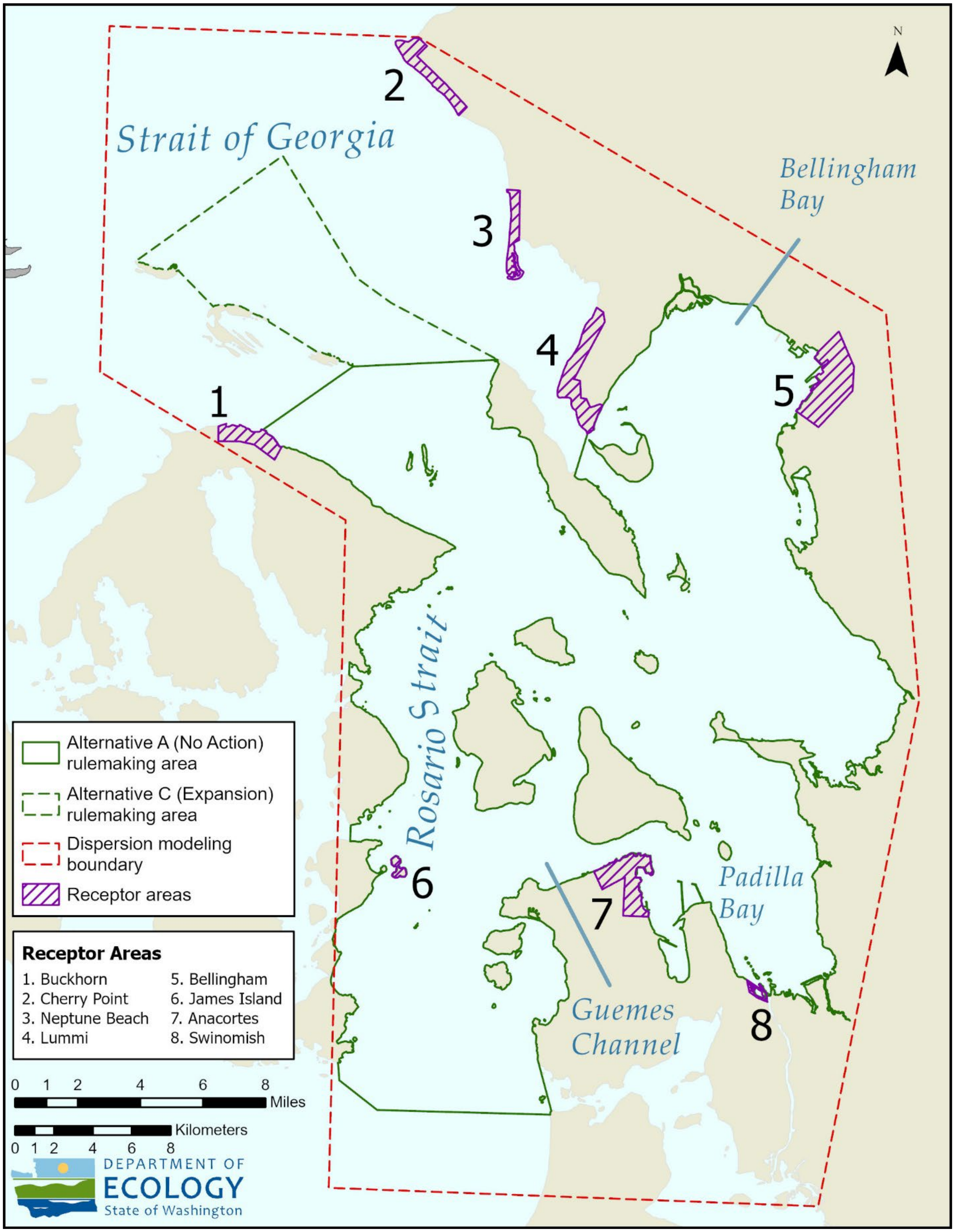


Figure 2-2. Receptor Areas for Dispersion Modeling

2.2 Quantification of Escort Tug Emissions Associated with the Proposed Rule

2.2.1 Vessel Activity – Hours and Spatial Distribution

Under Engrossed Substitute House Bill 1578, Ecology developed a model to simulate vessel traffic patterns and oil spill risk, including tug escort activity. The model was based on historical automatic identification system (AIS) data from 2015-2019 and was used to inform the 2023 Analysis of Tug Escorts for Tank Vessels. For the current EIS effort, Ecology used the model 1) to simulate the tracks of escort and assist[2] tug traffic, based on 2015-2019 historical AIS data, and 2) to simulate the current volumes of escort and assist tug traffic along these tracks while accounting for tug escort requirements that went into effect in 2020.

The model produced 1,000 annual simulations of escort and assist tug traffic. To represent current conditions and Alternative A (No Action), Ecology selected the simulation output with the highest amount of escort tug traffic (i.e., the "worst case scenario") to ensure that the EIS does not undercount potential environmental impacts and to account for other potential near-term growth in vessel traffic (e.g., traffic from the Trans Mountain Expansion). For Alternative C, Ecology modified the Alternative A simulated traffic outputs to account for the proposed changes in tug escort requirements under that alternative.

Ecology used 2023 historical AIS data (i.e., not simulated) to represent all vessel categories other than escort and assist tugs, with some adjustments to account for recreational and fishing vessels that are not equipped with AIS. Traffic for these other vessel categories did not require simulation because it would not change based on the rulemaking alternatives.

The simulation outputs are used here to show the differences in underway time for escort tugs under Alternative A and Alternative C. Figure 2-3 and Figure 2-4 show the results of these simulations, compiled to indicate the total minutes per year of escort tug underway time within each one-square-kilometer grid cell. Figure 2-5 depicts the change in escort tug underway time between Alternatives A and C. Escort tug activity under Alternative B would not be expected to be meaningfully different than under Alternative A, while Alternative D would result in zero tug escorts. Refer to the Transportation: Vessel Traffic Discipline Report for details regarding the vessels activity simulation methodology and results. This analysis used the model outputs representing simulated escort tug activity under Alternative A and Alternative C. These datasets do not include preexisting or other vessel traffic that is not impacted by the rulemaking alternatives.

The activity files mimicked the format of standard AIS data and contained the data elements listed in Table 2-1. The specific data elements used in this analysis included the coordinate locations, reported speed over ground, and duration as calculated by the time intervals represented by the AIS observations at 1-minute increments. The AIS data represent underway time, as records with speed less than 0.2 knots (kn) were culled from the dataset. The activity datasets included a total of

[2] In some datasets, escort tugs are referred to as "escort/assist tugs" in this analysis because the same vessels typically perform both escorting and assisting work. Ecology used the model to simulate traffic for both escorting and assisting work. However, Ecology's risk model allows us to separate out only the escort tug underway time associated with this rulemaking. Escorting of oil tankers over 40,000 DWT and all assist work would be unaffected by the proposed rulemaking.

610,107 records for Alternative A and 624,784 records for Alternative C, with each record representing 1 minute of escort tug activity at the specified coordinate locations.

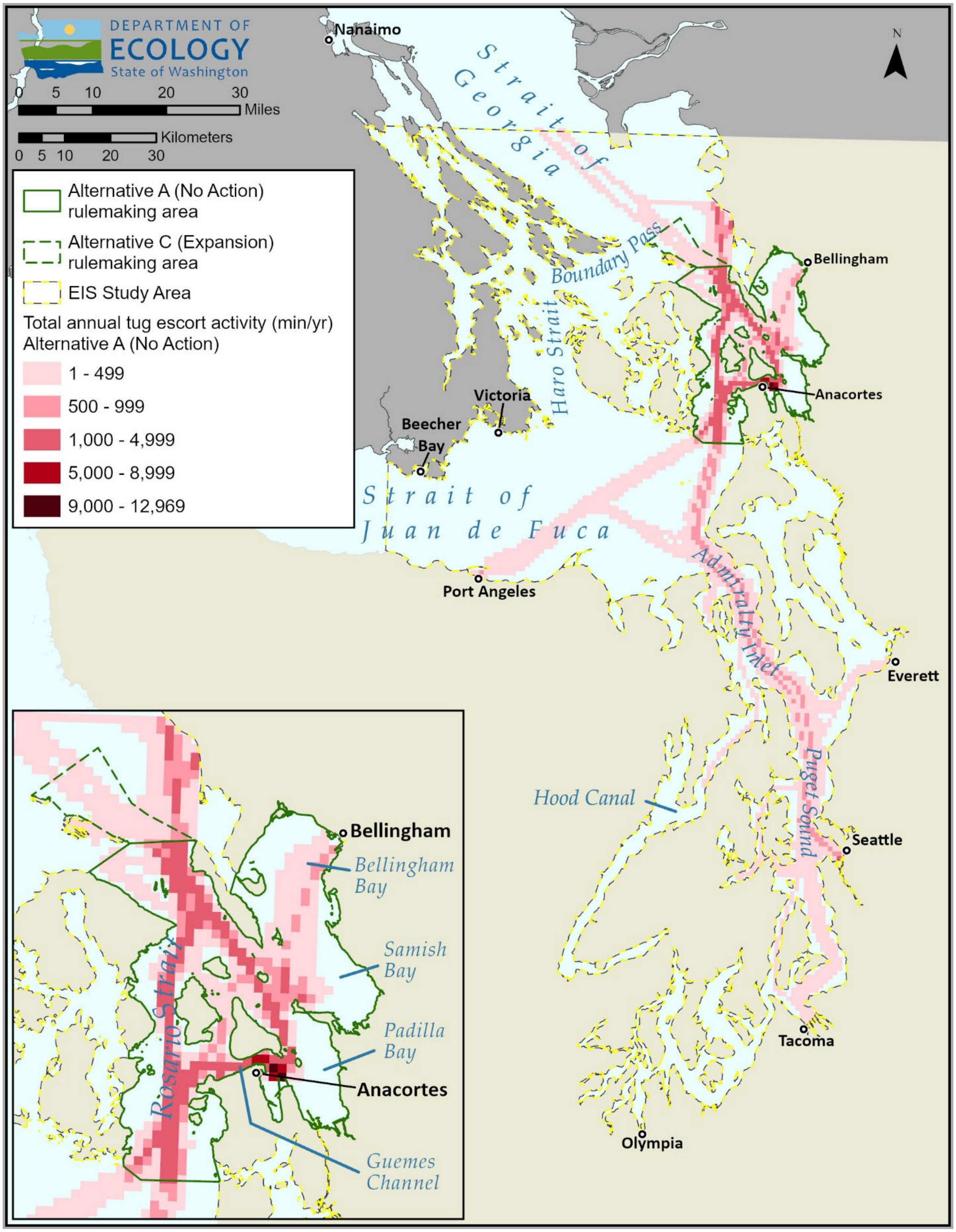


Figure 2-3. Simulated Escort Tug Underway Time Under Alternative A

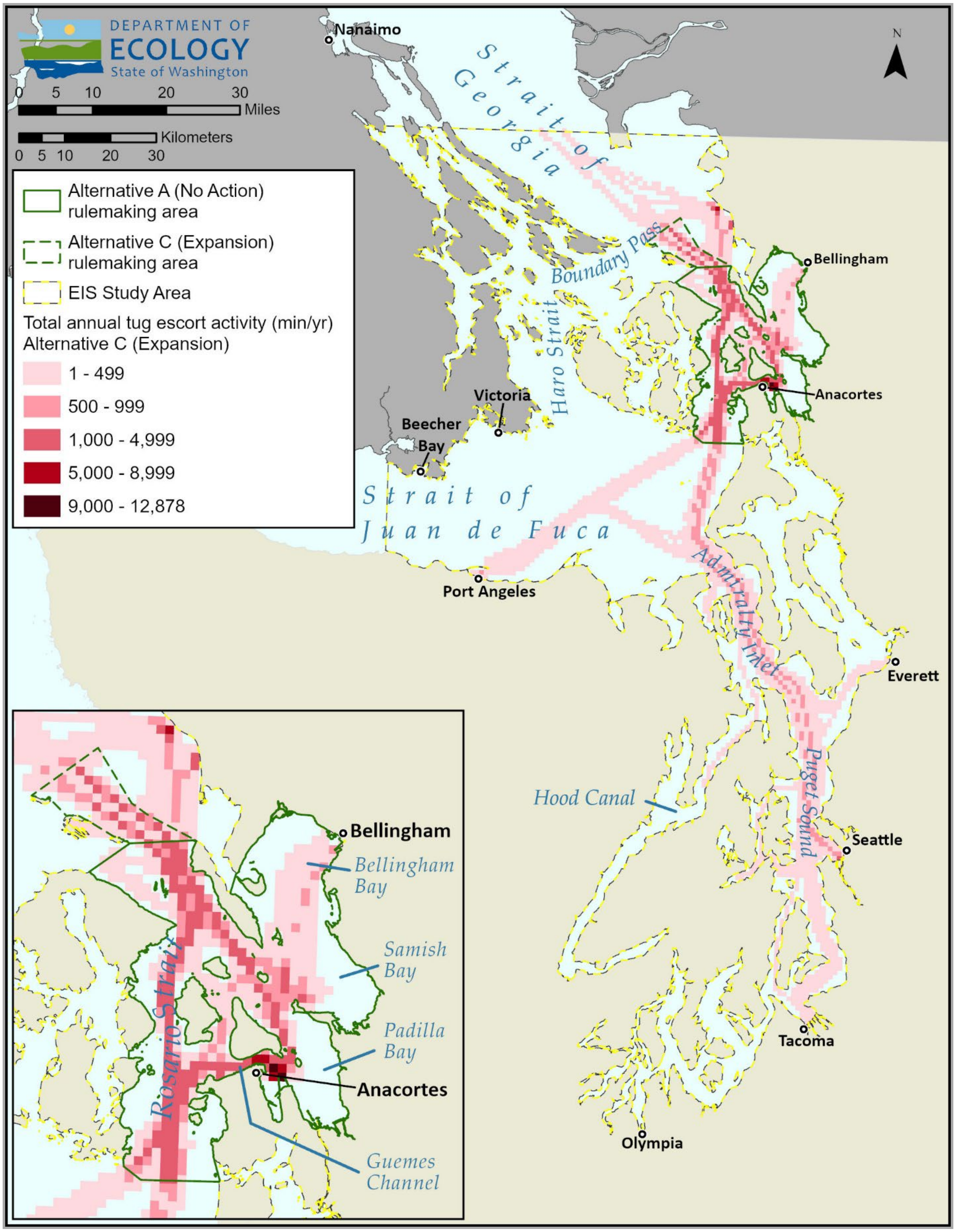


Figure 2-4. Simulated Escort Tug Underway Time Under Alternative C

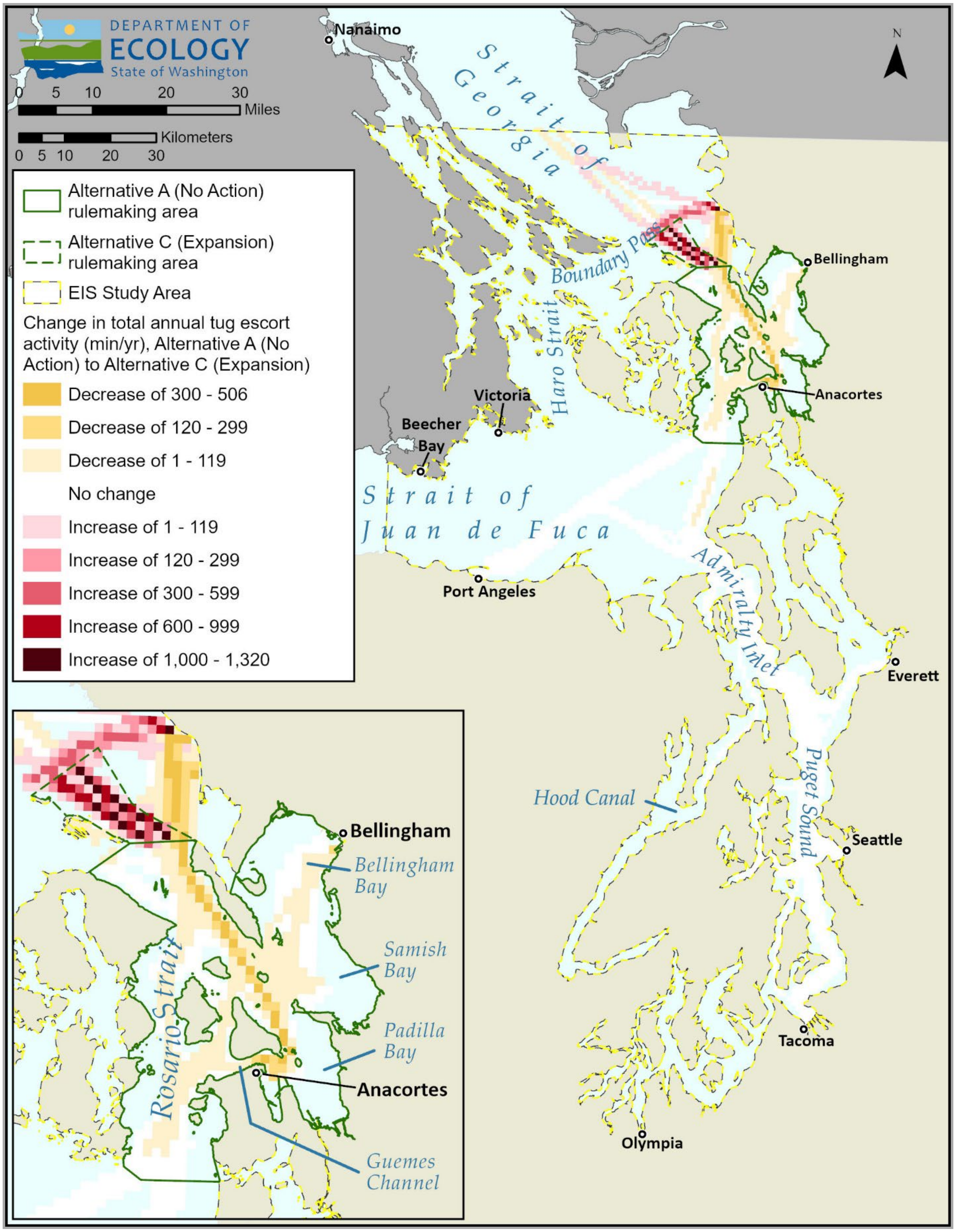


Figure 2-5. Simulated Change in Escort Tug Underway Time Between Alternative A and Alternative C. An additional accessible version of this map is available in Appendix M.

Table 2-1. Data Dictionary for Simulated AIS Data

Field	Description
TrackID	Unique identifier given to AIS tracks. Tracks generated by Ecology from MarineCadastre AIS data.
timeStep	The minute for the given point relative to the start of the model simulation.
X	X coordinate for vessel position in North American Datum (NAD) 1983 Universal Transverse Mercator (UTM) Zone 10.
Y	Y coordinate for vessel position in NAD 1983 UTM Zone 10.
ReportedSOG	Speed, in knots, reported in the original MarineCadastre AIS data

Because the simulated data represent only moving vessel activities, ERG conducted additional research into the idling practices of escort and assist tugs in the northwest. The 2021 Puget Sound Maritime Emissions Inventory report (Tables J.1 and J.2) indicates that propulsion and auxiliary engine hours of activity for assist/escort tugs are very similar: 2,763 and 2,856 hours, respectively. This is reflective of both engines running concurrently with a minimal amount of idling time at the beginning and end of each trip. Harbor vessel companies are also increasingly reporting adherence to best practices which include reduced idling and the resulting fuel efficiency improvements (Northwest Ports, 2021). According to the Northwest Clean Ports Strategy, several commercial vessels including tugs utilize shore power dockside, though it is unclear from available data if this includes the escort tugs affected by this rulemaking (Northwest Ports, 2020). Lastly, we consulted industry subject matter experts including a current Laker engineer with firsthand observation of tug operations who confirmed that dockside engine use is uncommon, with a preference toward utilizing shore power where available. Given these trends, dockside idling was not included in the emission calculations.

This analysis assumes that auxiliary engines are running concurrently with propulsion engines. This is consistent with hours of operation gained from vessel boarding surveys in recent inventory efforts, as noted above.

2.2.2 Vessel Activity – Characteristics

While the modeled AIS data represented the spatial and temporal aspects of escort tug operations, simulated transits are not tied to real vessels. Engine age and vessel engine power ratings are required to calculate emissions. To estimate the kilowatt rating of the tug engines, Ecology recommended using 18 tugs known to perform escort duties in the Pacific Northwest, as identified in Appendices P and Q of the 2021 Vessel Traffic Trend Study (Ecology & BPC, 2021). Vessel characteristics including propulsion engine power, service speed,[3] auxiliary engine power, and build year were collected from a variety of public resources including American Bureau of Shipping (*ABS Record*, 2025) and the U.S. Coast Guard's Port State Information Exchange (U.S. Coast Guard, 2025). The pertinent vessel characteristics gathered are shown in Table 2-2. This analysis assumes that, while the fleet conducting tug escort activity may have changed since the 2021 study (and may continue to change), the fleet will remain generally similar in composition and engine characteristics to those identified in the 2021 study.

[3] Service speed is a vessel's typical speed given normal engine load and typical conditions.

Table 2-2. Escort Tug Vessel Characteristics

Tug Name	Maritime Mobile Service Identity (MMSI)	International Maritime Organization (IMO)	Year Built	Propulsion (hp)	Service Speed (kn)	Auxiliary (hp)
Nanuq (Vanguard)	366760680	9178379	1999	10,192	14	510
Garth Foss	366767140	9070266	1993	8,000	15	601
Lindsey Foss	366767150	9070254	1993	8,000	15	483
Aware	366779430	9214408	2000	10,192	16	510
Response	366866930	9258806	2002	7,240	10	510
Tan'erliq	499929694	9178381	1999	10,192	15	510
Guide	366759530	9188556	1998	4,800	13*	-
Chief	366764740	9188582	1999	4,800	13*	-
Guard	366887300	9139830	1997	5,500	14*	282
Protector	366887970	9139828	1996	5,500	14*	282
Lynn Marie	366919770	9253583	2001	6,250	9	282
Henry Foss	366976870	8127555	1982	4,700	12	201
Wedell Foss	366976920	8127531	1982	4,700	12	201
Arthur Foss	366979360	8219011	1982	4,290	12	201
Brian S	366980250	8841943	1963	3,000	13*	161
Marshall Foss	366982320	8971877	2001	6,250	7	282
Olympic Scout	367183360	-	1976	2,250	13*	101
Dr Milton Waner	367741150	-	2010	4,000	13*	174
Average			**1993**	**6,103**	**13**	**330**

*Calculated hull speed

Propulsion engine service speed was not available from publicly available resources for seven vessels; in these cases, a substitute value was calculated using the hull speed formula, shown in Equation 1:

$$V_{hull} = 1.34 \times \sqrt{L_{WL}} \qquad \text{(Equation 1)}$$

Where:

V_{hull} = Hull speed[4] of the vessel (kn)

L_{WL} = Length of the vessel at the waterline (feet)

Once the vessel characteristics for the 18 vessels were identified, they were averaged to obtain a representative tug for use in the emissions calculations. The representative tug was a vessel with a 1993 build year, 6,103 hp propulsive engine, 330 hp auxiliary engine, and a service speed of 13 kn.

[4] Hull speed is the maximum vessel speed as determined by the length of the vessel. Hull speed is higher than the service speed, which optimizes engine operation and fuel efficiency and reflects a more typical vessel operation.

2.2.3 Emissions Calculations

Once the vessel's characteristics were finalized, emissions for each AIS observation were calculated using Equation 2:

$$E_i = T_i \times EF \times P \times L \qquad \text{(Equation 2)}$$

Where:

E_i = Emissions for interval *i*

T_i = Time for interval *i*, i.e., duration from previous AIS observation (hours, 60 min = hour [hr])

EF = EPA emission factor (EF) (grams per kilowatt hour [g/kWhr])

P = Engine power rating (kilowatts, 1 hp = 0.7457 kilowatts [kW])

L = Low load adjustment factor (unitless), where P < 0.2

EFs were obtained from EPA's most recent Port Emissions Inventory Guidance (EPA, 2022) for the following pollutants of interest shown in Table 2-3:

- Criteria pollutants: carbon monoxide (CO), nitrogen oxides (NOx), particulate matter (PM) with a diameter of 2.5 micrometers or less ($PM_{2.5}$), PM with a diameter of 10 micrometers or less (PM_{10}), and sulfur dioxide (SO_2)
- Volatile organic compounds (VOCs)[5]
- GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O)

Given the average build year of 1993, we used Category 1/Category 2[6] Tier 0 EFs, which apply to smaller vessels built before 2000 for which there are no regulations on NOx emissions.

[5] VOCs are carbon-containing compounds that evaporate at room temperature. Outdoors, they react with sunlight and nitrogen oxides to contribute to smog (i.e., tropospheric ozone).

[6] Category 1 engines are defined as having displacement below 7 liters per cylinder while Category 2 engines are defined as having displacement below 30 liters per cylinder and greater than or equal to 7 liters per cylinder. While displacement information wasn't available for the presumed fleet of 18 escort tugs, the U.S. marine fleet indicates that tugs are overwhelmingly Category 1 or 2 vessels.

Table 2-3. Category 1/Category 2 Propulsive and Auxiliary Emission Factors for Tier 0 Vessels

Pollutant	Emissions Factor (g/kWhr)
CO	1.612632
NOx	10.28152
PM_{10}	0.258902
$PM_{2.5}$	0.251135
SO_2	0.006246
VOC	0.295615
CH_4	0.005615
CO_2	679.47
N_2O	0.033228

Equation 3 is used to estimate the likely Power (P) applied for each vessel between consecutive AIS messages. Engine power depends on engine load. The load factor represents the percentage of the vessel's total installed power assumed to be used during that activity interval. Auxiliary engine power is represented by the first portion of Equation 3 below, with a default load of 0.43, consistent with the Puget Sound Emission Inventory (Puget Sound Maritime Air Forum, 2024). Propulsive power consumption is calculated using the Propeller Law, the second portion of Equation 3, which states that the load on a ship's engine is proportional to the cube of the propeller's rotational speed.

$$P = \mathrm{LF} \times P_{ref} = \left(\frac{V}{V_{ref}}\right)^3 \times P_{ref} \qquad \text{(Equation 3)}$$

Where:

P = Power per AIS message interval (kW)

LF = Load Factor

P_{ref} = Total Installed Propulsive Power (kW)

V = AIS reported speed (kn)

V_{ref} = Service Speed (kn)

The propeller law is most accurate when the ship is running at a steady state, such as at high speed and load. It is less accurate when the ship is running under partial loading conditions, such as at slower speeds or when maneuvering in port areas. The low load adjustment factor is a unitless factor which reflects increasing propulsive emissions during low load operations and is listed in Table 2-4 below.[7]

[7] At lower loads, the engine burns less to meet lower power demand, but air flow through the induction system is below the optimum design condition, leading to greater emissions. This inefficiency varies by individual pollutant and, for this effort, applies only to the pollutants listed in Table 2-4. Other pollutants would, therefore, have a low load adjustment factor of 1.0.

Table 2-4. Low Load Adjustment Factors

Load	$PM_{2.5}$	PM_{10}	NOx	VOC
0.01	7.29	7.29	4.63	21.18
0.02	7.29	7.29	4.63	21.18
0.03	4.33	4.33	2.92	11.68
0.04	3.09	3.09	2.21	7.71
0.05	2.44	2.44	1.83	5.61
0.06	2.04	2.04	1.6	4.35
0.07	1.79	1.79	1.45	3.52
0.08	1.61	1.61	1.35	2.95
0.09	1.48	1.48	1.27	2.52
0.1	1.38	1.38	1.22	2.18
0.11	1.3	1.3	1.17	1.96
0.12	1.24	1.24	1.14	1.76
0.13	1.19	1.19	1.11	1.6
0.14	1.15	1.15	1.08	1.47
0.15	1.11	1.11	1.06	1.36
0.16	1.08	1.08	1.05	1.26
0.17	1.06	1.06	1.03	1.18
0.18	1.04	1.04	1.02	1.11
0.19	1.02	1.02	1.01	1.05
0.2	1	1	1	1

Once the criteria pollutant, VOC, and GHG emissions were calculated, ERG estimated the HAP emissions. Appendix D of EPA's Port Emissions Inventory Guidance includes profiles to calculate HAPs as a speciation of VOC and $PM_{2.5}$ (EPA, 2022). ERG multiplied these HAP fractions by the emissions of their assigned basis pollutant to estimate HAP emissions throughout the entire EIS Study Area for both Alternatives A and C as shown in Equation 4 below.

$$E_{pc} = E_{Bp} \times SF_p \qquad \text{(Equation 4)}$$

Where:

Epc = Emissions for pollutant p and grid cell c

EBp = Emissions of basis pollutant B (i.e., VOC or $PM_{2.5}$) associated with pollutant p

SFp = EPA speciation factor for pollutant p

GHGs are also represented as carbon dioxide equivalents (CO_2e), calculated using the global warming potential of 28 and 265 for CH_4 and N_2O, respectively, according to Equation 5 below.

$$CO_2\ equivalents = CO_2e = CO_2 + (CH_4 \times 28) + (N_2O \times 265) \qquad \text{(Equation 5)}$$

The results of the emissions estimates are presented in Section 3.1 and in Supplement A, Table A-1.

2.3 Preparing Emissions Data for Dispersion Modeling

Air dispersion modeling of the escort tug emissions associated with the rulemaking alternatives was performed for CO, nitrogen dioxide (NO_2), $PM_{2.5}$, PM_{10}, and SO_2. For these pollutants, ERG summarized the emissions to grid cells within a fishnet encompassing the dispersion modeling area. As shown in Table 2-5, the size of the grid cells within the fishnet is variable as cells closer in proximity to the eight receptor areas are smaller than cells that are further away. This was done to reduce the processing time for dispersion modeling while retaining high spatial granularity, particularly close to the receptor areas. Larger grid cells were not permitted to overlap smaller grid cells within the fishnet. Smaller grid cells may extend beyond their associated proximity band to fill in gaps created by this rule. A section of the fishnet that surrounds the James Island receptor area is shown in Figure 2-6. The activity (kWhr) and emissions associated with simulated escort tug activity points within each resulting grid cell were summed and assigned to the grid cell's centroid and provided to AS1MET for dispersion modeling.

Table 2-5. Emissions Grid Cell Size by Distance to Receptor Area

Proximity to Receptor Area (km)	Grid Cell Size (m^2)
0 - 0.1	25
0.1 - 0.3	50
0.3 - 1.0	100
1.0 - 5.0	500
5.0 - 20	1,000
> 20	5,000

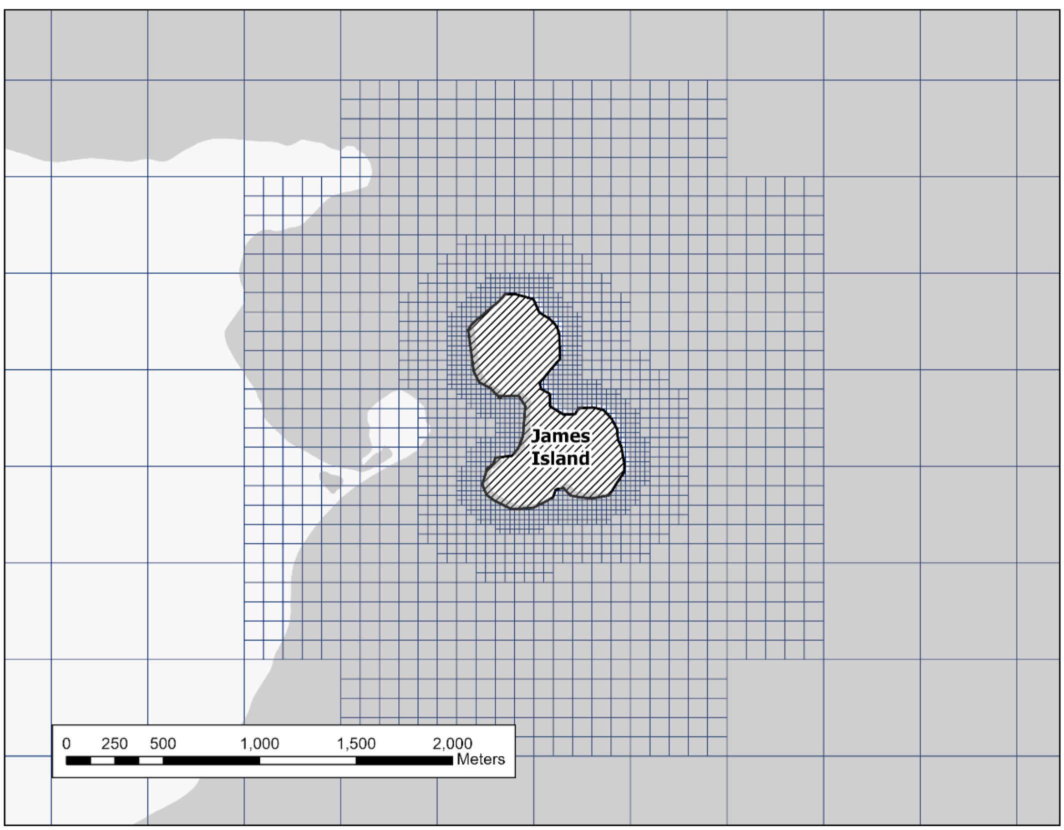


Figure 2-6. Example of Emission Grid Cell Sizes Around the James Island Receptor Area

ERG compiled the emissions estimates in this manner for two different timescales: annual and "peak day." To identify the individual simulation "peak day" for each receptor area—i.e., the day where nearby emissions are highest—the fishnet containing activity from the simulation data within 5 or 10 kilometers (km) of each receptor area was used to identify the maximum activity in kilowatt-hours for each alternative. [8] The "date" was calculated using the timestep, assuming the model began at midnight on New Years Day of a 365-day year. The activity data for each "date" were summed, and the date with the highest activity for each receptor was selected as the "peak day" for modeling purposes, as shown in Table 2-6 below. In all cases, the calendar date of the peak day was the same between Alternatives A and C. On these peak days, escort tug underway time under Alternative C increases near the Buckhorn, Cherry Point, and Neptune Beach receptor areas but decreases near the Lummi receptor area.

Using the data preparation method described above, ERG created emission grid fishnets for each peak day (Days 141, 167, 330, and 364) and provided these to AS1MET for dispersion modeling. These emission grids encompassed the entire dispersion modeling area and were not limited to the buffers used for purposes of identifying peak days.

Table 2-6. Identification of Peak Days for Each Receptor Area (Day 0 = January 1)

Receptor Area	Buffer	Simulation Day with Maximum Escort Tug Activity Within Buffer (i.e., Peak Day)		Escort Tug Activity Within Buffer on Peak Day (kWhrs)	
		Alternative A	Alternative C	Alternative A	Alternative C
Anacortes	5 km	364	364	17,297.74	17,297.74
Bellingham	5 km	141	141	2,747.23	2,747.23
Buckhorn	10 km	167	167	6,851.22	16,233.93
Cherry Point	10 km	330	330	7,167.25	8,925.14
James Island	5 km	364	364	14,411.16	14,411.16
Lummi	10 km	167	167	29,104.53	23,614.88
Neptune Beach	10 km	167	167	14,723.84	16,986.06
Swinomish	10 km	364	364	8,394.02	8,394.02

2.4 Dispersion Modeling

AS1MET conducted emissions dispersion modeling to predict air quality impacts of escort tug pollutant emissions under Alternative A and Alternative C at the eight selected receptor areas using the emissions quantified as described in Sections 2.2 and 2.3. This section describes the selected model, inputs, methods, and assumptions of the dispersion modeling.

2.4.1 Dispersion Model Selection

AERMOD is a steady-state plume dispersion model for assessment of pollutant concentrations from a wide range of source types and regulatory applications. Developed and promulgated as the preferred EPA model, AERMOD employs hourly sequential preprocessed meteorological data to determine concentrations from multiple point, area, or volume sources based on an up-to-date

[8] Some receptor areas had limited tug escort activity within 5 km or had substantial differences in tug escort activity between Alternatives A and C just beyond the 5 km boundary. In these cases, ERG evaluated tug escort activity within 10 km of the receptor area to identify the "peak day" for dispersion modeling purposes.

characterization of the atmospheric boundary layer. AERMOD is applicable to receptors in all types of terrain, including flat terrain, simple elevated terrain (less than height of stack), intermediate terrain (between height of stack and plume height), and complex terrain (above plume height). In addition, AERMOD provides a smooth transition of algorithms across these different terrains.

AERMOD Version 23132 was used for this study and represents the most recent regulatory version approved by EPA and Ecology for assessing mobile sources when this study was conducted (EPA, 2017). The model parameters specified for the modeled location, such as meteorological data, and receptor grid are discussed below.

2.4.2 Emissions and Source Characterization

Gridded escort tug emissions summaries Alternatives A and C were provided by ERG as described above. The emissions grid comprised the entire dispersion modeling area; however, only grid cells with non-zero emissions were included in the modeling. The escort tug emissions were modeled as a series of volume sources located at the centroid of each of the emissions grid cells. The horizontal dimension of the volume source was based on the grid cell sizes used in the emissions aggregation (see Table 2-7). An assumed release height of 15.24 meters (m) was modeled, which accounts for the tug exhaust release height plus initial vertical plume rise from the exhaust. An initial vertical dispersion height of 3.54 meters was assumed to account for vertical distribution of the plume. Figure 2-7 provides an example layout of the modeled emissions and receptors for Alternative A. For the short-term (peak day) analyses, modeled hourly emissions were based on uniformly distributing the maximum daily emissions over 24 hours per day. This is appropriate as tug escort operations are on-demand, operating 24 hours a day as needed.

Table 2-7. Modeled Source Characterization of Escort Tug Emissions by Proximity to Receptor Areas

Source Description	AERMOD Source Type	Distance from Emissions Grid to Receptor Area (m)	Release Height (m)[a]	Emissions Grid Cell Size (m)	Initial Lateral Dimension[b] (m)	Initial Vertical Dimension[a] (m)
Tugboat Exhaust	Volume	100	15.24	25	11.63	3.54
		300		50	23.26	
		1,000		100	46.51	
		5,000		500	232.5	
		20,000		1,000	232.5[c]	
		> 20,000		5,000	232.5[c]	

Notes:

a. Release height and initial vertical dimension are consistent with recent west coast port-related EIS efforts (Port of Los Angeles, 2023). The initial vertical dimension of the plume was estimated by dividing the initial vertical thickness (15.24) by 4.3 for elevated releases not on or adjacent to a building.

b. The lateral dimension of the plume was based on dividing the horizontal emissions grid cell size by 2.15 to account for multiple adjacent/overlapping volume sources.

c. For emission grid cell sizes > 500m, the lateral dimension was limited to 232.5m to avoid unreasonably large volume sources in the model. This is conservative as it compresses the emissions into a smaller volume than the entire emissions grid box.

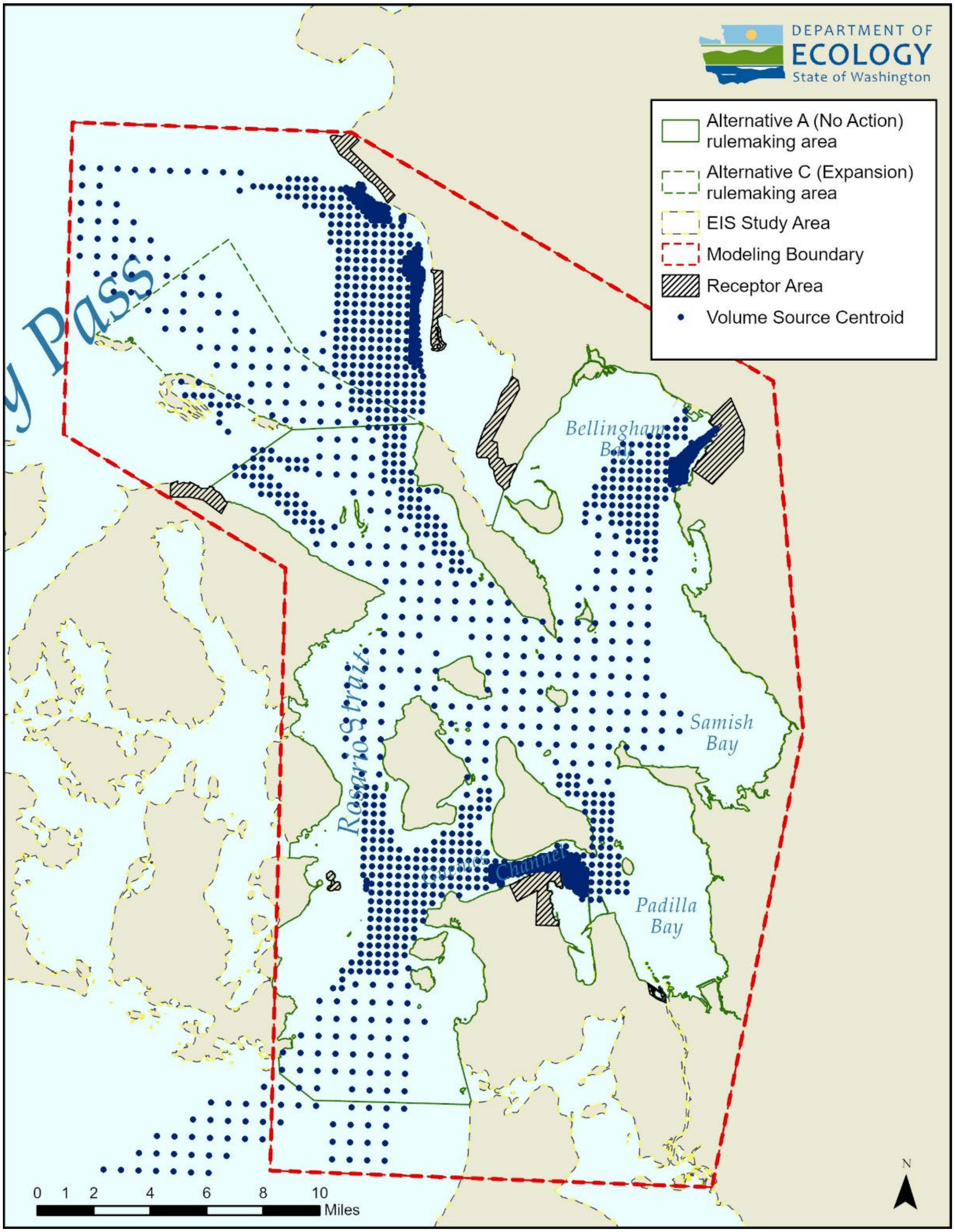


Figure 2-7. Modeled Volume Source Centroids and Receptor Locations (Alternative A)

2.4.3 Meteorological Data

The meteorological dataset was prepared by Trinity Consultants (Trinity). Trinity performed an evaluation of available overwater meteorological data sources within the modeling domain and determined that none of the nearby available data buoys or marine meteorological measurement stations along the coast collect the full set of necessary parameters for the American Meteorological Society/EPA Coupled Ocean Atmosphere Response Experiment (AERCOARE). Consequently, Trinity used Version 4.4 of the Weather Research and Forecasting (WRF) model to obtain site-specific prognostic meteorological data as authorized by EPA in the 2017 revision to the *Guideline on Air Quality Models* (EPA, 2017). The WRF model provides output for all important overwater meteorological variables needed for AERCOARE, including sea surface temperature and near-surface air temperature.

The WRF center point location was chosen as 48.635 N, 122.647 W, at the junction of Rosario Strait and Bellingham Bay and within 4 km of three different islands. This location was chosen as it is centrally located within the modeling domain and assumed to be generally representative of escort tug emissions transport over the study area. Due to the complex terrain surrounding the site, the WRF model was run using a finer 4-km domain resolution as opposed to the more typical 12-km resolution.

Trinity used EPA's recommended procedures for preparing AERMOD-ready meteorological data using the Mesoscale Model Interface Program (MMIF) Version 4.0 (Karamchandani et al., 2022). MMIF was used to extract raw meteorological data from the WRF model, then the raw data were processed through AERCOARE to produce the AERMOD-ready meteorological file. Specifically, the AERCOARE meteorological preprocessor was used to calculate the marine boundary layer parameters such as surface friction velocity and Monin-Obukhov length for AERMOD using overwater meteorology.

For this study, one year's worth of meteorological data for 2023 was processed for input to AERMOD. While EPA recommends that three years of WRF prognostic data be used for regulatory applications, an abbreviated dataset was developed to correspond with the single year of modeled "worst case" escort tug activity data.

2.4.4 Pollutant Conversion and Secondary Formation

In addition to modeling how emissions are transported across the landscape, AERMOD also addresses two additional considerations regarding NOx and $PM_{2.5}$. The escort tug emission contributions are expressed as NOx; however, the air quality criteria used to evaluate the emissions' air quality impacts are based on NO_2.[9] AERMOD takes the NOx emissions input and converts it to NO_2 using the Ambient Ratio Method. This default option incorporates a variable ambient ratio that is a function of model-predicted 1-hr NOx concentration based on an analysis of historical hourly ambient NOx monitoring data. This is a conservative approach to atmospheric formation of NO_2 from NOx as it relies on available ozone in the atmosphere and the project study has relatively low ozone concentrations. Therefore, model-predicted concentrations of NO_2 are likely overestimated.

[9] Nitrogen oxides (NOx) is a collective term used to refer to nitrogen monoxide (nitric oxide or NO) and nitrogen dioxide (NO_2)

ERG's approach also addresses secondary $PM_{2.5}$ formation due to atmospheric chemical reactions of precursor emissions of NOx and SO_2. EPA has established the Modeled Emission Rate of Precursors (MERPs) VIEW Qlik webpage, which provides an illustrative tool to provide access to EPA's hypothetical single source modeled impacts of $PM_{2.5}$. The development of the tool and related guidance is summarized in a memorandum from EPA (EPA, 2024).

Table 2-8 presents the results of the Tier 1 analysis using Alternative C emission totals of NOx (191.8 tons per year [tpy]) and SO_2 (0.1 tpy) assuming a worst-case hypothetical stack 3.0 meters tall. The worst-case MERP concentration is based on the ratio of Alternative C emission totals to the MERP values. Assuming domain-wide emissions come from a single stack results in a highly conservative estimate of secondary $PM_{2.5}$.

Table 2-8. Secondary $PM_{2.5}$ Impact Estimate

Precursor	Alternative C (tpy)	MERP Value*		Total Secondary Value (µg/m^3)	
		24-hr	Annual	24-hr $PM_{2.5}$	Annual $PM_{2.5}$
Nitrogen Oxide (NOx)	191.8	2,649	10,397	0.08725	0.00370
Sulfur Dioxide (SO_2)	0.11	359	1,820		

* source selection = worst-case (3.0 meter stack)

2.4.5 Receptor Grid

A Cartesian receptor grid was modeled that encompassed the eight selected receptor areas. For areas where escort tug operations were within 300 meters of the shoreline, a 25-meter grid was modeled. For receptor areas where the nearest activity was beyond 300 meters, a 100-meter shoreline receptor grid was used. All areas used a 100-meter receptor grid within the area itself.

All modeled receptors were assumed to be at ground level, with elevations determined from U.S. Geological Survey National Elevation Dataset files using the AERMOD Terrain Preprocessor (AERMAP, version 18081) (EPA, 2018). All coordinates were referenced to UTM NAD83, Zone 10. AERMOD averaging times were selected to match the form of the National Ambient Air Quality Standards (NAAQS) and air toxics standards: 1-hour (NO_2, SO_2, CO), 3-hour (SO_2), 8-hour (CO), 24-hr (PM_{10}, $PM_{2.5}$), and annual (NO_2, $PM_{2.5}$).

2.4.6 Impact Thresholds

Potential to Result in NAAQS Violations

ERG used EPA's NAAQS significant impact levels (SILs) to assess whether escort tug emissions could adversely affect air quality in the form of a NAAQS violation. The SILs, which are listed in Table 2-9, are a compliance demonstration tool that can be used to help assess the potential air quality impacts from a proposed stationary source. If dispersion modeling determines that the source's emissions would result in criteria pollutant concentrations below the corresponding SIL, this would indicate that the source has no potential to cause or contribute to a NAAQS violation. Modeled concentrations that exceed the SIL could indicate the need for additional air quality analyses as part of the permitting process.

The SILs and corresponding regulations only apply to the permitting of stationary sources and have no regulatory applicability to mobile sources or this rulemaking. ERG nonetheless considered the SILs to be reasonable screening-level indicators of potential air quality impacts from escort tug emissions because the impacts of criteria pollutants are presumed to be identical, regardless of whether they were emitted from a stationary or mobile source (e.g., escort tug).

Table 2-9. Modeled Air Pollutants and Corresponding NAAQS SILs

Pollutant	Averaging Period	SIL (µg/m^3)
CO	1-hr	2000
	8-hr	500
NO_2	1-hr	7.5*
	Annual	1
PM_{10}	24-hr	5
$PM_{2.5}$	24-hr	1.2
	Annual	0.13
SO_2	1-hr	7.8*
	3-hr	25

* Interim SIL

Human Health Risk

ERG used Ecology's acceptable source impact level (ASILs) to assess whether escort tug emissions could result in an unacceptable human health risk from exposure to toxic air pollutants (TAPs). ASILs, which are listed in WAC 173-460-150, are screening-level thresholds used to assess the potential health risk of a new or modified stationary air pollution source undergoing review for a Notice of Construction permit. ASILs indicate the TAP concentration that would result in an increased lifetime cancer risk of more than <u>one per million</u>, assuming continuous lifetime exposure for 70 years. If a screening-level review determines that the source's emissions would result in TAP concentrations below the ASIL, the health risks would be considered acceptable. If the TAP concentrations exceed the ASIL, the stationary source would require a more in-depth second tier review and health impact assessment, per the Air Toxics Rule (WAC 173-460-090). If this second assessment indicates that the stationary source's TAP emissions are not likely to result in an increased lifetime cancer risk of more than <u>ten per million</u> (i.e., ten times greater risk than is represented by the ASIL), the health risks would be considered acceptable.

For this analysis—which is not subject to the air toxics regulations—ERG chose a simplified version of the stationary source risk assessment described above. Specifically, ERG assumed that the air toxics emissions would be considered "acceptable" if the modeled air toxics concentrations were less than 10 times the ASIL.

Because escort tugs emit PM from the combustion of diesel fuel, ERG selected diesel PM (a TAP) as the representative pollutant for this air toxics analysis. ERG conservatively assumed that all modeled $PM_{2.5}$ would be considered diesel PM, and compared the modeled $PM_{2.5}$ concentrations at each receptor area against the diesel PM ASIL of 0.0033 micrograms per cubic meter (µg/m^3). As described above, if the modeled $PM_{2.5}$ concentrations were less than 10 times the ASIL, ERG concluded that the increased lifetime cancer risk would not be more than ten per million (and would therefore be considered "acceptable").

The ASILs and air toxics regulations only apply to the permitting of stationary sources and have no regulatory applicability to mobile sources or this rulemaking. ERG nonetheless considered the ASILs to be reasonable screening-level indicators of potential human health impacts from exposure to escort tug emissions because the impacts of TAPs are presumed to be identical, regardless of whether they were emitted from a stationary or mobile source (e.g., escort tug).

3. RESULTS

3.1 Quantification of Escort Tug Emissions Associated with the Proposed Rule

Total annual emissions of criteria pollutants, VOCs, GHGs, and HAPs within the EIS Study Area under Alternative A and Alternative C are shown in Table 3-1. As expected, annual emissions increase under Alternative C, with the increase being generally consistent with the 2.41 percent increase in escort tug underway time relative to Alternative A. Figure 3-1 and Figure 3-2 illustrate the estimated annual NOx emissions from escort tug underway time throughout the EIS Study Area under Alternative A and Alternative C, respectively. Figure 3-3 illustrates the change in these emissions between the two alternatives. While the amounts of emissions vary across pollutants, the spatial distribution and relative intensity of emissions throughout the EIS Study Area would be very similar across all pollutant categories, with minor differences due to the varying low load adjustment factors.

See Table A-1 in Supplement A for the full list of speciated HAP emissions.

Table 3-1. Annual Escort Tug Emissions Totals in the EIS Study Area (Tons)

Pollutant	Alternative A (tons)	Alternative C (tons)	Percent Increase
CO	28.221	28.964	2.63%
NOx	186.907	191.755	2.59%
PM_{10}	4.836	4.961	2.57%
$PM_{2.5}$	4.691	4.812	2.57%
SO_2	0.109	0.122	2.63%
VOC	6.289	6.444	2.46%
CH_4	0.119	0.122	2.46%
CO_2	11,890.87	12,203.57	2.63%
N_2O	0.604	0.62	2.59%
CO_2e	12,054.29	12,371.22	2.63%
HAPs	0.787	0.806	2.48%

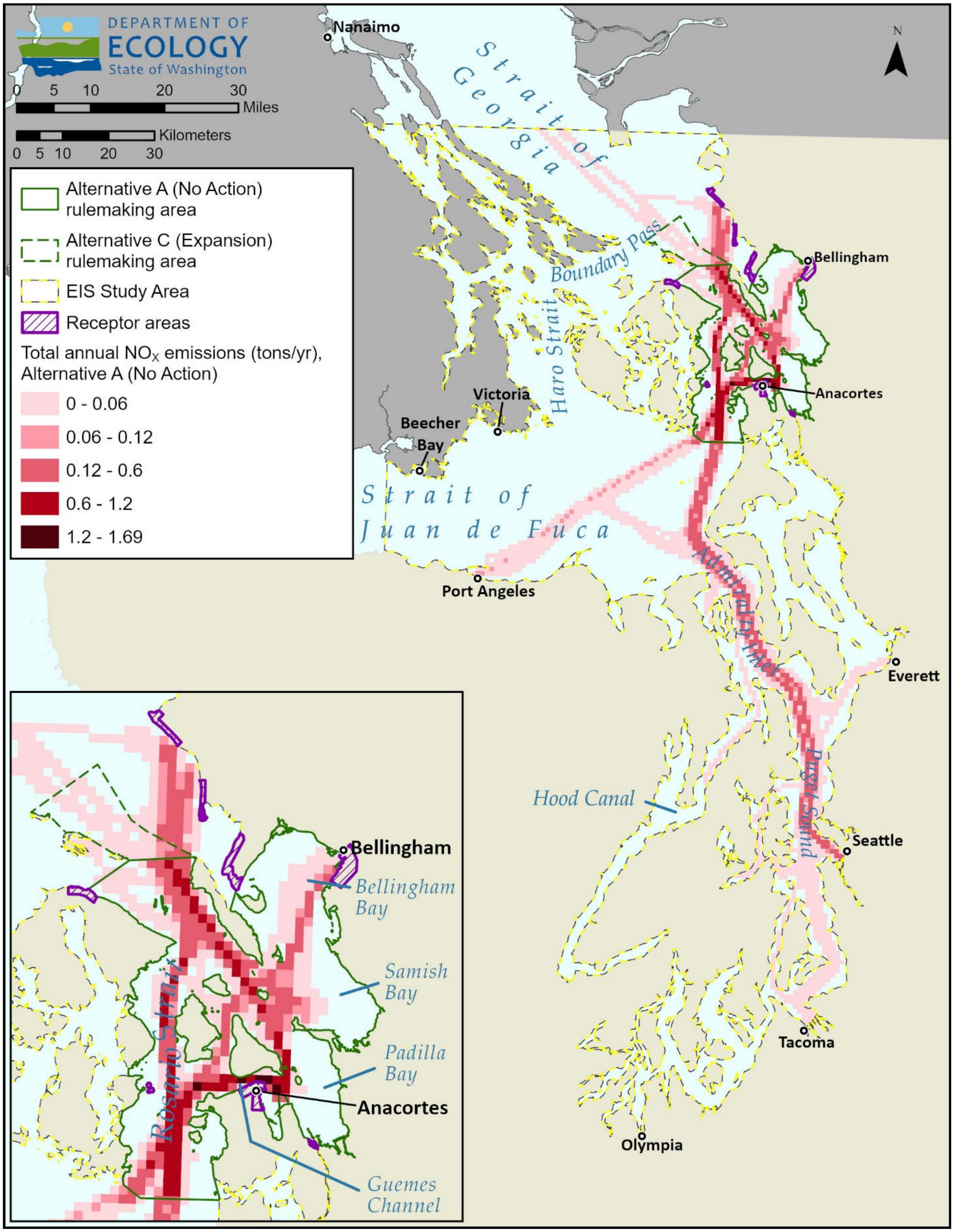


Figure 3-1. Annual Escort Tug NOx Emissions in the EIS Study Area – Alternative A

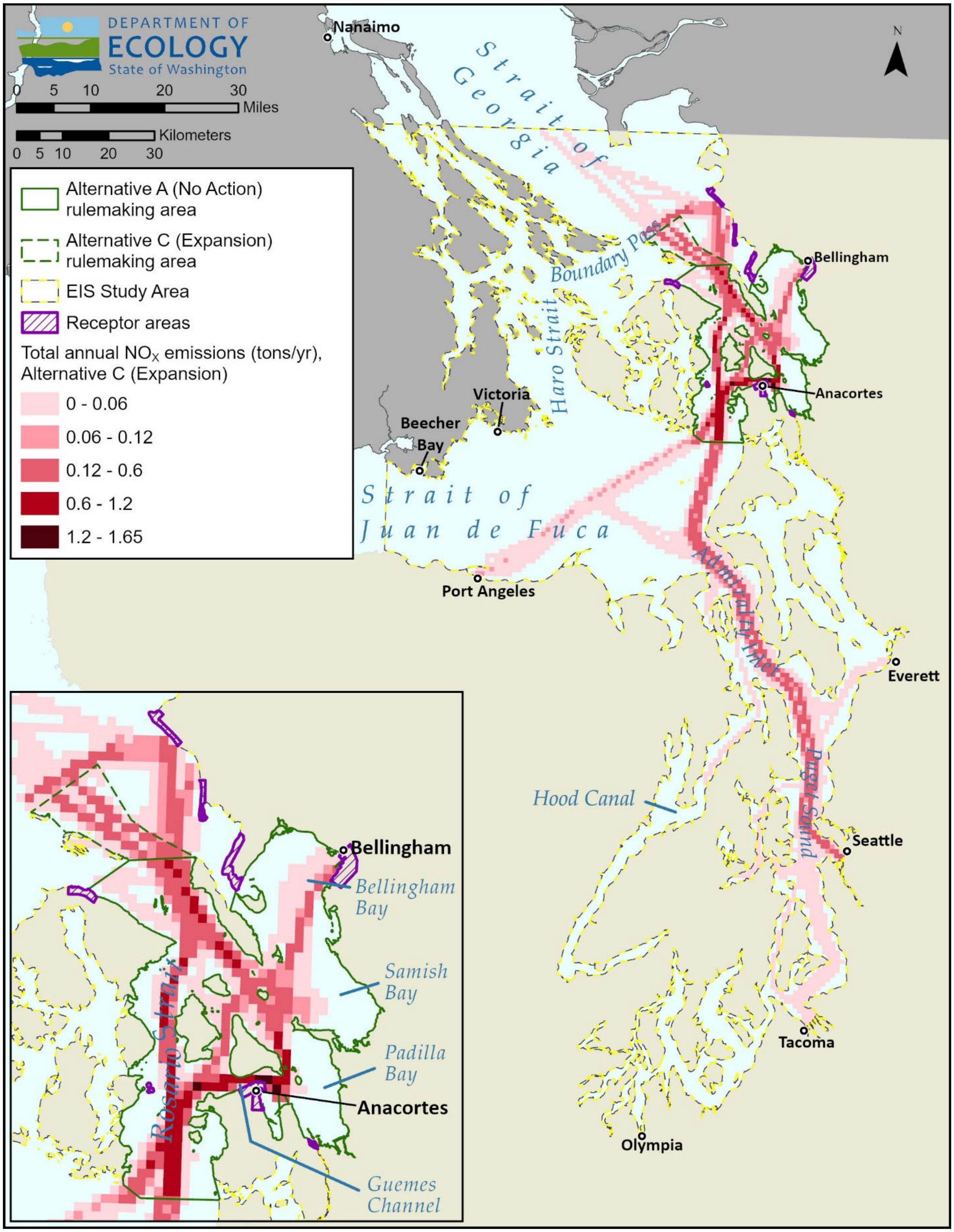


Figure 3-2. Annual Escort Tug NOx Emissions in the EIS Study Area – Alternative C

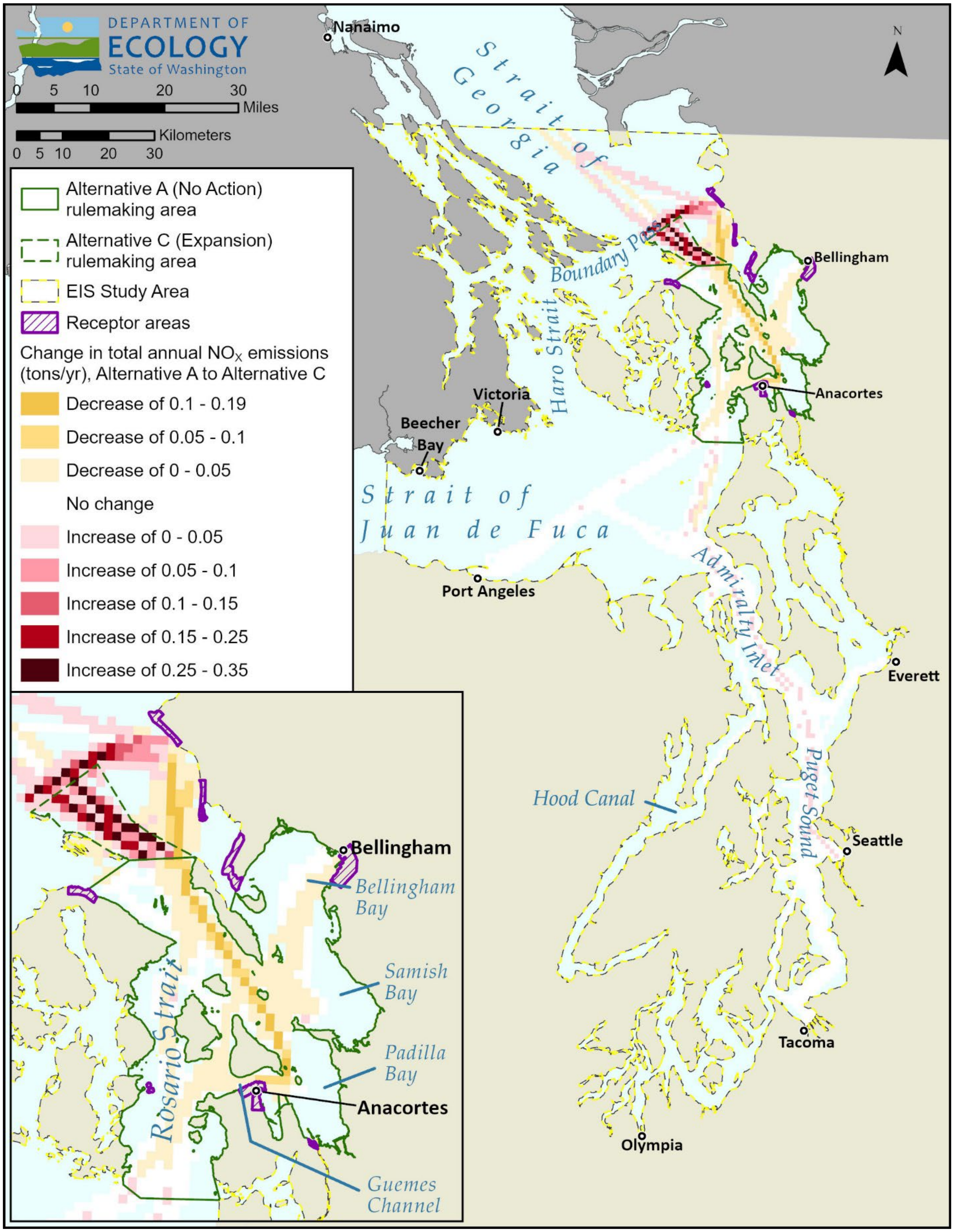


Figure 3-3. Annual Escort Tug NOx Emissions in the EIS Study Area – Change from Alternative A to Alternative C. An additional accessible version of this map is available in Appendix M.

For each receptor area, the grid cell centroids within five km of the receptor area were identified and their associated emissions were summed to illustrate emissions near the receptor areas under Alternatives A and C. The results, and the percentage change in emissions between Alternatives A and C, is shown in Table 3-2. These "nearby" annual emissions decrease under Alternative C for all receptor areas except Cherry Point, where the nearby emissions increase by approximately 10 percent to 22 percent. There is a substantial decrease in emissions near the Lummi and Neptune Beach receptor areas under Alternative C, as much of the nearby simulated escort tug activity under Alternative A moves further offshore under Alternative C.

Table 3-2. Annual Emissions (tpy) Within 5 km of Each Receptor Area

Receptor Area	CO	NOx	$PM_{2.5}$	PM_{10}	SO_2	VOC	CO_2e
Alternative A (No Action)							
Anacortes	3.017	22.134	0.593	0.611	0.012	1.017	1,290.603
Bellingham	0.281	1.915	0.049	0.050	0.001	0.071	120.267
Buckhorn	0.015	0.102	0.003	0.003	0.000	0.004	6.221
Cherry Point	0.419	3.345	0.094	0.097	0.002	0.184	179.588
James Island	2.467	16.238	0.406	0.419	0.010	0.534	1,053.493
Lummi	1.022	6.619	0.164	0.169	0.004	0.204	436.553
Neptune Beach	1.261	8.668	0.223	0.230	0.005	0.331	539.120
Swinomish	0	0	0	0	0	0	0
Alternative C (Expansion)							
Anacortes	2.865	21.111	0.567	0.584	0.011	0.980	1,225.764
Bellingham	0.240	1.645	0.042	0.044	0.001	0.062	102.665
Buckhorn	0.013	0.093	0.002	0.002	0.000	0.004	5.745
Cherry Point	0.511	3.935	0.108	0.112	0.002	0.202	218.695
James Island	2.453	16.152	0.404	0.416	0.010	0.532	1,047.754
Lummi	0.799	5.187	0.128	0.132	0.003	0.161	341.187
Neptune Beach	0.844	5.835	0.151	0.155	0.003	0.227	360.644
Swinomish	0	0	0	0	0	0	0
Change from Alternative A to Alternative C							
Anacortes	-5.0%	-4.6%	-4.4%	-4.4%	-5.0%	-3.6%	-5.0%
Bellingham	-14.6%	-14.1%	-13.7%	-13.7%	-14.6%	-12.3%	-14.6%
Buckhorn	-7.6%	-8.6%	-9.2%	-9.2%	-7.6%	-11.5%	-7.7%
Cherry Point	21.8%	17.6%	15.5%	15.5%	21.8%	9.6%	21.8%
James Island	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%
Lummi	-21.8%	-21.6%	-21.5%	-21.5%	-21.8%	-20.7%	-21.8%
Neptune Beach	-33.1%	-32.7%	-32.4%	-32.4%	-33.1%	-31.3%	-33.1%
Swinomish	N/A	N/A	N/A	N/A	N/A	N/A	N/A

3.2 Dispersion Modeling

3.2.1 Comparison to Significant Impact Levels

Air dispersion modeling of the escort tug emissions was performed for CO, NO_2, $PM_{2.5}$, PM_{10}, and SO_2. As described in Section 2.4.6, the model-predicted concentrations at all receptors were compared to the NAAQS SILs to assess whether escort tug emissions under Alternative A or Alternative C have the potential to cause or contribute to a NAAQS violation.

Table A-2 in Supplement A shows the highest modeled concentrations within each receptor area (i.e., the values for the single most-exposed receptor) under Alternative A and Alternative C and compares those values against their corresponding SILs. These results indicate the following, with the concentrations representing only the pollutant contributions from emissions associated with tug escort requirements:

- Modeled concentrations for CO, $PM_{2.5}$, PM_{10}, and SO_2 are all well below their corresponding SILs, indicating that escort tug emissions have no potential to cause or contribute to a violation of the NAAQS for these pollutants under either alternative.

- Annual average modeled concentrations for NO_2 are all well below the corresponding SIL. However, hourly NO_2 concentrations on the peak day exceed the corresponding SIL at all eight receptor areas. See below for additional discussion.

- Among the eight receptor areas, modeled concentrations are generally highest at Anacortes, James Island, and Cherry Point. Annual average concentrations are lowest at Bellingham, while peak day concentrations are generally lowest at Buckhorn.

- For most pollutants and all receptor areas, hourly concentrations on the peak day (i.e., those used for comparison against all SILs other than the annual SIL) are very similar or identical between the two alternatives.

- For NO_2 and $PM_{2.5}$ (the two pollutants with annual SILs), annual average concentrations under Alternative C increase by approximately 10 percent at Buckhorn, 3 percent at Cherry Point, and 0.5 percent at James Island relative to Alternative A. Annual average concentrations at all other receptor areas decrease under Alternative C (by approximately 2 percent to 4 percent).

Table A-3 in Supplement A shows the distribution by percentile of peak day modeled NO_2 concentrations within each receptor area under Alternative A and Alternative C. These results indicate that, on peak days, NO_2 concentrations under Alternative C decrease by approximately 10 percent to 20 percent at Buckhorn and by approximately 10 percent at Lummi and Neptune Beach relative to Alternative A. Peak day NO_2 concentrations at Cherry Point increase slightly (by approximately 1 percent) and are unchanged at all other receptor areas under Alternative C.

As noted above, the "peak day" analysis identified exceedances of the hourly NO_2 SIL (7.5 $\mu g/m^3$) at all receptor areas. Table 3-3 shows the counts of receptors where the peak day modeled NO_2 concentrations exceed the corresponding SIL under Alternative A and Alternative C. Figure 3-4 and Figure 3-5 depict the peak day modeled NO_2 concentrations at all receptors.

Table 3-3. Counts of Receptors with Exceedances of NO_2 SIL Under Alternative A and Alternative C

Receptor Area	Total # of Receptors	Receptors Where Peak Day Modeled NO_2 Concentration Exceeds SIL (7.5 µg/m^3)				
		Alternative A		Alternative C		Delta %
Anacortes	859	859	100%	859	100%	0.0%
Bellingham	1,028	661	64%	661	64%	0.0%
Buckhorn	360	253	70%	247	69%	-2.4%
Cherry Point	462	462	100%	462	100%	0.0%
James Island	46	46	100%	46	100%	0.0%
Lummi	760	760	100%	760	100%	0.0%
Neptune Beach	366	366	100%	366	100%	0.0%
Swinomish	74	74	100%	74	100%	0.0%
Total	**3,955**	**3,481**	**88%**	**3,475**	**88%**	**-0.2%**

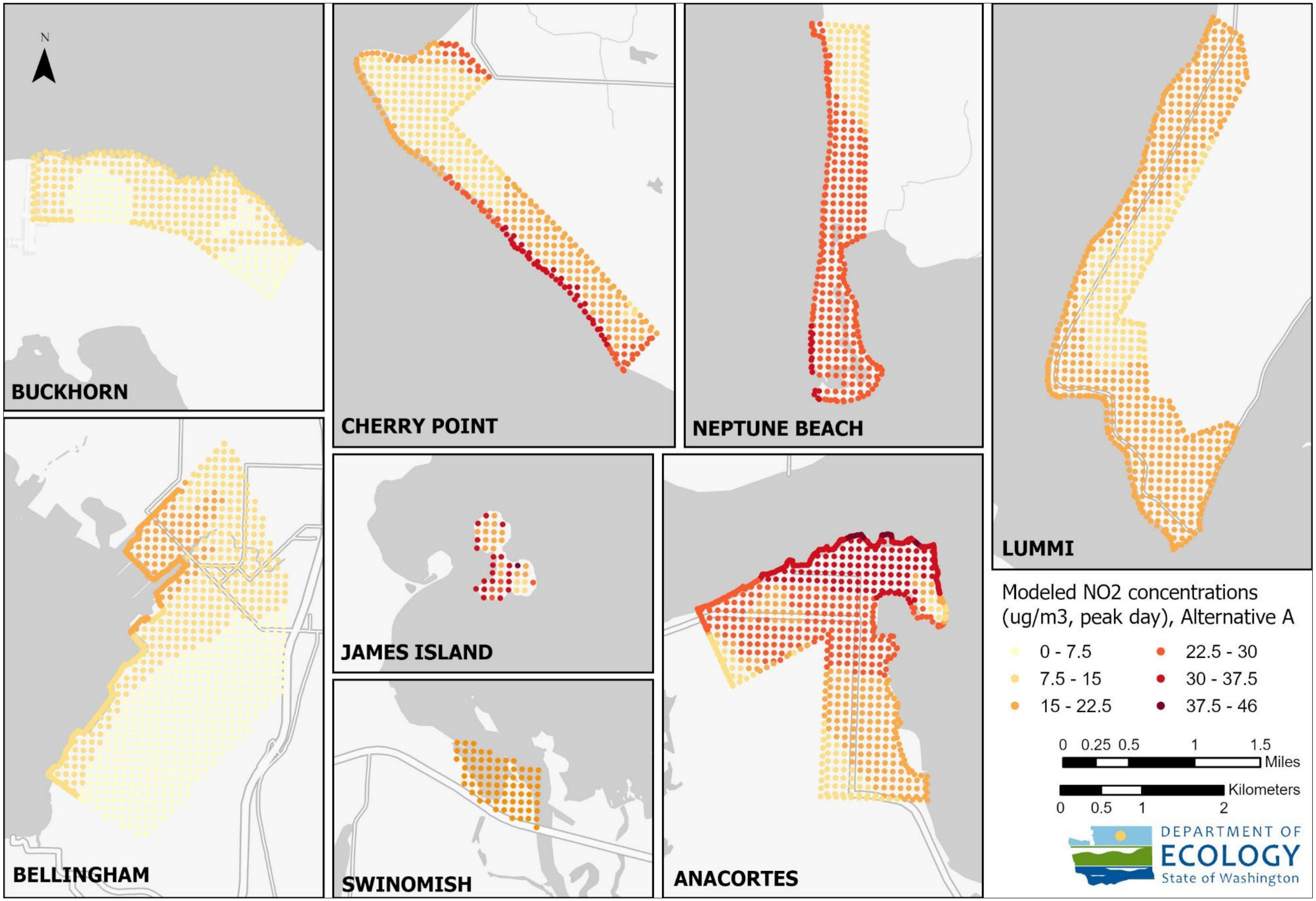


Figure 3-4. Modeled NO_2 Concentrations (ug/m^3, Peak Day) Resulting From Escort Tug Emissions – Alternative A

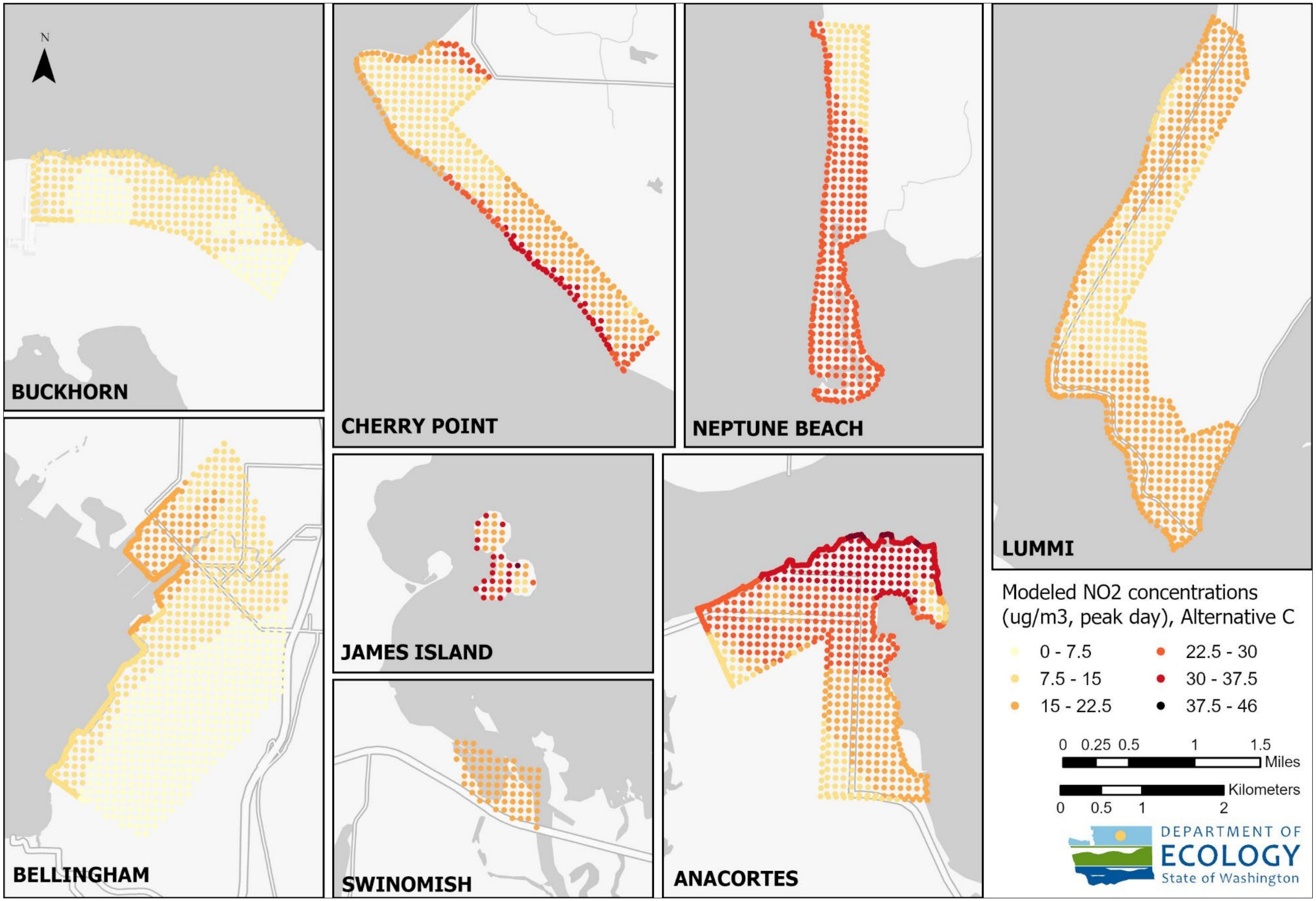


Figure 3-5. Modeled NO_2 Concentrations (ug/m^3, Peak Day) Resulting From Escort Tug Emissions – Alternative C

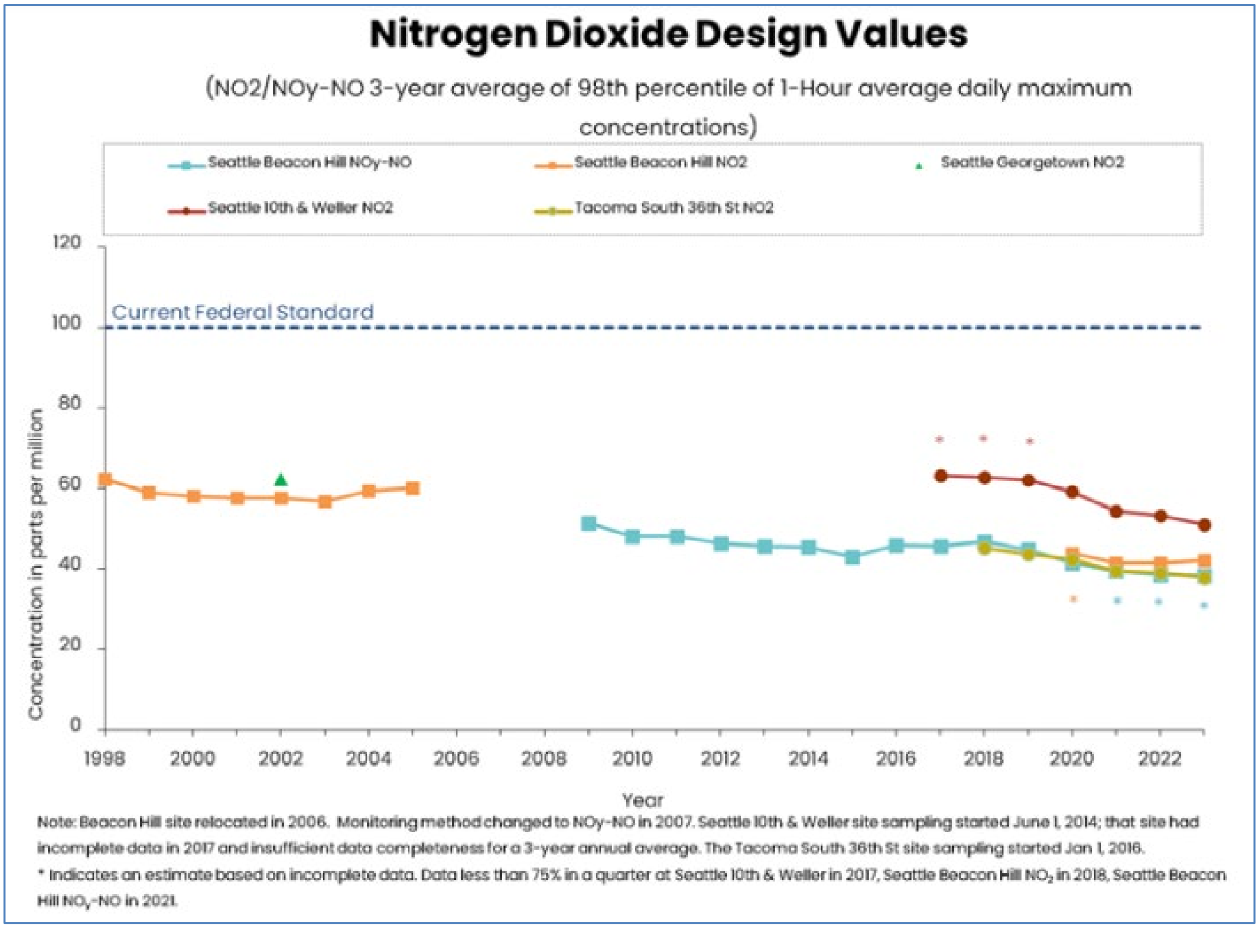
ERG then reviewed available air quality monitoring data and reports for NO_2 to provide further context on whether these escort tug emissions (existing emissions under Alternative A and changes in emissions under Alternative C) have the potential to cause or contribute to a violation of the hourly NO_2 NAAQS.

The Puget Sound Clean Air Agency examines and summarizes air quality monitoring data for criteria and air toxics annually, most recently with the 2023 Air Quality Data Summary. The June 2024 publication noted that air quality in Puget Sound has continued to meet the NO_2 NAAQS by a wide margin (Puget Sound Clean Air Agency, 2024). NO_2 levels in the Puget Sound region, as currently monitored by Ecology and shown in Figure 3-6, are typically far cleaner than the 2010 1-hour standard of 100 parts per billion (ppb) (based on the 98th percentile of 1-hour daily maximum concentrations, averaged over three years). When EPA promulgated the new national standard in 2010, Ecology added two near-road monitors to better capture peak ambient NO_2 concentrations that are expected to occur as a result of mobile source emissions. In the years since, the data show that NO_2 concentrations are trending around half the 100 ppb standard and still declining.

In addition to reviewing recent air quality studies and trends, ERG reviewed individual concentration data values for all NO_2 monitoring locations in the state for 2021-2023. Out of 78,673 observations, only 59 values (less than 0.1 percent) exceeded the more stringent annual average standard concentration of 53 ppb (Puget Sound Clean Air Agency, 2024). The highest value recorded was 78.5 ppb in downtown Seattle, near the harbor and an interstate highway interchange, and the 1-hour design values for sites in Washington are 39-53 ppb.[10] While the monitoring network does not include full coverage of all areas and potential sources of NO_2, it targets the most common sources of NOx and NO_2 (i.e., mobile sources) and is designed to capture peak hourly emissions events. While some locations are designated near-road monitors, they also represent urban conditions with nearby maritime-related activity. The Puget Sound area is home to significant marine vessel activity, such that the current monitoring data already reflect the emissions from high levels of vessel activity (including tug operations) without exceeding the air quality standards.

While the modeled escort tug emissions exceed the NO_2 SIL, existing air quality monitoring data do not reflect exceedances but rather demonstrate that maritime-related NOx emissions have been steadily decreasing due to improvements in fuel efficiency, changes in operations, and other initiatives (Puget Sound Maritime Air Forum, 2024). Therefore, continuation of existing tug escort requirements (Alternative A) and associated tug emissions would not be expected to cause or contribute to a violation of the hourly NO_2 NAAQS. Furthermore, as discussed above, modeled peak day NO_2 concentrations under Alternative C increase only slightly at one receptor area (Cherry Point) and decrease or are unchanged at all other receptor areas; this suggests that changes in tug escort requirements and associated tug emissions under Alternative C would not be expected to cause or contribute to a violation of the hourly NO_2 NAAQS.

[10] For comparison, the maximum modeled peak day NO_2 concentration obtained in this effort (46 $\mu g/m^3$) is equivalent to approximately 24.5 ppb. This represents only the pollutant contributions from tug escort emissions.



Note: The correct units of measurement on the Y-axis label are parts per billion.

Figure 3-6. Historic Puget Sound NO_2 Concentrations by Monitor Location

3.2.2 Comparison to Diesel PM Acceptable Source Impact Level

Table 3-4 shows the counts of receptors where the annual average modeled $PM_{2.5}$ concentrations exceed the diesel PM ASIL under Alternative A and Alternative C. Table A-4 in Supplement A shows the distribution by percentile of annual average modeled $PM_{2.5}$ concentrations within each receptor area under Alternative A and Alternative C.

As discussed in Section 3.2.1, the modeled $PM_{2.5}$ values are all well below the annual SIL (0.13 μg/m^3), indicating that escort tug emissions have no potential to cause or contribute to a violation of the annual $PM_{2.5}$ NAAQS. However, the diesel PM ASIL (0.0033 μg/m^3) is a much more protective threshold that is approximately 39 times lower than the SIL. As a result, the majority of receptors under both alternatives have modeled $PM_{2.5}$ values exceeding this very conservative threshold.

Table 3-4. Counts of Receptors with Exceedances of Diesel PM ASIL Under Alternative A and Alternative C

Receptor Area	Total # of Receptors	Receptors Where Annual Average Modeled $PM_{2.5}$ Concentration Exceeds Diesel PM ASIL (0.0033 µg/m^3)				
		Alternative A		Alternative C		Delta %
Anacortes	859	842	98%	842	98%	0.0%
Bellingham	1,028	383	37%	369	36%	-3.7%
Buckhorn	360	293	81%	307	85%	4.8%
Cherry Point	462	298	65%	359	78%	20.5%
James Island	46	46	100%	46	100%	0.0%
Lummi	760	746	98%	728	96%	-2.4%
Neptune Beach	366	329	90%	327	89%	-0.6%
Swinomish	74	74	100%	74	100%	0.0%
Total	**3,955**	**3,011**	**76%**	**3,052**	**77%**	**1.4%**

As discussed in Section 2.4.6, the ASIL is based on a very low risk threshold (one-per-million increased lifetime cancer risk) and assumes continuous lifetime exposure to the pollutant (i.e., 24 hours per day for 70 years). The highest annual average modeled $PM_{2.5}$ concentration, for any receptor under either alternative, is 0.01269 µg/m^3—approximately 3.8 times greater than the diesel PM ASIL. Because this exceeds the diesel PM ASIL by a factor of less than ten, it is very likely that a more in-depth second tier review and health impact assessment (a requirement that does not apply to mobile sources) would conclude that the escort tug emissions associated with the rulemaking alternatives represent an "acceptable" health risk under both alternatives.

4. CONCLUSIONS

This air quality and GHG analysis resulted in the following key findings:

- The total annual quantities of emissions from escort tug activities are approximately 2.5 percent greater under Alternative C as compared to Alternative A, with minor differences across pollutants.

- Alternative C would shift some escort tug activity, and the corresponding emissions, closer to the Cherry Point receptor area but away from the Lummi and Neptune Beach receptor areas.

- Under Alternative C, annual average concentrations of NO_2 and $PM_{2.5}$ specifically from escort tug emissions would increase by approximately 10 percent at Buckhorn, 3 percent at Cherry Point, and 0.5 percent at James Island relative to Alternative A. Annual average concentrations at all other receptor areas would decrease under Alternative C (by approximately 2 to 4 percent).

- In all eight receptor areas, modeled concentrations for CO, $PM_{2.5}$, PM_{10}, and SO_2 are all well below their corresponding SILs, indicating that escort tug emissions have no potential to cause or contribute to a violation of the NAAQS for these pollutants under either alternative. Annual average modeled concentrations for NO_2 are also well below the corresponding SIL.

- In all eight receptor areas, modeled hourly NO_2 concentrations on the peak day exceed the corresponding SIL under both alternatives. However, a review of available air quality monitoring data and reports for NO_2 indicates that these existing emissions under Alternative A are not causing or contributing to any known NAAQS exceedances, and that the minor changes in modeled NO_2 levels under Alternative C do not indicate a potential for any new NAAQS exceedances.

- As discussed in Section 3.2.1, the modeled $PM_{2.5}$ values are all well below the annual SIL (0.13 $\mu g/m^3$), indicating that escort tug emissions under the proposed alternatives have no potential to cause or contribute to a violation of the annual $PM_{2.5}$ NAAQS. However, the diesel PM ASIL (0.0033 $\mu g/m^3$) is a much more protective threshold that is approximately 39 times lower than the SIL. As a result, the majority of receptors under both alternatives have annual average modeled $PM_{2.5}$ values exceeding the diesel PM ASIL, which is a very conservative screening-level threshold that assumes continuous lifetime exposure to the pollutant. However, these exceedances are small enough to suggest that a more robust health impact assessment (a requirement that does not apply to mobile sources) would conclude that the escort tug emissions represent an "acceptable" health risk under both alternatives.

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Supplement A

Supplemental Tables of Escort Tug Emissions Estimates and Dispersion Modeling Results

Table A-1. Calculation of Hazardous Air Pollutant (HAP) Emissions from Tug Escorts, Based on HAP Speciation Profile for Commercial Marine Vessels

Pollutant	Basis	Fraction	HAP Emissions from Tug Escorts (tons/yr)	
			Alternative A	Alternative C
1,3-Butadiene	VOC	1.01E-03	6.37E-03	6.53E-03
2,2,4-Trimethylpentane	VOC	7.12E-03	4.48E-02	4.59E-02
Acenaphthene	VOC	5.09E-05	3.20E-04	3.28E-04
Acenaphthylene	VOC	1.18E-04	7.42E-04	7.60E-04
Acetaldehyde	VOC	9.78E-03	6.15E-02	6.30E-02
Acrolein	VOC	1.85E-03	1.16E-02	1.19E-02
Ammonia	PM2.5	1.92E-02	9.03E-02	9.26E-02
Anthracene	VOC	3.44E-04	2.16E-03	2.22E-03
Antimony	PM2.5	6.15E-04	2.89E-03	2.96E-03
Arsenic	PM2.5	2.59E-05	1.22E-04	1.25E-04
Benz[a]Anthracene	PM2.5	8.82E-06	4.14E-05	4.24E-05
Benzene	VOC	4.74E-03	2.98E-02	3.05E-02
Benzo[a]Pyrene	PM2.5	4.18E-06	1.96E-05	2.01E-05
Benzo[b]Fluoranthene	PM2.5	8.35E-06	3.92E-05	4.02E-05
Benzo[k]Fluoranthene	PM2.5	4.18E-06	1.96E-05	2.01E-05
Benzo(g,h,i)Fluoranthene	PM2.5	1.32E-04	6.19E-04	6.35E-04
Cadmium	PM2.5	2.36E-04	1.11E-03	1.14E-03
Chrysene	PM2.5	1.63E-05	7.65E-05	7.84E-05
Chromium (VI)	PM2.5	7.24E-09	3.40E-08	3.48E-08
Dibenzo[a,h]anthracene	PM2.5	8.65E-06	4.06E-05	4.16E-05
Ethyl Benzene	VOC	4.39E-04	2.76E-03	2.83E-03
Fluoranthene	PM2.5	8.97E-05	4.21E-04	4.32E-04
Fluorene	VOC	1.64E-04	1.03E-03	1.06E-03
Formaldehyde	VOC	4.27E-02	2.69E-01	2.75E-01
Indeno[1,2,3-c,d]Pyrene	PM2.5	8.35E-06	3.92E-05	4.02E-05
Lead	PM2.5	1.25E-04	5.86E-04	6.01E-04
Manganese	PM2.5	3.22E-06	1.51E-05	1.55E-05
Mercury	PM2.5	4.18E-08	1.96E-07	2.01E-07
Naphthalene	VOC	3.13E-02	1.97E-01	2.02E-01
Hexane	VOC	2.79E-03	1.75E-02	1.80E-02
Nickel	PM2.5	6.87E-04	3.22E-03	3.31E-03
Polychlorinated Biphenyls	PM2.5	4.18E-07	1.96E-06	2.01E-06
Phenanthrene	VOC	1.36E-03	8.53E-03	8.74E-03
Propionaldehyde	VOC	1.52E-03	9.54E-03	9.78E-03
Pyrene	PM2.5	3.37E-05	1.58E-04	1.62E-04
Selenium	PM2.5	4.38E-08	2.05E-07	2.11E-07
Toluene	VOC	2.04E-03	1.28E-02	1.31E-02
Xylenes (Mixed Isomers)	VOC	1.42E-03	8.94E-03	9.16E-03
o-Xylene	VOC	5.13E-04	3.23E-03	3.31E-03
Total			**0.787**	**0.806**

Table A-2. Modeled Concentrations (Maximum of All Receptors Within Each Receptor Area) Resulting from Tug Escort Emissions with Comparison to Significant Impact Levels (SILs)

Receptor Area	Pollutant	Significant Impact Level (SIL) (µg/m^3)	SIL Averaging Period	Alternative	Max Modeled Concentration in Receptor Area (µg/m^3)	Modeled Concentration vs. SIL
Anacortes	CO	2000	1-hr	Alt. A (No Action)	7.40252	0.4%
				Alt. C (Expansion)	7.40252	0.4%
		500	8-hr	Alt. A (No Action)	1.7456	0.3%
				Alt. C (Expansion)	1.7456	0.3%
	NO_2	7.5	1st-highest max daily 1-hr	Alt. A (No Action)	45.53945	607.2%
				Alt. C (Expansion)	45.53945	607.2%
		1	Annual	Alt. A (No Action)	0.42495	42.5%
				Alt. C (Expansion)	0.41059	41.1%
	PM_{10}	5	24-hr	Alt. A (No Action)	0.1671	3.3%
				Alt. C (Expansion)	0.1671	3.3%
	$PM_{2.5}$	1.2	1st-highest 24-hr	Alt. A (No Action)	0.16228	13.5%
				Alt. C (Expansion)	0.16228	13.5%
		0.13	Annual	Alt. A (No Action)	0.01269	9.8%
				Alt. C (Expansion)	0.01229	9.5%
	SO_2	7.8	1-hr	Alt. A (No Action)	0.02847	0.4%
				Alt. C (Expansion)	0.02847	0.4%
		25	3-hr	Alt. A (No Action)	0.01344	0.1%
				Alt. C (Expansion)	0.01344	0.1%
Bellingham	CO	2000	1-hr	Alt. A (No Action)	3.36444	0.2%
				Alt. C (Expansion)	3.36444	0.2%
		500	8-hr	Alt. A (No Action)	0.98968	0.2%
				Alt. C (Expansion)	0.98968	0.2%
	NO_2	7.5	1st-highest max daily 1-hr	Alt. A (No Action)	19.92401	265.7%
				Alt. C (Expansion)	19.92401	265.7%
		1	Annual	Alt. A (No Action)	0.15453	15.5%
				Alt. C (Expansion)	0.14824	14.8%
	PM_{10}	5	24-hr	Alt. A (No Action)	0.06798	1.4%
				Alt. C (Expansion)	0.06798	1.4%
	$PM_{2.5}$	1.2	1st-highest 24-hr	Alt. A (No Action)	0.06595	5.5%
				Alt. C (Expansion)	0.06595	5.5%
		0.13	Annual	Alt. A (No Action)	0.00437	3.4%
				Alt. C (Expansion)	0.0042	3.2%
	SO_2	7.8	1-hr	Alt. A (No Action)	0.01298	0.2%
				Alt. C (Expansion)	0.01298	0.2%
		25	3-hr	Alt. A (No Action)	0.00707	0.0%
				Alt. C (Expansion)	0.00707	0.0%

Table A-2. Modeled Concentrations (Maximum of All Receptors Within Each Receptor Area) Resulting from Tug Escort Emissions with Comparison to Significant Impact Levels (SILs)

Receptor Area	Pollutant	Significant Impact Level (SIL) ($\mu g/m^3$)	SIL Averaging Period	Alternative	Max Modeled Concentration in Receptor Area ($\mu g/m^3$)	Modeled Concentration vs. SIL
Buckhorn	CO	2000	1-hr	Alt. A (No Action)	1.99238	0.1%
				Alt. C (Expansion)	1.63711	0.1%
		500	8-hr	Alt. A (No Action)	0.69205	0.1%
				Alt. C (Expansion)	0.64362	0.1%
	NO_2	7.5	1st-highest max daily 1-hr	Alt. A (No Action)	11.66801	155.6%
				Alt. C (Expansion)	9.43654	125.8%
		1	Annual	Alt. A (No Action)	0.19491	19.5%
				Alt. C (Expansion)	0.2151	21.5%
	PM_{10}	5	24-hr	Alt. A (No Action)	0.05456	1.1%
				Alt. C (Expansion)	0.05704	1.1%
	$PM_{2.5}$	1.2	1st-highest 24-hr	Alt. A (No Action)	0.05292	4.4%
				Alt. C (Expansion)	0.05532	4.6%
		0.13	Annual	Alt. A (No Action)	0.00551	4.2%
				Alt. C (Expansion)	0.00607	4.7%
	SO_2	7.8	1-hr	Alt. A (No Action)	0.0077	0.1%
				Alt. C (Expansion)	0.00622	0.1%
		25	3-hr	Alt. A (No Action)	0.00439	0.0%
				Alt. C (Expansion)	0.00358	0.0%
Cherry Point	CO	2000	1-hr	Alt. A (No Action)	5.95806	0.3%
				Alt. C (Expansion)	6.05297	0.3%
		500	8-hr	Alt. A (No Action)	1.03391	0.2%
				Alt. C (Expansion)	1.04006	0.2%
	NO_2	7.5	1st-highest max daily 1-hr	Alt. A (No Action)	36.12788	481.7%
				Alt. C (Expansion)	36.66275	488.8%
		1	Annual	Alt. A (No Action)	0.18964	19.0%
				Alt. C (Expansion)	0.19541	19.5%
	PM_{10}	5	24-hr	Alt. A (No Action)	0.12105	2.4%
				Alt. C (Expansion)	0.12033	2.4%
	$PM_{2.5}$	1.2	1st-highest 24-hr	Alt. A (No Action)	0.11747	9.8%
				Alt. C (Expansion)	0.11674	9.7%
		0.13	Annual	Alt. A (No Action)	0.00547	4.2%
				Alt. C (Expansion)	0.00566	4.4%
	SO_2	7.8	1-hr	Alt. A (No Action)	0.02313	0.3%
				Alt. C (Expansion)	0.02351	0.3%
		25	3-hr	Alt. A (No Action)	0.01498	0.1%
				Alt. C (Expansion)	0.01526	0.1%

Table A-2. Modeled Concentrations (Maximum of All Receptors Within Each Receptor Area) Resulting from Tug Escort Emissions with Comparison to Significant Impact Levels (SILs)

Receptor Area	Pollutant	Significant Impact Level (SIL) (µg/m^3)	SIL Averaging Period	Alternative	Max Modeled Concentration in Receptor Area (µg/m^3)	Modeled Concentration vs. SIL
James Island	CO	2000	1-hr	Alt. A (No Action)	6.3106	0.3%
				Alt. C (Expansion)	6.3106	0.3%
		500	8-hr	Alt. A (No Action)	1.39071	0.3%
				Alt. C (Expansion)	1.39071	0.3%
	NO_2	7.5	1st-highest max daily 1-hr	Alt. A (No Action)	38.2508	510.0%
				Alt. C (Expansion)	38.2508	510.0%
		1	Annual	Alt. A (No Action)	0.34369	34.4%
				Alt. C (Expansion)	0.34554	34.6%
	PM_{10}	5	24-hr	Alt. A (No Action)	0.14531	2.9%
				Alt. C (Expansion)	0.14531	2.9%
	$PM_{2.5}$	1.2	1st-highest 24-hr	Alt. A (No Action)	0.14094	11.7%
				Alt. C (Expansion)	0.14094	11.7%
		0.13	Annual	Alt. A (No Action)	0.00957	7.4%
				Alt. C (Expansion)	0.00962	7.4%
	SO_2	7.8	1-hr	Alt. A (No Action)	0.02431	0.3%
				Alt. C (Expansion)	0.02431	0.3%
		25	3-hr	Alt. A (No Action)	0.01179	0.0%
				Alt. C (Expansion)	0.01179	0.0%
Lummi	CO	2000	1-hr	Alt. A (No Action)	3.68576	0.2%
				Alt. C (Expansion)	3.35373	0.2%
		500	8-hr	Alt. A (No Action)	0.73835	0.1%
				Alt. C (Expansion)	0.88903	0.2%
	NO_2	7.5	1st-highest max daily 1-hr	Alt. A (No Action)	21.59523	287.9%
				Alt. C (Expansion)	19.46999	259.6%
		1	Annual	Alt. A (No Action)	0.28629	28.6%
				Alt. C (Expansion)	0.27352	27.4%
	PM_{10}	5	24-hr	Alt. A (No Action)	0.08853	1.8%
				Alt. C (Expansion)	0.08089	1.6%
	$PM_{2.5}$	1.2	1st-highest 24-hr	Alt. A (No Action)	0.08587	7.2%
				Alt. C (Expansion)	0.07846	6.5%
		0.13	Annual	Alt. A (No Action)	0.00803	6.2%
				Alt. C (Expansion)	0.00768	5.9%
	SO_2	7.8	1-hr	Alt. A (No Action)	0.01433	0.2%
				Alt. C (Expansion)	0.01308	0.2%
		25	3-hr	Alt. A (No Action)	0.00585	0.0%
				Alt. C (Expansion)	0.00719	0.0%

Table A-2. Modeled Concentrations (Maximum of All Receptors Within Each Receptor Area) Resulting from Tug Escort Emissions with Comparison to Significant Impact Levels (SILs)

Receptor Area	Pollutant	Significant Impact Level (SIL) (μg/m^3)	SIL Averaging Period	Alternative	Max Modeled Concentration in Receptor Area (μg/m^3)	Modeled Concentration vs. SIL
Neptune Beach	CO	2000	1-hr	Alt. A (No Action)	5.14053	0.3%
				Alt. C (Expansion)	4.6497	0.2%
		500	8-hr	Alt. A (No Action)	0.8717	0.2%
				Alt. C (Expansion)	0.76929	0.2%
	NO_2	7.5	1st-highest max daily 1-hr	Alt. A (No Action)	30.3036	404.0%
				Alt. C (Expansion)	27.39963	365.3%
		1	Annual	Alt. A (No Action)	0.26068	26.1%
				Alt. C (Expansion)	0.2527	25.3%
	PM_{10}	5	24-hr	Alt. A (No Action)	0.08874	1.8%
				Alt. C (Expansion)	0.08396	1.7%
	$PM_{2.5}$	1.2	1st-highest 24-hr	Alt. A (No Action)	0.08607	7.2%
				Alt. C (Expansion)	0.08143	6.8%
		0.13	Annual	Alt. A (No Action)	0.00734	5.6%
				Alt. C (Expansion)	0.00711	5.5%
	SO_2	7.8	1-hr	Alt. A (No Action)	0.02	0.3%
				Alt. C (Expansion)	0.01791	0.2%
		25	3-hr	Alt. A (No Action)	0.00752	0.0%
				Alt. C (Expansion)	0.00624	0.0%
Swinomish	CO	2000	1-hr	Alt. A (No Action)	3.2791	0.2%
				Alt. C (Expansion)	3.2791	0.2%
		500	8-hr	Alt. A (No Action)	0.8482	0.2%
				Alt. C (Expansion)	0.8482	0.2%
	NO_2	7.5	1st-highest max daily 1-hr	Alt. A (No Action)	19.04647	254.0%
				Alt. C (Expansion)	19.04647	254.0%
		1	Annual	Alt. A (No Action)	0.19603	19.6%
				Alt. C (Expansion)	0.19227	19.2%
	PM_{10}	5	24-hr	Alt. A (No Action)	0.10234	2.0%
				Alt. C (Expansion)	0.10234	2.0%
	$PM_{2.5}$	1.2	1st-highest 24-hr	Alt. A (No Action)	0.09927	8.3%
				Alt. C (Expansion)	0.09927	8.3%
		0.13	Annual	Alt. A (No Action)	0.00572	4.4%
				Alt. C (Expansion)	0.00561	4.3%
	SO_2	7.8	1-hr	Alt. A (No Action)	0.01264	0.2%
				Alt. C (Expansion)	0.01264	0.2%
		25	3-hr	Alt. A (No Action)	0.00582	0.0%
				Alt. C (Expansion)	0.00582	0.0%

Table A-3. Modeled NO_2 Concentrations (ug/m^3, Peak Day) Resulting from Tug Escort Emissions, by Percentile

Receptor Percentile	Anacortes (859 Receptors)			Bellingham (1,028 Receptors)			Buckhorn (360 Receptors)			Cherry Point (462 Receptors)		
	Alt A	Alt C	Delta	Alt A	Alt C	Delta	Alt A	Alt C	Delta	Alt A	Alt C	Delta
100th	45.54	45.54	0.0%	19.92	19.92	0.0%	11.67	9.44	-19.1%	36.13	36.66	1.5%
90th	34.46	34.46	0.0%	17.55	17.55	0.0%	11.00	9.20	-16.4%	30.41	30.44	0.1%
80th	32.51	32.51	0.0%	15.86	15.86	0.0%	10.58	9.03	-14.6%	24.79	24.78	-0.1%
70th	31.00	31.00	0.0%	14.35	14.35	0.0%	10.16	8.94	-12.0%	21.20	21.41	1.0%
60th	26.99	26.99	0.0%	13.95	13.95	0.0%	9.77	8.90	-8.9%	20.32	20.03	-1.4%
50th	25.01	25.01	0.0%	12.30	12.30	0.0%	9.26	8.86	-4.3%	18.08	18.14	0.3%
40th	23.23	23.23	0.0%	9.55	9.55	0.0%	8.74	8.76	0.3%	15.91	16.02	0.7%
30th	19.03	19.03	0.0%	6.57	6.57	0.0%	7.67	6.57	-14.4%	14.43	14.63	1.4%
20th	16.73	16.73	0.0%	6.43	6.43	0.0%	6.83	5.19	-24.1%	12.97	13.06	0.7%
10th	13.72	13.72	0.0%	6.23	6.23	0.0%	4.61	4.31	-6.4%	12.02	12.20	1.5%
0	8.08	8.08	0.0%	5.73	5.73	0.0%	4.18	4.25	1.6%	8.77	8.81	0.4%

Receptor Percentile	James Island (46 Receptors)			Lummi (760 Receptors)			Neptune Beach (366 Receptors)			Swinomish (74 Receptors)		
	Alt A	Alt C	Delta	Alt A	Alt C	Delta	Alt A	Alt C	Delta	Alt A	Alt C	Delta
100th	38.25	38.25	0.0%	21.60	19.47	-9.8%	30.30	27.40	-9.6%	19.05	19.05	0.0%
90th	36.33	36.33	0.0%	20.69	18.35	-11.3%	29.68	26.79	-9.7%	18.58	18.58	0.0%
80th	35.07	35.07	0.0%	20.03	17.85	-10.9%	29.15	26.30	-9.8%	18.38	18.38	0.0%
70th	32.54	32.54	0.0%	19.09	17.07	-10.6%	28.72	25.92	-9.8%	18.27	18.27	0.0%
60th	30.71	30.71	0.0%	17.83	15.97	-10.4%	28.40	25.65	-9.7%	18.13	18.13	0.0%
50th	24.51	24.51	0.0%	17.52	15.57	-11.1%	28.15	25.34	-10.0%	18.01	18.01	0.0%
40th	16.91	16.91	0.0%	17.29	15.23	-11.9%	27.95	25.06	-10.3%	17.91	17.91	0.0%
30th	16.19	16.19	0.0%	17.13	15.08	-12.0%	27.54	24.73	-10.2%	17.87	17.87	0.0%
20th	16.00	16.00	0.0%	12.03	11.00	-8.6%	26.65	24.24	-9.0%	17.77	17.77	0.0%
10th	15.68	15.68	0.0%	9.03	8.02	-11.3%	13.73	12.28	-10.5%	17.67	17.67	0.0%
0	12.15	12.15	0.0%	8.56	7.63	-10.8%	13.27	11.97	-9.8%	17.62	17.62	0.0%

Table A-4. Modeled $PM_{2.5}$ Concentrations (ug/m^3, Annual Average) Resulting from Tug Escort Emissions, by Percentile

Receptor Percentile	Anacortes (859 Receptors)			Bellingham (1,028 Receptors)			Buckhorn (360 Receptors)			Cherry Point (462 Receptors)		
	Alt A	Alt C	Delta	Alt A	Alt C	Delta	Alt A	Alt C	Delta	Alt A	Alt C	Delta
100th	0.01269	0.01229	-3.2%	0.00437	0.00420	-3.9%	0.00551	0.00607	10.2%	0.00547	0.00566	3.5%
90th	0.00979	0.00950	-3.0%	0.00401	0.00385	-4.0%	0.00501	0.00552	10.2%	0.00526	0.00556	5.7%
80th	0.00892	0.00874	-2.1%	0.00365	0.00354	-3.0%	0.00485	0.00535	10.3%	0.00501	0.00540	7.8%
70th	0.00850	0.00834	-1.9%	0.00350	0.00340	-2.9%	0.00479	0.00528	10.2%	0.00420	0.00447	6.5%
60th	0.00837	0.00825	-1.4%	0.00305	0.00297	-2.7%	0.00467	0.00515	10.1%	0.00369	0.00391	6.0%
50th	0.00798	0.00781	-2.1%	0.00279	0.00273	-2.2%	0.00453	0.00499	10.2%	0.00348	0.00367	5.5%
40th	0.00771	0.00756	-1.9%	0.00215	0.00211	-2.0%	0.00437	0.00480	9.9%	0.00335	0.00353	5.4%
30th	0.00735	0.00722	-1.7%	0.00146	0.00143	-2.1%	0.00392	0.00425	8.3%	0.00323	0.00342	6.0%
20th	0.00618	0.00605	-2.2%	0.00117	0.00114	-2.6%	0.00336	0.00362	7.7%	0.00309	0.00327	5.8%
10th	0.00440	0.00435	-1.2%	0.00102	0.00099	-2.9%	0.00281	0.00302	7.4%	0.00296	0.00316	6.8%
0	0.00301	0.00298	-1.0%	0.00077	0.00075	-2.6%	0.00147	0.00163	10.9%	0.00260	0.00275	5.8%

Receptor Percentile	James Island (46 Receptors)			Lummi (760 Receptors)			Neptune Beach (366 Receptors)			Swinomish (74 Receptors)		
	Alt A	Alt C	Delta	Alt A	Alt C	Delta	Alt A	Alt C	Delta	Alt A	Alt C	Delta
100th	0.00957	0.00962	0.5%	0.00803	0.00768	-4.4%	0.00734	0.00711	-3.1%	0.00572	0.00561	-1.9%
90th	0.00927	0.00932	0.5%	0.00775	0.00741	-4.4%	0.00699	0.00679	-2.9%	0.00561	0.00551	-1.8%
80th	0.00890	0.00895	0.6%	0.00725	0.00694	-4.2%	0.00684	0.00665	-2.8%	0.00548	0.00538	-1.8%
70th	0.00835	0.00841	0.7%	0.00687	0.00658	-4.2%	0.00670	0.00652	-2.7%	0.00544	0.00534	-1.8%
60th	0.00674	0.00677	0.4%	0.00665	0.00637	-4.2%	0.00656	0.00641	-2.3%	0.00541	0.00532	-1.7%
50th	0.00610	0.00613	0.5%	0.00634	0.00609	-3.9%	0.00643	0.00628	-2.3%	0.00535	0.00526	-1.7%
40th	0.00526	0.00530	0.8%	0.00583	0.00564	-3.2%	0.00619	0.00609	-1.6%	0.00529	0.00520	-1.7%
30th	0.00492	0.00496	0.8%	0.00545	0.00528	-3.2%	0.00597	0.00586	-1.8%	0.00521	0.00513	-1.6%
20th	0.00437	0.00440	0.7%	0.00492	0.00472	-4.0%	0.00577	0.00566	-1.9%	0.00516	0.00507	-1.7%
10th	0.00401	0.00405	0.9%	0.00378	0.00363	-3.9%	0.00330	0.00327	-1.1%	0.00510	0.00502	-1.6%
0	0.00366	0.00369	0.8%	0.00315	0.00304	-3.5%	0.00266	0.00262	-1.5%	0.00489	0.00481	-1.6%