

INTERLOCAL AGREEMENT BETWEEN WASHINGTON STATE UNIVERSITY
AND THE NORTHWEST SEAPORT ALLIANCE
REGARDING AIR QUALITY MODELING STUDY

This Interlocal Agreement (“ILA”) is entered into this 6th day of November 2018 by and between Washington State University, a public university in the State of Washington (hereinafter the “WSU”), an institution of higher education and an agency of the state of Washington, and the **Northwest Seaport Alliance**, a Washington municipal corporation (“NWSA”), (collectively “Parties”) in consideration of the mutual covenants contained herein. The Parties hereby recite and agree as follows:

RECITALS

1. WHEREAS, The NWSA is charged by state statute with a mission of furthering economic development and chooses to do so in an environmentally responsible manner. To that end, the NWSA has integrated environmental stewardship into all aspects of the organization, including development activities, ongoing operations, and the operations of its customers; and

2. WHEREAS, The purpose of this ILA is to complete an air quality modeling study to assess air pollution related health risk associated with emissions associated with NWSA operations (“Air Study”). The Air Study work will be performed according to the agreed upon scope of work; and

3. WHEREAS, WSU has requested and the expressly subject to the terms herein, NWSA agrees to provide a not to exceed amount of \$130,823 for labor, equipment, facilities, and services to complete the Air Study. This amount will be provided in two payments of \$65,412, one in December 2018 and the other in May of 2019 upon project completion; and

4. WHEREAS, The NWSA finds the requested contribution meets the NWSA’s mission to develop, grow, and operate in an environmentally responsible manner as follows:

- a. The Air Study will assess the public’s exposure to port-related air emission in the Puget Sound region. This analysis demonstrates the NWSA’s commitment to understanding how their operations impact their funding constituencies from Pierce and King Counties; and
- b. Results of this Air Study will inform and further inform the update of the Northwest Ports’ Clean Air Strategy, which is a policy document that guides air quality programs at the NWSA. This Air Study will allow the NWSA and other strategy partners to target the sources of air emissions that pose the largest impact to health for the communities in which they operate.

NOW, THEREFORE, pursuant to Chapter 39.34 RCW, and in consideration of the mutual benefits and covenants described herein, the Parties agree as follows:

1. SCOPE OF WORK.

The WSU Ports Air Pollution Exposure Study Project will use state of the art modeling techniques to assess the effect on citizens in the Puget Sound region to port-related air emissions. The Air Study will consist of the following elements.

- Task 1: Adapt existing emissions inventory data to create inputs for the air quality modeling framework.
- Task 2: Run the air quality model using these inputs to assess the air emission concentrations that result from-port related sources in the Puget Sound Region.
- Task 3: Assess the exposure of the population in the Puget Sound Region to air emissions from port-related sources.
- All as described in the agreed upon scope of work that has been reviewed by WSU and NWSA, as attached hereto as **Attachment A**.

A. Duties of WSU

Task 1: Adapt emissions inventory to create model inputs.

WSU will work with the NWSA to create the emission inputs for the model. WSU will incorporate updated, spatially-resolved ocean-going vessel and harbor craft emissions into the model framework, which will be provided in a form that is ready to be input to the model. The NWSA will facilitate the delivery of these emissions data. WSU will scale existing emissions within the model for heavy-duty on road trucks, locomotives, and cargo handling equipment based on guidance from the NWSA. Once emissions estimates have been finalized, emission maps will be generated for each source category to visually portray the spatial distribution of emissions.

Deliverable Dates for Task 1: WSU will complete task 1 by December 31, 2018

Task 2: Run AIRPACT and PORTS framework simulations to estimate concentrations

WSU will use emissions data generated in Task 1 to run the AIRPACT 5 model for a special "PORTS" framework. The PORTS framework is a special adaption of the AIRPACT model, utilizing 1.33 km grid resolution and incorporating the port emissions. Downwind concentration estimates will be modeled for the Puget Sound Region, both on an annual average and the annual maximums. The model will be run for one month of each season to represent the entire year. A brute force method will be applied to attribute the resulting concentrations to each source category. Results will be provided graphically and in a form that can be used as input to the BenMAP model, which is used to assess health effects.

Task 3: Regional Exposure Analysis

Model results for pollutant concentrations associated with each source type will be correlated spatially with population to estimate exposure based on census block populations. WSU will

develop the appropriate exposure metric and/or simply use the population multiplied by the average concentration in each census block. The exposure analysis will be performed for each source type and summed for the entire model domain, to determine the relative exposure levels of different pollutants. WSU will also apply the BenMAP model using the attribution results to assess different health outcomes associated with simulated exposure rates. The exposure results will further be overlaid with demographic data. NWSA will assist as necessary with the demographic analysis.

Deliverable Dates for Task 2 and 3: The final report detailing the methods and results will be completed by WSU by May 31, 2019. Intermediary products (i.e. concentration and exposure maps and data) should be provided to NWSA as available. NWSA will be given the opportunity to review the draft results and draft report before publication.

B. Duties of the NWSA

Task 1: Adapt emissions inventory to create model inputs.

The NWSA will facilitate the delivery of spatially-resolved, ocean-going vessel and harbor craft emissions in a form that is easily incorporated into the model framework. The NWSA will also analyze emissions of heavy-duty on road trucks, locomotives, and cargo handling equipment to advise WSU on the proper scaling factors to use in both near port areas and other areas within the modeling domain. The ability of WSU to perform the work on time is contingent on receiving the emissions data from the NWSA in a timely manner.

Tasks 2 and 3:

The role of the NWSA in Tasks 2 and 3 is to provide timely feedback and advise WSU when questions about the Air Study arises and assist as necessary with the demographic analysis.

2. NWSA'S CONDITIONAL AGREEMENT TO CONTRIBUTE FUNDS.

Subject to the terms herein, the NWSA agrees to contribute to WSU an investment from the Environmental Department Budget for the Project in the amount not to exceed \$130,823. Further conditions of the NWSA's funding are as follows:

- In the event Project costs are higher than projected, WSU will assume any excess Project costs.
- The NWSA's annual Project contribution shall be allocated and specifically identified in the NWSA's 2018 and 2019 budgets.
- Payments from NWSA to WSU will be made in two lump sums. The first will be made in 2018 after the completion of Task 1 in the amount of \$65,412. The second will be made in 2019 after the completion of the Air Study project in the amount of \$65,412.

3. TIMEFRAME/PROJECT SCHEDULE.

The Air Study project will take place from November 2018 to July 2019. The anticipated timeline for the completion of major milestones is as follows.

- December 31, 2018: Task 1 completed.
- May 31, 2019: Task 2 and 3 completed and final report submitted to NWSA

4. WSU' S PROJECT FINANCIAL SUMMARY.

Total Project Cost: Not to exceed \$130,823

Source of Funds: NWSA's Environmental Program budget.

5. ABANDONMENT. If the Air Study Project is abandoned, then this ILA shall be of no further force or effect.

6. ASSIGNMENT. Neither Party to this ILA shall have the right to convey, assign, apportion or otherwise transfer any and all of its rights, obligations, conditions and interests under this ILA, without the prior written approval of the other.

7. THIRD PARTY BENEFICIARIES. This ILA is made and entered into for the sole protection and benefit of the Parties hereto and their successors and assigns. No other person shall have any right or cause of action based upon any provisions of this ILA or the resulting Air Study.

8. EQUAL DRAFTING. This ILA has been reviewed and revised by legal counsel for both parties, and no presumption or rule construing ambiguity against the drafter of the document shall apply to the interpretation or enforcement of this ILA.

9. SEVERABILITY. If any provisions of this ILA are determined to be unenforceable or invalid pursuant to a final decree or judgment by a court of law with jurisdiction, then the remainder of this ILA not decreed or adjudged unenforceable or invalid shall remain unaffected and in full force and effect to the extent that the primary purpose of this ILA can be preserved.

10. MODIFICATION. This ILA may not be modified except by mutual agreement reduced to writing in a formal amendment hereto and approved by each Party's governing body.

11. TERMINATION. This ILA shall terminate upon completion by both Parties of their respective obligations hereunder, or on May 31, 2019 unless terminated earlier.

12. GOVERNING LAW. This ILA shall be governed exclusively by the laws of the State of Washington both as to interpretation and performance without recourse to any principles of Conflicts of Laws. Any action at law, suit in equity or judicial proceeding for the endorsement of this ILA or any provisions thereof shall be instituted and maintained only in any of the courts of competent jurisdiction in Pierce County, Washington.

13. NOTICES. All notices given pursuant to this ILA shall be deemed delivered to the respective Party on the date that it is personally delivered to the address(es) set forth below, or on the date that it is successfully sent by email transmission to the email addresses set forth below:

WSU:

Attention: Office of Research Support and Operations

Email: orso@wsu.edu

NWSA:

1 Sicum Way

Tacoma, Washington 98421

Attention: Graham VanderSchelden

Email: gvanderschelden@nwseaportalliance.com

14. ENTIRE AGREEMENT. This ILA constitutes the entire agreement of the Parties, supersedes all previous oral or written understandings, and incorporates all prior discussions and agreements pertaining to this subject matter. The Parties participated equally in any negotiations and the process leading to execution of this ILA. If a dispute should arise with regard to the meaning or interpretation of any provision hereof, there shall be no presumption of draftsmanship as to such provision.

15. LEGAL RELATIONS.

A. Independent Municipal Governments. The Parties hereto are independent governmental entities and nothing herein shall be construed to limit the independent government powers, authority or discretion of the governing bodies of each Party. It is understood and agreed that this ILA and the resulting Air Study is solely for the benefit of the Parties hereto and gives no right to any other party. No joint venture or partnership is formed as a result of this ILA. No employees or agents of any Party shall be deemed, or represent themselves to be, employees of any of the other Party.

B. Legal obligations. This ILA does not relieve either Party of any obligation or responsibility imposed upon it by law.

C. Timely Performance. The requirements of this ILA shall be carried out in a timely manner according to a schedule negotiated by and satisfactory to the Parties.

D. Recording. A copy of this ALA shall be recorded with the Auditor of the County within which each Party is based as provided by law or shall be posted to each Parties' web site.

16. RECORDS AND AUDIT. During the term of this ILA, and for a period not less than six (6) years from the date of termination, records and accounts pertaining to the work of this ILA and accounting therefore shall be kept by each Party and shall be available for inspection and audit by representatives of either Party and any other entity with legal entitlement to review said records. If any litigation, claim, or audit is commenced, the records and accounts along with supporting documentation shall be retained until all litigation, claims, or audit finding has been

resolved, even though such litigation, claim, or audit continues past the six-year (6) retention period. This provision is in addition to and is not intended to supplant, alter or amend records retention requirements established by applicable state and federal laws.

17. LIMITS OF FINANCIAL OBLIGATIONS/PROPERTY OWNERSHIP. Except as provided above, each Party shall finance its own conduct of responsibilities under this ILA. No ownership of property will transfer as a result of this ILA.

18. INDEMNIFICATION AND HOLD HARMLESS.

A. Each Party hereto agrees to be responsible and assume liability for its own negligent acts or omissions, or those of its officers, agents, or employees to the extent permitted by law.

B. Each Party specifically assumes liability for actions brought by its own employees against the other Party and for that purpose each Party specifically waives, as respects the other parties only, any immunity under the Worker's Compensation Act, RCW Title 51.

C. The Parties recognizes that this waiver was the subject of mutual negotiation. In the event any Party incurs attorney's fees, costs or other legal expenses to enforce the provisions of this ILA against the other Party, all such fees, costs and expenses shall be recoverable by the prevailing Party.

D. No liability shall attach to any of the Parties by reason of entering into this ILA except as expressly provided herein.

E. The provisions of this Article 20 shall survive any termination or expiration of this ILA.

Agreed to the Parties:

WSU:

 Digitally signed by Derek Brown, Manager, Authorized Official
Date: 2018.11.13 16:19:38 08'00'
_____, [#WSU signee title#]
Date: _____

NWSA:



John Wolfe, CEO
Date: 11-21-18

Approved as to form:



NWSA Legal Counsel
Carmy Nale

Puget Sound Ports Air Quality Health Impacts Study WSU Scope of Work

Background:

In 2007, the Ports of Tacoma, Seattle, and Vancouver B.C. came together to create the Northwest Ports Clean Air Strategy (NWPCAS), a joint initiative to reduce air pollutant and greenhouse gas (GHG) emissions from port operations¹. In 2015, the Northwest Seaport Alliance (NWSA) was formed and was included as a member of the strategy. The ports developed the strategy in collaboration with government agencies, including the EPA and Washington State department of Ecology. The strategy sets overarching emission reduction targets for the ports in addition to activity-based targets for each emission sector encompassed in port operations. The NWPCAS is updated every five years to realign the targets with the latest science and technology, industry best practices, regional, national, and international policy, and port, community, and agency priorities. The ports are currently beginning the process of updating the NWPCAS for years 2020 and beyond. As part of this update process, the Northwest Seaport Alliance is looking to employ state-of-the-art scientific methods to better understand the health impacts of port-related emissions in the Puget Sound Airshed to inform targets, goals, and methods if the new NWPCAS.

Study Overview and Goals:

The Laboratory for Atmospheric Research (LAR) at Washington State University (WSU) operates the AIRPACT numerical air quality forecast system for the Pacific Northwest. This system uses state-of-the-art meteorological and chemical transport models to simulate ozone, PM_{2.5}, numerous air toxics, and related precursors and products on a one-hour time step over a 4 km x 4 km gridded domain covering Idaho, Oregon, Washington and peripheral areas. The AIRPACT framework is ideally suited, particularly after suitable modifications, to quantify the exposure of the population to port related air emissions, within the Puget Sound Airshed.

To accomplish this, WSU proposes creating a PORTS modeling framework, based upon AIRPACT, with a high-resolution model domain (1.3 km x 1.3 km grid cells) centered on the Puget Sound Airshed. The PORTS modeling system will be used to simulate the concentrations of important air pollutants based on emissions from port-related sources. The 1.33-km domain (Figure 2) will be 'nested' within the AIRPACT 4-km domain; AIRPACT 4-km results will provide initial conditions and boundary conditions for the PORTS simulations. The overarching study design is to isolate emissions from operations related to Puget Sound Area Ports involved in the NWPCAS update and to use these port specific emissions in PORTS to assess pollutant concentrations within the Puget Sound Airshed both for annual average and maximum short-term concentrations. A subsequent modeling exercise will assess the population's exposure to these air pollutants, using the BenMap health impact tool². These exposure effects will be evaluated for each source type individually, as well as in aggregate, with the goal of assessing the spatial

¹ EPA. Northwest Ports Clean Air Strategy. <https://www.epa.gov/ports-initiative/northwest-ports-achievements-reducing-emissions-and-improving-performance>

² EPA. BenMAP. <https://www.epa.gov/benmap/benmap-downloads>

distribution of pollutant concentrations as well as developing an airshed scale exposure metric for assessing the relative impacts of each source.

Summary of Tasks and Responsibilities:

1. Adapt emissions inventory to create PORTS inputs.

WSU, Washington State Department of Ecology (WSDOE), and NWSA will share in this task. Washington State Department of Ecology will update the AIRPACT emissions inventory to include vessel emissions estimates from the recently completed Puget Sound Maritime Emissions Inventory (PSEI)³. Other sources (locomotives, heavy-duty on-road vehicles, and cargo handling equipment) will be modeled by scaling the existing AIRPACT emissions inventory for the appropriate source types. NWSA will work with WSU to determine the scaling factors for port facilities. Once the emissions are finalized, WSU will create emission maps that NWSA can review and can use to inform the early NWPCAS update process.

2. Run AIRPACT and PORTS framework simulations to estimate concentrations.

Once the emissions inventory files have been created, WSU will run the AIRPACT and PORTS frameworks to estimate the regional concentrations of the pollutants of interest (DPM, PM_{2.5}, ozone, and other air toxics if applicable). AIRPACT runs will be needed to provide: 1) initial conditions for the start of each month of PORTS simulations, 2) daily boundary conditions for PORTS runs. In order to develop source attribution results, one base case PORTS simulation will be conducted with all port sources included; then additional individual attribution runs will be completed where emissions from the five source categories are zeroed out. Subtracting an attribution run from the matched base case run will yield a difference for each pollutant of interest, showing the portion of each pollutant attributable to that source. This approach, known as the 'brute force' technique, we believe will be more efficient in terms of computer resources than other approaches such as the Direct Decoupled Method which is designed for source-specific sensitivity analyses. Results will be provided graphically for each source category as well as for all port related sources combined, and data files will be generated that provide the required input for BenMAP. Model simulations will be completed for one month of each season and those four months used to estimate annual average concentrations for each pollutant as well as the domain maximum 1-hour concentrations. This approach is used in place of complete year-long simulations to reduce the computing resource requirements to a level where multiple runs can be completed for source attribution purposes.

3. Regional Exposure Analysis

PORTS results for pollutant concentrations associated with each source type will be correlated spatially with population to estimate exposure based on census block populations. WSU will develop an appropriate exposure metric and/or simply use the population

³ Starcrest, 2018. Puget Sound Maritime Air Emissions Inventory. <https://pugetsoundmaritimeairforum.org/2016-puget-sound-maritime-air-emissions-inventory/>

Attachment A

multiplied by the average concentration in each census block. This exposure analysis will be performed for each source type and summed for the entire model domain, to determine the relative health impacts of each source. Exposure will also be overlaid with demographic data. WSU and NWSA will work together as necessary to perform these analyses.

Deliverables:

Completion Date: December 31, 2018

- Produce emission maps for each source and primary pollutant to be used in stakeholder discussions.

Completion Date: May 31, 2019

Prior to the completion date, the NWSA will be given the opportunity to review the draft results and draft report before publication. The final deliverable from WSU to NWSA is a final report detailing the methods, results, and conclusions of the study as follows:

- Description of all modeling methods used.
- Map graphics showing gridded emissions for each pollutant and source category.
- Map graphics that show the resulting annual average and maximum air pollutant concentrations for each air pollutant and source category.
- Metrics that quantify the Puget Sound Population's exposure to each air pollutant and the corresponding health risk (i.e. concentration x population exposed, acute and chronic health risk metrics).
- Analysis of results identifying which sources pose the largest risk to public health.
- Analysis of results characterizing the composition of secondary pollutants and which sources are most significant.
- Characterization of port related emissions in context of other emissions.

WSU will also provide the model output results in the file format for BenMAP.

Overview of Proposed Methodology:

The PORTS framework will be employed to assess the impacts of port-related air pollution on the Puget Sound Airshed. The following is a high-level summary of the methodology to be followed.

Sources to be Modeled:

The Puget Sound area ports have 5 major sources of air pollutant emissions to be modeled. Emissions from the following sources will be included in the study.

- Ocean going vessels (OGVs) – the ocean-going vessel category consists of large vessels that carry cargo through the open ocean. This includes auto carriers, bulk carriers,

containerships, general cargo vessels, passenger cruise vessels, refrigerated vessels (reefers), and roll-on/roll-off (Ro-Ro) vessels.

- Harbor craft – for the ports, the harbor craft category includes assist tugboats used for helping OGVs maneuver in the harbor during arrival and departure.
- Cargo handling equipment (CHE) – cargo handling equipment is non-road equipment used to move cargo (containers, general cargo, and bulk cargo). Examples of cargo handling equipment include: forklifts, yard trucks, rubber tired gantry cranes, and straddle carriers.
- Locomotives – the locomotive category includes switching locomotives, used to sort rail cars on marine terminals and related intermodal yards, and line-haul locomotives, used for transporting cargo trains to their destination on the rail network.
- Heavy duty on-road vehicles – the heavy-duty category includes heavy duty (semi) trucks used to transport port related cargo. Busses used for transporting passengers for cruise terminals at Port of Seattle are also included, but represent a very small fraction of emissions.

Pollutants to be Modeled:

The pollutants likely to contribute the greatest health effects from port related emissions are diesel particulate matter (DPM) and fine particulate matter (PM_{2.5}). DPM may be treated, in CMAQ, either as a tracer or else as a non-reactive species subject to precipitation scavenging and deposition. In addition, port emissions of nitrogen oxides (NO_x) and volatile organic compounds likely contribute to tropospheric ozone and emissions of NO_x, VOCs, and SO₂ likely contribute to secondary aerosol formation. The model will include emissions of NO_x, CO, SO₂, VOCs, PM₁₀, DPM, and PM_{2.5} from the sources listed above. The project will assess the concentrations of the following pollutants as summarized below for each source type.

- Diesel particulate matter (primary): DPM is known to have significant chronic health risks⁴ and has been shown to be the most significant driver of inverse health effects from air toxics in the Puget Sound region⁵. As such, DPM emissions has been the indicator tracked by the port to assess its impact on regional air quality, since the majority of port emissions result from combustion of diesel fuel. DPM will likely account for the majority of the health risk associated with port-related pollution.
- Fine particulate matter (primary and secondary): As a Criteria Air Pollutant, PM_{2.5} also negatively impacts human health. For port-related sources, primary PM_{2.5} is roughly equivalent to DPM, though there are some processes (for example ship boiler

⁴ CARB. Overview: Diesel Exhaust and Health. <https://ww2.arb.ca.gov/resources/overview-diesel-exhaust-and-health>

⁵ Puget Sound Clean Air Agency. Tacoma and Seattle Area Air Toxics Evaluation. <https://www.pscleanair.org/DocumentCenter/View/145/2010-Tacoma-and-Seattle-Area-Air-Toxics-Evaluation---Full-Report-PDF?bidId=>

emissions) that are not counted as DPM and some fraction of DPM particles are larger than the 2.5 micrometers in diameter required to be classified as PM_{2.5}. Inclusion of the PM_{2.5} category is mostly to assess secondary particulate matter that results from port-related emissions. Specifically, emissions of nitrogen (NO_x), sulfur (SO_x) and organic (VOCs) compounds are often transformed into particulate matter through atmospheric chemistry. Emissions from shipping have been shown to significantly contribute to secondary aerosol concentrations over land⁶. This analysis will provide a comprehensive assessment of the port's contribution to regional particulate matter.

- Oxides of sulfur (SO_x): Sulphur emissions have traditionally been a point of emphasis for the maritime industry, as shippers tend to use fuels that have higher sulfur content than on-road fuels. This impact was reduced significantly with the introduction of the North American Emissions Control Area (ECA) in 2015, but still may be substantial.
- Benzene/other air toxics: Benzene is an air toxic, has been shown to pose a significant health risk in the Puget Sound Region⁵, and is known to be emitted from the combustion of fossil fuels. In addition, other air toxics such as, PAHs, formaldehyde, toluene, and acetaldehyde are known to be emitted during fossil fuel combustion. While these pollutants do pose relevant health risks, analyzing their concentrations may be difficult due to the limited scope of the emissions inventory. VOC emissions were reported in aggregated, meaning that emissions inventory estimates of volatile air toxics would be provided using estimated emission distributions to attribute the bulk VOC emissions. NWSA will make recommendations on whether benzene and other air toxics should be modeled based on the magnitude of their emissions, uncertainty of emission estimates, and computational resources required.
- Ozone: As a major source of NO_x and VOCs, port related emissions may have a significant effect on ground level ozone. The impact on regional maximum ozone concentration will be assessed and graphics and data files will be generated as appropriate.

Modeling Methods for Estimating Concentrations:

WSU will use a modeling framework called PORTS, derived from WSU's AIRPACT framework but operating on a high-resolution domain centered around the Puget Sound Airshed (Figure 1 and Figure 2). PORTS, using CMAQ v5.2, will be used to assess concentrations of DPM, PM_{2.5}, other air toxics, and maximum domain ozone concentration that result from the emissions of major port-related sources. Concentrations will be simulated for the Puget Sound Region on a 1.33-km domain. Spatial surrogates for the 1.33-km grid have already been developed by the Washington State Department of Ecology (WSDOE). Source apportionment using a brute force approach, as described above, will be used to determine the concentrations attributable to port-related sources. We will also investigate the feasibility of using the CMAQ Direct Decoupled Method to determine the sensitivity of model results to specific port source

⁶ Aksoyoglu et al., 2016. Contribution of ship emissions to the concentrations and deposition of air pollutants in Europe. *Atmospheric Chemistry and Physics* 16, 1895 – 1906.

types. However, our initial assessment is that DDM requires excessive computer time and it will be more efficient to use the 'brute force' approach.

Emissions Inventory:

Puget Sound area ports, along with other industry and agency partners, recently completed an emissions inventory for model year 2016 (PSEI)⁴. This inventory surveyed emissions for all maritime-related mobile sources in the Puget Sound area (Table 1). The PSEI emissions data will be used where practicable to develop the emissions inventory file to be used in AIRPACT. The preferred approach for each emission source is described below.

- Ocean-going vessels: OGV emissions have traditionally been adapted from the PSEI inventory effort to the AIRPACT grid by the WSDOE. The current inventory includes results from the 2011 PSEI. WSDOE staff is currently in the process of updating the AIRPACT inventory to include new emission estimates from the 2016 PSEI. Emissions from grid cells outside the shipping corridor from the strait of Juan de Fuca to the Ports of Tacoma and Seattle (i.e. south of Commencement Bay and north of the strait) may need to be excluded to isolate the ports' influence.
- Harbor vessels: similar to OGVs, the WSDOE is in the process of updating the inventory for assist tugboats. For this analysis, the emissions from assist tugboats should be scaled to include just the responsibilities of the NWSA, Port of Tacoma, and Port of Seattle.
- Cargo Handling Equipment: CHE emissions estimates are provided for each terminal by the PSEI. These will be modeled either by scaling existing non-road emissions estimates in AIRPACT based on the PSEI's emissions estimates, or adding point sources in the port areas for CHE.
- Locomotives: Locomotive emissions estimates will be created for this study by scaling the existing emissions estimates in the AIRPACT system. Two separate scaling factors will be applied. In port areas, where port-related railyards account for most of the traffic, a scaling factor will be developed for the ports' responsibility based on expert knowledge (likely near 100%). For rail network emissions (everywhere else), the ratio of port-related emissions in the PSEI to NEI regional emissions, for those counties included in the PSEI, for line-haul locomotives, will be used to scale emissions.
- Heavy-duty on-road trucks: Truck emissions estimates will be created for this study by scaling the existing emissions estimates in the AIRPACT system. Two separate scaling factors will be applied. In port areas, where port-related trucks account for a larger fraction of total heavy-duty vehicle emissions, a first scaling factor will be developed based on expert knowledge. For network emissions (everywhere else), the ratio of port-related emissions in the PSEI to NEI regional emissions, for those counties included in the PSEI, for heavy-duty diesel trucks, will be used to scale emissions.

Attachment A

Table 1. Total Port-Related Emissions within the Puget Sound Airshed for Port of Tacoma, Port of Seattle, and NWSA, in tons per year.

	NO _x	VOC	CO	SO ₂	PM ₁₀	PM _{2.5}	DPM
OGVs	8,635	253	714	257	136	127	129
Harbor	502	16	83	0	16	15	16
Locomotives	1,018	58	195	1	29	27	29
CHE	280	26	154	0	14	13	13
Heavy-duty Trucks	973	51	244	2	47	43	47
Total	11,407	403	1,390	260	242	225	234

Temporal Scale for Model Runs:

Because the pollutants to be analyzed are associated with both chronic and acute health effects, both annual average and maximum contributions will be reported for each source. Annual averages will be estimated by modeling a representative month from each season and extrapolating to the full year.

Model Spatial Scale:

The Puget Sound Airshed as defined in the PSEI is shown in the map below (Figure 1). The light green shaded area below the black dashed line, above the red line indicates the geographical extent of the emissions estimates for the airshed. Though the majority of the population lives to the east of Puget Sound, it is important to model emissions from the Strait of Juan de Fuca, since OGVs are the largest source of air pollutants in the PSEI. A major goal of this study is to understand the importance of these emissions when compared with terrestrial sources. Therefore, emissions will be considered over the entire airshed. Concentrations, at a minimum, should be assessed for the major population centers and along the shipping corridor. The blue outline denotes approximately the areas to be covered by a high-resolution modeling domain to be used for this work. Figure 2 shows WSU's suggested 1.33-km PORTS project domain, which is designed in response to Figure 1, for this work.

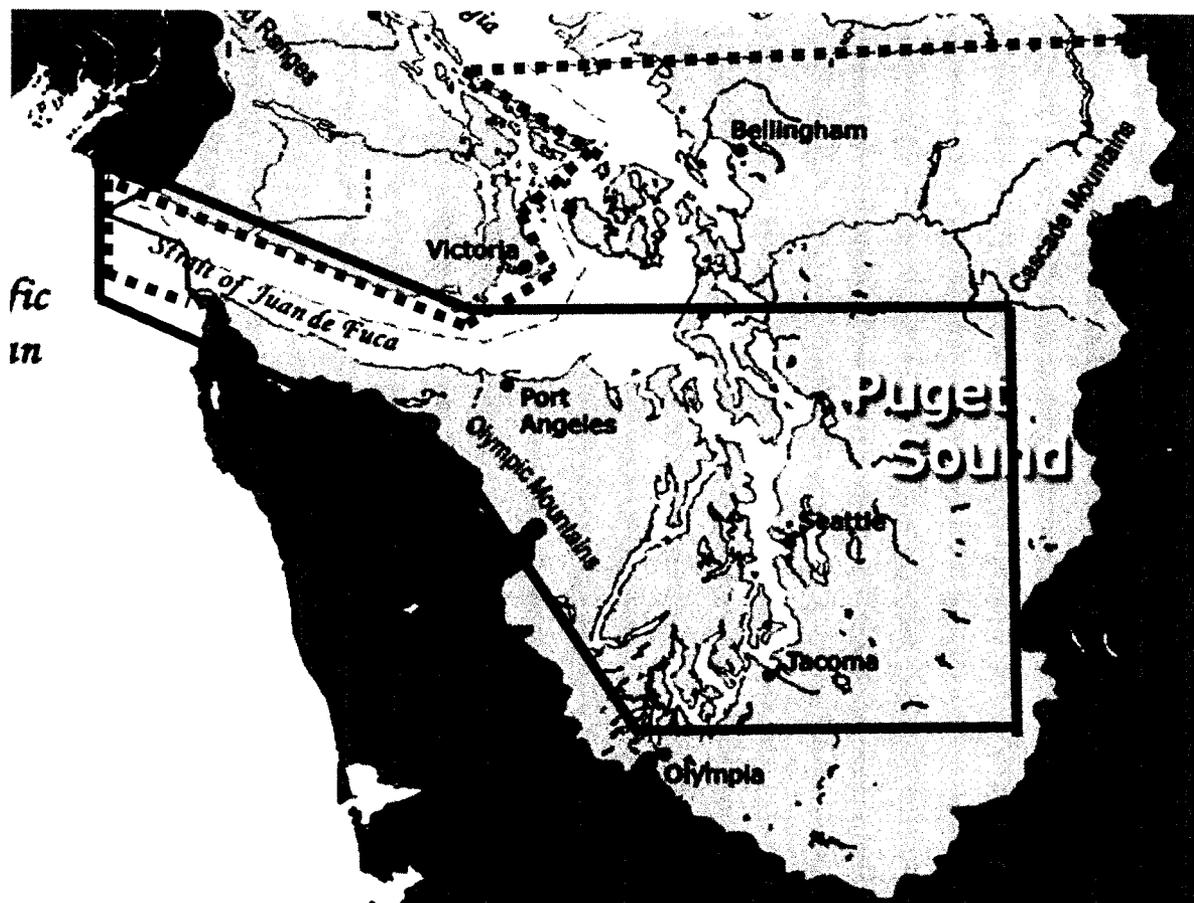


Figure 1. Puget Sound Airshed Boundary

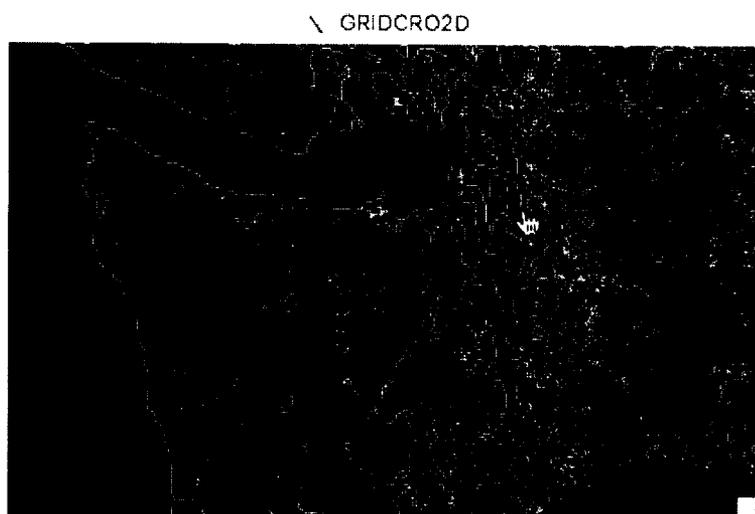


Figure 2. PORTS framework 1.33-km domain for port source modeling.

Research Products:

Within the analysis period, the magnitude and location of the maximum concentration of each pollutant (DPM, PM_{2.5}, ozone, and other air toxics if applicable) will be reported and its attribution to each source type. Annual average concentrations associated with each source type will be estimated for each grid cell as well as annual average concentrations for all sources together. Contour maps will be created to illustrate the concentration distribution. Gridded concentration data will be made available in a format appropriate for use in models that assesses community health effects (i.e. BenMAP; WSU has used BenMap in previous research and is familiar with the input requirements).

Health Effects/Exposure Assessment

To assess the impact on public health, annual concentration estimates from AIRPACT for each source type will be combined with population data to determine the exposure of the population. At a minimum, an exposure metric (concentration x population exposed) will be calculated for each census block for each pollutant (DPM, PM_{2.5}, and other air toxics if applicable) and the total exposure for the region will be summed. This will allow sources to be compared based on the exposure risk they pose. If scientifically defensible risk factors are available, public health risk may be calculated as well. Contour maps will be created to visually portray the spatial distribution of public health risk for each source. Overlays of demographic data with exposure, will be produced. NWSA will assist WSU as necessary to complete the demographic analysis.

Project Management and Personnel

Dr. Yunha Lee, Assistant Professor, will serve as the Principal Investigator for the project. Dr. Lee recently joined WSU, initially as a Research Assistant Professor, in 2015 and moved into her current position in 2017. At WSU, she has become a key investigator for AIRPACT modeling work. Dr. Joseph Vaughan, Associate Research Professor, will serve as a co-PI and assist with AIRPACT setup and simulations for the project. Dr. Vaughan has the primary responsibility for daily operation of AIRPACT and has considerable experience in regional air quality modeling for the Pacific Northwest. Dr. Brian Lamb, Regents Professor, will also assist with the overall design and analysis aspects of the project. Dr. Lamb led the development of AIRPACT and has more than three decades of experience with air quality measurements and modeling. Ms. Mashid Etesamifard, PhD graduate student, will play a key role in running the simulations and analyzing the results. Ms. Etesamifard has experience in emissions modeling, is very familiar with AIRPACT operations, and with CMAQ model options, and has recently completed a DDM analysis of ozone source sensitivity for the Kennewick region in Washington state.

