THE NORTHWEST SEAPORT ALLIANCE
MEMORANDUM

MANAGING MEMBERS
ACTION ITEM

Item No. 3C

Date of Meeting June 2, 2020

DATE: May 20, 2020

TO: Managing Members

FROM: John Wolfe, CEO

Sponsor: Jason Jordan, Director, Environmental and Planning Services

Project Manager: Graham VanderSchelden, Environmental Project Manager II

SUBJECT: Consent Agenda: No Cost Time Extension for ILA with WSU for Air Quality Modeling Study

A. ACTION REQUESTED

Request authorization to extend the duration of the Interlocal Agreement (ILA) with Washington State University (WSU) to complete an Air Quality Modeling Study from terminating on May 31, 2020 to terminating on May 31, 2021, or upon completion of the work, whichever comes second, or 30 days from written notice by either party. No adjustments are proposed to the approved cost or scope. The ILA states that any modification to the agreement is subject to approval by each party's governing body, this memo seeks the requisite approval from Managing Members to extend the agreement as described.

B. SYNOPSIS

While the WSU modeling work is delayed, it will add significant value to our air quality program by providing insight and data on how regional populations are exposed to port related emissions, important for prioritizing work as we shift to implementation of the Northwest Ports Clean Air Strategy (NWPCAS) and for communicating our impacts and priorities. This will not delay the finalization of the NWPCAS update, as the study results will be integrated into the NWSA's implementation plan. WSU has overcome the technical challenges that led to the delays, which broadly include integrating new data into the model, identifying methods for isolating port related sources, and challenges in getting the specialized model running for our study, and expect to have the study finished by the end of 2020. Staff are confident in the timeline because WSU has demonstrated, through graphics and test model runs, that the emissions data and model are in place to accomplish the remaining tasks.

C. BACKGROUND

On November 6, 2018, Managing Members gave authorization to enter into an ILA with Washington State University for an Air Quality Modeling Study to assess the spatial distribution of air emissions from port related sources, model the concentrations of pollutants regionally, and correlate the modeled concentrations with population and demographic data. The results of the study will provide insight into the port's impact on air quality related health impacts and allow us to better prioritize and communicate the benefits of future emission reduction projects by understanding the relative impacts of each port related source type (i.e., vessels, trucks, cargo-handling equipment, etc.). The original memo presented to Managing Members fully describing the study as well as the ILA are attached to this memo, providing further background.

Though the results are delayed, they will still have tremendous value as a decision making, prioritization and communication tool. The study of local pollutant dispersion and exposure will be incredibly valuable as a way to quantify, visualize, and communicate the relative impacts of trucks vs. ships vs. cargo handling equipment vs. rail, etc. on our local communities.

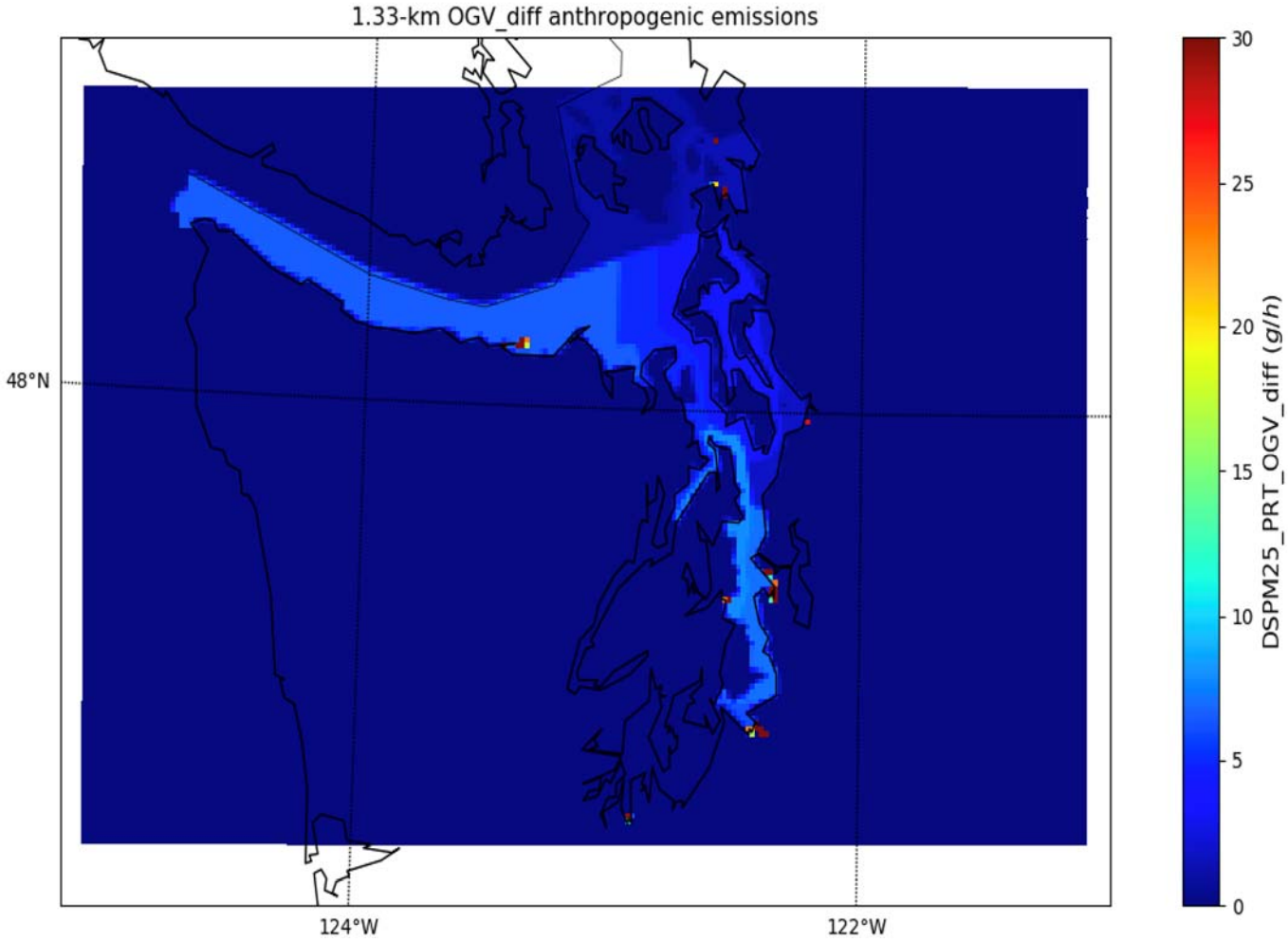
D. PROJECT PROGRESS

Throughout the last calendar year, staff have met with WSU on a weekly to bi-weekly basis to track progress and create accountability. To date, the scientists at WSU have completed task 1 of the project by fully incorporating the updated emissions from the Puget Sound Maritime Inventory for vessels into the AIRPACT air quality model, developed specialized code for isolating the port related emissions within the larger emission inventory during model runs, and developed emission graphics for the Puget Sound Airshed that illustrate the port related emissions for each source. An example graphic for ocean-going vessels (OGVs) is shown below. In addition, WSU has developed and completed test model runs of the specialized, finely resolved version of the model to be used for simulating pollutant dispersion and developed and tested code for identifying the resulting concentrations from each port related source. Having these elements in place allows WSU to take the next steps in running the model for each source and then performing the exposure analysis with population data.

Example $PM_{2.5}$ Emission Graphic for OGVs:

The heat map below is a visual representation of the average emissions by location from ocean-going vessels in the Puget Sound Airshed. Cooler colors (purple/blue) represent lower emissions in grams per hour for each 1.3 by 1.3 km sized grid cell, and hotter colors (green/yellow/red) represent higher emissions. The graphic presents a typical snapshot of the emissions data that will be used to model the resulting concentrations from each source.

In the ocean-going vessel graphic, the shipping lanes through the Strait of Juan de Fuca are illuminated in light blue/green indicating the presence of ship activity and emissions. Hot spots can be seen in yellow and red at the port areas indicating the presence of vessels at berth.



$PM_{2.5}$ Emissions snapshot from ocean-going vessels

E. PROJECT SCHEDULE AND NEXT STEPS

WSU expects to complete the study by the end of calendar year 2020, lining up with the planned completion of the Northwest Ports Clean Air Strategy Update. This will allow results to be used as a communication tool and to prioritize work as we move into implementation. The schedule below was developed to show the timeline of completing the various subtasks remaining based on the computing resources presently available to the WSU staff. Subtasks 2-11 are parts of task 2 and 3 in the agreed upon scope of work and subtask 1 below is the last of task 1. WSU will be working to add another “computing node” to their available resources in order to accelerate the modeling work, which could roughly halve the time required for steps 4-8. Staff are confident in this schedule because we have seen the emission graphics, demonstrating that the emissions are in place to run the model, and have seen a test dispersion modeling and source apportionment run, demonstrating that the model is ready as well.

Schedule for PORTS Dispersion Modeling Study

	May				Jun				Jul				Aug			
1. Generating emission maps																
2. Simulating the base case																
3. Developing post-processing scripts																
4. Simulating the ocean-going vessels knockout																
5. Simulating the harbor craft knockout																
6. Simulating the cargo-handling equipment knockout																

	Sept				Oct				Nov				Dec			
6. Simulating the cargo-handling equipment knockout																
7. Simulating the locomotive knockout																
8. Simulating the trucks knockout																
9. Postprocessing																
10. BenMap (demographics)																
11. Writing the report																

F. DETAILS OF EXTENSION

Work began on the project in late November 2018 and was to be completed, per the ILA, by May 31, 2019. However, the original timeline has proven far too aggressive for a variety of reasons, the greatest of which is that this study is a much more significant technical challenge than originally thought. WSU's assessment and communication of these challenges, particularly how they relate to the project timeline, has been frustrating to staff at times. Even so, WSU remains committed to completing the work at the cost originally quoted and staff still believe there is great value in the work. A summary of the reasons for delays are: a significant health issue that has kept the principal investigator out on medical leave since near the beginning of the study, technical challenges interpreting and implementing data from the Department of Ecology which required unexpected reworking and "debugging," significant effort to explore and identify the right methods, emission source codes, and spatial profiles within the existing mode to represent the port-related sources, and unforeseen challenges in getting the finely resolved model (special for our study) running. These types of challenges are not uncommon in a novel research project like this one that has not been done before.

Staff recommend updating the termination language in the ILA from terminating on May 31, 2020 to, "this interlocal agreement shall terminate upon completion by both Parties of their respective obligations hereunder, or on May 31, 2021, whichever is later, or upon thirty (30) days' written notice from either party." This change in language would provide additional flexibility for completing the work but also allow NWSA to terminate the ILA at will if progress is not satisfactory.

G. FINANCIAL IMPLICATIONS

None. There are no changes to scope or cost as a result of extending this ILA.

The total commitment of the ILA was $130,823, to be paid in two phases of $65.412.50, lining up with the main project task deliverables. To date, one payment of $34,523 was made in 2019 towards the first phase and an invoice for $30,889 is expected in May 2020 based on deliverables met. The outstanding amount for deliverables not yet received is $65,413.

H. ATTACHMENTS TO THIS REQUEST

- November 6, 2018 Managing member memo: ILA with WSU for Air Quality Modeling Study
- ILA with WSU
- ILA with WSU Amendment 1

THE NORTHWEST SEAPORT ALLIANCE
MEMORANDUM

MANAGING MEMBERS
ACTION ITEM

Item No. 4B

Date of Meeting November 6, 2018

DATE: October 24, 2018

TO: Managing Members, The Northwest Seaport Alliance

FROM: John Wolfe, Chief Executive Officer

Sponsor: Jason Jordan, Director, Environmental and Planning Services

Project Manager: Graham VanderSchelden, Environmental Project Manager I

SUBJECT: ILA with WSU for Air Quality Monitoring Study

A. ACTION REQUESTED

As referenced in NWSA Resolution No. 2016-04, Exhibit A, Delegation of Authority Master Policy, Paragraph 8.b.i. requires authorization from Managing Members to enter into an Interlocal Agreement (ILA) with another public agency.

Request authorization for the NWSA CEO to enter into an Interlocal Agreement (ILA) with Washington State University (WSU) in the amount of $130,823 for work associated with the WSU Ports Air Quality Modeling Study, funded under NWSA Master Identification No. 201007.01.

B. SYNOPSIS

The costs of the services being provided by WSU will cover labor, equipment, and facilities to complete an air quality modeling study, designed to assess the exposure of the Puget Sound community to the major sources of port-related air pollution. The model, operated by WSU, will provide estimated concentrations of air pollution that originate from port-related sources (ocean-going vessels, harbor vessels, heavy-duty trucks, locomotives, and cargo-handling equipment) for each 1.3 kilometer by 1.3 kilometer “cell” of the Puget Sound Region. The modeled concentrations will be correlated spatially with population to develop a metric that quantifies the exposure of the population to port-related air pollution. The exposure metric will be provided for each source category, allowing the relative impacts of each to be compared.

Comparing the relative public exposure to air pollution from each port-related source will allow emission reduction measures in the Northwest Ports Clean Air Strategy (NWPCAS) to be prioritized for the sources that truly pose the largest health risk to the public. Because past efforts to quantify the impacts of port-related air pollution (Puget Sound Maritime Air Emissions Inventories) have simply provided aggregate annual emission totals for the entire region, without quantitative consideration of where the emissions occur relative to population centers,

this analysis would provide significant opportunity to design air quality programs more effectively and efficiently.

Value Added Beyond the Scope of Puget Sound Maritime Air Emissions Inventory:

- Assessment of the spatial distribution of emissions for each port-related source.
    - Traditionally, emissions that occur off port terminals have been quantified in aggregate across large spatial scales.
    - Refining the spatial allocation of emissions allows the location of emissions relative to population centers to be considered.
- Quantify public health risk associated with port-related air pollution.
    - Use location of emissions, dispersion of pollutants, and spatially specific population data to assess the public health risk from port-related air pollution.
    - Contextualize the port-related air pollution risk with other regional sources.
- Understand the relative public health impacts of each source.
    - Allows emission reduction programs to be prioritized for sources that pose the largest public health risk.

C. BACKGROUND

Northwest Ports Clean Air Strategy

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 operations[1]. 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 Puget Sound Clean Air Agency, 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 to guide air quality programs at the port.

Puget Sound Maritime Air Emissions Inventory

The NWSA, Port of Tacoma, and Port of Seattle have participated in a regional effort, called the Puget Sound Maritime Air Emissions Inventory (PSEI) to quantify air pollutant and greenhouse gas emissions from maritime related sources. The PSEI has been completed three times, for calendar years 2005, 2011, and 2016, using an activity-based methodology where emissions are calculated using reported vessel, equipment, and vehicle usage.

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

The emissions data presented in the PSEI has been used to inform air emission reduction efforts in the NWPCAS as well as other port initiatives. The PSEI provides emission data for each port and each emission sector over an entire year. Distinction is provided between emissions that occur on and off port terminals, but no further analysis is provided on the spatial distribution of emissions or the dispersion of port-related pollution relative to population locations.

Washington State University AIRPACT Model

The Laboratory for Atmospheric Research (LAR) at Washington State University (WSU) operates the AIRPACT numerical air quality forecast system for the Pacific Northwest[2]. This system uses state-of-the-art air quality modeling techniques to estimate ambient concentrations of ozone, fine particles ($PM_{2.5}$), and numerous toxic air pollutants on a one-hour time step over a 4 km x 4 km gridded domain covering Idaho, Oregon, Washington and peripheral areas. AIRPACT is currently used and funded by regional and state air quality agencies (including Puget Sound Clean Air Agency and the Department of Ecology) and used for a variety of air quality forecasting applications including assessment of wildfire smoke impacts, burn ban decision making, and assessment of ground level ozone. The AIRPACT framework is ideally suited, particularly after suitable modifications, to quantify the exposure of the population to port-related air pollution within the Puget Sound Airshed. Because WSU has this robust air quality modeling framework already in place and have experts in air quality modeling on staff, NWSA staff, after consulting with staff at the department of Ecology and the EPA, have determined that contracting with WSU is the best path forward for completing this work. An example of emissions and air pollutant concentration graphics from AIRPACT are shown in Figure 1.

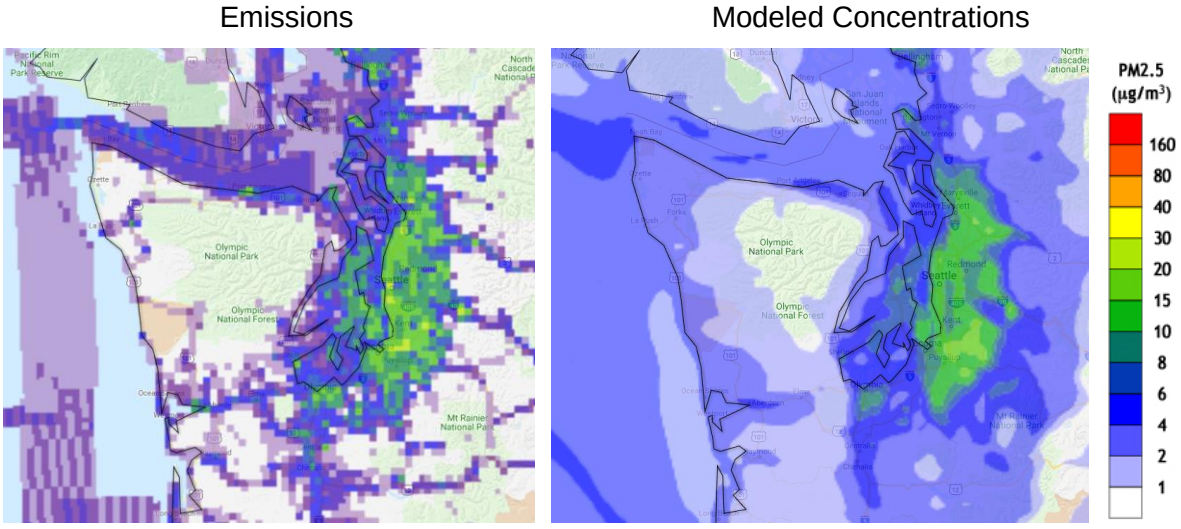


Figure 1. Example emissions and modeled $PM_{2.5}$ concentrations from AIRPACT.

[2] WSU, 2018. AIRPACT 5 Model. http://lar.wsu.edu/airpact/gmap/ap5/ap5.html

D. MOTIVATION

By assessing the population's exposure to pollution from each source, this study will provide a more robust basis for prioritizing emission reduction measures, by truly understanding which sources most significantly impact the community. For example, ships (ocean-going vessels) are the largest port-related source of diesel particulate matter (DPM) emissions, but a large percentage of their emissions occur while transiting through the Strait of Juan de Fuca and the Puget Sound. Because many of these emissions occur far away from major population centers, ship emissions may not contribute to public health risk as much as other sources that operate closer to population centers, such as heavy-duty trucks and locomotives. This study will ensure that the port has the most complete information possible when assessing health related benefits from emission reductions and prioritizing emission reduction efforts, ensuring that the air quality benefits are maximized for the money spent on air quality programs.

E. PROJECT METHODOLOGY AND DETAILS

The WSU AIRPACT model will be used to analyze air pollutant concentration for each 1.3 kilometer by 1.3 kilometer "cell" in the Puget Sound region. To do this, WSU will create a special modeling framework with a high-resolution domain (grid cell size of 1.3 km x 1.3 km) centered on the Puget Sound Airshed, operated by WSU on their "computing clusters". The overarching study design is to isolate emissions from operations related to the NWSA, Port of Tacoma, and Port of Seattle and to use these port specific emissions as inputs to the model to assess annual average and short-term maximum pollutant concentrations within the Puget Sound Airshed. A subsequent modeling exercise will assess the population's exposure to these air pollutants, using the BenMap health impact tool to spatially correlated air pollutant concentrations with population[3]. These exposure effects will be evaluated for each source type individually, as well as in aggregate, with the goal of assessing the spatial distribution of pollutant concentrations in addition to developing an airshed scale exposure metric for assessing the relative impacts of each source. The model will also estimate concentrations for non-port-related sources, allowing the port's impact to be contextualized with other regional emissions. A full description of the study methodology and scope can be found in Attachment B.

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 their 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. For each emission source category, an exposure metric will be calculated for each census block and total regional exposure will be calculated. Contour maps will be created to visually portray the spatial distribution of public health risk/exposure for each source type.

[3] EPA. BenMAP. https://www.epa.gov/benmap/benmap-downloads

Project Deliverables and Schedule:

Task 1 – Produce emission maps for each source and pollutant emitted.

- Completion Date: December 31, 2018

Tasks 2 and 3 – Perform modeling analyses and produce final report.

- Completion Date: May 31, 2019

The 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 regional emissions.

F. FINANCIAL IMPLICATIONS

The cost to NWSA to fund this study is $130,823. This will be paid in two equal installments of $65,412, one in 2018 and one in 2019. All costs will be expensed as incurred.

Source of Funds

The Capital Investment Plan (CIP) allocates $750,000 in 2018 and $590,000 in 2019 for Northwest Ports Clean Air Strategy projects (MID 201007.01), with $80,000 budgeted for this project in each calendar year.

G. ATTACHMENTS TO THIS REQUEST

A. Interlocal Agreement between WSU and NWSA

B. Complete project scope of work

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 choses 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 Sitcum 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

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 join initiative to reduce air pollutant and greenhouse gas (GHG) emissions from port operations[1]. 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, PM2.5, 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 tool [2]. 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/

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.

<u>Sources to be Modeled:</u>

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 SO_2 likely contribute to secondary aerosol formation. The model will include emissions of NO_x, CO, SO_2, VOCs, PM_{10}, 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 risks[4] and has been shown to be the most significant driver of inverse health effects from air toxics in the Puget Sound region[5]. 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 land[6]. 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 Region[5], 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.

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.

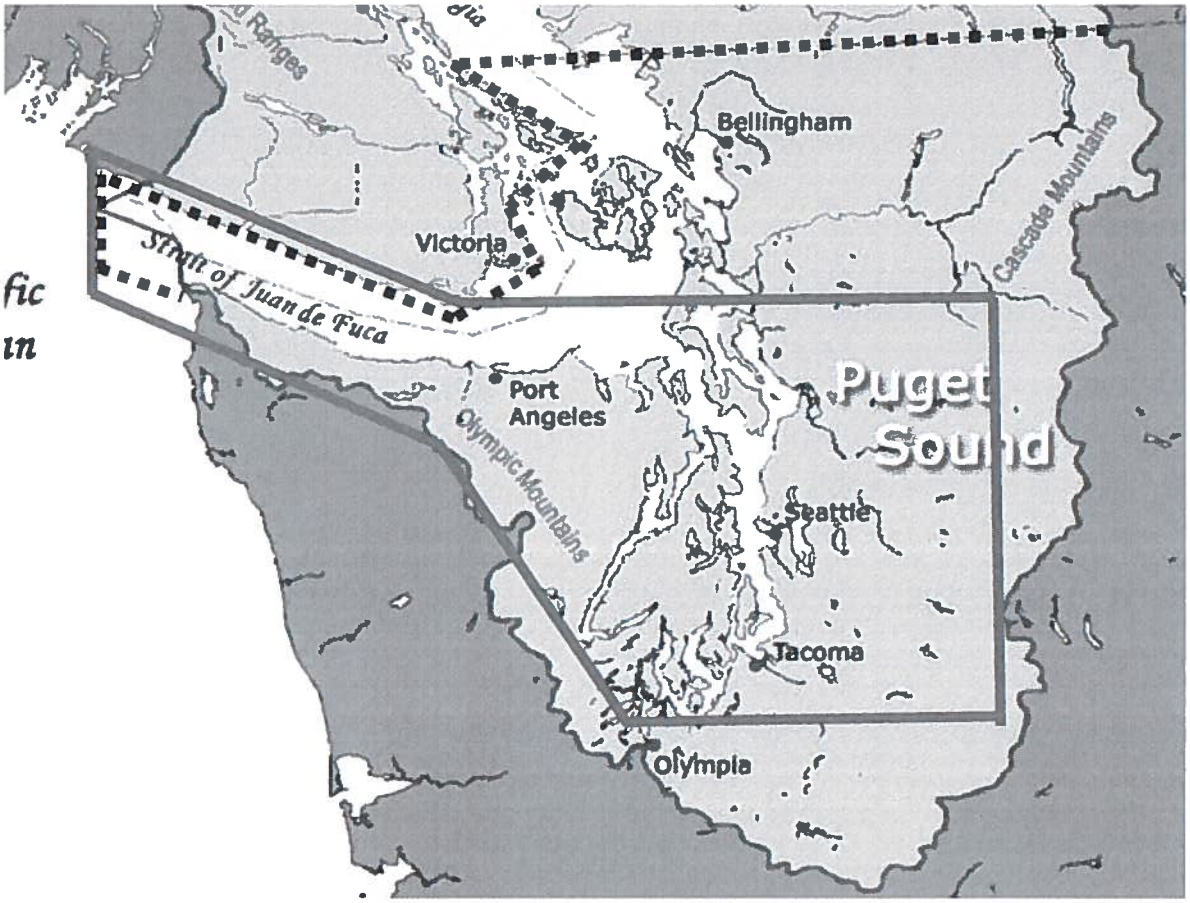


Figure 1. Puget Sound Airshed Boundary

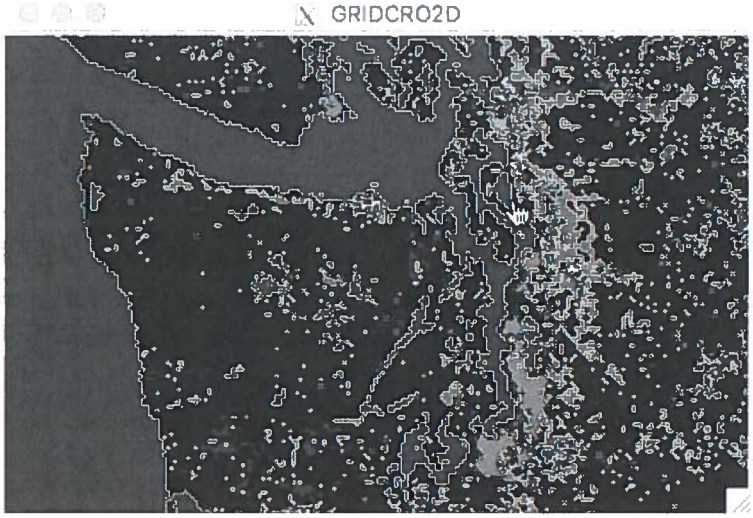


Figure 2. PORTS framework 1.33-km domain for port source modeling.

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.

FIRST AMENDMENT
OF
INTERLOCAL AGREEMENT 071089
FOR
AIR QUALITY MODELING STUDY
BY AND BETWEEN
THE NORTHWEST SEAPORT ALLIANCE AND
WASHINGTON STATE UNIVERSITY

This amendment reflects language changes in Section 3 TIMEFRAME/PROJECT SCHEDULE and Section 11 TERMINATION revised to reflect project extension date.

3. TIMEFRAME/PROJECT SCHEDULE

The Air Study project will take place from November 2018 to May 31, 2020. The anticipated timeline for the completion of major milestones is as follows. Section III remains:

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

11. TERMINATION.

This ILA shall tem1inate upon completion by both Parties of their respective obligations hereunder, or on May 31, 2020 unless terminated earlier.

WASHINGTON STATE UNIVERSITY

By _____
Derek Brown Date
Manager

THE NORTHWEST SEAPORT ALLIANCE

By _____ 9-5-19
John Wolfe Date
Chief Executive Officer

9/4/19
NWSA Legal Counsel
Carolyn Lake