City of Tacoma Memorandum

TO: Elizabeth Pauli, City Manager
FROM: Evette Mason and Graham VanderSchelden
COPY: Infrastructure, Planning and Sustainability Committee
SUBJECT: Puget Sound Maritime Air Emissions Inventory
DATE: June 13, 2018

SUMMARY:
This presentation is a briefing from the Northwest Seaport Alliance (NWSA) and Port of Tacoma on the recent Puget Sound Maritime Air Emissions Inventory (PSEI) and port-related air emissions in Commencement Bay. This emissions inventory allows the Ports to quantify their impact on air quality in the region and broader climate, track progress towards their emission reduction targets as set forth by the Northwest Ports Clean Air Strategy (NWPCAS), set a baseline for the recently approved Greenhouse Gas Resolution, and plan and prioritize future emission reduction programs.

This study found that emissions of key air pollutants have decreased significantly since 2005. Specifically, emissions of sulfur dioxide (SO_2) are down 95%, diesel particulate matter (DPM) are down 77%, and emissions of black carbon are down 57%. Additionally, greenhouse gas emissions have been reduced by 7%. While significant progress has been made, further efforts must be taken to address air pollutant and greenhouse gas emissions from port operations. The Northwest Seaport Alliance and Port of Tacoma, along with Port of Seattle and Port of Vancouver B.C. will be updating the Northwest Ports Clean Air Strategy in the coming year to set the framework for further emission reductions.

BACKGROUND:
For a third time, the Puget Sound Maritime Air Forum (a committee of seven ports, six government agencies and three industrial partners), led by The Northwest Seaport Alliance (NWSA), conducted an update of the Puget Sound Maritime Air Emissions Inventory (PSEI) for calendar year 2016. Before the formation of NWSA, project leadership was assumed by Port of Seattle in 2005 and Port of Tacoma in 2011. The objective of the PSEI is to quantify air emissions in the Puget Sound Airshed from all maritime-related activities. Within the inventory, emissions were reported for each port as well as the entire airshed, allowing NWSA's progress towards emission goals to be assessed. Results from the inventory revealed that the NWSA has made significant progress in reducing its air pollutant emissions.

Emission Reduction Strategies

The NWSA and Port of Tacoma have two key strategies that govern their air emission reduction efforts. The first is the Northwest Ports Clean Air Strategy (NWPCAS), which was created in 2008 from a collaboration of the Port of Tacoma, Port of Seattle, the Port of Vancouver B.C., and government agencies such as the EPA, Puget Sound Clean Air Agency, and the Washington State Department of Ecology. The NWPCAS sets both operational and overarching emission targets. The emission targets, relative to 2005 levels and normalized to tonnage of cargo throughput, to be achieved by 2020 are:

- 80% of diesel particulate (DPM)
- 15% of greenhouse gases (GHG, reported as CO_2 equivalents, CO_2e)

The Northwest Seaport Alliance and Port of Tacoma also approved identical Greenhouse Gas Resolutions. The targets of these greenhouse gas resolutions are as follows:

By 2030:

- 50% below 2005 levels (Scope 1,2, and 3 emissions)

By 2050:

- Carbon neutral (Scope 1 and 2)
- 80% below 2005 levels (Scope 3 emissions)

Inventory Method

An emissions inventory is an accounting of all emissions from a defined set of sources, in a delineated geographic area over a specific time period. The purpose of an emissions inventory is to provide scientifically defensible estimates of the nature, location, and magnitude of air pollutant emissions to assess the air quality impacts of the inventoried sources on their surrounding areas and to inform air quality policy. The PSEI was an activity based inventories that primarily leaned on guidance from the EPA for its methodologies. Specifically, the Motor Vehicle Emissions Simulator (MOVES) was used to develop emission estimates for on-road and non-road vehicles, equipment, and vessels. Additional guidance was taken from EPA documents on rail and ocean-going vessel emissions inventory development, as well as other supplementary sources of information.

Inventory Domain

The PSEI estimated emissions from maritime-related activities in tons per year within the U.S. portion of the Puget Sound/Georgia Basin International Airshed. This area spans from the U.S./Canadian border through the Strait of Juan de Fuca to just south of Olympia (~140 miles) north to south and from the Cascade Mountains to the Olympic Mountains and the mouth of the Strait of Juan de Fuca from east to west (~160 miles), as shown in Figure 1. This includes mobile source emissions off port terminals within the airshed boundary for relevant sources.

Figure 1. PSEI and GHG Inventory boundaries (Puget Sound Airshed). NWSA maritime-related activity that occurs in the US portion of the light green shaded area (below the dashed black US-Canada boundary line) is included in the NWSA's inventories.

Within the inventory, emissions were estimated on both the airshed scale and the port scale. The port scale includes only emissions that occur within port terminal boundaries, while airshed scale emissions include all emissions associated with port activity within the airshed. Notable emissions activity that are included in the airshed scale emission, but not in the port scale emissions are OGV transiting, trucks on-road driving, line-haul locomotive emissions and harbor vessel transiting.

Puget Sound Maritime Forum

The inventory was commissioned by the Puget Sound Maritime Air Forum, an association of private and public maritime organizations, ports, air agencies, environmental and public health advocacy groups and other parties with regulatory responsibilities associated with the maritime industry. The 2016 inventory update was funded by contributions from the Air Forum partner organizations, and Starcrest Consulting Group was competitively selected to develop the inventory.

Puget Sound Maritime Air Forum major partners:

- The Northwest Seaport Alliance
- Port of Anacortes
- Port of Everett
- Port of Olympia
- Port of Port Angeles
- Port of Tacoma

- Port of Seattle
- Northwest Clean Air Agency
- Puget Sound Clean Air Agency
- U.S. Environmental Protection Agency (EPA)
- Washington State Department of Ecology
- Washington State Department of Transportation
- Puget Sound Regional Council
- North West and Canada Cruise Association
- Pacific Merchant Shipping Association
- Western States Petroleum Association

Data were gathered for six major maritime-related source categories:

- Ocean-going vessels (cargo, cruise, and tanker ships)
- Harbor vessels (tugs, ferries, and other government and commercial vessels)
- Recreational vessels, cargo-handling equipment (cranes, forklifts, straddle carriers, and yard tractors)
- On-road, heavy-duty vehicles (semi-trucks and buses)
- Terminal operator fleet vehicles (passenger cars and trucks)
- Rail operations

Pollutants Inventoried:

The PSEI estimated emissions of relevant criteria pollutants and precursors as designated by the U.S. Environmental Protection Agency (carbon monoxide (CO), nitrogen oxides (NOx), sulfur dioxide (SO2), volatile organic compounds (VOCs) and particulate matter (PM), greenhouse gasses (carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), reported as CO2 equivalents (CO2e)), diesel particulate matter (DPM) and black carbon (BC).

- Particulate matter (PM): Solid and liquid particles suspended in the atmosphere. The composition of particulate matter includes a wide variety of substances including unburned fuel components, soot, dust, pollen, sea salt, smoke, and many more. Particulate matter can be directly emitted (primary PM) or formed because of chemical transformation and/or condensation of certain gasses in the atmosphere that were previously emitted (secondary PM). PM is typically classified by size, specifically the particle diameter. Smaller particles are thought to be more dangerous than larger particles because the can travel deeper into the lungs, increasing the probability of toxic chemicals reaching the blood stream. Exposure to $PM_{2.5}$ is linked with respiratory disease, decreased lung function, asthma attacks, heart attacks, and premature death.
    - PM_1: Also known as ultrafine particulate matter, PM_1 refers to the fraction of PM that is 1 micrometer in diameter or less.
    - $PM_{2.5}$: Also known as fine particulate matter, $PM_{2.5}$ refers to the fraction of PM that is 2.5 micrometers in diameter or less.
    - PM_{10}: Also known as coarse particulate matter, PM_{10} refers to the fraction of PM that is 10 micrometers in diameter or less.

- Diesel Particulate Matter (DPM): DPM is the particulate component of diesel exhaust that is directly emitted from diesel engines. Diesel exhaust was classified as a carcinogen by the International Agency for Research on Cancer (IRAC) and was estimated to account for 70% of the total cancer risk from air pollution by the California Air Resources Board (CARB). Operators of diesel equipment and citizens who live in areas that are disproportionately impacted by diesel exhaust are thought to have an increased risk of cancer due to elevated exposure to DPM. In addition to being a known carcinogen, DPM poses similar acute health effects as $PM_{2.5}$.
- Carbon Monoxide (CO): Carbon is a product of incomplete combustion of fossil fuels and biomass. At high concentrations, CO is an asphyxiant, bonding to hemoglobin in the blood and preventing the distribution of oxygen to the body.
- Nitrogen Oxides (NO_x = NO + NO_2): Nitrogen oxides are formed during the combustion process either through oxidation of nitrogen in the fuel (fuel NO_x) or by breaking apart N_2 and O_2 molecules contained in ambient air due to the high temperatures of combustion. Therefore, high temperature combustion, such as diesel engines, is a large source of NO_x. NO_2 is a criteria pollutant as designated by the EPA and is associated with respiratory effects. NO_x is also a key component of the series of chemical reactions that forms ground level ozone (which is a criteria pollutant) and is there labeled as an ozone precursor.
- Volatile Organic Compounds (VOCs): VOCs are released in exhaust as unburned fuel components pass through the engine, or when fuel is partially combusted. VOCs are not criteria pollutants, but they are ozone precursors and many have been labeled as air toxics by the EPA, meaning that they are a cancer risk and are associated with other health effects.
- Sulphur Dioxide (SO_2): SO_2 is released as a result of the oxidation of Sulphur in the fuel, and is the main form in which fuel Sulphur is released. SO_2 is a criteria pollutant as designated by the EPA and is associated with respiratory discomfort and impairment.
- Greenhouse Gasses (reported as CO_2 equivalents, CO_2e): Greenhouse gasses are not associated with direct human health effects, but they affect the radiative balance of the earth by trapping solar radiation near the surface of the Earth, raising Earth's surface temperature. In other words, they contribute to climate change. Greenhouse gasses are reported in CO_2 equivalents by multiplying the emissions of each by their global warming potentials. The global warming potential accounts for how "strong" each GHG is and how long it lasts in the atmosphere. This product is then summed for all GHG.

  The three main greenhouse gasses inventoried were:

  - Carbon Dioxide (CO_2): When a carbon-based fuel (fossil fuels, biomass) is combusted for energy, the vast majority of the carbon in the fuel is released as CO_2. The global warming potential of CO_2 is 1-ton CO_2e per ton CO_2 emitted.
  - Nitrous Oxide (N_2O): Nitrous oxide is a byproduct of fuel combustion, and is typically emitted in much lower quantities than CO_2. The global warming potential of nitrous oxide is 298 tons CO_2e per ton N_2O emitted.
  - Methane (CH_4): Methane is a byproduct of combustion and can also be released as a result of fossil fuel supply chain leakages. The global warming potential of methane is 34 tons CO_2e per ton CH_4 emitted.

- Black Carbon: Black carbon, otherwise known as soot, is a particulate emission from the combustion of fossil fuels, specifically diesel engines. Black carbon has been linked to negative health effects including respiratory effects, cardiovascular disease, cancer and birth defects. Black carbon also accentuates climate change, by absorbing radiation while in the atmosphere, and accumulating on snow and ice, which decreases the amount of radiation reflected by Earth's surface.

RESULTS:

The results of the PSEI demonstrated that air emissions from port-related activities have been reduced significantly since 2005. As shown below in Figure 2, emissions of all inventoried pollutants have decreased since the baseline year of 2005. Compounding the analysis of intermediary years somewhat was the formation of the Northwest Seaport Alliance in 2015. Because cargo can be shifted between both North Harbor (Seattle based) and South Harbor (Tacoma based) facilities, emissions in either harbor can increase or decrease without affecting emissions in the Puget Sound. Cargo shifts were likely responsible for the increases in emissions between 2011 and 2016.

Results also demonstrated that the overall contribution of the maritime industry to regional diesel particulate matter (DPM) emissions has decreased from 2011 to 2016, as shown in Figure 3. DPM is an important pollutant because it is known to have severe health effects and is thought to pose the largest risk of all toxic air pollutants in the Puget Sound. The reduction in contribution from the maritime industry (from 27% of regional DPM in 2011 to 18% in 2016) indicates that emission reductions from the maritime industry has outpaced other regional emission reduction efforts. While the impact of the maritime industry in Puget Sound has decreased since 2011, maritime activity is still responsible for 524 tons of DPM per year and the ports are committed to making significant efforts to reduce these emissions.

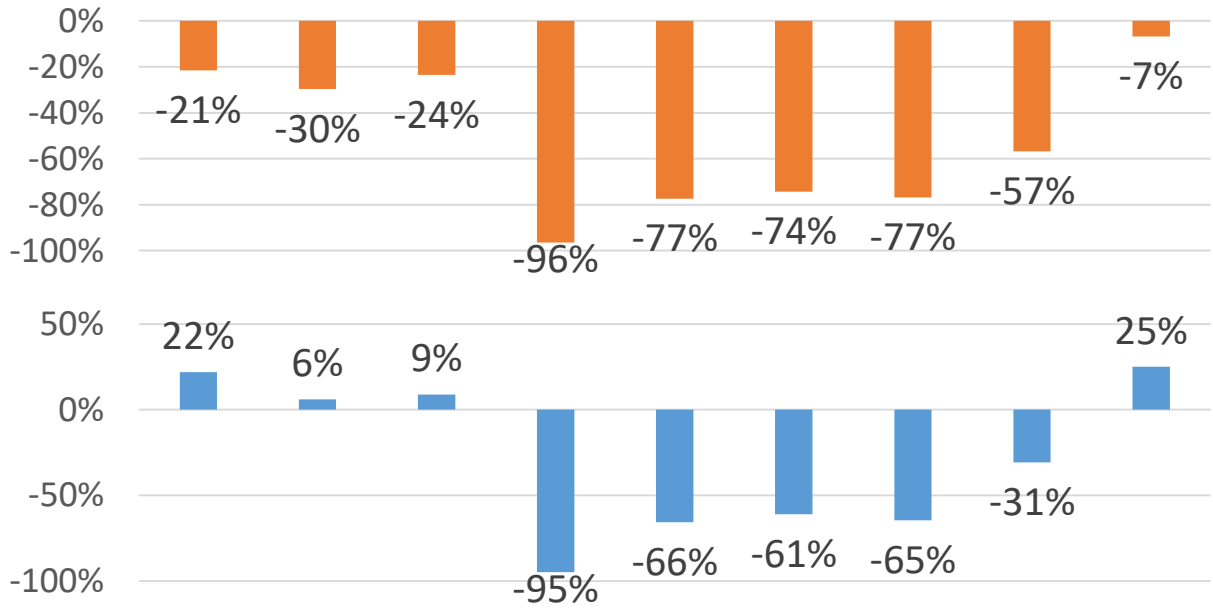

Figure 2. Emission changes from port-related activity in Commencement Bay (Facilities owned by Port of Tacoma before the formation of NWSA). The upper chart (orange bars) shows the emission changes from 2005 to 2016 and the lower chart shows emission changes from 2011 to 2016.

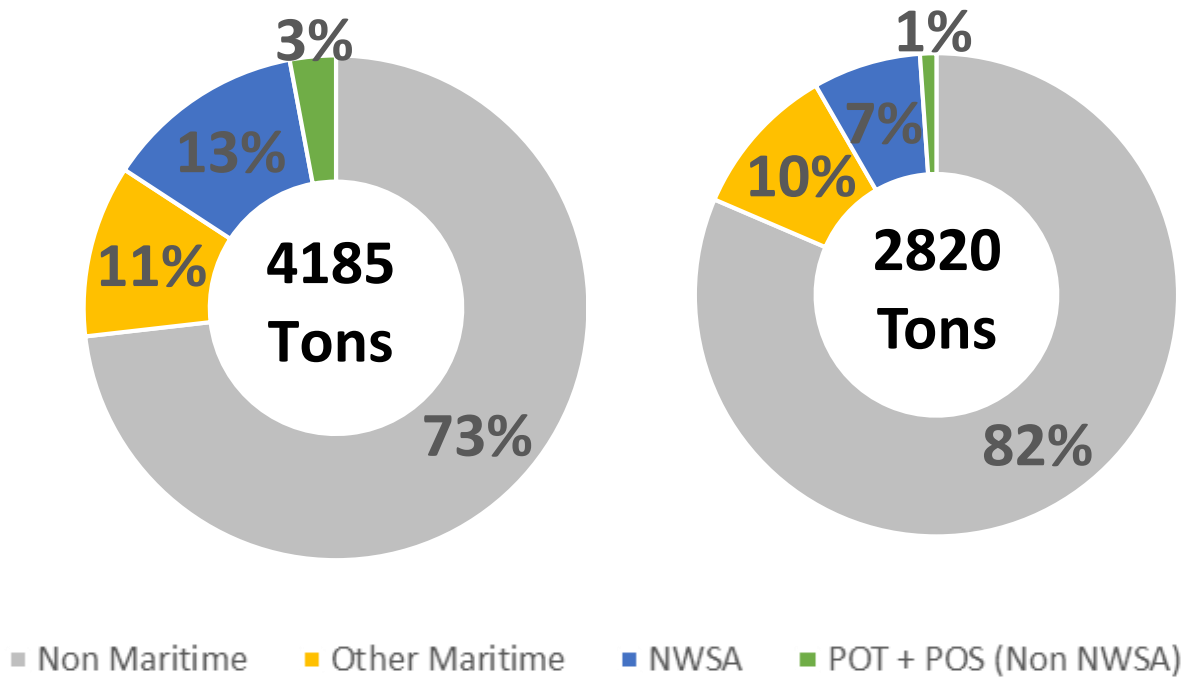

Figure 3. Regional distribution of diesel particulate matter emissions

Major reasons for emission reductions were:

- North American Emissions Control Area (ECA): Decreased fuel sulfur limit for ocean-going vessels from 3.5% to 0.1%, which drove large decreases of PM and SO_2 emissions. The ECA was implemented in 2015.
- Increased cargo transport efficiency for ocean-going vessels: Similar cargo tonnage moved by fewer vessels, drove emission reductions for all pollutants.
- Increased shore power usage influenced emission reductions for all pollutants.
- Switching on-road trucks, non-road equipment, locomotives, and harbor vessels to ultra-low sulfur diesel (ULSD), drove large reductions in SO_2 and PM emissions. The rule for on-road trucks was fully implemented in 2010, and the non-road rule was fully implemented in 2014. ULSD has a Sulphur content of 15 ppm, or 0.0015%. Before 2010, highway diesel fuel was 500 ppm Sulphur, or 0.05%. Non-road diesel was unregulated before 2007 and had a 500 ppm (0.05%) sulfur limit from 2007 to 2014.
- Stricter emission standards for on-road trucks, non-road equipment, locomotives and vessels along with fleet turnover, drove emission reductions for all pollutants.

EMISSION REDUCTION STRATEGIES AND PROGRAMS

The NWSA and Port of Tacoma continue to be committed to reducing their impact on air quality and climate through clean air and greenhouse gas reduction programs. Specifically, the NWSA is currently in the process of implementing its clean truck program, has developed a glidepath for achieving greenhouse gas reduction targets, and will be updating the NWPCAS with updated targets within the coming year.

Clean Truck Program

The goal of the NWSA Clean Truck Program is to replace all class 8 heavy duty drayage trucks (semi-trucks) with model year 2007 or newer engines by January 1, 2019. The benefit of 2007 and newer trucks is that they emit 90% less particulate matter due to heightened EPA emission standards. As of April 2018, 58% of the trucks serving NWSA terminals are model year 2007 and newer. To assist drivers who may have financial difficulty purchasing a new truck, the NWSA has created a loan program, in which drivers that demonstrate financial need will receive financial counseling and access to fair, market rate loans. The NWSA will deny entry to its terminals to trucks that do not meet 2007 emission standards after January 1, 2019.

Greenhouse Gas Glidepath

The NWSA developed a glidepath to guide future emission reduction efforts towards meeting its aggressive greenhouse gas reduction targets. The glidepath estimates the amount of emission reductions required in each sector as well the technological feasibility of possible emission reduction strategies to identify the best methods of reaching the targets in the Resolution.

Development of the glidepath was largely a technology review, where emission reduction measures were assessed in each source category for technological feasibility and emission reduction potential. The goal of the study was to understand to what extent operation changes would be necessary to achieve the GHG targets. The glidepath is split in two phases, the 2030 targets and the 2050 targets. Each includes the measures that are expected to be technologically feasible in their respective timeframes. The emission reduction results of the various measures are summed to demonstrate their cumulative effect and their efficacy at meeting the GHG Resolution targets. Where shortfalls exist, renewable fuels should be considered as a means to achieve the targets and GHG offsets may be considered where renewable fuels are not available.

Figure 4 displays the emission reductions associated with each strategy along with the total emission reductions. Even with this aggressive plan, the emission reductions associated with the proposed strategies will require supplementation with renewable fuels and offsets to meet the targets. The proposed measures fall short of the targets by 270,339 tons in 2030, and 384,746 tons in 2050. By fully electrifying the truck and CHE fleets by 2030, an additional 186,977 tons CO2e could be mitigated, leaving a 83,362 ton shortfall. The main reason for these shortfalls is that there is no technically feasible alternative to burning fossil fuels for international shipping expected by 2050. However, the use of renewable fuels to power international ships could help close this gap if the technology matures.

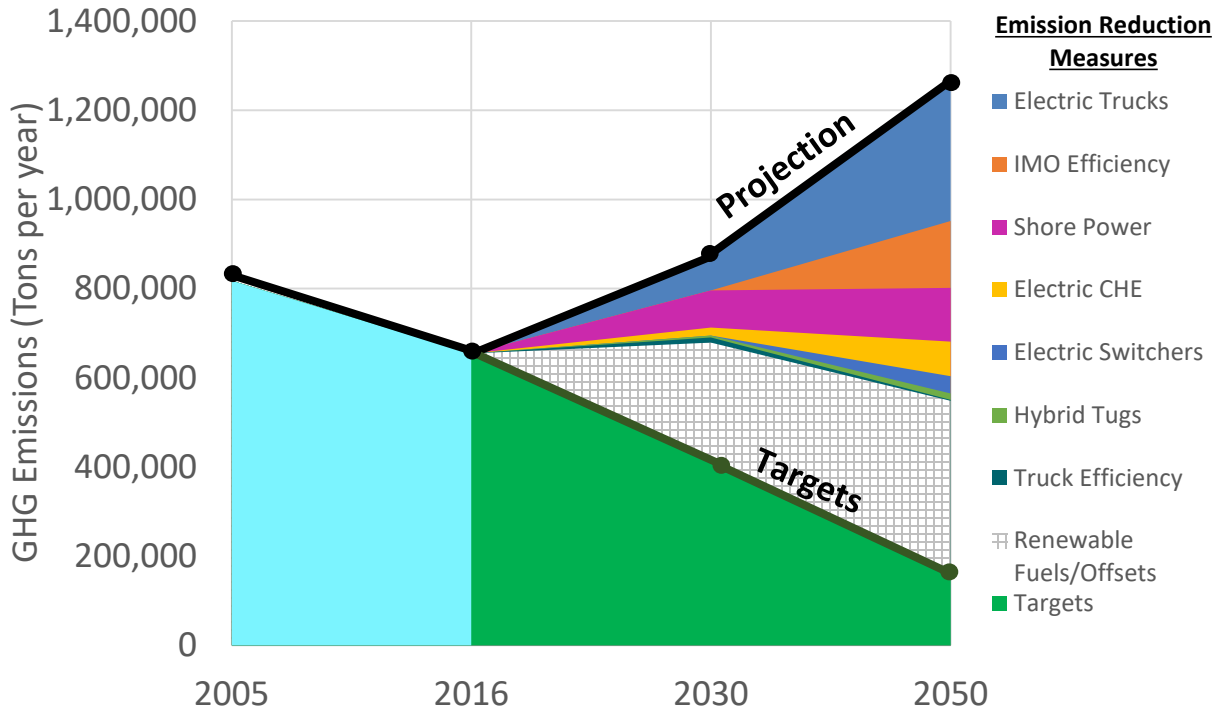

Figure 4. Cumulative effect of glidepath emission reduction measures as summarized above, illustrating the emission reduction measures necessary to get from the projections (black line) to the targets (green line). The light blue shaded area indicates the emission levels associated with the emissions estimates for 2005 and 2016. The decrease reflects progress made by the NWPCAS. The green shaded area and dark green line indicate the GHG Resolution targets in 2030 and 2050. The hatched area is the difference between proposed emission reduction measures and the targets, indicating the extent to which renewable fuels and GHG offsets must be considered. The other shaded areas represent the emission reductions associated with each individual reduction measure, where the black line on top indicates estimated and projected emissions.

Northwest Ports Clean Air Strategy Update
In the coming year, the NWSA and Port of Tacoma, along with the Port of Seattle and Port of Vancouver B.C. will be updating the Northwest Ports Clean Air Strategy. This update will allow for new short term and long-term targets to be set to guide the Ports' clean air programs for the next five years and beyond. Through this process, input will be considered from a diverse group or public, private, tribal, and government stakeholders to develop a strategy that is in the best interests of all parties.

ALTERNATIVES:
This is an information briefing on a Port of Tacoma project.

FISCAL IMPACT:
This an information briefing on a Port of Tacoma project.

RECOMMENDATION:
This is an information briefing on a Port of Tacoma project.