EXECUTIVE SUMMARY

The Port of Oakland (Port) 2005 Seaport Air Emissions Inventory (Emissions Inventory) identifies and quantifies air emissions from the Port's maritime activities, organized by the major source categories:

- Deep-Draft Ocean-Going Marine Vessels (OGV)
- Commercial Harbor Craft (dredging and assist tugs)
- Cargo Handling Equipment (CHE)
- Trucking (container movements)
- Locomotives

Since 1927, the Port of Oakland has managed the efficient movement of goods in and out of the region, bringing the benefits of the global marketplace to the San Francisco Bay Area. The Port manages maritime, airport and commercial real estate operations along 19 miles of waterfront on the eastern shore of San Francisco Bay. The Port's seaport is the fourth busiest container port in the United States. The container terminals, which are leased to terminal operators, encompass 19 active deepwater berths and 37 gantry container cranes. The Port is an independent department of the City of Oakland, acting through the Board of Port Commissioners. All Port activities are funded through operating income or through revenue bonds; no state or local tax money is used to support operations.

The Port of Oakland voluntarily chose to prepare an air emissions inventory of its seaport in advance of any regulatory directive. This emissions inventory highlights the Port's commitment to improve understanding of the nature, location and magnitude of emissions from its maritime-related operations. The Port is committed to conducting its operations in the most sustainable and environmentally sensitive manner possible.

The purpose of this inventory is to better understand the emissions that occur from typical Port activities so the Port can better address its impact on air quality. The inventory will:

- Establish a baseline for evaluating changes in Port emissions as air pollution control regulations are phased in.
- Provide an input to regional air quality plans – plans that are required by the Federal and State Clean Air Acts and are designed to map the region's approach to attaining Federal and State ambient air quality standards.
- Inform local, state and federal regulatory decision-makers in their effort to reduce air emissions from Port-related sources and improve air quality.
- Provide air quality background information to be used in future environmental documents.
- Provide Port specific emission inventory data to inform and support special studies such as the West Oakland Health Risk Assessment, currently under development by the California Air Resources Board (ARB).
- As the Port develops an air quality plan for the Seaport, the emissions inventory will provide a technical basis for setting priorities and evaluating the cost-effectiveness and potential benefits of air pollutant control measures.

The inventory provides estimates for emissions of five "criteria" air pollutants, reported as tons per year. The pollutants are:

- Reactive organic gas (ROG)
- Carbon monoxide (CO)
- Nitrogen Oxides (NOx)
- Particulate matter (including diesel) (PM)
- Sulfur dioxides (SOx as SO2)

The particulate matter estimated in this report is primarily diesel particulate matter (DPM), which is also a toxic air contaminant that has been listed by ARB. A small percent of particulate matter emissions, typically less than 5% of the total, come from boilers and LPG-powered engines, and thus are not DPM.

Introduction, Scope and Coordination

This is an inventory of the air emissions generated by maritime activities conducted by the Port of Oakland's tenants. On the water side, the spatial domain of the inventory includes Port-related marine vessel transit from dockside out through the Golden Gate Bridge, to the first outer buoys beyond the Sea Buoy, approximately 30 miles away from the Port. On the landside, the spatial scope of the inventory includes nine marine terminals, one rail yard, and the road traffic between those facilities and the nearest freeway interchanges. The Port area was defined approximately by the boundaries of I-80, I-880, and the Howard Terminals (Berths 67 and 68) adjacent to Jack London Square. Within this defined geographic area, three significant areas were specifically excluded: the Schnitzer Steel terminal, the Union Pacific rail yard, and the former Oakland Army Base located between Maritime Street and I-880. These areas were not controlled or operated by the Port of Oakland in 2005. Figures 1-1 and 2-1 in the body of the report illustrate the spatial scope of the inventory.

With the exception of a limited roll-on and roll-off activity at Berth 34, the Port of Oakland operated almost exclusively as a container port in 2005. The Port discontinued much of the roll-on and roll-off activity during 2005. All 1,916 calls were by deep-draft vessels designed as container ships, or built for other uses but converted to transport containers. On the land side, Port terminals operated as a collection of intermodal sites where cargo handling equipment transferred containers to and from vessels to truck or rail transportation.

ENVIRON International, with assistance from the Sierra Nevada Air Quality Group, prepared the emissions inventory for the Port. ENVIRON assembled the emissions inventory by analyzing the time-in-mode, load or speed, and engine characteristics of the marine vessels and other equipment used to transport container cargo. The time-in-mode characteristic allowed for the emissions inventory to be spatially defined. Input data from previous studies and literature reviews, or ARB input data or models, were used when more precise estimates could not be generated during the period of this study.

ENVIRON and the Port worked closely with ARB and the Bay Area Air Quality Management District (BAAQMD) in preparing this inventory, coordinating through weekly conference calls which included discussion of many input factors and review of emissions inventory methodologies. Additionally, in January 2007 the Port released to the public a draft working document presenting the Port-proposed methodology for estimating emissions for each source category, along with ARB's comments on the proposed methodology. Public comment on the methodology was accepted through a Port-sponsored meeting on January 31, 2007; no comments directly related to the methodology were received.

The Port and its contractors provided ARB with detailed spatial information on particulate emissions so the inventory could be used as input to the dispersion modeling that ARB will perform for the West Oakland Health Risk Assessment.

Technical Approach to Major Source Categories

Emissions were estimated for the five source categories as described below, and a summary of the emission results are presented in Table ES-1.

Ocean-going Marine Vessels. Ocean-going vessel emissions were estimated in several operating modes: cruising, cruising in the reduced speed zone (RSZ) inside the Bay, maneuvering (lower speed operation between the Bay Bridge and their berths in the Inner or Outer Harbors), and hotelling (vessels at berth being loaded and offloaded and at anchor in the Bay). Separate mode estimates are important because of location, especially the proximity to on-shore areas like West Oakland. Emissions sources included the vessels' main propulsion engines, auxiliary engines, and small auxiliary boilers. Except for the boilers, all emission sources in ocean-going vessels were diesel engines.

About three-fourths of the ocean-going vessels that called at the Port of Oakland in 2005 were classified as "larger" vessels (750 feet or longer). The age of vessels ranged from new to 35 years. Newer vessels that were five years old or less made about one-third of the vessel calls. All 1,916 ships that called at the Port of Oakland in 2005 were carrying containers. No cruise ships, or liquid or dry bulk vessels were included in this inventory.

Harbor Craft. Smaller marine vessels are included in a category described as "Commercial Harbor Craft". Vessels in this category are associated with Port of Oakland maritime operations and consist primarily of assist tugs and a few small boats that supported maintenance dredging. One or two tugs assist all vessels during the maneuvering mode as they enter and leave the Port. At least eight tug companies provided assist services, some located in the immediate vicinity of the Port and others in San Francisco and Richmond. Information from several data sources was used to characterize the tug fleet and installed equipment. The inventory includes tug emissions estimates in two operating modes, vessel assist and transit to and from the vessel assist point. Emissions sources include tug main propulsion and auxiliary diesel engines.

The inventory also addresses emissions from operation and maintenance dredging, which occurs annually to maintain safe depths in Federal channels and at Port berths. Dredging activity was

low in 2005 compared to average years. Emissions were estimated from dredges, dredge tenders, crew and work boats, and tugs that push barges containing dredged material to disposal or reuse areas. Dredging equipment is typically powered by diesel engines, though in 2005 most maintenance dredged materials were removed by an electric powered dredge, which was at the Port deepening the berths to -50 feet.

Cargo Handling Equipment. ENVIRON collected specific activity information for cargo handling equipment used in the Port of Oakland in 2005 to move containers within maritime and rail yards. ENVIRON and ARB determined annual emissions for each piece of equipment according to engine characteristics (model year, rated power, and equipment type) and equipment operation (hours of operation and fuel consumption rates). Yard trucks (sometimes called hostlers), side picks and top picks were the most prevalent types of equipment. Other equipment included rubber tired gantry cranes, forklifts, and tractors. Nearly 90% of the equipment was powered by diesel engines and many units had been retrofitted with emissions control devices or repowered under a Port incentive program. About 10% of the cargo handling units were fueled by liquid petroleum gas (LPG).

An important input to calculating emissions from cargo handling equipment is load factor, which describes the average relative load in-use as a fraction of maximum power. Load factors can be difficult to discern because the duty cycle of equipment can vary widely during normal operation, with periods of high power operation interspersed with periods of extended zero-load idling. The load factor methodology as used in the emissions estimates, therefore, represents an approximate estimate for overall activity reflecting typical engine loads during normal equipment operation. Emissions estimates for container handling equipment are reported as a range in Section 4 to reflect the uncertainty in the average load.

Trucking. Maritime operations create a demand for a significant number of truck trips, including short trips within the Port moving containers from marine terminals to other locations. Trucks arrive at the Port terminals primarily via freeway interchanges or rail yards, and leave through the same general exits. Even if trucks arrive via surface streets, the trips primarily pass through the intersections that define the primary freeway interchanges. The spatial scope of the truck emissions inventory was therefore defined to include truck routes from the marine terminals to each of three freeway interchanges and the two rail yards. This inventory does not include emissions from Port trucks operating on freeways.

ENVIRON's general approach to estimate truck emissions was to determine truck travel by estimating the number of truck trips to and from the marine terminals, the trip mileage to and from the terminals, and the average link and trip speed. Input activity data used to develop the emission estimates was derived from several sources. To estimate the truck trips, the Port of Oakland conducted an in-depth survey with the terminal operators to determine the gate counts by configuration of each truck (as a tractor only or the tractor with a trailer) at the entrance and exit to the terminals. ENVIRON then estimated truck trips from truck gate count data and container lift data provided by the port.

Emissions from trucks depend on the age distribution of the transport trucks as well as site-specific conditions. Age distribution plays a significant role because of regulations over the past decades that make newer trucks significantly cleaner than older trucks. In the past, some studies have shown that Port trucks tend to be older than average. In 2006, as part of the emissions

inventory effort, the Port conducted a specially designed study, reviewed by ARB, to determine a Port of Oakland specific truck age distribution. The results of this study showed the near nonexistence of post-1999 trucks (trucks younger than 6 years) at the Port of Oakland. The age distribution of the fleet serving the Port was primarily between model years 1993 and 1999, inclusive, accounting for 80% of all truck trips.

ENVIRON estimated emissions for four truck operating modes: idling at terminal queues, in-terminal idling, in-terminal driving, and over-the-road driving to and from the rail yard and freeway exits. ENVIRON used the most recent version (at the time of this study, January 2007) of the EMFAC2007 model to estimate emission rates for the various modes, as presented in Section 5. For consistency with previous ARB studies, a pre-release beta version of EMFAC was used for the truck emissions presented in Table ES-1.

Locomotive. The Oakland International Gateway (OIG) rail yard is a Port of Oakland terminal operated under a lease by Burlington Northern Santa Fe (BNSF) railway. BNSF uses the OIG as a near dock transfer point for Port of Oakland maritime traffic and only Port containers are handled at the yard. Locomotives and trains enter the general port area from the north via the Union Pacific (UP) lines, and leave in the same direction via tracks going north through Richmond and onto BNSF lines out of the Bay Area. The Union Pacific rail yard (UP Railport) that sits adjacent to the Port terminals serves as an intermodal yard for freight movements through the port, but it is not included in the Port's emissions inventory because it is independently operated and also handles non-Port cargo. UP has provided the ARB with an independent analysis of the emissions from its Oakland facility.

Because different locomotive and engine models have different emission characteristics, it was important to characterize the types and models of the locomotives that arrive/depart and are serviced at OIG. ENVIRON estimated the locomotive fleet fractions for different locomotive types and models using data provided by BNSF. The number of engines moving through the yard was determined from a BNSF-supplied train arrival and departure database. One switching engine is usually assigned to the OIG yard with very similar engine models used for this purpose, and its operations were included in this emission estimates.

Results

The results of the Port of Oakland Seaport Emissions Inventory are summarized in Table ES-1.

Table ES-1. Port of Oakland emissions summary by emission source category – tons in 2005.

Emission Source Category	ROG	CO	NOx	PM	SO2
Ocean-going vessels (OGV)	117	235	2,484	219.5[1]	1,413
Harbor Craft	22	83	345	13.4[2]	3
CHE	53	408	766	21.7[1, 2]	7
Truck	49	149	334	15.9[2]	2
Locomotive	7	11	76	2.0	2
Total	**248**	**886**	**4,005**	**272.5**	**1,427**

[1] A small portion of the particulate in these categories includes boiler or LPG engine emissions; most of the emissions (208.5 tons from OGV and 21.2 tons from CHE) are from diesel exhaust. Total DPM = 261 tons

[2] Alternative emission estimates, primarily for assist tugs, cargo handling equipment and trucks, are presented in sections 3, 4 and 5 of the report, respectively, to reflect technical uncertainty inherent in making emissions estimates of complex activities and the sensitivity of the estimate to site-specific versus general inputs.

Ocean-going vessels constitutes the largest source category for all pollutants, producing 80-85% of estimated particulate matter emissions and the major portion of other pollutants within the scope of this emissions inventory. Table ES-2 shows a more detailed assessment of ocean going vessel emissions by mode of operation. Trucks, harbor craft, and cargo handling equipment each produced 5-10% of the estimated Port-related particulate matter emissions. Locomotives from the one rail yard included in this study produced a small fraction of the total emissions.

It is important to keep in mind that location of emissions is often as significant as the total quantity because emissions generated close to community receptors will have a greater effect on human health risk on a per ton basis. The impact of the various source categories on West Oakland air quality will not necessarily be directly proportional to the magnitude of their emissions because proximity to the community is not addressed in this emissions inventory. For example, the particulate matter emissions from ocean-going vessels in cruising mode, which occurs outside the Golden Gate, will have less impact to sensitive receptors in Oakland than emissions that occur closer to shore during the maneuvering or hotelling modes. The greater the distance is between the emission source and affected area, the lower the pollutant concentration is at a sensitive receptor.

Table ES-2. OGV emissions summary by mode, using ARB-specified activity emission factors – tons in 2005.

Emission Mode	ROG	CO	NOx	PM	SO2
OGV – Cruise	16	46	588	52.4	383
OGV – RSZ	27	63	647	60.2	395
OGV – Maneuver	53	58	458	43.6	157
OGV – Berth	21	65	767	61.3	464
OGV – Anchorage	1	2	24	2.0	15
OGV subtotal	**117**	**235**	**2,484**	**219.5**	**1,413**

An emissions inventory is best understood as an estimate of the quantity of pollutants that a group of sources produce in a given area, over a prescribed period of time. Emissions inventories should be used with care and in conjunction with other information and tools to evaluate and assess air quality problems.