SECTION 1 INTRODUCTION

The Port of Long Beach (the Port) shares San Pedro Bay with the neighboring Port of Los Angeles (POLA). Together, the San Pedro Bay Ports comprise a significant regional and national economic engine for California and the United States (U.S.), through which more than 40% of all containerized trade in the nation flows. The San Pedro Bay Ports customs district accounts for approximately $300 billion in annual trade. Economic forecasts suggest that the demand for containerized cargo moving through the San Pedro Bay region will more than double by the year 2020. The economic benefits of the Ports are felt throughout the nation.

The Ports recognize that their ability to accommodate the projected growth in trade will depend upon their ability to address adverse environmental impacts (and, in particular, air quality impacts) that result from such trade. Therefore, in November 2006, the San Pedro Bay Ports adopted their landmark, joint Clean Air Action Plan (CAAP) designed to reduce air emissions and health risks while allowing port development to continue. This detailed annual activity-based inventory, with associated emissions estimates, is a critical and integral component to the success of the CAAP.

The Port of Long Beach (Port) is a landlord port; it builds terminal facilities and leases them to shipping lines and stevedoring companies. The Port does not operate the terminals, ships, yard equipment, trucks or trains that move the cargo.

1.1 Reason for Study

The Port released its first activity-based emissions inventory in April 2004. The 2002 Baseline Air Emissions Inventory\(^2\) evaluated emissions from three port-related source categories: offroad cargo handling equipment, rail locomotives and onroad heavy-duty vehicles that operates within the Port’s boundary. An Addendum to the 2002 Inventory\(^3\) was concurrently developed with the 2005 Inventory\(^4\) to evaluate emissions from ocean-going vessels, harbor craft, and the off-port emissions associated with rail locomotives and onroad heavy-duty vehicles.

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This report represents the 2006 port-wide inventory of air emissions which includes emissions estimates based on 2006 activity levels. The 2006 Inventory also includes for the first time emission estimates for greenhouse gases (GHGs) for port-related maritime mobile sources which will establish a baseline and track future changes for GHG.

1.2 Goods Movement

Goods Movement (GM) has become a key issue associated with both the growth of the California economy and the significant challenges to meeting the National Ambient Air Quality Standards (NAAQS) in the Southern California Air Basin (SoCAB). The Business, Transportation and Housing Agency (BTH) and the California Environmental Protection Agency (Cal/EPA) have recently updated their Goods Movement Action Plan (GMP). The GMP is intended to develop an action plan to address GM related issues such as current and future infrastructure needs, impact on environment, adverse impact mitigation measures to protect public health and community concerns, public safety and security issues, and workforce development opportunities regarding goods movement. As stated in the GMP, “it is the policy of this Administration to improve and expand California’s goods movement industry and infrastructure in a manner which will:

- Generate jobs.
- Increase mobility and relieve traffic congestion.
- Improve air quality and protect public health.
- Enhance public and port safety.
- Improve California’s quality of life.”

The GMP is focused to address goods movement in California’s four major “port-to-border” goods movement corridors:

- Los Angeles-Long Beach/Inland Empire
- Bay Area
- San Diego/Border
- Central Valley

Over decades, these corridors have become major routes for ship to rail, ship to truck, and truck to rail exchanges to move millions of containers per year to their ultimate destinations. As stated in the GMP, “to help develop order of magnitude estimates of how effort should be distributed among the corridors, the agencies compiled a series of indices to compare and contrast key indicators among the corridors.

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Items included:

- Value by customs district
- Maritime container volume
- Port of Entry tonnage
- Logistics jobs
- Daily vehicle hours of delay
- Mean average annual daily truck volume
- Total emissions per day
- Population

While the relative fractions or contributions of each of these factors vary by corridor, an unweighted aggregate of the fractions indicate that the Los Angeles/Long Beach-Inland Empire corridor in southern California ranks first by a large margin with about 60 percent of the aggregate shares. The Bay Area, Central Valley, and San Diego corridors represent 19 percent, 13 percent, and 8 percent, respectively. More specific analysis will be necessary to determine the relative allocation of effort among the corridors to achieve simultaneous and continuous improvement.  

As a part of the GMP, the California Air resources Board (CARB) is responsible to developing an emissions reduction plan based on international as well as domestic goods movement related future activities of the four corridors mentioned above. In April of 2006, CARB adopted the Emissions Reduction Plan for Ports and Goods Movement in California. The international goods movement category includes emissions from all on-port sources, including

- All ocean-going vessels up to 24 nautical miles,
- All harbor craft up to 24 nautical miles,
- All cargo handling equipment,
- All on-port trucks operation,
- All on-port rail operations,
- International goods movement portion of off-port truck operation, and
- International goods movement portion of off-port rail operation.

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According to the GMP, the State’s five specific goals for addressing the air pollution associated with goods movement are:

A. Reduce total statewide international and domestic goods movement emissions to the greatest extent possible and at least back to 2002 levels by year 2010;

B. Reduce the statewide diesel particulate matter (PM) health risk from international and domestic goods movement 85 percent by year 2020;

C. Reduce NO\textsubscript{x} emissions from international goods movement in the South Coast 30 percent from projected year 2015 levels, and 50 percent from projected year 2020 levels based on preliminary targets for attaining federal air quality standards;

D. Apply the emission reduction strategies for ports and goods movement statewide to aid all regions in attaining air quality standards; and

E. Make every feasible effort to reduce localized risk in communities adjacent to goods movement facilities as expeditiously as possible.”

This emissions inventory will be utilized by the stakeholders to track emissions from port-related sources and to document reductions from both regulatory and Port-led reduction efforts.

1.3 Container Movements

Container terminals and their associated cargo movements are complex intermodal operations that are critical to international trade. Containerized cargo has significantly increased the efficiency and capacity the transportation system over the prior general cargo/break bulk cargo models (which still exist for non-containerized cargo). Due to the inherent efficiencies of containerized cargo, the types of cargo shipped via containers are increasing annually. To better understand the operations of the international transportation network associated with ports, this subsection describes overseas container transport, import cargo containers, export cargo containers, and how empty cargo containers are handled.

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7 CARB 2006.
Overseas Container Transport

Imported cargo generally starts at an overseas manufacturer, supplier, or consolidation facility, where items are boxed and placed inside metal shipping containers. Containers generally come in two common sizes 20 feet or one twenty-foot equivalent (TEU), or 40-foot or two TEUs. Other sizes such as 45 foot and 53 foot are also used. The U.S. buyer may contact an industry professional know as a “freight forwarder,” or logistics company, to coordinate landside transportation of the cargo. The container is then transported to a foreign port, assessed for possible security risks, and placed on board a containership, which is specifically designed to carry containerized cargo. Containerships calling at the San Pedro Bay ports range from 2,000 to over 8,000 TEUs per ship. The containership transports the containerized cargo the Port, where it is unloaded, and forwarded to local or national destinations. Figure 1.1 presents the steps that are associated with overseas cargo movements.8

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8 Port of Long Beach, Cargo Movement In Focus, 2006
Figure 1.1: Overseas Container Transport

Key:
1) Product ordered
2) Container transported to foreign port (not shown)
3) Security check conducted by U.S. Customs agents based at foreign ports
4) Container loaded onboard
5) Coast Guard review conducted for ship, crew, and cargo manifests
6) Containership boarded and docked by a Port pilot
7) Ship unloaded by longshore workers (see Figure 1.2 for details)
8) Security check conducted by U.S. Customs agents
9) Container surveyed for radiation
Import Container Transport

Once the ship arrives at the Port, the imported containers are either transported by train or by truck to their final destination, or to one of several intermediate destinations such as a railyard, warehouse, distribution center, or “transload” facility (a sorting, routing, and short-term storage facility). A container’s final destination will determine exactly what path it will take once it leaves the dock. Figure 1.2 illustrates the steps that are associated with imported container cargo movements. 

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9 Port of Long Beach, Cargo Movement In Focus, 2006
Figure 1.2: Import Container Transport

Key:

1) Containership unloaded; the marine terminal operator will arrange for unionized longshore workers to unload the ship. Containers are place on trucks, rail, or terminal cargo handling equipment for storage on terminal.
2) Trucking company or train operator contacted by freight forwarder or logistics provider to move container out of the terminal.
3) Cargo placed directly on rail using “on-dock” rail (as available).
4) Near-dock rail yards are used for terminals without on-dock rail or if additional rail capacity is needed. Trucks are used to “dray” containers from terminals to railyard.
5) Off-dock railyards are used to coordinate rail deliveries to national destinations. Containers are delivered by truck, then sorted and grouped by final destination. These railyards handle Port cargo as well as domestic cargo from other sources.
6) Containers are often moved initially to a “transload” facility where cargo is unloaded, sorted, and repackaged into larger-sized truck trailers. The cargo is then delivered from the facility to regional distribution centers, local stores, or off-dock railyards.
Export Container Transport

Export container cargo is similar to import containers however the flow is in the opposite direction. As with imported cargo, exported cargo may require multiple intermediate stops between its producer/manufacturer and the Port. Figure 1.3 presents the steps that are associated with exported container cargo movements\textsuperscript{10}.

\textsuperscript{10} Port of Long Beach, Cargo Movement In Focus, 2006
Figure 1.3: Export Container Transport

Key:

1) Local origin cargo delivered directly to the marine terminal from the producer, manufacturer, or exporting company.
2) Local or non-local origin cargo delivered to a warehouse/consolidator where the cargo may be temporarily stored with other cargo bound for export. Cargo may also be transferred from domestic truck trailers to marine shipping containers.
3) Some non-local origin cargo shipped by rail and delivered to off-dock railyards where the cargo is placed onto truck for final delivery to marine terminals.
4) Some non-local origin cargo shipped by rail directly to the marine terminal where it is loaded onto a ship or stored temporarily for the appropriate ship to arrive.
5) Some non-local origin cargo shipped by rail to near-dock railyards, where the cargo is picked up by truck for a short trip to the marine terminal.
6) Vessel loading of export cargo conducted after the ship has been unloaded of its import cargo.
Empty Containers

Since the U.S. imports more goods than it exports, many empty containers are sent overseas to be reused or are used domestically for other purposes. Typically, about a third of the containers loaded onto a ship at the Port will be filled with cargo, while about two-thirds will be empty. The figure below, diagrams the movement of empty containers after the delivery of full, imported containers to local businesses and/or transload facilities\(^\text{11}\). Intermodal containers returning to the local area empty are not depicted; they would enter the system at the marine terminal or empty container storage yard.

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\(^{11}\) Port of Long Beach, Cargo Movement In Focus, 2006
Key:
1) Empty container delivered to a local exporter to fill. Direct delivery of containers between importers and exporters is encouraged to reduce the number of truck trips a container takes in the South Coast.
2) Empty container delivered to container storage yard from a transload facility or local importer. From the storage yard, containers are moved by truck to the marine terminal for export or to a local exporter to be filled with cargo.
3) Empty container delivered directly from a transload facility or local importer to the marine terminal for export.
4) Empty container loaded onto a containership to be exported and reused overseas.
1.4 Regulatory and San Pedro Bay Ports Clean Air Action Plan (CAAP) Measures

This section discusses the regulatory and port measures which address port-related activity. Almost all port-related emissions come from five diesel-fueled source categories: ocean-going vessels (OGVs), on-road heavy-duty vehicles (HDVs), cargo handling equipment (CHE), harbor craft and rail locomotives (RL). The responsibility for the emissions control of the majority of these sources falls under the jurisdiction of local (South Coast Air Quality Management District, SCAQMD), state (CARB) or federal (U.S. Environmental Protection Agency, EPA) agencies. The Ports of Long Beach and Los Angeles adopted the landmark San Pedro Bay Ports Clean Air Action Plan (CAAP) in November 2006 to curb port-related air pollution from trucks, ships, locomotives and other equipment by at least 45 percent in five years. A model for seaports around the world, the CAAP is the boldest air quality initiative by any seaport, consisting of wide-reaching measures to significantly reduce air emissions and health risks while allowing for the development of much-needed port efficiency projects. Below is a list of recently adopted and proposed regulatory measures in addition to the CAAP measures that will reduce emissions from the ports over the next five years and beyond.

1.4.1 Ocean-going Vessels

EPA's Final Regulation – Control of Emissions of Air Pollution from Locomotive and Marine Compression Ignited Engines Less than 30 Liters Per Cylinder – (EPA, 2008)\(^{12}\)

This regulation, adopted 14 March 2008, applies to all remanufactured and new-built auxiliary engines used on U.S. flagged ocean-going vessels. Engines covered are category 1 and 2 engines with greater than 800 horsepower (hp) rating less than 30 liter per cylinder (l/cyl) displacement. This is a three part regulation as follows:

1. Remanufactured engines – establishes more stringent emissions standards requirements for existing engines when they are remanufactured. Depending upon the availability, these standards are applicable as early as 2008.
2. Tier 3 – more stringent emissions standards for new engines with phase-in starting in 2009. Tier 3 standards target PM and NO\(_x\) emissions based on currently available onroad and Tier 4 non-road technologies.
3. Tier 4 – most stringent emissions standards for new engines with phase-in starting in 2014. Tier 4 standards are based on highly efficient after-treatment catalyst technologies along with the use of ultra low sulfur fuel.

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\(^{12}\) See: [http://www.epa.gov/otaq/regs/nonroad/420f08004.htm#exhaust](http://www.epa.gov/otaq/regs/nonroad/420f08004.htm#exhaust) (EPA 2008)
Emission Standards for Marine Diesel Engines Above 30 l/cyl (Category 3 Engines)

EPA is pursuing two parallel, related actions for emission standards for Category 3 marine diesel engines. On one track, EPA is a member of the U.S. delegation in negotiations at the International Maritime Organization (IMO) with regard to amendments to MARPOL Annex VI\(^\text{13}\) that consider additional NO\(_x\) limits for new engines; additional sulfur content limits for marine fuel; methods to reduce PM emissions; potential NO\(_x\) and PM limits for existing engines; and potential volatile organic compounds (VOCs) limits for tankers. On second track, EPA is planning to develop new national standards for Category 3 marine diesel engines over the next few years, taking into consideration the state of technology that may permit emission reductions and the status of international action for more stringent standards.

CAAP Measure- SPBP-OGV5; OGV Main & Auxiliary Engine Emissions Improvements

This measure provides for main and auxiliary engine emissions reductions that are validated through the Technology Advancement Program. The goal of this measure is to reduce main and auxiliary engine DPM, NO\(_x\), and SO\(_x\) emissions by 90%. The first engine emissions reduction technology identified for this measure is the use of MAN B&W slide valves for main engines. The implementation mechanism for this measure is the terminal lease renewal.

CARB’s Regulation to Reduce Emissions from Diesel Auxiliary Engines on Ocean-going Vessels While at Berth at a California Port\(^\text{14}\)

On 6 December 2007, CARB’s board approved a regulation that requires operators of containerships, passenger ships and refrigerated cargo ships to shut off their diesel auxiliary-powered engines for most of the time during their stay at a California port. It is anticipated that the OGV operators while at berth will either utilize electrical power from the shore or clean emissions control technologies that will reduce PM and NO\(_x\) emissions by 50% in 2014 and 80% in 2020. The phase-in requirement starts on 1 January 2010.

Emissions Standard for Marine Propulsion Engines

The IMO adopted limits for NO\(_x\) in MARPOL Annex VI in 1997. These NO\(_x\) limits apply to marine engines over 130 kilowatts (kW) installed on vessels built on or after 2000. The NO\(_x\) standards are from 17.0 grams per kilowatt hour (g/kW-hr) for < 130(rpm) to 9.8 g/kW-hr for <2000 rpm, depending upon the engine speed. The required number of countries ratified the Annex in May 2004 and it went into force for those countries in May 2005. The Annex has not yet been ratified by the U.S. Engine manufacturers have been certifying engines to the Annex VI NO\(_x\) limits since 2000 as the standards are retroactive.

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Vessel Speed Reduction (VSR) Program

In May 2001, a Memorandum of Understanding (MOU) between the Port, the Port of Los Angeles, EPA Region 9, CARB, SCAQMD, the Pacific Merchant Shipping Association (PMSA), and the Marine Exchange of Southern California was signed. This MOU called for OGVs to voluntarily reduce speed to 12 knots at a distance of 20 nautical miles (nm) from Point Fermin. The term of this MOU expired in 2004; however, currently a significant number (roughly 82% in 2006 CY) of the OGVs operating at the port of Los Angeles are abiding by VSR speeds within 20 nm from Point Fermin.

CAAP Measure – SPBP-OGV1; Vessel Speed Reduction (VSR) Program

The San Pedro Bay Ports Clean Air Action Plan adopted by the Ports of Los Angeles and Long Beach require 90% VSR compliance for OGVs that come to terminals which are due for lease renewal. Reduction in speed demands less power on the main engine, which in turn reduces NOx emissions and fuel usage.

Low Sulfur Fuel for Marine Auxiliary Engines

In December 2005, CARB adopted low sulfur fuel requirements for marine auxiliary engines within 24 nm of the California coastline. As of January 2007, the regulation required use of marine diesel oil (MDO) or marine gas oil (MGO) with sulfur content of equal or less than 0.5% sulfur by weight, followed by use of MGO with sulfur content of equal or less than 0.1 % sulfur in 2010. The use of low sulfur fuel will reduce emissions of NOx, DPM and SOx. The vessel operators have voluntarily complied with the regulation throughout 2007 and early part of 2008. The PMSA filed for a court injunction and the ninth circuit court ruled in favor of the PMSA on 27 February 2008. The ninth circuit court also made it clear that Air Resources Board may start enforcing this upon CARB’s receipt of authorization from USEPA. At this time CARB has suspended the enforcement of this regulation and plan to submit a request for authorization from USEPA and while the request for authorization to USEPA is being submitted, CARB is developing a new fuel regulation for ship auxiliary engines that will address the issues raised by PMSA. CARB staff plans to propose this new regulation to the Board in July of 2008.

Low Sulfur Fuel for Marine Propulsion Engines and Boilers

Currently CARB is developing a regulation that will require use of low sulfur fuel in main and auxiliary boilers of all U.S. and foreign-flagged OGVs within 24 nm of the California coast. CARB is proposing a two step requirement as follows:

1. Starting in 1 July 2009 – use of MGO or MDO with sulfur content limit of 0.5%.

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15 See: [http://www.arb.ca.gov/ports/marinevess/presentations/030508/030508regpres.pdf](http://www.arb.ca.gov/ports/marinevess/presentations/030508/030508regpres.pdf)
2. Starting in 1 January 2012 – use of MGO or MDO with sulfur content of 0.1% to 0.2%.

Steamships that use boilers as a primary source of propulsion are excluded from this proposed regulation.

CAAP Measures- SPBP-OGV3 and 4; OGV Main & Auxiliary Engine Fuel Standards
This measure is designed to require the use of lower sulfur distillate fuels in the auxiliary and Main engines of OGVs within 40 nm of Point Fermin and while at berth. Upon lease renewal, this measure requires the use of distillate fuels that have a sulfur content of ≤0.2% S MGO. The Ports are focusing this measure and SPBP-OGV4 (Main Engine Fuel Standards) to target fuel quality with the goal of synchronizing both the auxiliary and main engine fuels.

Low-Sulfur Vessel Main Engine Fuel Incentive Program
To quickly reduce emissions from Ocean-going Vessels, the ports of Long Beach and Los Angeles have adopted an incentive program to encourage vessel operators to discontinue the use of highly polluting bunker fuel in favor of clean, 0.2 percent low sulfur distillate fuel. The program will pay eligible shipping lines the difference between the cost of bunker fuel and the more expensive low-sulfur distillate when used in main engines within the terms of the program. It encourages the use of cleaner fuels among ocean-going vessels prior to the implementation of lease-based low-sulfur fuel agreements and prior to the start of international treaties, U.S. Environmental Protection Agency, or California Air Resources Board regulations requiring low-sulfur fuel use. This program will end on June 30, 2009, upon the expected implementation of statewide low sulfur fuel regulations.

CARB’s Regulation Related to Ocean-going Vessel Onboard Incineration
This regulation was adopted by CARB’s board in 2005 and amended in 2006. As of November 2007, it prohibits all cruise ships and ocean-going vessels of 300 registered gross tons or more from conducting on-board incineration within three nautical miles of California coast. Enactment of this regulation will reduce toxics air contaminants such as dioxins and toxics metals exposure to public. It will also reduce PM and hydrocarbon emissions generated during incineration.

1.4.2 Harbor Craft
EPA’s Emission Standards for Harbor Craft Engines
EPA final regulation, Control of Emissions of Air Pollution from Locomotive and Marine Compression Ignited Engines Less than 30 Liters per Cylinder described in Section 1.4.6, applies to harbor craft as well. On 14 March 2008, EPA established new engine standards for new Category 1 and 2 diesel engines – engines rated over 50 hp used for propulsion in most harbor craft. These standards are to be phased in between 2004 and 2007 and limit NOx, hydrocarbon, CO and DPM, but the emissions reductions achieved are modest in the next five years. EPA expects 24%
reduction in NOx and 12% reduction in DPM in 2030 when the harbor craft engine fleet is fully turned over to these new engines.

CARB’s Regulation to Reduce Emissions from Diesel Engines on Commercial Harbor Craft – Adopted in November 2007

As a part of Diesel Risk Reduction Plan and Goods Movement Plan, CARB adopted a regulation that will reduce DPM and NOx emissions from new and in-use commercial harbor craft. Under CARB’s definition, commercial harbor craft includes tugboats, towboats, ferries, excursion vessels, work boats, crew boats, and fishing vessels. This regulation requires stringent emissions limits for auxiliary as well as propulsion engines installed in commercial harbor craft. All in-use, new purchases or replacement engines have to meet EPA’s most stringent emissions standards per a compliance schedule set by CARB for in-use engines, and at the time of purchase for new engines. The in-use requirement only applies to tugboats, towboats, ferries, work boats, and crew boats. The compliance schedule for in-use engine replacement starts in 2009.

Low Sulfur Fuel Requirement for Harbor Craft

In 2004, CARB adopted a low sulfur fuel requirement for harbor craft. As of 1 January 2006 (in SoCAB) harbor craft operating in SoCAB are required to use onroad diesel fuel (e.g., ultra-low sulfur diesel, ULSD, which has a sulfur content limit of 15 parts per million (ppm) sulfur, and lower aromatic content. Use of lower sulfur and aromatic fuel will result in NOx and DPM reduction benefits. In addition, use of low sulfur fuel will facilitate retrofitting of harbor craft with emissions control devices such as diesel particulate filters (DPFs) that have potential to reduce PM by 85%.

DPM and NOx Emission Reductions from In-Use Harbor Craft

As a part of the Diesel Risk Reduction Plan and the Goods Movement Plan, CARB staff is proposing a regulation to reduce DPM and NOx from new and in-use commercial harbor craft. Under CARB’s definition, commercial harbor craft include tugboats, towboats, ferries, work boats, crew boats, military vessels and fishing vessels. The goal of this regulation is to achieve reduction in DPM and NOx by 25% in 2010, 30% in 2015 and 40% in 2020.

1.4.3 Cargo Handling Equipment

Emissions Standards for Non-Road Diesel Powered Equipment

The EPA’s and CARB’s Tier 1, Tier 2, Tier 3, and Tier 4 (interim Tier 4 and final) emissions standards for non-road diesel engines require compliance with progressively more stringent standards for hydrocarbon, CO, DPM, and NOx. Tier 4 standards for non-road diesel-powered equipment complement the latest 2007+ onroad heavy-duty engine standards requiring 90 percent reduction in DPM and

NOx when compared against the current level. To meet these standards, engine manufacturers will produce new engines with advanced emissions control technologies similar to those already expected for on-road heavy-duty diesel vehicles. These standards for new engines were phased in with smaller engines in 2008 until all but the very largest diesel engines meet NOx and PM standards in 2015. Currently, the interim Tier 4 standard includes 90% reduction for PM and a 60% reduction in NOx.

**CARB's Cargo Handling Equipment Regulation**

In December of 2005 CARB adopted a regulation to reduce emissions from CHE such as yard tractors and forklifts starting in 2007. The regulation calls for the replacement or retrofit of existing engines with engines that use Best Available Control Technology (BACT). As of 1 January 2007 the regulation requires that newly purchased, leased, or rented CHE be equipped with either a 2007 or later onroad engine, a Tier 4 offroad engine or the cleanest verified diesel PM emissions control system which reduces DPM by 90% and NOx by at least 70% for yard tractors. For cargo handling equipment other than yard tractors, currently verified technologies reduce PM by 85%.

**CAAP Measures- SPBP-CHE1- Performance Standards for CHE**

This measure calls for further CHE improvements at the time of terminal lease renewal. Beginning 2007, all CHE purchases will meet one of the following performance standards: Cleanest available NOx alternative-fueled engine meeting 0.01 g/bhp-hr PM, available at time of purchase; or cleanest available NOx diesel-fueled engine meeting 0.01 g/bhp-hr PM, available at time of purchase. If there are no engines available that meet 0.01 g/bhp-hr PM, then must purchase cleanest available engine (either fuel type) and install cleanest VDEC available.

By the end of 2010, all yard tractors operating at the San Pedro Bay Ports will meet at a minimum the EPA 2007 on-road or Tier IV engine standards.

By the end of 2012, all pre-2007 on-road or pre Tier IV off-road top picks, forklifts, reach stackers, RTGs, and straddle carriers <750 hp will meet at a minimum the EPA 2007 onroad engine standards or Tier IV off-road engine standards.

By end of 2014, all CHE with engines >750 hp will meet at a minimum the EPA Tier IV off-road engine standards. Starting 2007 (until equipment is replaced with Tier IV), all CHE with engines >750 hp will be equipped with the cleanest available VDEC verified by CARB.
1.4.4 Railroad Locomotives

Emissions Standards for New and Remanufactured Locomotives and Locomotive Engines- Latest Regulation Finalized on 14 March 2008

In 1998, EPA adopted Tier 0 (1973-2001), Tier 1 (2002-2004), and Tier 2 (2005+) emissions standards applicable to newly manufactured and remanufactured railroad locomotives and locomotive engines. These standards require compliance with progressively more stringent standards for emissions of hydrocarbon, CO, NOx, and DPM. Although the most stringent standard, Tier 2, results in over 40% reduction in NOx and 60% reduction in DPM compared to Tier 0, full potential of these reductions will not be realized in the next five years because of the long life of diesel locomotive engines. Further, EPA has published its final regulation – “Control of Emissions of Air Pollution from Locomotive and Marine Compression Ignited Engines Less than 30 Liters per Cylinder –14 March 2008.” This regulation applies to all remanufactured and new-built locomotive engines installed on line haul, switch and passenger locomotives.

EPA Advance Notice of Proposed Rulemaking (ANPRM) for Locomotives

According to the ANPRM, EPA is considering standards modeled after the 2007/2010 highway and Tier 4 non-road diesel engine programs, with an emphasis on achieving large PM emission reductions as soon as possible through the use of advanced emission control technology starting as early as 2011. This technology, based on high-efficiency catalytic after treatment, is enabled by the availability of clean diesel fuel with sulfur content capped at 15 ppm. EPA is currently developing the NPRM for this program.

Low Sulfur Fuel Requirement for Intrastate Locomotives

In 2004, CARB adopted a low sulfur fuel requirement for intrastate locomotives. Intrastate locomotives are defined as those locomotives that operate at least 90 percent of the time within borders of the state, based on hours of operation, miles traveled, or fuel consumption. Mostly applicable to switchers, starting 1 January 2006, statewide, intrastate locomotives are required to use CARB offroad diesel fuel which has a sulfur content limit of 15 ppm sulfur and a lower aromatic content. Use of fuel with lower sulfur and lower aromatics will result in NOx and DPM reductions. In addition, use of low sulfur fuel will facilitate retrofitting of locomotives with emissions control devices such as DPFs that have potential to reduce DPM by 85%.

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18 EPA 2008.
Statewide 2005 Memorandum of Understanding

In order to accelerate the implementation of Tier 2 engines in SoCAB, CARB and EPA Region 9 entered into an enforceable MOU in 1998 with two major Class 1 freight railroads [Union Pacific (UP) and Burlington Northern Santa Fe (BNSF)] in California. This MOU requires UP and BNSF to concentrate introduction of the Tier 2 locomotives in the SoCAB, which will achieve 65% reduction in NO\textsubscript{x} by 2010.

In 2005, CARB entered into another MOU with UP and BNSF whereby these two railroads have agreed to phase out non-essential idling and install idling reduction devices, identify and expeditiously repair locomotives that smoke excessively and maximize the use of 15 ppm sulfur fuel.

1.4.5 Heavy-Duty Vehicles

Emission Standards for New 2007+ Onroad Heavy-Duty Vehicles

In 2001, CARB adopted EPA's stringent emission standards for 2007 and later model HDV, which will ultimately result in 90% reductions in emissions NO\textsubscript{x} and PM. According to this regulation, HDV engine manufacturers will be meeting a PM standard of 0.01 g/bhp-hr starting in 2007, which is 90% lower than the 2004 PM standard of 0.1 g/bhp-hr. The NO\textsubscript{x} standard requires a phase-in of the 0.2 g/bhp-hr NO\textsubscript{x} standards between 2007 and 2010. By 2010, all engines have to meet the 0.2 g/bhp-hr NO\textsubscript{x} standard, which is over 90% lower than the 2004 NO\textsubscript{x} standard of 2.4 g/bhp-hr. It is expected that between 2007 and 2010, on average, manufacturers will be producing HDV engines meeting the PM standard of 0.01 g/bhp-hr and a NO\textsubscript{x} standard of 1.2 g/bhp-hr. This latter standard is referred to as the 2007 interim standard.

Heavy-Duty Vehicle On-Board Diagnostics (OBD) Requirement

In 2005, CARB adopted a comprehensive HDV OBD regulation, which ensures that the increasingly stringent HDV emissions standards being phased in are maintained during each vehicle’s useful life. The OBD regulation requires manufacturers to install a system in HDVs to monitor virtually every emissions related component of the vehicle.

Ultra-Low Sulfur Diesel (ULSD) Fuel Requirement

In 2003, CARB adopted a regulation requiring that diesel fuel produced or offered for sale in California for use in any onroad or non-road vehicular diesel engine (with the exception of locomotive and marine diesel engines) contain no more than 15 ppm of sulfur by weight, as of June 2006 statewide. ULSD fuel is needed in order for retrofit technologies, such as DPF, to work successfully.
CARB’s Regulation for Reducing Emissions from Onroad Heavy-Duty Diesel Trucks Dedicated to Goods Movement at California Ports

As a part of CARB’s emissions reduction plan for ports and goods movement in California, in December of 2007, ARB board adopted a regulation to modernize the drayage truck fleet that operate at California ports. This goal is achieved in two phases as follows:

1. By 31 December 2009, all trucks operating at California Ports have to meet 1994 – 2003 onroad heavy duty truck engine standards plus be retrofitted with CARB’s level 3 verified emissions control technologies that reduces PM at least by 85%; or meet 2004 and later onroad heavy-duty truck engine standards.
2. By 31 December 2013, all trucks operating at California Ports have to meet 2007 and beyond onroad heavy-duty truck engine standards.

CAAP Measures- SPBP-HDV1- Performance Standards for On-Road Heavy-Duty Vehicles

Per the stated goals of the CAAP, the Ports of Los Angeles and Long Beach approved a tariff plan which progressively bans older trucks from operating at the two ports. The ban is implemented in three phases as follows:

1. By 1 October 2008 – All pre-1989 trucks are banned from ports services.
2. By 1 January 2010 – All 1989-1993 trucks along with un-retrofitted 1994-2003 trucks are banned from ports services.
3. By 1 January 2012 – All trucks that do not meet 2007 and later onroad heavy-duty engine standards are banned from ports services.

1.4.6 Greenhouse Gases

In California, assembly bill AB 32\(^{19}\), signed by the governor in September 2006, created a comprehensive, multi-year program to reduce statewide GHG emissions. It gives CARB the authority to develop strategies to achieve an overall goal of restoring emissions to 1990 levels by the year 2020, which is an approximate 25% reduction in GHG emissions. In addition, AB 1803, passed in January 2007, mandates CARB to adopt a regulation to require the reporting and verification of statewide GHGs beginning with the source or category that contributes the most to the statewide emissions.

\(^{19}\) See: [http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_0001-0050/ab_32_bill_20060927_chaptered.pdf](http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_0001-0050/ab_32_bill_20060927_chaptered.pdf).
In December 2007, CARB staff presented to their board, California’s 1990 GHG emissions (six Kyoto gases) inventory\textsuperscript{20} for major sectors such as transportation, electric power, industry, petroleum refining, agriculture, and forestry. These are statewide estimates and each major sector has its own sub categories. Following the mandate of AB 1803\textsuperscript{21}, CARB’s board has also adopted a mandatory reporting regulation that requires annual GHG reporting from largest commercial and industrial stationary sources in California. Transportation sources are not currently covered by this regulation.

The recently adopted CARB regulations, anticipated CARB rulemakings, and the measures in the CAAP will provide a vital and complementary combination of measures that support the overall effort to meet both State and San Pedro Bay Ports air quality improvement goals.

One non-regulatory program that is also helping to significantly reduce emissions from sources including those associated with ports is the Carl Moyer Program. This program is a CARB administered grant program implemented in partnership with local air districts to fund the replacement of older, “dirty” engines or to cover the incremental cost of purchasing cleaner-than-required engines and vehicles. Under this program, owners/operators of mobile emissions sources can apply for incremental funding to reduce emissions. The program is also being expanded to include a fleet modernization component. Emissions source categories at the Ports that have been successful in obtaining Carl Moyer funding includes: heavy-duty vehicles, cargo handling equipment, harbor craft, and rail locomotives. It is important to note that only emission reductions that are surplus to regulatory requirements are eligible for Carl Moyer funding. As regulations are developed which require retrofit or replacement of specific equipment and/or vehicles, those projects will no longer be eligible for funding.

1.5 Scope of Study

The scope of the study is described in terms of the year of activity used as the basis of emissions estimates, the pollutants quantified, the included and excluded source categories and the geographical extent. The purpose of the 2006 Inventory of Air Emissions (2006 EI) is to develop emission estimates based on activities that occurred in calendar year 2006.

\textsuperscript{20}See: \url{http://www.arb.ca.gov/cc/inventory/inventory.htm}.

\textsuperscript{21}See: \url{http://www.arb.ca.gov/cc/reporting/ghg-rep/ghg-rep.htm}. 
1.5.1 Pollutants

Exhaust emissions of the following pollutants have been estimated:

- Particulate matter (PM) (10-micron, 2.5-micron)
- Diesel particulate matter (DPM)
- Oxides of nitrogen (NOx)
- Oxides of sulfur (SOx)
- Total hydrocarbons (HC)
- Carbon monoxide (CO)
- Carbon dioxide (CO2)
- Methane (CH4)
- Nitrous oxide (N2O)

The greenhouse gases, CO2, CH4 and N2O have been estimated based on emission factors presented in the corresponding source category sections and/or appendices. Each greenhouse gas differs in its ability to absorb heat in the atmosphere. Sometimes, estimates of greenhouse gas emissions are presented in units of carbon equivalents which weight each gas by its global warming potential (GWP) value. To normalize these values into a single greenhouse gas value, the GHG emissions estimates can be multiplied by the following values and then added together resulting in a single greenhouse gas value (CO2 equivalent). The values are as follows22:

- CO2 – 1
- CH4 – 21
- N2O - 310

1.5.2 Emission Sources

The scope includes the following five source categories:

- Ocean-going vessels
- Harbor craft
- Cargo handling equipment
- Railroad locomotives
- Heavy-duty vehicles

The inventory does not include stationary sources, as these are included in stationary source permitting programs administered by the SCAQMD. The inventory does not include emissions from vessels and equipment used for oil operations located within the port boundary and off-shore. The oil industry-related emissions are included in a separate study conducted by the Port.

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1.5.3 Geographical Extent

The 2006 EI includes tenant source category emissions from Port-related goods movement activities that occur on Port-owned and privately owned land with the Port boundary/district. An overview of the geographical extent is provided below for each of the source categories. The geographical scope for cargo handling equipment is the terminals and facilities on which they operate.

Figure 1.5 shows the land area of active Port terminals in 2006.

**Figure 1.5: Port of Long Beach Map of Terminals**
Emissions from switching and line haul railroad locomotives were estimated for on-dock rail yards, intermodal yards on Port property, and the rail lines linking these facilities. For heavy-duty trucks related to the hauling of cargo, emissions from queuing at terminal entry gates, for travel and idling within the terminals, and for queuing at the terminal exit gates have been included. In addition to emissions that occur inside the Port facilities, emissions from locomotives and onroad trucks transporting cargo to or from the Port have been estimated for activity that occurs within the SoCAB boundaries. Emissions are estimated up to the cargo’s first point of rest within the SoCAB or up to the basin boundary, whichever comes first. First point of rest is the location where the cargo, such as a container of goods, is first off-loaded from the transport device (truck or train) after leaving the Port. Examples include cargo transported from the Port by truck to a distribution center or to an off-Port intermodal yard.

Figure 1.6 shows the SoCAB boundary for rail and HDV in relation to the location of the Port. Since the ports of Long Beach and Los Angeles are interconnected with intermodal transportation linkages, every effort was made to only account for freight movements originating from or having a destination at the Port.

Figure 1.6: South Coast Air Basin Boundary
For marine vessels, OGVs and commercial harbor craft, the geographical extent of the EI is based on the same boundary that was used in previous marine vessel inventories developed for the SCAQMD. The portion of the study area outside the Port's breakwater is four-sided, and geographically defined by the following coordinates:

- NW corner: 34°02'42.4” north (N) latitude by 118°56'41.2” west (W) longitude
- SW corner: 33°00'00.0” N latitude by 119°30'00.0” W longitude
- SE corner: 32°30'00.0” N latitude by 118°30'00.0” W longitude
- NE corner: 33°23'12.7” N latitude by 117°35'46.4” W longitude

Figure 1.7 shows the geographical extent of the study area for marine vessels (dark blue) and the traffic separation zone (orange). The red lines on either side are guidelines for vessels arriving and departing the port. The small red striped area is the precautionary zone (PZ) which will be further discussed in Section 2.1.

Figure 1.7: OGV and Harbor Vessel Out of Port Geographical Extent
1.5.4 Facilities Not Included

There are certain industrial operations and other emission-producing activities that are located on Port property or on private property within the Port boundaries that are not included in this inventory. The facilities that have not been included are:

- Harbor Cogeneration
- South East Resource Recovery Facility
- Tidelands Oil Production Company
- THUMS Oil Operations
- Long Beach Generating

Some of these operations and activities are within the Port for historical reasons, for example some operations were present prior to an area becoming Port property. Other operations take place on property leased from Port but are not in any way related to the activities or operations of the Port, and in many cases, the Port does not have authority or influence over these operations.

Emissions associated with the oil operations located at the Port are excluded from this inventory (Tidelands and Thums Oil Operations) but are included in a separate study conducted to quantify oil industry-related emissions published in 2006. Stationary sources are not included in this inventory.

1.6 General Methodology

The basic approach to developing an activity-based EI is through collecting data through interviews and conversations with tenants, who own, operate and maintain equipment and own or charter vessels. Port tenants and shipping lines played an essential role in the development of this EI by providing the most accurate information available. The activity and operational data collected was input into a database for storage and to estimate emissions for each of the various source categories in a manner consistent with the latest estimating methods, as agreed to by the Port and the participating regulatory agencies. The information gathered, analyzed, and presented in this report continues to improve the understanding of the nature and magnitude of Port-wide emission sources. Specific data collection and analytical approaches unique to each of the five source categories are summarized below; along with a summary of the key updates to the inventory.

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23 Long Beach Gas and Oil Air Emissions Inventory, prepared by Starcrest Consulting Group, LLC, October 2006.
In general, emissions were estimated using the activity and operational information described above and emission factors, which are measures of emissions that express the mass of emissions in terms of a unit of activity. For example, emission factors may be expressed in terms of pounds of emissions (of a particular pollutant) per horsepower-hour. Horsepower-hours are the product of in-use horsepower times hours of operation. Emissions can be calculated, then, by multiplying hours of operation per year (activity data) by in-use horsepower (operational information) by an emission factor (such as pounds per horsepower-hour) to provide an estimate of pounds of emissions per year. The actual calculations are often more complex than this example, because such parameters as in-use horsepower must be estimated as part of the calculations. In addition, the emission factors often vary depending on equipment-specific factors such as the model year and the accumulated hours of use, and fuel correction factors may need to be applied. The methods of calculating emissions are more completely described in the sections covering each source category.

### 1.6.1 Ocean-going Vessels

The basic methodology for estimating emissions from the various types of ocean-going vessels that call on the Port use local activity-based data to the greatest extent possible. This includes call records from the Marine Exchange of Southern California, which tracks and records the movement of all OGVs entering or departing San Pedro Bay and information from the Jacobsen Pilots. In addition, the Port has undertaken a Vessel Boarding Program (VBP) that focuses on gathering specific vessel characteristics and operational data from ships visiting the Port, to gain a greater understanding of how the different types of OGVs arrive, depart, and transit San Pedro Bay and the harbor, as well as how they operate while at dock (“hotelling”).

Additional ship-specific OGV data was obtained from Lloyd's Register of Ships (Lloyd’s), a marine vessel data system that can provide vessel specific data for virtually every OGV in the world fleet. Lloyd’s data was also used to develop profiles for parameters that are not known for every ship. The general vessel classifications included in the 2005 EI include the following:

- Automobile carriers
- Bulk carriers
- Containerships
- Cruise ships
- General cargo ships
- Ocean-going tugboats
- Refrigerated vessels
- Roll-on roll-off ships
- Tankers
Emission factors were developed for different types of OGV engines by review of the literature and discussion/coordination with the regulatory agencies. Emissions were calculated by multiplying the emission factors by vessel-specific activity parameters such as in-use horsepower and hours of operation. Numerous calculations were made for each port visit to adequately characterize the complicated activities of OGVs; (e.g., separate calculations were made for vessel transit, maneuvering, and hotelling activities for propulsion, auxiliary engines, and auxiliary boilers). The results of all the calculations were summed to produce the overall emission estimates.

### 1.6.2 Harbor Craft

Harbor craft operators whose vessels work within Port waters were interviewed to update the inventory of harbor craft. The harbor craft are separated into the following categories:

- Assist tugboat
- Towboats and push boats
- Ferries
- Excursion vessels
- Crew boats
- Work boats
- Government vessels

Emission factors were developed for different types of harbor craft engines by review of the literature and discussion/coordination with the regulatory agencies. Emissions were calculated by multiplying the emission factors by the appropriate measure of activity (such as annual hours of operation).

### 1.6.3 Cargo Handling Equipment

Cargo Handling Equipment (CHE) consists of various types of equipment and vehicles that fall within the offroad designation and are used to move cargo within terminals and other offroad areas. The emission estimation methodology for this category followed CARB’s CHE emissions estimation methodology which follows CARB’s OFFROAD\(^{24}\) model methodology plus additional modifications\(^{25}\) made by CARB’s staff for CHE. Equipment operators and owners were interviewed and asked to supply updated information such as activity hours, size and model year of all of their CHE used at the port.


1.6.4 Railroad Locomotives

Railroad operations are typically described in terms of two different types of operation, line haul and switching. Line haul operations involve long-distance transportation between the Port and points across the country whereas switching is the local movement of railcars to prepare them for line haul transportation or to distribute them to destination terminals upon their arrival in port. Different companies conduct switching (Pacific Harbor Line) and line haul (Burlington Northern Santa Fe, Union Pacific) operations within the port and the line haul companies also operate switching locomotives at off-port rail yards.

The on-port switching company operates a dedicated fleet of locomotives, while the line haul locomotives that service the Port are part of a nation-wide fleet, meaning that individual locomotives are not assigned specifically to port or South Coast Air basin service. Therefore, the types of information available for these two types of activity differs – for the on-port switching locomotives, information on each locomotive and its activity (e.g., fuel use and throttle notch setting frequency) can be used to estimate emissions; whereas for the line haul locomotives the information is more general (e.g., in terms of fuel use per ton of cargo and total tons of cargo carried). The EPA has published emissions information for switch and line haul locomotive operations in both throttle notch and fuel consumption modes, so this information was used to estimate emissions and to cross-check between the estimating methods.

1.6.5 Heavy-Duty Vehicles

Heavy-duty onroad vehicles transport cargo between the port and off-port locations such as rail yards, warehouses, and distribution centers. To develop emission estimates, truck activities have been evaluated as having three components:

- On-terminal operations, which include waiting for terminal entry, transiting the terminal to drop off and/or pick up cargo, and departing the terminals.
- Off-terminal port operations, consisting of travel on public roads within the Port jurisdictional boundaries.
- Onroad operations outside the Port boundaries but within the SoCAB. This includes travel within the boundaries of the adjacent Port of Los Angeles, because the routes many trucks take run through both ports on the way to and from Port terminals.
For estimating onroad HDV emissions, activity information was developed by a traffic consultant using the trip generation and travel demand models that were used in previous Port traffic studies. For estimating on-terminal HDV emissions, terminal operators were interviewed with regards to on-terminal traffic patterns, including time spent waiting at the entry gate, time and distance on terminal while dropping off and/or picking up cargo, and time spent waiting at exit gates.

Emissions from HDVs were estimated by multiplying the speed-specific emission factor derived from ARB's emission factor model EMFAC 2007 by the distance parameters established for the terminals (on-terminal emissions) or road segments (onroad emissions). On-terminal idling emissions were estimated by multiplying the EMFAC idling emission factor by estimated idling times.

1.7 Report Organization

This report presents the 2006 emissions and the methodologies used for each category in each of the following sections:

- Section 2 discusses ocean-going vessels
- Section 3 discusses harbor craft
- Section 4 discusses cargo handling equipment
- Section 5 discusses locomotives
- Section 6 discusses heavy-duty vehicles
- Section 7 discusses findings and results
- Section 8 compares 2006 emissions to 2005 emissions

The report also includes:

- Appendix A – Ocean-going vessels
- Appendix B – Harbor craft
- Appendix C – Cargo handling equipment
- Appendix D – Heavy-duty vehicles
