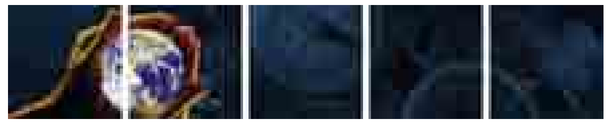
Appendix A:

Protocol Baseline Bay-Wide Regional Human Health Risk Assessment for Diesel Exhaust Particulate Matter (DPM)



PROTOCOL BAY-WIDE REGIONAL HUMAN HEALTH RISK ASSESSMENT FOR DIESEL EXHAUST PARTICULATE MATTER (DPM)

Prepared for:
Port of Los Angeles and
the Port of Long Beach
Los Angeles, California
and Long Beach, California

Prepared by:
ENVIRON International Corporation
Emeryville, California

Date:
December 14, 2009

Project Number:
04-6395O3A8

Contents

List of Tables

List of Figures

List of Appendices

ACRONYMS and ABBREVIATIONS

AERMAP	AERMOD's Terrain Preprocessor
AERMET	AERMOD Meteorological Preprocessor
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
ARB	Air Resources Board
AT	Averaging Time
Basin	South Coast Air Basin
BR	Breathing Rate
BW	Body Weight
BWHRA	Bay-Wide Health Risk Assessment
C_a	Concentration of DPM in Air
CAAP	Clean Air Action Plan
Cal/EPA	California Environmental Protection Agency
CEQA	California Environmental Quality Act
CHE	Cargo Handling Equipment
COPC	Chemicals of Potential Concern
CSF	Cancer Slope Factor
DEM	Digital Elevation Maps
DPM	Diesel Exhaust Particulate Matter
ED	Exposure Duration
EF	Exposure Frequency
Eq.	Equation
HDV	Heavy-duty Vehicle
HRA	Health Risk Assessment
IARC	International Agency for Research on Cancer
IGRA	Integrated Global Radiosonde Archive
ISCST3	Industrial Source Complex Short Term (Version 3) Air Dispersion Model
kg	Kilogram
km	Kilometer
L	Liter
m^3	Cubic Meter
µg	Microgram
MSA	Metropolitan Statistical Area
NAS	Naval Air Station
NCDC	National Climatic Data Center
NEPA	National Environmental Policy Act
NLCD	National Land Cover Dataset
NRC	National Research Council
NWS	National Weather Service
OEHHA	Office of Environmental Health Hazard Assessment
OGV	Ocean-going Vessels
Ports	Port of Los Angeles and Port of Long Beach

PM	Particulate Matter
PRIME	Plume Rise Model Enhancement
REL	Reference Exposure Level
SCAQMD	South Coast Air Quality Management District
SPPS	St. Peter and Paul School
Starcrest	Starcrest Consulting, LLC
TAC	Toxic Air Contaminants
TITP	Terminal Island Treatment Plant
TWG	Technical Working Group
URF	Unit Risk Factor
USEPA	US Environmental Protection Agency
USGS	United States Geological Survey

1 Introduction

The Port of Los Angeles and Port of Long Beach, referred to collectively as the San Pedro Bay Ports (the Ports), are working to develop and establish a Bay-Wide Health Risk Standard to comply with the San Pedro Bay Clean Air Action Plan ([CAAP] 2006). To help establish and monitor progress toward the Bay-Wide Health Risk Standard, the Ports are developing a health risk assessment (HRA) protocol that can be used for the preparation of a Bay-wide health risk assessment (BWHRA) for Ports-related emissions of diesel exhaust. The technical approach and methodologies to be followed in the air dispersion modeling and human HRA elements of the BWHRA are described in this protocol document. The approaches used for emissions estimation and emissions forecasting are described in separate documents prepared by Starcrest Consulting, LLC ([Starcrest] 2007 a,b,c).

The emphasis of the BWHRA on diesel exhaust reflects the fact that long-term exposure to air pollution in the South Coast Air Basin (Basin) has been linked to a number of serious health effects including impaired lung function and an increased incidence of asthma (Air Resources Board [ARB], 2004a) and impaired lung development in children (Gauderman et al. 2007). Diesel exhaust contributes particulate matter (PM) and other components to air pollution, and ARB determined that diesel exhaust particulate matter (DPM) accounts for approximately 70% of the States' estimated potential cancer risk from toxic air contaminants (TACs) based on its monitoring data (ARB 2000). The Multiple Air Toxics Exposure Study of air pollution identified the harbor areas as significant contributors to DPM in the Basin (MATES II 2002). The ARB's Exposure Assessment of the Ports focused solely on DPM because of its potential to cause cancer and other health effects, and because health risks from diesel exhaust tend to be highest in areas with concentrated emissions (ARB 2006a). Consistent with those facts, ARB's analysis identified elevated regional cancer risks associated with ports-related DPM emissions (ARB 2006a). Because these results indicate that DPM sources at the ports may be the most significant single contributor of any TAC to regional cancer risk, the Ports will focus solely on DPM in the BWHRA.

The objectives of the BWHRA will be accomplished by preparing an exposure assessment for the baseline year 2005, and comparing estimated cancer risks from that year to those estimated for 2023 under two separate scenarios of (1) Ports growth and implementation of adopted regulations; and (2) Ports growth, implementation of adopted regulations, and implementation of additional control measures identified in the CAAP (2006). These scenarios, the underlying assumptions, and emissions estimation methodologies were developed by Starcrest (2007c) with the participation of staff of the Ports, the ARB, and the South Coast Air Quality Management District (SCAQMD).

For diesel exhaust from goods movement in particular, the ARB has prepared a series of risk assessments, including HRAs for a number of railyards (e.g., ARB 2004b; 2007a,b), a human HRA for diesel emissions associated with the statewide goods movement system (ARB 2006b), and an evaluation of regional health risks posed by diesel emissions from the Ports (ARB 2006a). While the risk assessments prepared for the individual rail yards focused on local impacts, the risk assessments prepared as part of the Emission Reduction Plan for Ports and Goods Movement (ARB 2006b) and for the Ports (ARB 2006a) focused on more regional impacts. The BWHRA described in this protocol document also focuses on more regional, rather than local, impacts. Local impacts are addressed in the facility-specific risk assessments prepared with project-specific protocols by the Ports under the California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) as part of the Ports' environmental management program.

Like any risk assessment for chemicals emitted to air, the BWHRA will include estimation of air emissions, dispersion modeling to estimate exposure concentrations, and estimation of health risks associated with modeled exposure concentrations. The risk assessment methods to be used in the BWHRA are based on the fundamental principles of human HRA described by the National Research Council ([NRC] 1983, 1994). The risk assessment methods of the BWHRA will be consistent with guidance of the California Environmental Protection Agency (Cal/EPA), Office of Environmental Health Hazard Assessment (OEHHA 2003), the United States Environmental Protection Agency (USEPA 2005a) and the SCAQMD (2003, 2005). These regulatory guidelines were developed to conform to the fundamental human HRA principles of the NRC (1983, 1994).

To foster comparability of the cancer risk estimates that will be produced by the BWHRA with risk estimates from other assessments prepared for goods movement in California, the methods proposed for the BWHRA are generally consistent with the risk assessment guidelines cited above (in particular with the ARB Hot Spots Guidance). However, because those guidance documents were developed as part of specific regulatory programs that are not addressed by the BWHRA, the detailed guidance in those documents is not necessarily consistent with the objectives of the BHWRA. Accordingly, the methodology of the BWHRA will be developed to support the goals of the CAAP (2006) and development of the Bay-wide health risk standard, and not necessarily the specific goals or guidance applicable to other regulatory programs.

The BWHRA will use default exposure assumptions that are consistent with those recommended by OEHHA for screening-level (i.e., Tier 1) assessments under the AB2588 Hot Spots program (OEHHA 2003). Cancer risk will be calculated using a cancer slope factor (CSF) for DPM that was derived by OEHHA to represent the toxicity of the diesel exhaust mixture (OEHHA 1998; 2000a). The BWHRA will evaluate residential and off-site worker receptor populations, with exposure quantified for the inhalation exposure pathway. Details of how the HRA will be performed are given in Section 5.

As was shown by the ARB (2006a) in their Exposure Assessment for the Ports, DPM exposures in the vicinity of the Ports are below the current reference exposure level (REL). Consequently, the BWHRA will focus solely on cancer risk estimation.

The BWHRA will be based on mass emission estimates of DPM from all mobile sources associated with Ports operations developed from one year (2005) of independently-collected emissions data. As noted above, two scenarios for emission estimates in the year 2023 will also be provided (refer to Starcrest 2007c). While the emissions inventory contains data on a number of compounds, the BWHRA will only evaluate DPM as it is the dominant contributor to cancer risk from Ports' emissions.

Consistent with the Ports emissions inventories, and for comparability to ARB (2006b), the BWHRA will address mobile sources within the Ports' boundaries as well as certain over-water emissions. In addition, DPM emissions from trucks on major roadways (i.e., Interstates 110 and 710 and Highways 47 and 103) and locomotives on the major rail line (i.e., the Alameda Corridor) associated with Port operations will be considered outside the Ports' boundaries. Based on an evaluation of meteorological data collected from stations in the vicinity of the Ports, the out-of-port truck and locomotive DPM emissions will be considered over an area extending approximately to Interstate 405 as shown in Figure 1 and discussed in more detail in Attachment I.[1]

For air dispersion modeling, the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) will be used to estimate DPM exposure concentrations at off-site receptor locations. Air dispersion modeling with AERMOD will follow a similar approach to that used by the ARB (2006b). Additional details of how the air modeling will be performed are provided in Section 4.

[1] The section of Interstate 110 between 223rd Street and Interstate 405 in northern Long Beach will not be included in the analysis, as discussed in Attachment I.

2 Project Scope

The Port of Los Angeles and the Port of Long Beach are owned by the cities of Los Angeles and Long Beach, respectively, and are operated and managed under a State Tidelands Trust that grants local municipalities jurisdiction over ports. Collectively, the two Ports encompass approximately 10,700 acres and more than 50 miles of waterfront. The Ports build and lease the terminals, but do not operate the ships, cargo handling equipment (CHE), trucks, and locomotives that support activities of the Ports tenants. The BWHRA will evaluate mobile source emissions from the Port of Los Angeles and the Port of Long Beach, and their respective cargo terminals, passenger terminals, inter-modal rail facilities, warehousing and distribution facilities, and maritime support services. Port-related truck emissions on major freeways (i.e., Interstates 110 and 710 and Highways 47 and 103) and locomotive emissions on the major rail line (i.e., the Alameda Corridor) in the vicinity of the Ports will also be considered in BWHRA. The mobile source categories evaluated in the BWHRA include ocean-going vessels (OGVs), harbor craft (e.g., tugboats, ferries, commercial fishing vessels, etc.), off-road CHE, railroad locomotives, and on-road heavy-duty vehicles (HDVs) (see Section 3).

To facilitate comparisons with ARB's exposure assessment of the Ports (ARB 2006a), the BWHRA will assess regional impacts of DPM, and will use the same geographic area (domain) of air dispersion modeling for estimation of DPM exposure point concentrations as that used by ARB.

Figure 1 provides a map of the two Ports that shows their proximity to each other, their location relative to the surrounding communities, and the air dispersion modeling domain of the BWHRA.

3 Air Emission Inventory Methodology

Starcrest was commissioned by each of the Ports to conduct a comprehensive, activity-based emissions inventory of off-road CHE, railroad locomotives, on-road HDVs, OGVs, and harbor craft associated with the Ports activities (Starcrest 2007a,b).

The Starcrest inventories address emissions that occur within the Ports boundaries from the five mobile sources categories noted above [OGVs, harbor craft (e.g., tugboats, ferries, commercial fishing vessels, etc.), CHE, railroad locomotives, and HDVs]. In addition, out-of-port Port-related truck emissions on major freeways (i.e., Interstates 110 and 710 and Highways 47 and 103) and locomotive emissions on the major rail line (i.e., the Alameda Corridor) in the vicinity of the Ports are also included in the BWHRA. For consistency with ARB (2006a), certain over-water emissions from OGVs have also been included. The Starcrest inventories do not include emissions from activities or facilities within the Ports' boundaries that are either on private land or that are unrelated to Ports operations. As noted in the Introduction, only those emission sources under Ports control are evaluated in the BWHRA.

The baseline inventory encompasses emissions from a single calendar year (2005), and relied on methodologies described in Starcrest (2007a,b). Although Starcrest developed emissions data for a number of compounds, the BWHRA will only utilize data for DPM emissions (see discussion in Introduction). Starcrest has also been tasked with developing two separate sets of activity-based emission forecasts for 2023 (Starcrest 2007c). These emission forecasts will incorporate growth projections for mobile sources at the Ports that reflect (1) adopted regulations, and (2) adopted regulations as well as implementation of the CAAP (2006). The underlying assumptions regarding activity levels and growth by emission source category are described in Starcrest (2007c).

4 Air Dispersion Modeling Methodology

Air dispersion modeling will be performed to estimate exposure concentrations from the dispersion of DPM emissions from sources at the Port of Los Angeles and the Port of Long Beach. Air dispersion modeling requires the selection of an appropriate dispersion model and input data based on regulatory guidance, previous air modeling studies, common industry standards/practice, and/or professional judgment. In general, ENVIRON will perform the air dispersion modeling consistent with ARB's Exposure Assessment study of the Ports (ARB 2006a). Air dispersion methodologies from other previous studies and/or guidance documents related to intermodal and railyard facilities prepared by ARB (2004b, 2005a, 2005b, 2006d) and SCAQMD (2003) will also be used, where appropriate.

ENVIRON will perform air dispersion modeling to estimate DPM exposure concentrations at off-site receptor points for three emissions scenarios, as described in Section 3:

- Baseline (year 2005) emissions inventory;
- Year 2023 emissions inventory including projected growth of the Ports and emissions reductions due to adopted regulations; and
- Year 2023 emissions inventory including projected growth of the Ports, emissions reductions due to adopted regulations, and implementation of the CAAP.

These scenarios, the underlying assumptions, and emissions estimation methodologies were developed by Starcrest (2007a,b,c) with the participation of staff of the Ports, the ARB, and the SCAQMD. The type of air dispersion model and modeling inputs (i.e., pollutants to be modeled with appropriate averaging times, source characterization and parameters, meteorological data, building downwash, terrain, land use, and receptor locations) that will be used in the air dispersion modeling are discussed below.

4.1 Model Selection and Options

To estimate ambient air concentrations at the receptor locations described below, ENVIRON proposes to use version 07026 of AERMOD, the USEPA-recommended air dispersion model (USEPA 2005c). The AERMOD model is also recommended by both the Technical Working Group (TWG) and the ARB (ARB 2006d) for intermodal operations, such as the operations under consideration in this HRA protocol. AERMOD was developed as a replacement for USEPA's Industrial Source Complex Short Term (ISCST3) air dispersion model to improve the accuracy of air dispersion model results for routine regulatory applications and to incorporate the progress in scientific knowledge of atmospheric turbulence and dispersion. Both models are near-field, steady-state Gaussian plume models, and use site-representative hourly surface and twice-daily upper air meteorological data to simulate the effects of dispersion of emissions from industrial-type releases (e.g., point, area, and volume) for distances of up to 50 kilometers.

For the past 20 years, refined near-field air dispersion modeling has typically been conducted using USEPA's ISCST3 model. However, on November 9, 2005, the USEPA promulgated final revisions to the federal Guideline on Air Quality Models (USEPA 2005c). These revisions recommend that AERMOD, including the plume rise model enhancement (PRIME) building downwash algorithms, be used for dispersion modeling evaluations of criteria air pollutant and toxic air pollutant emissions from typical industrial facilities. As of November 9, 2006, ISCST3 is no longer considered a USEPA-approved model for certain regulatory applications. AERMOD provides better characterization of plume dispersion than does ISCST3, according to USEPA (2003).

AERMOD is appropriate for use in estimating ground-level short-term ambient air concentrations resulting from non-reactive buoyant emissions from sources located in simple and complex terrain. This analysis will be conducted using AERMOD in the regulatory default mode, as recommended by USEPA (2005c) and ARB (2006d), with the exception of the parameters discussed in section 4.3.3. These defaults include the following modeling control options:

- adjusting stack heights for stack-tip downwash,
- using upper-bound concentration estimates for sources influenced by building downwash from super-squat buildings,
- incorporating the effects of elevated terrain,
- employing the calms processing routine, and
- employing the missing data processing routine.

4.1.1 Model Pollutants and Averaging Periods

Calculation of chemical concentrations for use in exposure analysis requires the selection of appropriate concentration averaging times. ENVIRON based the selection of an appropriate averaging time on the availability of toxicity criteria for DPM.

OEHHA developed a CSF to quantify the probability of cancer associated with exposure to DPM (OEHHA 2005). Accordingly, the annual average DPM concentration over the span of the offsite meteorological data will be calculated for use in estimating cancer risk.

4.2 Source Characterization and Parameters

Source characterization, location, and parameter information is necessary to model the dispersion of air emissions. ENVIRON will perform the air dispersion modeling analyses assuming the use of a simplified source treatment, including identification of major source categories (e.g., OGVs, harbor craft, locomotives, CHE, and on-road HDVs), approximation of locations for major source categories, and use of fleet-average source parameters, similar to ARB's Exposure Assessment study of the Ports (ARB 2006a).

ENVIRON will model emissions sources as point, volume, or area sources, similar to ARB's modeling source configuration in ARB's study (ARB 2006a). The selection of modeling source type will generally depend on the type of source (i.e., movement or stack), the sizes and configurations of the source operating area(s), and the availability of source parameter data (e.g., release temperature, velocity, and diameter). These modeling source types include:

- Point source (a source with emissions emanating from a known point, with buoyancy due to either thermal or mechanical momentum). A point source is characterized by a height, diameter, temperature, and exit velocity.
- Volume source (a source with emissions that have no buoyancy and are emanated from a diffuse area). A volume source is characterized by an initial lateral and vertical dimension (initial dispersion) and a release height.
- Area source (a source from a two-dimensional region with no buoyancy). An area source is characterized by a length and a width of the region, and a release height.
- Line source (a series of volume sources spaced at equal distances apart).

As indicated above, ENVIRON will generally model emission source activities similar to ARB's study (ARB 2006b). However, ENVIRON may use line sources (i.e., series of volume sources) to model movement emission source activities along well-defined travel paths, such as OGVs and harbor craft maneuvering inside the breakwater, locomotive on rail lines, and on-road HDVs. ENVIRON will generally use area sources to model activities or travel paths that occur over large areas or in areas where activities or travel paths are not well defined. For instance, due to the length of OGV and harbor craft travel paths outside the breakwater (up to 80 kilometers as shown in Figure 2), and to increase modeling efficiency, ENVIRON will model OGV and harbor craft sources outside the breakwater as line sources or a series of area sources. Similarly, depending upon the length of the freeways and rail lines modeled outside of the Ports, these emission sources may be modeled as either line sources or sets of area sources. ENVIRON will provide additional information (e.g., references and/or sensitivity evaluations) if ENVIRON's selection of source types deviates from the source type selection in ARB's study (ARB 2006a). ENVIRON will locate emission sources at the Ports based on the spatial allocation data provided by Starcrest (2004a,b; 2007a,b,c) and spatial information in the ARB ISCST3 air dispersion modeling input files provided by ARB (2006a). Starcrest's spatial allocation data were generated as part of the development of the emission inventories for the Port of Long Beach (Starcrest, 2004a, 2007b) and the Port of Los Angeles (Starcrest 2004b; 2007a). ARB's air dispersion modeling files were generated as part of the ARB study of the Ports (ARB 2006a). Based on discussions with Port staff, ENVIRON understands that Starcrest's spatial allocation data reflect emission source operating areas specific to individual tenants, freeways, and rail lines. ENVIRON will use maps of Port facilities, high resolution aerial photographs, and information provided by the Ports' staff and Starcrest to identify and compare the locations of all current leaseholders at the Ports with the emission source locations provided in the Starcrest spatial allocations and ARB air dispersion modeling files. If differences are noted, ENVIRON will work with Starcrest and the Ports' staff to confirm the names and boundaries of all current leaseholders at the Ports and to make refinements to the spatial allocations as needed. A similar methodology will be used to confirm the placement of emission sources on individual freeways and rail lines within and outside of the Ports.

ENVIRON will generally assume that source parameter data (e.g., release heights, roadway and rail segment widths, and exit velocities, temperatures, and diameters for ship hoteling sources) reported in ARB's study (ARB 2006a) may be used to approximate fleet-average source parameters for each source category. However, these data will be compared to source parameter data provided in Starcrest's spatial allocation data for the Port of Los Angeles and the Port of Long Beach, if available, and the most appropriate source parameter data will be selected and documented. As a quality assurance check, ENVIRON will also compare the fleet-average source parameter data in ARB's study of the Ports (ARB 2006a) and Starcrest's spatial allocation spreadsheets to fleet-average source parameter data used by ENVIRON for similar source categories (i.e., locomotives, CHE, and HDVs) in previous air dispersion modeling analyses provided to ARB (ENVIRON, 2006b,c,d,e). ENVIRON will account for temporal (i.e., hourly, daily, weekly, and/or seasonal) variations in activities and emissions from each of the major source types by using variable hourly, daily, and seasonal emission factors, where available. ENVIRON will use temporal data for the major source types from ARB's study (ARB 2006a) and modify and/or supplement these data with information provided in Starcrest's baseline emission inventory, if available.

4.3 Meteorological Data

AERMOD requires a meteorological input file to characterize the transport and dispersion of pollutants in the atmosphere. Surface and upper air meteorological data inputs, along with surface parameter data describing the land use and surface characteristics near the Ports are first processed using AERMET, the meteorological preprocessor to AERMOD. The output file generated by AERMET is the meteorological input file required by AERMOD. The focus of the air quality assessment is the determination of potential air quality impacts in areas immediately surrounding the Ports and major freeways (i.e., Interstates 110 and 710 and Highways 47 and 103) and rail line (i.e., the Alameda Corridor) extending from the Ports north to approximately Interstate 405. As such, meteorological data for air dispersion modeling should be selected based upon their spatial and temporal representativeness of conditions in the immediate vicinity of the Ports and the freeways near the Ports. Details of AERMET and AERMOD meteorological data needs are described in USEPA guidance documents (USEPA 2004a,b). USEPA (2005c) and OEHHA (2003) typically recommend using a minimum of one year of on-site meteorological data or five years of representative meteorological data from a nearby site (USEPA 2005c). Data from the most recent, readily available consecutive five-year period are preferred, but the ARB guidelines acknowledge the potential use of less then five years of data depending on data availability and the evaluation of representative criteria (ARB 2006d). On-site hourly meteorological data can be used to conduct air quality analyses for regulatory purposes, provided these data were monitored, calibrated, and audited according the requirements found in the USEPA Quality Assurance Handbook (USEPA 2000). This section describes the selection of representative surface and upper air meteorological data for the Ports and the major freeways and rail lines near the Ports. The selection methodologies were previously approved by ARB for use in the intermodal rail yard assessments, including the BNSF Watson/Wilmington Rail Yard (ENVIRON 2006a) located less than one mile from the Ports.[2]

According to the USEPA, meteorological data used for air quality modeling purposes should be at least 90 percent complete before substitution and contain no data gaps greater than two weeks (USEPA 2000). For meteorological data sets meeting these criteria, substitution of missing meteorological data to obtain a meteorological data file with 100 percent complete data will be performed using Atkinson and Lee (1992) substitution procedures.

4.3.1 Hourly Surface Meteorological Data Selection

When characterizing near-field air dispersion using models such as AERMOD, representative hourly surface meteorological data inputs are required in order to characterize the atmospheric transport and dispersion in the area to be studied. AERMET, the meteorological preprocessor to AERMOD, requires certain surface meteorological parameters in order to prepare an AERMOD meteorological data input file. The minimum surface meteorological parameters required include wind speed, wind direction, temperature, and cloud cover (USEPA 2004b). Station pressure is also recommended, but not required, for AERMET (USEPA 2004a).

ENVIRON performed an evaluation of surface meteorological stations in the vicinity of the Ports [i.e., within approximately 20 kilometers (km) of the Ports]to select meteorological data that are representative of conditions at the Ports. A detailed discussion of ENVIRON's evaluation of the availability of surface meteorological data and data selection criteria and methodologies is presented in Attachment I. As a result of this evaluation, seven meteorological stations were selected as candidates to represent meteorological conditions within or near the Ports:

- St. Peter and Paul School (SPPS)
- Liberty Hill Plaza
- Terminal Island Treatment Plant (TITP)
- Berth 47
- Gull Park
- Super Block
- Santa Monica Buoy Station (Santa Monica)

In order to determine the area(s) over which individual meteorological stations would be applicable, ENVIRON divided the Ports' operational areas into four zones:

[2] Personal communication, J. Yuan of ARB by e-mail to D. Daugherty of ENVIRON on August 3, 2006.

- Inner Harbor
- Middle Harbor
- Outer Harbor
- Beyond the Breakwater

The geographical area comprising each operational zone is shown in Figure 3 and defined in Attachment I. Based on the definitions of each zone, two meteorological stations fall within each zone, except for the Beyond the Breakwater zone, which only contains one station (i.e., Santa Monica). However, based on a comparison of windroses, the Berth 47 station also appears to be representative of meteorological conditions in this zone.

After the operational zone(s) were identified for emission source activity, a more in-depth analysis was conducted to select a specific meteorological data set, as outlined in Attachment I. This analysis generally consisted of an evaluation of data availability, the relative location of the meteorological station to the emission source operating areas, areas of water, and terrain features, and a comparison of the wind patterns for meteorological stations within a given zone. ENVIRON used this methodology to select surface meteorological data for on-port emission sources, land-side out-of-port emission sources, and ocean-side emission sources. The remainder of this section summarizes the surface meteorological selection for on-port emission sources, land-side out-of-port emissions sources, and ocean-side emission sources.

4.3.1.1 Hourly Surface Meteorological Data Selection for On-Port Emission Sources

On-port emissions (i.e., emissions within the Port's boundaries or inside the breakwater) were evaluated for OGVs, harbor craft, CHE, HDVs, and locomotives. The geographical area over which the on-port sources operate covers portions of three operational zones (i.e., the Inner Harbor, Middle Harbor, and Outer Harbor zones) as shown in Figure 3. The evaluation and selection of meteorological data for each of these zones was performed separately.

As indicated in Attachment I, the SPPS and Super Block stations are representative of meteorological conditions in the Inner Harbor zone. However, a full year of quality-checked meteorological data is not yet available for the Super Block station. Thus, a more detailed analysis, as described in Attachment I, is not necessary and ENVIRON selected surface meteorological data from the SPPS station for air dispersion modeling of on-port emissions in the Inner Harbor zone.

In the Middle Harbor zone, the Liberty Hill Plaza and TITP stations are representative of meteorological conditions. Both stations have a full year of complete (i.e., greater than 90% complete) meteorological data,[3] and the windroses for both stations indicate generally similar

[3] Due to data gaps in the meteorological data sets for both the Liberty Hill Plaza and Berth 47 stations, a common

wind patterns (noting that TITP indicates a higher frequency of winds from the south and Liberty Hill Plaza shows a higher frequency of winds from the southeast). A comparison of the relative locations of the two stations indicates that the TITP station is situated in a more central location within the Middle Harbor zone while the Liberty Hill Plaza station is located on the western edge of the zone and immediately adjacent to the Main Channel (see Figure 3). Based on this comparison, the TITP meteorological data are likely more representative of conditions over a larger portion of the Middle Harbor zone. Thus, the TITP station was selected for air dispersion modeling of on-port emissions in the Middle Harbor zone.

In the Outer Harbor zone, the Berth 47 and Gull Park stations are representative of meteorological conditions. However, a full year of quality-checked meteorological data is not yet available for the Gull Park station. Thus, a more detailed analysis, as described in Attachment I, is not necessary and ENVIRON selected surface meteorological data from the Berth 47 station for air dispersion modeling of on-port emissions in the Outer Harbor zone.

4.3.1.2 Hourly Surface Meteorological Data Selection for Land-Side Out-of-Port Emission Sources

Land-side out-of-port emissions were evaluated for HDVs on the major freeways (i.e., Interstates 110 and 710 and Highways 47 and 103) and locomotives on the major rail line (i.e., the Alameda Corridor) extending from the Ports' northern boundaries to Interstate 405. This geographical area, over which the land side out-of-port emission sources operate, corresponds to the Inner Harbor zone, as shown in Figure 3. As indicated in Attachment I, two surface meteorological stations are generally recommended for the Inner Harbor zone: SPPS and Super Block. However, as discussed in Section 4.3.1.1, a full year of quality-checked meteorological data are not yet available for the Super Block station. ENVIRON evaluated the need to identify additional meteorological stations representative of conditions in the expanded modeling domain. Based on that analysis, ENVIRON determined that surface meteorological data from the SPPS station are sufficient for air dispersion modeling of land-side out-of-port emissions in the Inner Harbor zone.

4.3.1.3 Hourly Surface Meteorological Data Selection for Ocean-Side Emission Sources

Ocean-side emissions from Port emission sources were evaluated for OGVs and harbor craft in the San Pedro Bay and Pacific Ocean outside the breakwater out to approximately 80 km. This geographical area, over which the ocean-side emission sources operate, corresponds to the Beyond the Breakwater zone, as shown in Figure 4. As indicated in Attachment I, two surface meteorological stations are generally recommended for the Beyond the Breakwater zone: Santa Monica Buoy and Berth 47 stations. A full year of meteorological data are available for

year of complete data is not yet available.

both stations. A comparison of the locations of both stations indicates that the Berth 47 station is much closer to the Ports than the Santa Monica station (see Figure 4). The windroses indicate the same general wind patterns, however, the Santa Monica Station has a higher frequency of winds that are parallel or away from the shoreline. Because the Berth 47 station is much closer to the Ports and may predict more conservative (i.e., higher) air concentrations at over-land receptors, ENVIRON selected the Berth 47 station for air dispersion modeling for ocean-side emission sources. Depending upon the magnitude of emissions from OGVs and harbor craft outside the breakwater, ENVIRON may conduct a sensitivity analysis to evaluate the impact of meteorological data selection on air dispersion modeling results in the Beyond the Breakwater zone.

4.3.1.4 Cloud Cover Data Selection

In general, most non-National Weather Service (NWS) stations do not collect cloud cover, but AERMET, the meteorological preprocessor to AERMOD, requires cloud cover data. Therefore, since cloud cover data was not available for the stations identified as the most representative for the Port area in the other required surface parameters, the nearest available cloud cover data from an NWS station was selected for use. The substitution of data from a nearby NWS station into an incomplete set of otherwise more representative data is an option in the AERMET preprocessor algorithm (USEPA 2004a). In addition, substitution of nearby cloud cover data was approved by ARB.[4] Based on ENVIRON's evaluation of nearby cloud cover data, discussed in detail in Attachment I. ENVIRON selected cloud data from the Long Beach Daugherty Field station for use with the surface meteorological data from the stations identified above.

4.3.2 Upper Air Data

When characterizing near-field air dispersion using models such as AERMOD, representative upper air meteorological data inputs are also required in order to characterize the atmospheric transport and dispersion in the area to be studied. AERMET, the meteorological preprocessor to AERMOD, requires upper air sounding data in order to prepare an AERMOD meteorological data input file (USEPA 2004a). The upper air sounding data are typically only available from National Climatic Data Center (NCDC) or NWS stations and are measurements of various meteorological parameters such as wind speed and direction, temperature, and pressure, usually taken at multiple levels in the atmosphere. AERMET checks four different between-level gradients: ambient temperature gradient, wind speed shear, wind direction shear, and dew point temperature gradient. The remainder of this section discusses the availability of such upper air sounding data, the selection process used to choose representative upper air data for the Ports, and the results of this selection methodology.

---

[4] Personal communication, J. Yuan of ARB by e-mail to D. Daugherty of ENVIRON on August 3, 2006.

4.3.2.1 Upper Air Station Availability

Sources of upper air sounding data available in the vicinity of the Ports were obtained from NCDC's Integrated Global Radiosonde Archive (IGRA) (NCDC 2006a), a comprehensive database identified by the USEPA Support Center for Regulatory Air Models (SCRAM) as a source of upper air data. Geographic information systems (ESRI ArcGIS Desktop version 9.1) software, in conjunction with location information from the IGRA station inventory, was used to identify individual stations near the Ports.

4.3.2.2 Upper Air Station Selection

Multiple potential upper air stations were identified in the vicinity of the Ports by the methodology described above. Although these stations collect data, many are not full-time stations, have incomplete data sets, or have potential data quality issues. This includes potential sources of upper air meteorological data in the immediate vicinity of the Ports such as Long Beach Daugherty Field, the Los Angeles International Airport, and Ontario Airport stations. For the reasons identified above, the Oakland International Airport and San Diego-Miramar Naval Air Station (NAS) stations are the only upper air stations in California that NCDC recommends for reliable, complete, and representative upper air stations for air dispersion modeling purposes.[5] The San Diego-Miramar NAS station is significantly closer to the Ports than the Oakland International Airport. Thus, upper air data from the San Diego Miramar NAS will be used in AERMET processing for the Ports. As the majority of emissions will be modeled as volume, area, or line sources, the use of upper air data from San Diego Miramar NAS will likely have a minimal impact on predicted receptor concentrations.

4.3.3 Surface Parameters

Prior to running AERMET, AERMOD's meteorological preprocessor, it is necessary to specify the surface characteristics for the meteorological monitoring site and/or the selected Port facilities. The surface parameters include surface roughness, Albedo, and Bowen ratio, and are used to compute fluxes and stability of the atmosphere (USEPA 2004a) and require the evaluation of nearby land use and temporal impacts on these surface parameters. The evaluation and selection of surface parameters, including the selection of surface parameter values and land use sectors, will generally follow the methodology used by ENVIRON in the intermodal rail yard assessments (ENVIRON 2006a,b,c,d,e). Land-use sectors around each surface meteorological data collection site will be determined using United States Geological Survey (USGS) land cover maps in conjunction with recent aerial photographs. Land use data in the form of the National Land Cover Data from 2001 (USGS 2001) will be analyzed to assign the surface parameter matrix that will be entered into AERMET. When a land-use sector consists of multiple land use types, an area-weighted average of each surface parameter will be calculated as recommended by USEPA (2004a). A comparison of the surface parameters will

[5] Personal communication. William Brown of NCDC by telephone to Catherine Mukai of ENVIRON. 2006.

be performed for the selected Port facilities and surface meteorological data collection sites to determine if surface parameters measured at the meteorological site are appropriate for use at the selected Port facilities.

ENVIRON notes that the analysis of surface parameters for AERMET preprocessing is an area with relatively undeveloped guidance in which the application of professional judgment is required. Where available and appropriate, USEPA guidance (USEPA 2004a) will be followed. However, USEPA guidance was developed based on nation wide averages and there are instances in which known local characteristics differ from national norms and would impact the methods used to evaluate the surface parameters. In addition, large transitions in surface parameters (such as surface roughness) perpendicular to the wind flow can result in significant inaccuracies in predicted airborne concentrations if not addressed during the development of the AERMET surface parameters. The methods described below were used in previous ENVIRON intermodal rail yard air dispersion assessments and were reviewed and approved previously by ARB.[6] Table 1 shows the mapping between the two sets of land use classifications that will be used in the air dispersion analysis of the Project area.

Table 1: Mapping of Land Use Classification Categories around Meteorological Station

US EPA Code	US EPA Type	2001 Land Use Code	2001 Description
9	Water	11	Open Water
8	Urban	21	Developed, Open Space
		22	Developed, Low Intensity
		23	Developed, Medium Intensity
		24	Developed, High Intensity
4	Desert Shrubland	31	Barren Land (Rock/Sand/Clay)
		52	Shrub/Scrub
5	Grassland	71	Grassland/Herbaceous
7	Swamp	90	Woody Wetlands

[6] Personal communication, J. Yuan of ARB by e-mail to D. Daugherty of ENVIRON on August 3, 2006.

4.3.3.1 Surface Parameter Values

There are several issues in the determination of the specific values to use for the surface parameters for which available guidance is not specific and professional judgment must be used. First, USEPA guidance provides several tables of surface parameter values which contain eight land use categories (USEPA 2004a). The National Land Cover Dataset (NLCD) in contrast, includes twenty-one categories with an additional eight coastal wetlands subcategories (USGS 2001). The NLCD categories were mapped to the USEPA categories based on descriptions available from the USGS and professional judgment.

Second, AERMET accepts surface parameters for annual, seasonal, or monthly temporal periods (USEPA 2004a). The AERMET User's Manual contains tables of values for the surface parameters based on four seasonal vegetative cycles. However, the determination of the appropriate seasonal value for a given period, in additional to the choice of monthly, seasonal, or annual temporal divisions, is left to the user. This is particularly crucial in California, which has seasonal weather that is atypical from the rest of the county. The AERMET User's Manual defines the seasons as follows: "Spring" refers to the period when vegetation is emerging and partially green and applies to the 1-2 months after the last killing frost, "Summer" applies to the period when vegetation is lush, and "Autumn" refers to the period of the year when freezing conditions are common, deciduous trees are leafless, soils are bare after harvest, grasses are brown, and no snow is present. "Winter" conditions apply to snow covered surfaces and subfreezing temperatures. The AERMET User's Manual also cautions that the seasons do not correspond to a particular group of months, but more on latitude and the annual vegetative growth cycles (USEPA 2004a).

California's climate is very different from national norms and the months of the year do not always correspond to the default seasons provided in the AERMET user's guide. Therefore, ENVIRON has developed guidelines for determining which months belong in each season for the Port area, based on local temperature and precipitation patterns and the growth cycle definitions above (ENVIRON 2006a). For example, "Winter" values were not considered for these sites because snow cover is rare in Southern California. Furthermore, ENVIRON proposes that a season between summer and autumn (summer/autumn) would be more representative of conditions for some months of California's dry season due to the prolonged dry period after the growth of summer vegetation and the browning of grasses. The months proposed for each season are presented in Table 2. In addition to defining the months of the seasons at the Port area, ENVIRON has also evaluated precipitation data in order to select a condition (wet, dry, average) for the Bowen ratio. As suggested by the AERMET user's guide, those precipitation totals were compared to historical precipitation averages (USEPA 2004a). The analysis of local conditions for surface parameter selection described above has previously been approved by ARB for use in intermodal rail yard assessments.[7]

[7] Personal communication, J. Yuan of ARB by e-mail to D. Daugherty of ENVIRON on August 3, 2006.

Table 2: Seasons for AERMET Surface Parameter Analysis	
Spring	February
	March
Summer	April
	May
	June
Summer/Autumn	July
	August
	September
	October
Autumn	November
	December
	January

4.3.3.2 Analysis Area Determination

Land cover information from a specific defined area surrounding the selected meteorological station will be used to calculate the area weighted average surface parameter values for each sector. AERMET guidance recommends the use of an upwind fetch distance of three km for estimation of the surface parameters, corresponding to a circle with a radius of three km surrounding the facility. The recommendation is based on the estimated distance required to obtain a new turbulent boundary layer height after a roughness transition (USEPA 2004a). According to USEPA guidance, shorter fetch distances can be considered in cases of urban areas or areas with large roughness length. A three-kilometer (km) circle from the geographic center of each the meteorological stations will be used to calculate the surface parameters.

4.3.3.3 Sector Selection and Analysis

AERMET accepts as input a table of surface parameters defined according to radial sectors covering segments of wind direction. A maximum of twelve sectors of at least 30 degrees can be chosen based on patterns in the local land use. The number of sectors and the directions included in each are left to the determination of the user. ENVIRON will define the sectors to be used in the modeling to include homogenous areas within each sector and minimize significant transitions within sectors.

Due to the large difference in surface parameters between water and land, the use of meteorological data from stations located near the shoreline may require a more detailed land use analysis than for a station in a more homogenous area. The division of the surface parameter analysis area into radial sectors does not account for transitions in surface parameters that occur normal to the sector boundaries. Specifically, analyses of the effect of cross-wind transitions in surface roughness (the surface parameter that can influence AERMOD predicted airborne concentrations most significantly (ENVIRON 2005; Long 2004), indicate that changes more than two orders of magnitude can result in significant over estimates or under estimates of concentrations (Hanna and Britter 2002). In such cases, applying a distance weighted average based on zones defined in the radial direction from the meteorological station can result in surface roughness estimates which, when used for dispersion modeling applications, produce more representative results. In practice, changes of several orders of magnitude in surface roughness most frequently occur in transitions between water and land. Berth 47 includes large areas of open water within the surrounding analysis area (3 km fetch distance) with water and land on generally opposing sides of a land/water interface. The methodology described in Hanna and Britter (2002) for calculating representative surface roughness when there is a transition perpendicular to the wind direction will be used for the Berth 47 surface parameter analysis, as described in Attachment II. Distance-weighting is not required for sectors that are relatively homogeneous or do not have surface roughness varying by a few orders of magnitude. The TITP station includes areas of open water within the surrounding analysis area (i.e., within the three km fetch distance), however, these areas of water represent discrete, relatively narrow channel areas that are intermixed with urbanized land-uses. In this case, the transition distance is not sufficient such that the Hanna and Britter method would be applicable to the surface parameter analysis. The SPPS meteorological station is located more than three km from any significant regions of open water, and consequently the surface parameters in its vicinity will not require this more complicated analysis.

In the AERMOD model, land-use analysis is performed such that concentrations estimated in a sector downwind of a source are based on surface characteristics upwind from the source. However, for shoreline sources, the assignment of surface parameters to such a mixed-use sector containing significant amounts of both land and water based on upwind surface characteristics can significantly over or under predict concentrations depending on the configuration of the land-use, sources, and receptors. The approach adopted in Hanna and Britter (2002) only includes the effects of roughness downwind of the source, because the distance to achieve a new equilibrium boundary layer is typically much less than distances of interest. Thus, for the Berth 47 meteorological station ENVIRON will also perform an evaluation of the assignment of upwind or downwind land-use patterns for each sector as recommended by Hanna and Britter (2002), as described in more detail in Attachment II.

4.4 AERMET Mixing Height

For each year, surface and upper air data files will be combined using version 04300 of AERMET to develop the required model-ready meteorological data files. AERMET processes the data in three stages. The first stage extracts meteorological data from archive data files and processes the data through various quality assessment checks. The second stage merges all data available for 24-hour periods and stores these data together in a single file. The third stage reads the merged meteorological data and estimates the necessary boundary layer parameters for use by AERMOD. Following USEPA's guidance (USEPA 2004a), the upper air data will be subject to preliminary quality control by employing the MODIFY keyword, which makes three adjustments to the sounding data: first, it deletes mandatory levels from the sounding; second, it sets non-zero wind directions to zero if the wind speed is zero; third, it replaces missing ambient and dew point temperatures with interpolated values. Aside from employing the 'modify' keyword, missing periods of meteorological data will be left unaltered. For each year, AERMET generates two files for AERMOD: a file of hourly boundary layer parameter estimates and a file of multiple-level observations of wind speed and direction, temperature, and the standard deviation of the fluctuating components of wind.

4.5 Land Use

AERMOD can evaluate heat island effects from urban areas to atmospheric transport and dispersion using an urban boundary layer option. Due to the industrial, commercial, and compact residential land use at the impacted receptors, and consistent with ARB's Ports study (ARB 2006a) and SCAQMD's past practices, the area in the vicinity of the Ports will be considered urban, and ENVIRON will select the urban boundary layer option. Selection of the urban boundary layer option in AERMOD also requires an estimate of the population of the urban area in order to make adjustments to the urban boundary layer. ENVIRON will use published census data corresponding to the Metropolitan Statistical Area (MSA) for the metropolitan Los Angeles area, as recommended by USEPA (2005b).

4.6 Terrain

Another important consideration in an air dispersion modeling analysis is whether the terrain in the modeling area is simple or complex (i.e., terrain above the effective height of the emission point). Although the emission source operating areas at the Ports are located on flat terrain, significant terrain features (i.e., the Palos Verdes Hills) are located immediately to the west of the Ports. Thus, ENVIRON will include USGS 7.5 minute digital elevation maps (DEMs) for the entire modeling domain, similar to ARB's Ports study (ARB 2006a). Terrain elevation data will be incorporated into the AERMOD model using version 06341 of AERMAP, AERMOD's terrain preprocessor.

4.7 Building Downwash

Building downwash is the effect of buildings and structures on the dispersion of emissions from nearby point (stack) sources due to, for example, aerodynamic wakes and eddies. Building-induced aerodynamic downwash effects are calculated in the AERMOD model by specifying building and structure dimensions (i.e., location of building and structure corners and heights of buildings and structures) in the vicinity of all stack sources. The AERMOD model does not account for building downwash effects for volume and area sources. Consistent with ARB's modeling methodology in ARB's Ports study (ARB 2006a), ENVIRON's air dispersion modeling analysis will not account for building-induced aerodynamic downwash effects. As most emission sources at the Port of Los Angeles and the Port of Long Beach are mobile sources that will be modeled as volume or area sources, the exclusion of building downwash effects is not likely to significantly impact air dispersion modeling results. ENVIRON will conduct a sensitivity analysis to evaluate the impact of building downwash of ships at ship hoteling locations.

4.8 Receptor Locations

Two Cartesian grids representing off-site receptors points around the Ports will be included in the dispersion modeling. The spacing and extent of the two receptor grids were selected based on the focus of the BWHRA (i.e., regional DPM impacts) and to maintain modeling efficiency and consistency with ARB's Ports study (ARB 2006a). ENVIRON will use a receptor grid with 200-meter spacing, similar to ARB's Ports study (ARB 2006a), out to a distance of two km from the Ports' boundaries. A second Cartesian receptor grid with 500-meter spacing covering a total area of approximately 20 miles by 20 miles will also be included. The extent of this grid will be similar to the Cartesian receptor grid in ARB's Ports study (ARB 2006a) and extend south of the Ports over the San Pedro Bay, north to approximately Lynwood, west to approximately Torrance, and east to approximately Buena Park. Similar to ARB's study (ARB 2006a), and consistent with the focus of the BWHRA on regional impacts of DPM, ENVIRON will not include on-site receptors (i.e., receptors located within the boundaries of the Port of Los Angeles and the Port of Long Beach) or individual receptor points at off-site locations corresponding to sensitive receptors (e.g., schools, hospitals, and daycare centers).

4.9 Estimation of Exposure Concentrations

ENVIRON will perform air dispersion modeling using unit emissions rates (e.g., one gram per second) for each emissions source to estimate annual-average dispersion factors for each emissions source at each receptor. The source-specific dispersion factors will be combined with the actual DPM emission rate for each source provided by Starcrest and the resulting concentrations summed over all sources to estimate the total DPM exposure concentration at each receptor for each of three emissions scenarios identified above. ENVIRON assumes that the spatial configuration and temporal profiles for DPM emissions sources at the Ports will not change for the three emissions scenarios described above. Thus, ENVIRON will generate a single set of annual-average dispersion factors for use in estimating DPM exposure concentrations for each of the three emissions inventory scenarios.

5 Health Risk Assessment Methodology

This section describes the approach and methodology to be used in evaluating health effects that may result from human exposure to DPM emitted during operations of the Ports. As defined by the NRC (1983), risk assessment is "….the use of a factual base to define the health effects of exposure of individuals and populations to hazardous materials and situations". Quantification of potential health effects from DPM exposure includes four elements of risk assessment (NRC 1983): (1) hazard identification (including identification of chemicals of potential concern); (2) exposure assessment; (3) dose-response assessment; and (4) risk characterization. Each of these components is addressed in the following sections.

The risk assessment regulations and guidance documents that were considered in developing this HRA protocol are:

- Air Toxics Hot Spots Program Risk Assessment Guidelines (OEHHA 2003),
- Air Resources Board Recommended Interim Risk Management Policy for Inhalation-Based Residential Cancer Risk (ARB 2003b)
- Air Resources Board Health Risk Assessment Guidance for Rail Yard and Intermodal Facilities (ARB 2006d).
- South Coast Air Quality Management District Air Toxics Control Plan for the Next Ten Years (SCAQMD 2000)
- South Coast Air Quality Management District Health Risk Assessment Guidance for Analyzing Cancer Risks from Mobile Source Diesel Idling Emissions for CEQA Air Quality Analysis (SCAQMD 2003)
- South Coast Air Quality Management District. Addendum to the Air Toxics Control Plan March 2000 (SCAQMD 2004).
- South Coast Air Quality Management District Rule 3503. Emission Inventory and Health Risk Assessment for Railyards (SCAQMD 2005).
- United States Environmental Protection Agency. Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities. (USEPA 2005a).

The primary analyses of the BWHRA will utilize Tier 1 assumptions and parameters in accordance with the guidance cited above. The focus of the BWHRA on regional effects distinguishes it from project-specific CEQA or NEPA evaluations at the Ports, which are designed to address questions of local and cumulative impacts and health effects associated with a project or facility. Using air dispersion modeling of contaminants to near-source receptors, project-specific analyses examine impacts to sensitive receptors and other receptor populations that are not consistent with the source characterization methods and regional air dispersion modeling of the BWHRA. In contrast, the BWHRA will be used to estimate the overall regional risks attributable to DPM emissions from the Ports. That knowledge will inform emission reduction strategies in general, but will not be used to evaluate the acceptability of an individual project or facility.

5.1 Hazard Identification (Identification of Chemicals of Potential Concern)

Hazard identification is defined by the NRC (1983) as the determination of whether a particular chemical is or is not causally linked to particular health effects. Chemicals deemed to be potentially linked to adverse health effects are carried through the risk assessment as chemicals of potential concern (COPC). In practice, the identification of COPCs is also included in the process of hazard identification.

Diesel exhaust is a complex mixture of hydrocarbons, particulates, gases, water, and other compounds. The precise composition of the mixture depends on several factors including the fuel source, engine type, engine age, and operating condition. Diesel exhaust is classified by OEHHA and the USEPA as a carcinogen, and both agencies also recognize that diesel exhaust causes non-cancer effects as well (OEHHA 1998, 2007; USEPA 2007). Under California regulatory guidelines (OEHHA 1998, 2007), DPM is used as a surrogate measure of exposure to the chemical mixture that is diesel exhaust, and the CSF reflects that approach. Recent scientific data have also linked prolonged exposure to PM to premature mortality, respiratory effects, and cardiovascular disease (see discussion in Section 1).

5.2 Exposure Assessment

This component of a human HRA is used to determine the extent of human exposure before or after application of regulatory controls (NRC 1983). As implemented in the BWHRA, the exposure assessment will identify the scenarios and relevant receptor populations, and select exposure pathways and exposure parameters appropriate to quantification of intake and potential cancer health effects associated with DPM emissions from the Ports. Theoretical chemical intakes for each potentially exposed human population and exposure pathway will be estimated using equations consistent with or recommended by OEHHA (2003) and ARB (2003b).

5.3 Potentially Exposed Populations

The BWHRA will quantify health effects to two receptor populations: residential and off-site workers. In accordance with the regional focus of the BWHRA, impacts on sensitive receptors are not addressed in this protocol. Those receptor populations are considered in project HRAs that address local impacts.

The BWHRA will evaluate the two receptor populations as follows:

- Residential receptors occur within all residential areas, including areas zoned for residential use but not currently used for this purpose, in proximity to the Ports.

- Off-site worker receptors occur outside of the Ports boundaries, excluding over water areas.

5.4 Exposure Pathways

DPM will be released to ambient air as exhaust from internal combustion engines. Because air is the principal environmental medium affected by DPM emissions, inhalation will be the dominant route of exposure. In recognition of this fact, OEHHA has opted to only develop inhalation toxicity values for DPM. Consistent with this fact, and with OEHHA (2003) and ARB (2003b, 2006a), this HRA will only evaluate exposures incurred by inhalation.

5.5 Exposure Assumptions

The parameters used to calculate exposure are based on a series of reported and assumed factors regarding human activity and land use patterns in the vicinity of the Ports e.g., exposure time, exposure frequency, and exposure duration. Separate exposure parameters also account for physiological factors such as breathing rate and body weight.

5.5.1 Exposure Parameters

The exposure parameters listed below for residential and off-site worker populations are consistent with a screening level, Tier 1 risk assessment when applied pursuant to OEHHA guidelines (OEHHA 2003). Tier 2, 3, or 4 assessments that utilize either different discrete site-specific values or distributions of values, may also be presented in the BWHRA (OEHHA 2003).

Residential Receptors. Exposure estimates for residential receptors will be based on the assumption that exposure to DPM occurs outdoors 24 hours per day, 350 days per year for 70 years [i.e., that residents are present in their home seven days a week for 50 weeks a year (or about 96 percent of the time) with approximately two weeks (15 days) spent away from home] (OEHHA 2003). Inhalation will be calculated using the 80th percentile breathing rate of 302 liters per kilogram of body weight per day (L/kg BW-day) (ARB 2003). This estimate will be bounded by additional calculations that utilize the 65th percentile (“average”) breathing rate of 271 L/kg BW-day 95th percentile (“high end”) breathing rate of 393 L/kg BW-day (ARB 2003b). A default value for averaging time (70 years, which is equal to 25550 days) will be used.

Off-Site Worker Receptors. Exposure calculations for off-site worker populations will utilize exposure assumptions of 8 hours per day, 245 days per year for 40 years for exposure frequency and duration, respectively (OEHHA 2003). Further, OEHHA (2003) recommends using the default occupational breathing rate established by the USEPA (1997) of 447 L/kg BW-day. This value is equal to 149 L/kg BW-day over an 8-hour work day (OEHHA 2003). The default value for averaging time will be also used for off-site workers.

For each receptor group exposed to a given, modeled concentration of DPM, exposure is calculated by the following equation:

$$Exposure = \frac{Ca \times BR \times EF \times ED}{BW \times AT} \qquad \text{(Eq.5-1)}$$

C_a = Concentration of DPM in Air
BR = Breathing Rate
EF = Exposure Frequency
ED = Exposure Duration
BW = Body Weight
AT = Averaging Time

5.6 Dose-Response Assessment

The dose-response assessment quantifies the relation between the magnitude of exposure and the probability of occurrence of the health effect (NRC 1983). Toxicity values used to estimate the likelihood of adverse effects are identified as part of the dose-response assessment process. The CSF is the toxicity value used to estimate cancer risk, and is defined by OEHHA (2003) as "the theoretical upper bound probability of extra cancer cases occurring in an exposed population assuming a lifetime exposure to the chemical when the chemical dose is expressed in exposure units of milligrams/kilogram-day (mg/kg-d)." The dose-response relationship between exposure to a carcinogen and the risk of cancer can also be expressed as a Unit Risk Factor, defined by OEHHA as "the theoretical upper bound probability of extra cancer cases occurring in the exposed population assuming a lifetime exposure to the chemical when the air concentration is expressed in exposure units of per microgram/cubic meter ($\mu g/m^3$)."

5.6.1 Toxicity Values

Cal/EPA's OEHHA developed a toxicity value to assess the cancer risk associated with inhalation of DPM. The CSF for DPM of 1.1 $(mg/kg\text{-}d)^{-1}$ was selected by OEHHA from a range of values calculated from human epidemiological data as the best estimate of cancer potency (OEHHA 1998). The methodology and assumptions used to derive the DPM CSF will be discussed in this section.

5.7 Risk Characterization

Risk characterization involves the description of the nature and magnitude of human risk, including the attendant uncertainty (NRC 1983). The initial component of the risk characterization process involves combining and analyzing the results of the emissions estimation, air dispersion modeling, exposure assessment, and toxicity assessment in order to quantify the carcinogenic risks associated with exposure. The BWHRA will also include a qualitative discussion of non-cancer health effects such as asthma and premature mortality recently linked to exposure to DPM and other PM. The second step of the risk characterization process identifies the critical uncertainties in the estimated risks; these are discussed below in Section 5.8.

5.7.1 Estimated Cancer Risks Attributable to DPM

Carcinogenic risks are estimated by calculating the upper-bound incremental probability that an individual will develop cancer over a lifetime as a direct result of exposure to a potential carcinogen such as DPM. The equation used to calculate potential excess cancer risk is:

$$Risk = Exposure\ (dose) \times CSF \qquad \text{(Eq. 5-2)}$$

5.7.2 Risk Characterization Discussion

The risk characterization results will be used to put estimated risks and other potential health impacts in perspective with respect to background levels, regulatory criteria, and recently completed assessments of DPM (ARB 2004b; 2006a; 2007 a,b). The results for this HRA will include estimates of risks for residents and off-site workers based on modeled annual average concentrations of DPM. Cancer risk for the residential and off-site worker receptor populations will be depicted in isopleths overlain on aerial photographs. These figures will identify total baseline risks based on 2005 emissions inventory data. Analogous figures will depict risk for each of the 2023 emissions forecast scenarios identified in Sections 1 and 3 of this Protocol. A discussion of the association between PM and DPM and the variety of health effects discussed in the toxicity assessment section will also be included as part of the risk characterization section of the report.

5.8 Uncertainties Associated with the Health Risk Analysis

A number of uncertainties are inherent in the estimates of potential carcinogenic risk presented in a risk assessment. These uncertainties are generally associated with the assumptions, models, and extrapolations that comprise the risk assessment process. The potential effect of these uncertainties on estimates of risk (overestimation or underestimation) varies from readily predicted to difficult to assess. Possible uncertainties will be described in the context of each of the four elements of the risk assessment process. A significant component of this section will focus on a qualitative characterization of uncertainty associated with the DPM CSF. Consistent with OEHHA risk assessment guidelines (2000b, 2003), additional analyses that correspond to a Tier 2 assessment will address the uncertainties inherent in single-point estimates of exposure. The BWHRA may also incorporate the results of residential receptor exposure assessments that use either exposure factor distributions developed by OEHHA (i.e., a Tier 3 assessment), or site-specific exposure factor distributions (Tier 4 assessment) if data are available (OEHHA 2000b, 2003).

5.9 BWHRA Report

To facilitate the timely development of the Bay-Wide Health Risk Standard, the results of the BWHRA will initially be presented to the Ports in summary form. Subsequently, a comprehensive draft report will be provided that describes the technical approach, assumptions and methods of the BWHRA. The draft report will contain supporting tables, figures, and references. A final report will be prepared that incorporates comments on the draft by Ports staff as well as members of the Technical Working Group.

6 References

AERMOD; Version 07026 ed.; American Meteorological Society/ Environmental Protection Agency, version 07026.

Air Resources Board (ARB). 2000. Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles, Staff Report. October, 2000. http://www.arb.ca.gov/diesel/documents/rrpFinal.pdf.

ARB. 2003a. Community Air Quality Monitoring: Special Studies: Wilmington

ARB. 2003b. Recommended Interim Risk Management Policy for Inhalation-Based Residential Cancer Risk. October 9.

ARB. 2004a. Epidemiologic Investigations to Identify Chronic Effects of Ambient Air Pollutants in Southern California (Children's Health Study). http://www.arb.ca.govG4

ARB. 2004b. Roseville Rail Yard Study. October 2004.

ARB. 2005a. ARB Comments on the Health Risk Assessment Protocol for Port of Los Angeles Terminal Improvement Projects. May 23, 2005

ARB. 2005b. ARB/Railroad Statewide Agreement, Particulate Emissions Reduction Program at California Rail Yards. June.

ARB. 2006a. Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach. April.

ARB. 2006b. Emission Reduction Plan for Ports and Goods Movement in California. April 20, 2006.

ARB. 2006c. Quality Assurance Air Monitoring Site Information http://www.arb.ca.gov/qaweb/siteinfo.php

ARB. 2006d. Health Risk Assessment Guidance for Rail Yard and Intermodal Facilities (Preliminary Draft). July.

ARB. 2007a. Draft Health Risk Assessment for the Four Commerce Railyards. Stationary Source Division. Release Date: May 23, 2007

ARB. 2007b. Draft Health Risk Assessment for the BNSF Railway Hobart Railyard. Stationary Source Division. Release Date: May 23, 2007

Atkinson, D. and Lee, R. 1992. Procedures for Substituting Values for Missing NWS Meteorological Data for Use in Regulatory Air Quality Models. Research Triangle Park, NC. U.S. Environmental Protection Agency.

Clean Air Action Plan (CAAP). 2006. San Pedro Bay Ports Clean Air Action Plan. Port of Los Angeles, Port of Long Beach, US EPA, California Air Resources Board, and South Coast Air Quality Management District. San Pedro Bay Ports Clean Air Action Plan. Final.

ENVIRON International Corporation (ENVIRON). 2005. Developing State-Wide Guidance for the Use of AERMOD – A Workgroup's Experience. Air and Waste Management Association Annual Fall Conference, Baton Rouge, LA.

ENVIRON. 2006a. Meteorological Data Selection and Processing Methodology for 2006 BNSF Designated Rail Yards. Prepared for BNSF Railyards and submitted to the California ARB.

ENVIRON. 2006b. Air Dispersion Modeling Assessment of Air Toxic Emissions from BNSF Commerce/Mechanical Rail Yard. November 2.

ENVIRON. 2006c. Air Dispersion Modeling Assessment of Air Toxic Emissions from BNSF Commerce/Eastern Rail Yard. November 13.

ENVIRON. 2006d. Air Dispersion Modeling Assessment of Air Toxic Emissions from BNSF Wilmington Rail Yard. December 1.

ENVIRON. 2006e. Air Dispersion Modeling Assessment of Air Toxic Emissions from BNSF Hobart Rail Yard. December 14.

ESRI ArcGIS Desktop; Environmental Systems Research Institute, version 9.2.

Gauderman, W., Vora, H., McConnell, R., Berhane, K., Gilliand, F., Thomas, D., Lurmann, F., Avol, E., Kunzli, N., Jerrett, M., and Peters, J. 2007. Effect of exposure to traffic on lung development from 10 to 18 years of age: a cohort study. Lancet 369: 571-577.

Hanna, S.R., and Britter, R.E. 2002. Wind Flow and Vapor Cloud Dispersion at Industrial and Urban Sites; American Institute of Chemical Engineers: New York, New York.

Long, G.E.; Cordova, J.F., Tanrikulu, S. 2004. An Analysis of AERMOD Sensitivity to Input Parameters in the San Francisco Bay Area. 13th Conference on the Applications of Air Pollution Meteorology with the Air and Waste Management Association. Vancouver, B.C. Canada.

MATES-II. 2000. Multiple Air Toxics Exposure Study (MATES-II). Final Report. March 2000. South Coast Air Quality Management District.

National Climatic Data Center (NCDC). 2006a. Integrated Global Radiosonde Archive - Station Inventory http://www.ncdc.noaa.gov/oa/cab/igra/index.php

NCDC. 2006b. NCDC Weather Observation Station Locator http://www.ncdc.noaa.gov/oa/climate/stationlocator.html Tuesday, 28-Mar-2006 07:52:21 ncdc.webcliserv@noaa.gov

NCDC. 2006c. Surface Inventories/ Station Lists http://www.ncdc.noaa.gov/oa/climate/surfaceinventories.html Monday, 20-Mar-2006 09:40:58 EST Mark.Lackey@noaa.gov

National Research Council (NRC). 1983. Risk Assessment in the Federal Government: Managing the Process. Committee on the Institutional Means for Assessment of Risks to Public Health. Commission on Life Sciences. National Research Council. National Academy Press, Washington D.C.

NRC. 1994. Science and Judgment in Risk Assessment. Committee on Risk Assessment of Hazardous Air Pollutants. Board on Environmental Studies and Toxicology. Commission on Life Sciences. National Research Council. National Academy Press, Washington D.C.

Office of Environmental Health Hazard Assessment (OEHHA). 1998. Findings of the Scientific Review Panel on The Report on Diesel Exhaust, as adopted at the Panel's April 22, 1998, meeting. Available electronically at http://www.arb.a.gov

OEHHA. 2000a. Technical Support Document for the Determination of Noncancer Chronic Reference Exposure Levels. Air Toxics Hots Spots Risk Assessment Guidelines Part III.

OEHHA. 2000b. Air Toxics Hot Spots Program Risk Assessment Guidelines: Part IV Technical Support Document for Exposure Assessment and Stochastic Analysis. California Environmental Protection Agency (Cal/EPA). September.

OEHHA. 2003. The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments.

OEHHA. 2005. California Environmental Protection Agency (Cal/EPA). All Chronic Reference Exposure Levels Adopted by Office of Environmental Health Hazard Assessment. California Environmental Protection Agency (Cal/EPA).January.

OEHHA. 2007. Air Toxics Hot Spots Program Risk Assessment Guidelines: Part II Technical Support Document for Describing Available Cancer Potency Factors. California Environmental Protection Agency (Cal/EPA). December.

South Coast Air Quality Management District (SCAQMD). 2000. Air Toxics Control Plan for the Next Ten Years. Final Draft. March 2000.

SCAQMD. 2003. Health Risk Assessment Guidance for Analyzing Cancer Risks from Mobile Source Diesel Idling Emissions for CEQA Air Quality Analysis. August 2003.

SCAQMD. 2004. Addendum to the Air Toxics Control Plan March 2000.

SCAQMD. 2005. Rule 3503. Emission Inventory and Health Risk Assessment for Railyards. October 2005.

Starcrest Consulting Group, LLC (Starcrest). 2004a. 2002 Baseline Emissions Inventory, Prepared for the Port of Long Beach. March.

Starcrest. 2004b. 2002 Port-Wide Baseline Emissions Inventory, Prepared for the Port of Los Angeles, Final Draft. June.

Starcrest. 2007a. 2005 Emission Inventory for the Port of Los Angeles.

Starcrest. 2007b. 2005 Emission Inventory for the Port of Long Beach.

Starcrest. 2007c. San Pedro Bay Ports Emissions Forecasting.

United States Environmental Protection Agency (USEPA). 1997a. Exposure Factors Handbook. Office of Research and Development. Washington, D.C. August 1997

USEPA. 2000. Meteorological Monitoring Guidance for Regulatory Modeling Applications. Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina. EPA-454/R-99-005. 6-32. February 2000.

USEPA. 2002. Revised Draft User's Guide for the AMS/EPA Regulatory Model – AERMOD. August 10 2002.

USEPA. 2003. Comparison of Regulatory Design Concentrations; AERMOD vs ISCST3, CTDMPLUS, ISC-PRIME. Office of Air Quality Planning and Standards. Emissions Monitoring and Analysis Division. Research Triangle Park, North Carolina. EPA-454/R-03-002. June

USEPA. 2004a. User's Guide for the AERMOD Meteorological Preprocessor (AERMET). Office of Air Quality Planning and Standards. Emissions Monitoring and Analysis Division. Research Triangle Park, North Carolina. EPA-454/B-03-002. 5-9, 4-49. November

USEPA. 2004b. User's Guide for the AMS/EPA Regulatory Model - AERMOD. Office of Air Quality Planning and Standards. Emissions Monitoring and Analysis Division. Research Triangle Park, North Carolina. EPA-454/B-03-001. September

USEPA. 2005a. Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities. EPA530-R-05-006. September 2005

USEPA. 2005b. AERMOD Implementation Guide. Research Triangle Park, North Carolina. September 27

USEPA. 2005c. Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions; Final Rule. 40 CFR Part 51, Appendix W (Federal Register) 70216

USEPA. 2007 Integrated Risk Information System (IRIS). United States Environmental Protection Agency. http://www.epa.gov/iris/

United States Geological Survey (USGS). 2006. Multi-Resolution Land Characteristics Program. National Land Cover Dataset 2001 (NLCD 2001) http://www.mrlc.gov/mrlc2k_nlcd.asp. 2006.