CHAPTER I

PUBLIC HEALTH IMPACTS

Air pollution from international trade and goods movement is a major public health concern at the statewide, regional and community level. Adverse health impacts from the pollutants associated with goods movement include but are not limited to premature death, cancer risk, respiratory illnesses, and increased risk of heart disease. This plan attempts to quantify the aggregate health effects of goods movement related pollutants where such data are available. Where health studies suggest a link between air pollution and certain effects but data is limited, we discuss those effects qualitatively. This preliminary health assessment (see Appendix A) will undergo scientific peer review concurrent with the public review process.

The emissions inventory in this plan illustrates that goods movement activities occur throughout California. The emissions and associated health impacts are greatest in regions with major ports. However, there are goods movement-related truck emissions throughout the State and comparable locomotive emissions in several regions as well.

Health risk at the community level is of special concern because exposure is highest near ports, rail yards, and along high volume truck traffic. ARB staff recently did health risk assessments for the Ports of Los Angeles and Long Beach, and for the Roseville Rail Yard, which characterize the elevated health risks near these facilities. Additional facility-specific risk assessments are pending for the Port of Oakland and for 16 major rail yards in the State. The strategies in this plan are essential to reducing localized health risks and to meet the goal of an 85 percent reduction in health risk from diesel particulate matter by 2020.

A. <u>PARTICULATE MATTER AND OZONE</u>

The health assessment quantifies the following health effects on a statewide basis: premature death, hospital admissions (respiratory causes), asthma attacks, work loss days, minor restricted activity days, and school absence days. With one exception, these effects were calculated with the scientific methodology and peer-reviewed epidemiological studies used in ARB's recent reviews of state ambient air standards. However, for particulate matter, the most recent research on mortality effects (Pope, et al, 2002) was used to determine premature deaths. See Appendix A for further details.

The health outcomes shown in Table I-1 take into account a number of factors including the relationship between air pollutant concentrations and the effect found in health studies, the relative contribution of emission sources to monitored pollutants in a region, and the population in a region. The regional impacts (by air basin) were added to provide a statewide total. There is a range of values shown for each health effects reflecting the potential uncertainty in the assessment. The range is derived using a commonly accepted statistical method (i.e., the 95 percent confidence interval).

Table I-1
Annual 2005 Statewide PM and Ozone Health Effects Associated with Ports and International Goods Movement[1]

Health Outcome	Cases per Year	Uncertainty Range[2]	Valuation (in millions)	Uncertainty Range[3]
Premature Death	750	260 to 1,300	$6,200	$2,100 to 12,000
Hospital Admissions (Respiratory Causes)	290	170 to 410	$10	$6 to 14
Asthma Attacks	15,000	3,600 to 26,000	$1	$0 to 2
Work Loss Days	130,000	110,000 to 150,000	$23	$19 to 26
Minor Restricted Activity Days	880,000	630,000 to 1,100,000	$53	$25 to 110
School Absence Days	330,000	85,000 to 610,000	$28	$7 to 53
TOTAL VALUATION	N/A	N/A	$6,300	$2,200 to 12,000

[1]Does not include the contributions from particle sulfate formed from SO_X emissions, which is being addressed with several ongoing emissions, measurement, and modeling studies.
[2]Range reflects uncertainty in concentration-response functions, but not in emissions or exposure estimates.
[3]Range reflects statistically combined uncertainty in concentration-response functions and economic values, but not in emissions or exposure estimates.

To put these estimates in context, the total statewide premature deaths from levels of ozone and particulate pollution above the State standards is about 9,000 annually. With the estimate of premature deaths from ports and international goods movement emissions at 750 for the current year, the health effects attributed to this emissions sector are about 8 percent of the statewide total.

The newly revised quantification method for premature death from particulate matter is based on a peer reviewed, published paper that expanded the available data set from the original epidemiological study. An improved analysis was possible because additional data were collected and analyzed. The end result is a more comprehensive analysis that increased the number of premature deaths from particulate matter by 25 percent compared to the previous methodology. An issue raised in the preliminary peer review was the possibility of using another study just published in November 2005 to calculate mortality estimates (Jerrett, et al, 2005). Since this study was limited to the Los Angeles region, ARB staff concluded it would be premature to apply this approach for mortality estimates statewide without confirmatory analyses for other areas. However, we may use this study in future assessments after more evaluation.

The method used to quantify the health effects from ozone is detailed in ARB's review of the State ozone standard. The analysis was based on ozone concentrations above the ARB's newly approved State 8-hour ozone standard. Premature mortality was calculated based on a number of epidemiological studies of short-term (daily) exposure to ozone. As with particulate matter, other types of studies were used to estimate the relationship between air pollution and hospital admissions and other effects.

The health effects shown in Table I-1 are from a combination of exposure to ozone, directly emitted (primary) diesel particulate matter, and particulate matter formed in the atmosphere (secondary) from goods movement emissions. Ozone and particulate related effects are analyzed separately based on the health studies linking an effect to a pollutant. For example, ozone and particulate matter are independently associated with premature death. For premature death, Table I-2 shows the relative contribution by pollutant -- primary PM, secondary PM, and ozone for 2005, 2010, and 2020. This analysis shows that the health impacts will continue to increase without mitigation and the strategies in this plan.

Table I-2
Mortality Effects Associated with International Goods Movement: Pollutant Contributions
(95% confidence limits in parentheses)

Pollutant	Number of Deaths in Each Year		
	2005	2010	2020
Primary Diesel PM	260 (88-460)	270 (94-490)	370 (130-650)
Secondary Diesel PM (Nitrates)	450 (150-800)	450 (150-790)	510 (180-900)
Ozone	44 (22-66)	42 (21-64)	48 (24-72)
Statewide Total	750 (260-1,300)	760 (270-1,300)	920 (320-1,600)

ARB's health impacts analysis (Appendix A) provides additional detail on the data used to calculate the statewide values in Table I-2. This includes exposure estimates by pollutant and mortality effects for each basin. Not surprisingly, 60 percent of premature deaths associated with goods movement are in the South Coast air basin. The South Coast has more emissions and more people. San Diego, San Francisco, and the San Joaquin Valley air basins collectively account for 18 percent, with the remaining distributed primarily among a few other urban areas.

The summary of non-quantified effects in Table I-3 includes several types of health effects. For example, particulate air pollution is associated with increased risk of heart disease but we cannot yet quantify the effects. Adverse birth outcomes, effects on the immune system, multiple respiratory effects, and neurotoxicity are additional potential health effects not captured by quantitative risk assessments. For those with underlying heart disease or diabetes, exposure to air pollution can compound the effects of their illnesses. Understanding the relationship between existing disease and increased exposure will be extremely important in further quantifying the health effects of air pollution.

Table I-3
Summary of the Health Effects of Diesel PM and Ozone

Effect	Identified		Quantified	
	PM	Ozone	PM	Ozone
Premature Death				
All-cause mortality	X	X	X	X
Cardiopulmonary[1]	X	X		
Coronary heart disease[1]	X	X		
Lung cancer[1]	X	X		
Respiratory Effects				
Asthma attacks	X		X	
New cases of asthma[2]	X	X		
Increased respiratory symptoms[3]	X	X		
Chronic bronchitis[3]	X			
Increased hospitalization for respiratory disease		X		X
Reduced lung capacity (adults)[4]	X	X		
Decreased lung function in children[4]		X		
Cardiovascular Disease (CVD)				
Increased hospitalization for CVD[5]	X			
Underlying CVD (atherosclerosis)[4]	X			
Other Effects				
Cumulative health impacts[3]	X			
Birth outcomes[5]	X	X		
Infant mortality[5]	X			
Minor restricted activity days	X	X	X	X
Neurotoxicity[4]	X			
School absences		X		X
Work loss days	X		X	

[1] This health endpoint is included in the all-cause mortality estimate.
[2] New cases of asthma related to ozone, see: McConnell *et al*. 2002; PAHs (PM) linked to asthma in newborns (Miller *et al*., 2004); NO_2 linked to new asthma in Gauderman *et al*., 2005.
[3] Some portion of these effects may be captured by the estimate of increased hospitalization for respiratory disease.
[4] There is insufficient epidemiologic evidence to quantify these effects.
[5] Estimates could be generated after extensive review of the epidemiologic literature.

B. COMMUNITY HEALTH

The concentration of diesel particulate emissions in communities is a major public health concern and focus of this plan. As a component of particulate matter pollution, diesel particulate contributes to premature death and the other health effects quantified in our assessment. In addition, diesel PM was identified by ARB as a toxic air contaminant in 1998. At that time, the health risk assessment focused on cancer risk. A number of epidemiological studies found exposure to diesel exhaust was linked to increased lung cancer risk. In the intervening years, many other health effects have been linked to diesel particulate matter either separately or as a component of particulate matter air pollution. While many of these effects cannot yet be quantified, they are important in the overall characterization of the health problem posed by diesel particulate emissions.

The effects of diesel particulate pollution are of special concern for individuals especially vulnerable to the effects of air pollution. This includes children, pregnant women, and those with existing illnesses. Understanding the types of exposures experienced by vulnerable populations in communities is necessary to define the scope of health risk posed by diesel particulate pollution. In short, close proximity to the source of air pollution will increase the health risk. For example, air pollution studies indicate that living close to high traffic increases health risk beyond regional risk levels. Many of these epidemiological studies focused on children living or attending school near heavily traveled roadways. The effects found include reduced lung function in children, asthma and bronchitis symptoms, and increased asthma hospitalizations. In these studies the distance from roadway and truck traffic densities were key factors affecting risk.

Air quality modeling studies done for ports and rail yards have also shown that health risk varies with distance. ARB's study of the Roseville rail yard predicted potential cancer risk was highest immediately adjacent to the yard's maintenance operations (within 1000 feet). For these reasons, ARB has adopted land use guidance that recommends providing appropriate distance between major air pollution sources and new homes, schools, and other sensitive land uses. The goal is to prevent elevated health risk due to close proximity as new air pollution control strategies continue to reduce existing health risk.

C. HEALTH RISK ASSESSMENTS FOR DIESEL PARTICULATE

About 70 percent of the potential cancer risk from toxic air contaminants in California is due to diesel particulate. International goods movement activities are a significant source of exposure to this pollutant. The regional risk for diesel particulate in urban areas is about 500-800 potential cancers per million people over a 70-year period. For areas in close proximity to major diesel sources, such as ports, rail yards and along major transportation corridors, the increase in cancer risk from these sources alone can exceed 500 per million in some locations. Since the concentration of diesel PM in the air declines with distance from the sources, risk decreases the farther one moves away from goods movement activity centers. However, even several miles away, the associated cancer risk can exceed 10 per million.

The potential cancer risks are highly dependent on site specific variables such as meteorological conditions, the types of activities occurring, the locations and emission rates of the equipment, operating schedules and the actual location where people live in relation to a goods movement operation. To better understand the potential health risk associated with goods movement activities, ARB staff conducted two key health risk assessments. One is for a major port complex and the other for a large rail yard.

ARB's assessment of diesel PM health impacts for the Ports of Los Angeles and Long Beach characterized the increased risk of cancer and non-cancer health effects to nearby neighborhoods. The study quantified these non-cancer health effects in the study area: 29 premature deaths, 750 asthma attacks, 6,600 days of work loss, and 35,000 restricted activity days. In the health assessment for this plan, ARB staff updated the analysis of the non-cancer health effects in three ways. First, the impact of the two ports was calculated for the entire air basin, not the smaller study area near the ports. Second, the updated methodology (Pope, et al 2002) for calculating premature death was used. Third, the emissions inventory was updated from 2002 to 2005. The results of the updated analysis are shown in Table I-4 below. Similar analyses can be done for other ports once additional port-specific emissions inventories are completed.

Table I-4
Non-Cancer Health Effects
for the Ports of Los Angeles and Long Beach
(2005)

Health Outcome	Cases Per Year	Range
Premature Death (Age 30)	74	(25-130)
Asthma Attacks	1,500	(370-2,700)
Days of Work Loss (Age 18-65)	14,000	(12,000-16,000)
Minor Restricted Activity Days (Age 18-65)	72,000	(58,000-86,000)

The port assessment found that the areas with the greatest impact outside port boundaries have an estimated cancer risk of over 500 in a million. About 50,000 people live in these locations. The area where cancer risk is predicted to exceed 200 in a million is more widespread and includes over 400,000 people. Overall, the study found that the impact areas extend several miles from the ports. The predicted cancer risk at some locations at the edge of the study area was as high as 100 in a million, so not all impact areas were identified.

The port study also looked at the cancer risk for individual emissions sources and activities. The largest contributors to cancer risk were cargo handling equipment and ships using diesel engines at dock (hotelling). While ships in transit produce a substantial portion of total port-related diesel particulate, they did not produce a comparable cancer risk because these emissions are released off-shore and impact a very wide area.

The risk assessment done for the Roseville Rail Yard estimated potential cancer risk from diesel particulate for all the locomotive operations at the yard. The total diesel particulate emissions at this yard break out as follows: moving locomotives account for about 50 percent, idling locomotives account for about 45 percent, and locomotive testing account for about 5 percent. ARB's air quality modeling predicts potential cancer risks greater than 500 in a million, based on 70 years of exposure, offsite and adjacent to the maintenance operation area. Risk levels of 100-500 in a million occur over an area where about 20,000 people live. Risk levels between 10 and 100 in a million occur over an area where about 150,000 people live. The health impacts of other rail yards will be site specific. Risk assessments for an additional 16 rail yards in California will be developed over the next two years.

D. <u>HEALTH-RELATED COSTS</u>

The costs associated with the health impacts discussed here are high. ARB staff has quantified the health impacts for premature death, hospital admissions, asthma attacks, work loss days, minor restricted activity days, and school absence days. Using that data we have also monetized the value of these impacts. ARB staff's assessment in Appendix A discusses the methodology applied. The valuations used for individual health effects are shown here in Table I-5.

Table I-5
Values for Health Effects per Case of Mortality, Hospital Admissions and Minor Illnesses
(in 2005 dollars)

Health Endpoint	Year			References
	2005	2010	2020	
Mortality				
Premature death[1] (in millions)	$8.2	$8.6	$9.3	U.S. EPA (2003), 9-27
Hospital Admissions				
Acute Respiratory	34,000	34,000	34,000	CARB (2003), 63
Minor Illnesses				
Minor restricted activity day (MRAD)	61	61	63	U.S. EPA (2004), 9-159
Work loss day	178	178	178	2002 California wage data, US Department of Labor
Asthma – acute (per symptom day)	50	51	52	U.S. EPA (2004), 9-158
School absence day	87	87	87	U.S. EPA (2004), 9-159

[1] The premature death values are adjusted by an income factor for the respective years.

U.S. EPA's monetary values are used for premature death, minor restricted activity days, acute asthma, and school absence days. ARB calculated the cost of hospital admission for acute respiratory problems as the direct cost of illness plus associated costs such as time lost from productive activity. Work day loss was calculated using California wage data. The valuations for premature death increase over time based on expected increases in real income. The values assume that real income increases at a constant rate of 0.8 percent per year through 2020.

The statewide valuation of health effects is shown in Table I-6. These numbers are calculated using the health impacts estimates, the monetary valuations, and the discount rates recommended in U.S. EPA's guidance on social discounting.

Table I-6
Cost of Health Impacts of Statewide PM and Ozone From Ports and International Goods Movement with Measures Adopted as of 2005
(in 2005 dollars)

	Year		
	2005	2010	2020
Cost (in millions)	$6,300	$4,800 to $5,800	$3,100 to $5,600