WEST OAKLAND TRUCK SURVEY

Bay Area Air Quality Management District
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EXECUTIVE SUMMARY

A. Introduction

West Oakland is situated adjacent to the Port of Oakland, bounded by three major freeways (I-580, I-880, and I-980), and home to a major U.S. Postal Service Distribution Center. During the fall and winter of 2008, the Bay Area Air Quality Management District (the District) in partnership with Sonoma Technology, Inc (STI), Wiltec, and the West Oakland Environmental Indicators Project (WOEIP) developed and implemented a truck-traffic survey in West Oakland. The study was initiated to address uncertainties raised in the Health Risk Assessment (HRA) conducted by the California Air Resources Board (CARB) in 2008 to assess health risks from diesel exhaust in the West Oakland community (Diesel Particulate Matter Health Risk Assessment for the West Oakland Community). The risk assessment reported that West Oakland residents are exposed to high concentrations of diesel particulate matter—almost three times higher than the average background levels in the Bay Area—and that the largest source of risk (71%) is attributed to truck traffic. However, the study noted that there were significant uncertainties associated with (1) estimates of truck volumes and routes in West Oakland and (2) estimates of the percentage of truck traffic (and therefore emissions and risk) attributable to activity at the Port of Oakland. The HRA concluded that the:

"data limitations may have led to potential overestimate of overall trucking emissions within the modeling domain and a potential underestimate of the overall fraction of trucking emissions that are attributable to the Port of Oakland."

A major goal of this study was to reduce these uncertainties in order to apportion the health risk to the appropriate source by estimating:

- the volume of medium heavy-duty (MHD) and heavy heavy-duty (HHD) truck traffic on the freeways and surface streets of West Oakland;
- the primary routes of truck travel;
- the locations and duration of truck idling activity;
- the vehicle miles travelled for trucks within the study area;
- the age distribution of trucks in West Oakland; and
- the fraction of trucks transporting goods and passing through West Oakland in services related to the Port of Oakland (Port).

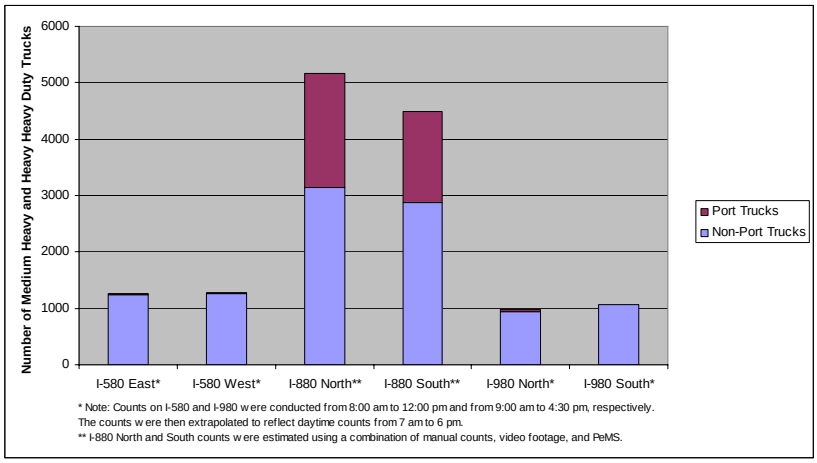
To achieve these goals, the District collaborated with the members of the West Oakland community to survey surface streets and estimate traffic volumes, routes, and speeds of medium heavy duty and heavy heavy duty trucks along surface streets and freeways in West Oakland in order to improve the spatial representation of roadway emissions and differentiate the contribution of Port versus non-Port trucks. Select local businesses were also surveyed regarding their idling activity and truck licenses were recorded to develop a current truck age distribution for West Oakland. The HRA assumptions were then compared to the survey results and health risks were adjusted accordingly to derive new risk estimates that approximately reflect the findings of this survey.

B. Key Findings

The key findings drawn from the study and subsequent analysis are:

- The District estimated that 7,200 trucks (medium heavy duty and heavy heavy duty) travel daily on surface streets through West Oakland from 7:00 am to 6:00 pm. Of these trucks, 51% or 3,700 are Port-related trucks.
- As shown in the Figure ES-1, the daily freeway volumes on I-880 from 7:00 am to 6:00 pm is approximately 9,700 trucks with 37% of them being Port related. Conversely, I-580 and I-980 had about 2,100 to 2,600 trucks travel daily during the same hours with one to two percent classified as Port trucks.

Figure ES-1. Estimated Freeway Volumes Based on Survey



- The District estimated daily vehicle miles traveled (VMT) by all trucks in West Oakland to be 7,900 (7:00 am to 6:00 pm). Port trucks had an estimated VMT of 3,050 during that period.
- Idling survey responses, confirmed through curbside observations, indicated that a majority of local businesses are complying with the five minute idling restriction required by CARB regulations.
- The median and average model year for all trucks and diesel-powered trucks identified during the West Oakland truck survey was 1997, which is consistent with the Port's revised 2005 Seaport Air Emissions Inventory Report (ENVIRON, 2008). Approximately 85% of the trucks had model year of 1994 or newer. 49% of the trucks were registered in the Bay Area; 27% were registered in non-Bay Area California cities; and 24% were either registered out of state or no longer in use since the data were recorded.

When these findings were compared to assumptions used in the HRA, the survey concurred with the HRA regarding the age distribution, average speed, and idling activity. The survey also confirmed suspicions raised in the HRA that the overall trucking emissions were potentially overestimated and the fraction of trucking emissions attributed to the Port of Oakland was underestimated. The main differences in traffic volumes found between the two studies are that:

- The survey found significantly fewer trucks on surface streets, but a higher percentage of Port trucks;
- The survey counted fewer trucks on freeways I-980 and I-580; and
- The survey estimated a higher number of Port and non-Port trucks on freeway I-880.

Some of the discrepancies may be attributed to differences in survey methods and assumptions used when identifying a truck as a Port truck. However, methodological differences do not bridge the gap between the two study results. In order to quantify the impact these changes have on the health risk for West Oakland, the District performed calculations that adjusted the health risk in the HRA by the survey results. The adjusted risks are shown in Table ES-1.

Table ES-1. Summary of the Adjusted Population Weighted Cancer Risks (Cases per Million) Based on the Survey

Source Category	Part I Port	Part II Union Pacific	Part III Non-Port and Non-UP	Combined
OGV Transiting, Maneuvering, and Anchoring	57	0	23	80
OGV Hoteling	57	0	10	67
Harbor Craft	15	0	78	93
Trucks	**103** (42)	7	**415** (795)	**525** (844)
Cargo Handling Equipment	16	21	7	44
Locomotives	4	15	37	56
Others	0	0	2	2
Total	**252** (192)	43	**572** (951)	**867** (1,186)
% Risk	**29%** (16%)	**5%** (4%)	**66%** (80%)	100%

Note: Revised risks are noted in bold text. The values in parentheses ( ) are the original population-weighted cancer risks presented in Table 7 of the HRA.

The adjusted risk suggests:

- The Port's contribution to the population weighted risk for West Oakland is significantly higher than the 16% attributed in the HRA. While this study did not re-run modeling of risk calculations, survey findings suggest the Port contribution to the health risk is about 29%.
- Conversely, the population weighted risk from trucks not associated with the Port or the Union Pacific railyard decreased to 415 cases in a million. Likewise, the risk from all trucking operations decreased from 844 cases in a million to 525 cases in a million.
- Port trucking operations become the highest contributor to the overall risk from Port activities, as shown in Figure ES-2.
- Trucks remain the single highest sources of diesel emissions in West Oakland, responsible for 61% of the population weighted risk, as shown in Figure ES-3.

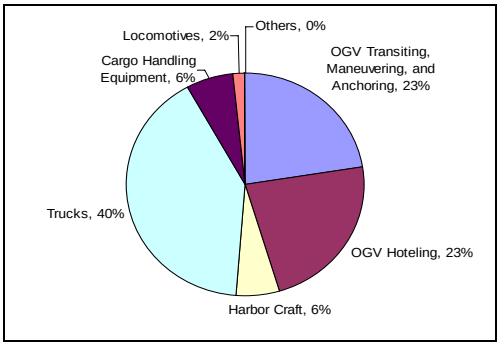


Figure ES-2. Percent Contribution to Adjusted Cancer Risk from Port Sources

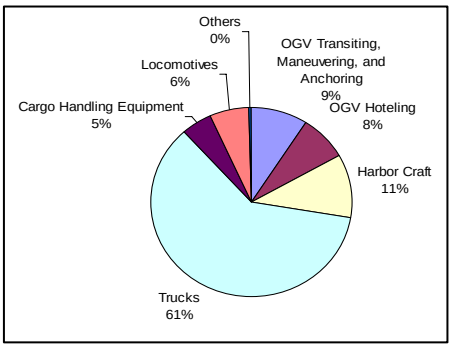


Figure ES-3. Percent Contribution from All Diesel Sources to the Adjusted Cancer Risk

The revised risk estimates indicate an increased population-weighted risk from Port trucks. This finding is not a reflection of changes since the HRA—indeed the Port has experienced a decline in vessel calls and cargo shipments since the HRA was conducted. Rather the finding is a reflection of additional data which show, as was asserted in the HRA, that the trucking operations data for West Oakland in the HRA likely underestimated the Port's contribution.

C. Conclusions

The survey findings confirm and support the conclusions presented in the HRA and further demonstrate that the residents of West Oakland are exposed to unhealthful levels of diesel particulate matter emissions. The revised risk estimates showed a 13% increase in population weighted cancer risk from Port trucks and a corresponding decrease of 14% in the cancer risk attributed to non-Port and non-Union Pacific activities. Overall, the revised risk from all trucking operations decreased from 844 cases in a million to 525 cases in a million. Truck emissions are the single highest source of diesel emissions in West Oakland; compliance with regulations adopted by CARB is an essential mitigation strategy. The Port also has a significant role to play in reducing these emissions. The contribution of Port-related activities to the total cancer risk in West Oakland increased to 29%, with Port trucks being the highest contributor. More collaborative initiatives with CARB and the District will help in reducing these emissions. The study findings show some important progress has been made: local businesses are complying with the idling regulation and older, higher polluting truck engines are being phased out. The Port has also adopted a resolution to ban trucks older than 1994 from entering terminals.

The adjusted health risk indicates that the District's initiative to focus incentives and grants funding in this area should have a significant impact in improving the air quality in West Oakland. The District also will continue to support outreach efforts to businesses to curb idling and support efforts by Alameda County and the Port of Oakland to move truck services and offer long term parking on Port property. All of these measures are steps in the right direction.

These recommendations alone will not achieve the emission reductions required to sufficiently improve health conditions in West Oakland. The District has initiated a Clean Air Communities Initiative program that includes a multi-pronged approach to improve air quality for impacted communities such as West Oakland. The program uses a variety of strategies including targeted regulations, focused grant and incentive funding, outreach and communication to community,

businesses, and health departments, including air quality in critical land use decisions to protect current and future residents, monitoring local sources, and enforcement of CARB and District regulations. The District will continue to work on additional emission reduction strategies through this program to reduce the potential health risk associated with diesel emissions in West Oakland.

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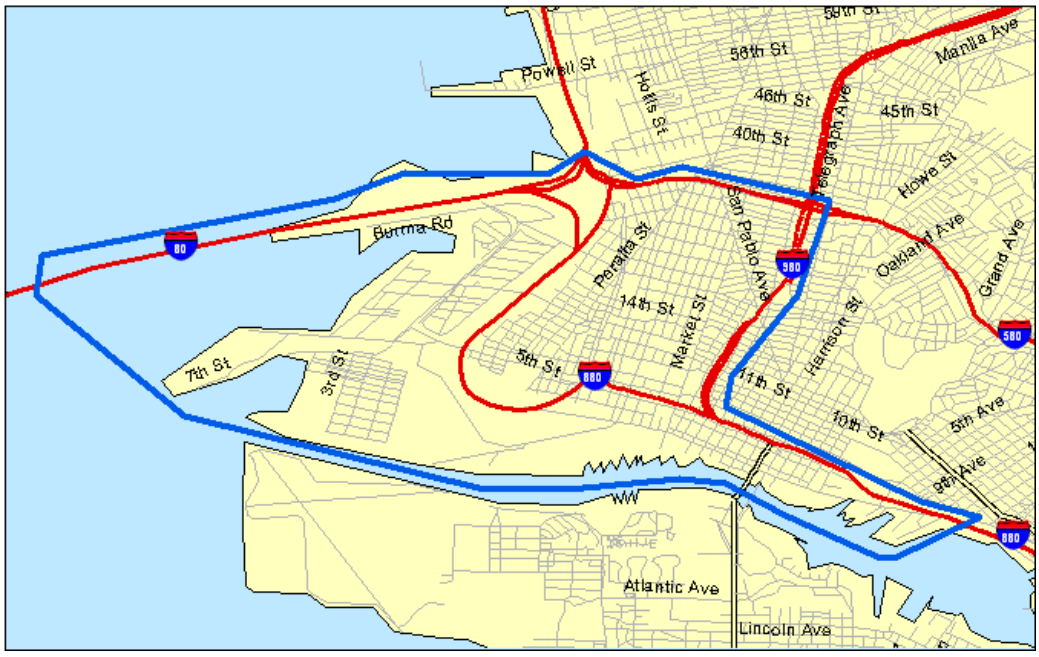
1. INTRODUCTION

1.1 BACKGROUND

West Oakland, one of the oldest districts in Oakland, is home to about 22,000 residents (see Figure 1 for the approximate boundaries of the study region outlined in blue). The neighborhood is adjacent to the Port of Oakland and is bounded by three major freeways (I-580, I-880, and I-980). The Port of Oakland is the 5th largest container seaport in the United States. The Port operates over 13 container terminals and received 1,928 cargo vessels in 2008. In addition, West Oakland is home to a major U.S. Postal Service distribution center and a number of other truck-based businesses. As a result, significant numbers of diesel-fueled trucks travel through West Oakland on a daily basis, raising concerns about emissions of diesel particulate matter—a pollutant the Office of Environmental Health and Hazards Assessments (OEHHA) has identified as a toxic air contaminant based on its potential to cause cancer and other adverse health effects.

Figure 1. Blue line shows approximate boundaries of the West Oakland study region.



The Bay Area Air Quality Management District (the District) initiated the Community Air Risk Evaluation (CARE) program in 2004 to identify locations with high levels of risk from ambient toxic air contaminants (TAC) and locations with sensitive populations and use the information to help focus risk reduction activities. The District developed an inventory of TAC emissions that was combined with demographic and heath indicator data (BAAQMD, 2006) to identify areas with relatively high risk and sensitive populations. Population statistics of youth, seniors, and low-income families were mapped in combination with TAC emissions. This mapping analysis identified West Oakland as being one of the most highly impacted communities within the San Francisco Bay Area. Diesel particulate matter (diesel PM), emitted from on-road and off-road diesel engines, contributed the majority (over 85%) of the cancer-risk weighted emissions totals.

Diesel PM is composed of soot and is a known health hazard. Exposure to diesel PM has been linked to respiratory illnesses and increased risks of heart disease and lung cancer. Children and the elderly are especially vulnerable to the effects of diesel PM.

To evaluate the impacts of diesel emissions on the West Oakland community, California Air Resources Board (CARB) conducted a health risk assessment (HRA) in collaboration with the District and the Port of Oakland. Data on diesel activity in West Oakland was provided by CARB and the District as well as the Port of Oakland and the Union Pacific Railroad. The purpose of the study was to quantify diesel particulate matter (PM) emission impacts under current and future activity levels at the Port of Oakland, Union Pacific Railyard, local freeways, and other sources of diesel emissions.

The resulting summary report, entitled "Diesel Particulate Matter Health Risk Assessment for the West Oakland Community" (CARB, 2008) concluded that approximately 71% of the risk from diesel particulate matter in West Oakland was produced by on-road heavy-duty trucks. The report found that the West Oakland community is exposed to diesel PM ambient concentrations that are almost three times the average background diesel PM ambient concentrations in the Bay Area. CARB reported that the data in the truck inventory used to make the emission estimates were limited and resulted in large uncertainties in the estimate of trucking emissions within West Oakland. CARB states that the data limitations may have lead to potential overestimate of overall trucking emissions and a potential underestimate of the overall fraction of trucking emissions that are attributable to the Port of Oakland. One of the recommendations of the HRA report was that "[t]he BAAQMD should continue working with the community and the Port to implement its studies of trucking operations in the West Oakland community."

To refine the truck traffic data cited in the report, the District in collaboration with its consultants and community members implemented this study, a comprehensive truck survey designed to count the number of trucks attributed to Port and non-Port activities. The main goal of this study was to improve the accuracy of the roadway emissions estimates by conducting a field survey that recorded the truck traffic patterns and idling activities in West Oakland. The results of this survey were then compared to estimated truck activity data used in the HRA to determine the uncertainty associated with the risk estimates. The results will also support ongoing outreach in the community to address ways to reduce diesel PM exposures. This study was completed through a collaborative effort with staff from the District, Sonoma Technology, Inc. (STI), Wiltec, and the West Oakland Environmental Indicators Project (WOEIP).

1.2 OBJECTIVES

The main goal of this study was to improve the accuracy of diesel PM emissions estimates from on-road trucks in West Oakland. To achieve this goal, the West Oakland truck field survey was designed to collect data on trucks and their activities in and around the Port and within the West Oakland community. The specific objectives of the study were to:

- Improve the estimates of volumes, by time of day and day-of-week, of medium-heavy-duty (MHD) and heavy-heavy-duty (HHD) truck traffic on the freeways and surface streets of West Oakland;

- Estimate the speeds of trucks on individual roadways;
- Identify the primary routes of truck travel and improve the spatial representation of trucks within West Oakland;
- Determine the locations and duration of truck idling activity;
- Estimate the vehicle miles travelled (VMT) for trucks on local roadways within the study area,
- Estimate the age distribution of trucks in West Oakland;
- Evaluate the fraction of trucks transporting goods and passing through West Oakland in services related to the Port on freeways and surface streets;
- Engage the community in assisting with the study and continue outreach to improve the air quality in West Oakland.

The work completed for this study used a variety of survey methods to gather information in support of these objectives. The information gathered was used to refine the estimates of potential health risks from diesel PM emissions from on-road trucks and to improve estimates of the portion of risk attributed to Port-related activities. The work produced from this study will be used in ongoing efforts to reduce the health risks associated with diesel emissions in the West Oakland community.

1.3 STUDY OVERVIEW

The District identified four distinct tasks to be completed as part of this study in order to meet the study's objectives. The specific tasks completed in this study include:

- Task 1 – Survey local streets and estimate traffic volumes, routes, and speeds of MHD and HHD trucks along surface streets and freeways in the West Oakland study area in order to improve the spatial representation of roadway emissions and differentiate the contribution of Port versus non-Port trucks;
- Task 2 – Verify previously surveyed truck idling locations and interview additional truck-related businesses in the West Oakland study area to gather information on the time of day that trucks idle and the length of time spent idling;
- Task 3 – Collect license data for developing a truck age distribution to refine truck emission estimates; and
- Task 4 – Compile survey data from Task 1 to compare with on-road truck estimates used in the HRA for both Port-related and non-Port-related activity. This task includes an analysis of truck routes and VMT on local streets.

Section 1.4 presents the previous studies that were used in developing the field protocol and for collecting the data. Section 2.0 describes, in more detail, the data collection efforts (Tasks 1-3) performed by this study. The District partnered with community groups to manually count trucks along specific traffic intersections in West Oakland in order to estimate the number of trucks by hour and day of week and types of trucks. The study focused on characterizing activity of medium HD and heavy HD trucks. Light heavy duty (LHD) trucks such as sports utility

vehicles and pickup trucks were not included in this study because although they contribute to the overall VMT, a majority of the vehicles run on gasoline and not diesel. Emissions from LHD vehicles were so low that they contributed less than one percent of the total emissions from all diesel vehicles from both surface streets and freeways. Counters were also trained to distinguish between Port versus non-Port trucks. In conjunction with the manual counts, counters captured license plate data to develop a truck age distribution. Automatic counters were installed along key intersections to develop daily 24 hour representation of traffic volumes and speeds and discern weekday versus weekend traffic patterns. The District also verified idling activity by re-interviewing previously surveyed local truck businesses as well as surveying businesses that were not previously included in any survey. Section 3 presents analysis methods for interpreting the data collected from Tasks 1-3. Section 4 summarizes the findings and compares the results to HRA assumptions (Task 4). While the HRA model was not rerun, Section 5 applies the truck-traffic study findings to generate approximate adjusted risk estimates. Section 6 summarizes the study findings and conclusions.

1.4 PREVIOUS WEST OAKLAND STUDIES

Several truck studies have been conducted previously in West Oakland. The following section presents short descriptions of studies that were most relevant and assisted in developing this study's protocol.

During a 2001 diesel particulate matter emissions study for the City of Oakland, emission estimates were prepared for diesel trucks operating at the Port of Oakland, on freeways, and at truck-related businesses in West Oakland (Harding ESE, 2001). Surveys were used to collect truck trip data for 45 truck-related businesses in West Oakland, and it was estimated that these businesses were generating about 2,500 truck trips per day. Traffic count data from the California Department of Transportation (Caltrans) were used to estimate emissions from freeway truck traffic.

One of the most comprehensive studies was conducted by TIAX LLC in September 2003 for the Pacific Institute on behalf of WOEIP (TIAX, 2003). The WOEIP Report by the Pacific Institute in conjunction with the Coalition for West Oakland Revitalization was supported through a US EPA grant. As part of the study, TIAX trained community members to conduct the truck count and idling study, focusing on container trucks servicing the Port of Oakland.

In the WOEIP report, nine locations (see accompanying Table 1 and Figure 2) representing high truck traffic intersections were surveyed for up to three days. Surveyors collected data on six categories of trucks: container semi-trailer trucks (2-axle cab), container semi-trailer trucks (3-axle cab), non-container semi-trailer trucks (2-axle cab), non-container semi-trailer trucks (3-axle cab), cabs only (2-axle), and cabs only (3-axle). These counts included typical Port trucks as well as US Postal truck-trailer rigs. Other vehicles such as box trucks, pickup trucks, and vans were excluded from the study. In addition to counting the axles on the trucks, surveyors also noted the direction of travel for each vehicle as it passed through the intersection.

The WOEIP report estimated that approximately 6,300 trucks per day enter the Port of Oakland through local streets in West Oakland. Approximately 290 trucks visited West Oakland for basic services such as fuel, truck repair, food and beverages, and overnight parking. Although several

of the streets that were surveyed prohibited truck travel, the survey found that about 40 trucks per day illegally travelled through these streets. The report also estimated that truck drivers spend up to four hours idling at the Port terminals while delivering or picking up containers.

Table 1. WOEIP Report (TIAX, 2003) Survey Locations

Location	Manual Counts
7th Street and I-880 Frontage Road	3-day survey
7th Street and Mandela Parkway	3-day survey
West Grand Avenue and Mandela Parkway	3-day survey
7th Street and Adeline Street	1-day survey
11th Street and Wood Street	1-day survey
Goss Street and Wood Street	1-day survey
14th Street and Campbell Street	1-day survey
16th Street and Campbell Street	1-day survey
West Grand Avenue and Campbell Street	1-day survey

The report offered some possible mitigation measures to reduce the diesel PM emissions generated from the transport of goods and idling at Port terminals including dedicated truck services on Port property, subsidized repowering/replacing of old truck engines, and installation of road barriers.

In a more recent study, the City of Oakland Public Works Agency conducted a truck-following study and analyzed 24-hour vehicle axle classification machine counts and manual intersection turning movement counts (Dowling Associates, 2006). The purpose of the study was to gather data on goods movements and truck traffic through eleven key intersections at the Emeryville/Oakland border. Table 2 presents a summary of the locations that were chosen for the City's Phase I priority list of locations in West Oakland while Figure 2 graphically depicts the sampling locations.

The focus of the study was to count the number of articulated trucks (i.e., vehicles with detachable trailers) that have three to seven axles used to transport goods to and from Oakland and Emeryville. Non-articulated trucks such as delivery trucks were not counted in the survey. Manual intersection turning movement counts were then conducted at eight of the survey locations during peak morning, noon, and afternoon hours. Three of the locations were not surveyed due to the low truck volumes revealed during the automatic machine counts. Lastly, Dowling Associates performed a truck following survey where they randomly followed articulated trucks within the boundaries of 40th Street, San Pablo Avenue-I-980 freeway, 16th Street, and Wood Street/Beach Street. The surveyor documented the start and end times of the truck following, number of axles, number of trailers, and truck route.

Table 2. City of Oakland (Dowling Associates, 2006) Study Survey Locations

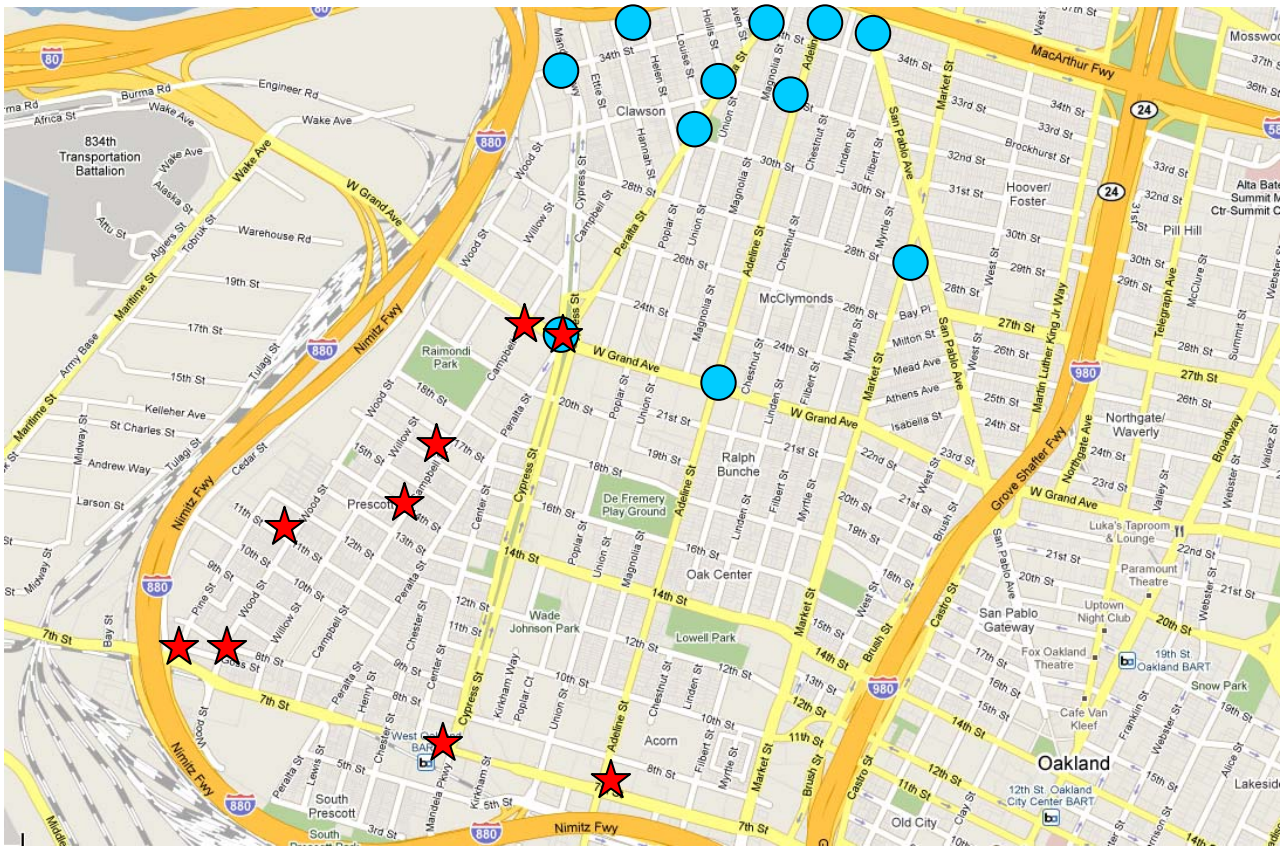
Location	Machine Count	Manual Count
Mandela Parkway north of 34th Street	All lanes counted	Peak hours count
Adeline Street south of 35th Street	Lane closest to the curb was not counted due to lack of median.	No manual count
San Pablo Avenue south of 35th Street	All lanes counted	Peak hours count
Hollis Street north of 34th Street	All lanes counted	Peak hours count
Peralta Street south of 35th Street	All lanes counted	Peak hours count
Peralta Street south of 32nd Street	All lanes counted	Peak hours count
Adeline Street south of 32nd Street	All lanes counted	No manual count
Poplar Street south of 30th Street	Lane closest to the curb was not counted due to lack of median.	Peak hours count
Market Street south of 28th Street	Lane closest to the curb was not counted due to lack of median.	No manual count
West Grand Avenue east of Mandela Parkway	Middle lane not counted	Peak hours count
West Grand Avenue east of Adeline Street	Middle lane not counted	Peak hours count

The City of Oakland study concluded that most of the articulated truck activity is constant throughout the day from 8:00 am to 4:00 pm and, based on the truck-following survey, that most of the trucks used local streets in West Oakland for transporting their goods within the study area. The study followed 48 articulated trucks and found that a majority of the trucks traveling on local streets in West Oakland had origins or destinations within the study area. About 10% of local truck movements observed in the manual counts were from trucks transporting goods solely between Oakland and Emeryville.

One City of Oakland survey location corresponded to the same location where data was collected by community members for the WOEIP report. The intersection of West Grand Avenue and Mandela Parkway is heavily used by trucks going eastbound or westbound on West Grand Avenue. The City of Oakland study measured 271 articulated trailers passing through the intersection within a 24 hour period with approximately 180 of the trucks traveling from 6:00 am to 2:00 pm. Under similar conditions, the WOEIP reported 131 container trucks, 306 non-container trucks, and 131 cabs that traveled through the intersection from 6:30 am to 2:30 pm. There are several reasons that may account for the differences in the counts of container trucks (180 versus 131) between the two studies. The City of Oakland survey counted more types of trucks than the WOEIP survey and used automatic counters that are less reliable at classifying

trucks based on the number of axles (see Appendix B). In addition, the difference in counts is consistent with weekday variability that was determined through this study (see Section 3.1.2).

Figure 2. WOEIP Report (TIAX, 2003; red stars) and City of Oakland (Dowling, 2006; blue circles) Survey Locations



The Port of Oakland has sponsored various truck studies including a recent pilot study with the Bay Area World Trade Center (Bay Area World Trade Center, 2007). In the pilot study, the activity of 300 truck drivers representing 14 truck companies that serviced the Port from 2006 to 2007 was tracked using global positioning system (GPS) units in the driver's cell phones. The objective of the Port truck tracking study was to increase efficiency and utilization of the appointment system thereby improving goods movement through the Port, reducing Port and regional congestion, and improving air quality.

GPS units transmitted the truck speed and the longitude and latitude locations every two minutes. District staff compiled all the GPS data within West Oakland and presented the results in Figure 3. Each two minute count was represented by a yellow square of 25 meters in length. As more counts overlapped, darker colors were used. Yellow represented two to 20 counts, orange represented 20 to 2,500 counts and red represented 2,500 to 100,000 counts. The red highlighted locations are representative of heavy traffic or overnight parking areas. Two of the frequently used locations are public scales and one is a truck repair business. The truck routes referenced in Section 4.0 were derived from data collected by the GPS trucking study.

Figure 3. Port of Oakland GPS Truck Tracking Study (2006-2007)

Note: the darker shades of yellow to orange areas represent longer residence times of trucks or higher density of trucks.

In 2007, STI was contracted by the District to develop a complete inventory of diesel sources associated with truck-related businesses and construction projects within the boundary of West Oakland. STI and District staff conducted a survey of truck-based businesses in West Oakland to estimate truck trips and idling times at each facility (Reid, 2007). That study identified 52 truck-based businesses in West Oakland and estimated that these businesses generated almost 3,000 daily truck trips in the neighborhood. The report estimated that the total daily truck activities at truck-based businesses in West Oakland was approximately 3,000 diesel truck trips per day on any given weekday based on survey responses from these businesses. However, the data were insufficient to address most of the objectives of this study and thus, further data collection was deemed necessary to understand truck traffic patterns and idling activities in West Oakland.

Following up on the mitigation measures recommended in the WOEIP report, the Alameda County Congestion Management Agency (ACCMA) sponsored a survey (Tioga Group and Dowling Associates, 2008) to question truck drivers on their selection of parking locations. The survey was completed in January 2008. Truck drivers typically park on public streets to make early morning deliveries, to access services, to wait until freeways are less congested, or for mandatory rest periods. Several communities have regulations prohibiting overnight truck parking on city streets, but leave no suitable alternative for truck parking. The purpose of the study was to determine where truck drivers parked, how long they parked, and if they would use a dedicated truck parking location if it were available.

The survey consisted of 179 face-to-face interviews at known truck parking locations. At the time of the interview, most of the trucks were stopped for less than 30 minutes waiting to receive their cargo, resting, or gathering additional instructions from their dispatcher. Many of the drivers stopped at a particular location because it was an available truck stop or it was closest or the most convenient location to their next pickup. Many of the trucks were affiliated with truck companies outside of the Bay Area and consequently did not have a working terminal or yard in which to park. The study determined that given the opportunity to overnight at truck stop, only truck drivers that domicile outside of the Bay Area would use a full service facility, while Bay Area drivers prefer to return to their normal, permanent parking locations. The most desirable parking locations were determined to be in East Oakland, Hayward, and San Leandro, as close to the interstate highway as possible.

In October/November of 2008, the Port of Oakland conducted a Drayage Truck License Plate Field Survey (Port of Oakland, 2008) by collecting license plate data from trucks entering or leaving terminal gates. Several terminal operators also collected license plates at their specific terminals. The data were compiled to develop an age distribution of Port trucks transporting goods to and from the Port of Oakland. A comparison of the results from Port terminal to the age of trucks estimated from this study is discussed in Section 4.5.

These studies highlight the significant volumes of diesel truck traffic in West Oakland and the difficulty in understanding their activity and travel patterns in order to develop effective emission reductions strategies. The intent of this study is to better characterize truck activities by estimating the volume and distance traveled by trucks in this neighborhood. In so doing, this would assist in estimating diesel PM emissions and assessing the health risks associated with those emissions.

2. DATA COLLECTION TASKS AND TRUCK SURVEY PROTOCOL

The goals of this survey were to assess diesel truck activity in West Oakland and estimate the number of trucks by hour and day of week, their types, ages, idling behaviors, and average speeds. In addition, the study estimated the number of Port versus non-Port trucks traveling along freeways and surface roads and the number of Port and non-Port trucks entering and exiting West Oakland each day. Each truck that crossed a surveyed intersection was counted. It is possible that a truck, on a single trip, passing surveyed intersections could be counted more than once. This study focused on estimating truck volumes on surveyed roadways and not on estimating the number of "truck trips."

The specific data-collection tasks completed in this study include:

- Task 1 – Survey local streets and estimate traffic volumes, routes, and speeds of MHD and HHD trucks along surface streets and freeways in the West Oakland study area in order to improve the spatial representation of roadway emissions and differentiate the contribution of Port versus non-Port trucks;

- Task 2 – Verify previously surveyed truck idling locations and interview additional truck-related businesses in the West Oakland study area to gather information on the time of day that trucks idle and the length of time spent idling; and

- Task 3 – Collect license data for developing a truck age distribution.

This section presents the general protocol for completing each of the three data-collection tasks, including information on the sampling frequency, station locations, and identification of specific trucks. The majority of the work was completed by STI with guidance from the District and support from a subcontractor, Wiltec, and community members organized by WOEIP. Analysis of data collected in support of these tasks is described in Section 3. The final Task 4 of compiling the survey data and comparing it to the on-road truck estimates used in the HRA for both Port-related and non-Port related activities is presented in Sections 4 and 5.

2.1 TASK 1: ESTIMATE TRAFFIC VOLUMES AND SPEEDS

The purpose of Task 1 was to estimate the truck traffic on local streets, major roadways, and freeways using manual and automatic counters.

2.1.1 Freeway Volumes

West Oakland contains portions of the I-580, I-980, I-880, and I-80 freeways, as well as the eastern span of the Bay Bridge. The focus of the first task was to estimate freeway traffic along the heavily used segment of I-880 north and east of the Port of Oakland and the UP railyard. The District used manual counts, video footage and data from the Freeway Performance Measurement System (PeMS), a joint project of the California Department of Transportation (Caltrans) and the University of California Berkeley, to estimate truck volumes and speeds on this freeway. PeMS processes 30-second loop detector data from freeway segments across

California and provides Caltrans with data to assess the performance of the freeways. The District used the complete sensor data to estimate the total traffic (cars and trucks) traveling through on I-880 by subtracting the number of vehicles exiting or entering the freeway. The District did not use the pre-sorted HHD truck count data available for download on PeMS, but instead estimated percentage of total trucks and Port trucks on each freeway based on the manual counts and video footage.

To estimate the fraction of truck traffic and the truck-fraction associated with Port activity, STI with cooperation from the Bay Area Rapid Transit District (BART) collected video footage of the north and south bound I-880 freeway from the West Oakland BART platform. A portable handheld camcorder was used to record traffic on I-880 on the following dates and times:

- Monday, December 8, 2008 from 7:30 am to 11:30 am
- Wednesday, December 10, 2008, from 1:00 pm to 4:30 pm
- Saturday, December 13, 2008, from 7:30 am to 11:30 am
- Sunday, December 14, 2008, from 7:30 am to 4:30 pm

Video footage was collected in half hour intervals that were alternated with half hour intervals of manual counting from the West Oakland platform. STI staff recorded the number of axles on passing trucks and identified if the truck was associated with Port activity as it traveled on either the northbound or southbound traffic lanes during every 30 minutes of manual counting. Port trucks were identified as having vertical ribs and corner castings on the container (see Section 2.1.2.2). A similar processing procedure was implemented by District staff for each ½ hour of video film. (See Appendix C for details on the analysis using PeMS data with video clips and manual counts to derive truck percentages.)

After the data from I-880 was processed, the District concluded that manual traffic counts on I-980 and I-580 were necessary to characterize activities from all major freeways. No video footage was made of the I-580 and I-980 freeway traffic. Instead, STI manually counted trucks following a similar protocol for I-880 for sections of I-980 and I-580 freeways. Counts were collected for I-580 from the rooftop of the California Hotel at 3501 San Pablo Avenue and for I-980 from the 11th and 12th Street overpasses on the following dates:

- Tuesday, May 5, 2009, from 8:00 am to 12:00 pm – I-580 East and West
- Tuesday, May 5, 2009 from 9:00 am to 12:00 pm – I-980 East and West (12th Street)
- Tuesday, May 5, 2009, from 1:00 pm to 4:30 pm – I-980 East and West (11th Street)

2.1.2 Major and Minor Street Volumes

On roadways other than freeways, traffic data collection methods were employed to estimate truck volumes and speeds by hour, day of week, and season. Locations for data collection activities were determined based on a variety of data sources, including:

- Data collected by community groups during the 2003 Pacific Institute study and other projects.

- Data on truck trips generated by truck-related businesses in West Oakland compiled by STI for the West Oakland HRA.
- Previous truck counts conducted by Dowling Associates, Inc. for the City of Oakland.
- A truck-following survey conducted by STI and District staff on November 29, 2007.
- GPS data from the Port of Oakland's Truck Tracking Survey, which uses GPS technology to track activities of Port trucks.
- Personal communications with West Oakland community members.

These data sources were used to identify the 38 locations that were manually surveyed for this study. Table 3 lists the survey locations (Figure 4), reason for selecting the location, and the survey duration. Four survey locations represent the main arterial roads leading to the Port of Oakland: (1) Maritime Avenue/West Grand Avenue, (2) 7th Street/I-880 Frontage Road, (3) Adeline Street/3rd Street, and (4) 3rd Street/Market Street. From these roadways, trucks transport goods through the West Oakland community and have freeway access to Interstate 80 (north and eastbound), Interstate 880 (southbound), Interstate 580 (eastbound), and Interstate 980 (eastbound). Thirteen survey locations were selected within West Oakland that correspond to major arterial roadways frequently used for goods movement. An additional 16 locations were surveyed along the perimeter of West Oakland to estimate the number of trucks that daily enter and exit the area. Surveys were also conducted on five minor streets in close proximity to schools, parks, recreational centers, and on truck restricted roads.

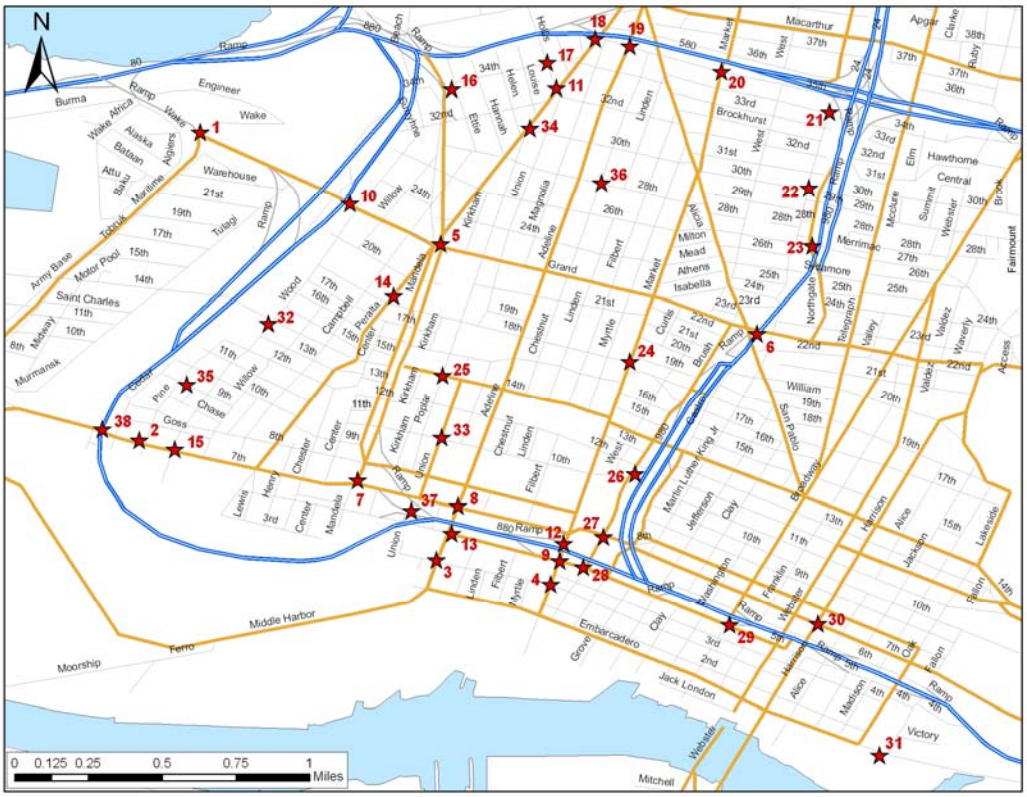
In addition to the manual counts, Wiltec deployed four automatic vehicle classification counters co-located with manual survey locations to evaluate the manual counts and provide an overall estimate of the traffic volume, vehicle type, and vehicle speeds. The automatic counters provided continuous counts for a longer period than was practical with a manual survey. The four locations represent two high traffic locations (3rd Street/Adeline Street and Mandela Parkway/West Grand Avenue), one moderate traffic location (Market Street/18th Street), and one low activity street (30th Street/ Martin Luther King Drive).

Two types of counters were used. The vehicle classification counters that identify the type of trucks can only be deployed across a single lane of traffic, while the more commonly used total vehicle counters can be used over multiple lanes. For three lane roadways such as West Grand Avenue, vehicle classification counters were set up on the two outside lanes while a third vehicle counter was set up to capture total traffic volumes across all three lanes. The vehicle count on the middle lane was estimated by subtracting the individual counts yielded from the two outside lanes from the total volume count of all three lanes. Because vehicle classification counts were not available from the middle lane, the fraction of trucks traveling on the two outside lanes was used to estimate the number of trucks traveling on the middle lane per hour. The counters recorded vehicles 24 hours a day for five consecutive days from August 19 through 23, 2008, to estimate truck volumes by hour and day of week.

Table 3. Survey Locations

Survey Number	Street Name	Reason	Survey Frequency	Automatic Counter
1	Maritime and West Grand Avenue	Port entrance/exit	3 days	
2	7th Street and Frontage	Port entrance/exit	3 days	
3	3rd Street and Adeline Street	Port entrance/exit	3 days	X
4	3rd Street and Market Street	Port entrance/exit	3 days	
5	Mandela Parkway and West Grand Ave	Major intersection	2 days	X
6	San Pablo Avenue and West Grand Ave	Major intersection	2 days	
7	7th Street and Mandela Parkway	Major intersection	2 days	
8	7th Street and Adeline Street	Major intersection	2 days	
9	5th Street and Market Street	I-880 ramp	2 days	
10	Frontage and West Grand Avenue	I-80 ramp	1 day	
11	Hollis Street and Peralta Street	Significant truck traffic	1 day	
12	6th Street and Market Street	I-880 ramp	1 day	
13	5th Street and Adeline Street	I-880 ramp	1 day	
14	18th Street and Peralta Street	Significant truck traffic	1 day	
15	7th Street and Wood Street	Post office	2 days	
16	Mandela Parkway and 34th Street	Perimeter entrance	½ day	
17	Hollis Street and 34th Street	Perimeter entrance	½ day	
18	Peralta Street and 35th Street	Perimeter entrance	½ day	
19	Adeline Street and 35th Street	Perimeter entrance	½ day	
20	Market Street and 35th Street	Perimeter entrance	½ day	
21	Martin Luther King Drive (MLK) and 34th Street	Perimeter entrance	½ day	
22	30th Street and MLK	Perimeter entrance	½ day	X
23	27th Street and Northgate Avenue	Perimeter entrance	½ day	
24	Market Street and 18th Street	Perimeter entrance	½ day	X
25	14th Street and Poplar Street	High activity street	½ day	
26	12th Street and Brush Street	Perimeter entrance	½ day	
27	7th Street and Brush Street	Perimeter entrance	½ day	
28	6th Street and Brush Street	Perimeter entrance	½ day	
29	5th Street and Broadway Street	Perimeter entrance	½ day	
30	7th Street and Harrison Street	Perimeter entrance	½ day	
31	Embarcadero and Fallon Street	Perimeter entrance	½ day	
32	Wood Street and 14th Street	Alternative access to Port	½ day	
33	10th Street and Union Street	Proximity to schools	½ day	
34	Poplar Street and 30th Street	Proximity to schools	½ day	
35	9th Street and Pine Street	Truck restricted road	½ day	
36	Chestnut Street and 28th Street	Proximity to schools	½ day	
37	5th Street and Union Street	I-880 ramp	1 day	
38	7th Street and I-880 (Southbound)	I-880 ramp	1 day	

Figure 4. Surveyed Locations



Note: Plot numbers correspond to survey numbers listed in Table 3.

2.1.2.1 Manual Survey Procedures

For the manual counts, survey teams were posted at selected locations including arterials roads leading to the Port of Oakland, main arterial roadways, and surface streets within the West Oakland community. Survey teams consisted of Oakland residents recruited by the WOEIP and trained by STI and Wiltec to identify trucks and use the survey sheets (Appendix A). Counters were required to have a high school degree, possess a valid California driver license or identification card, and be at least 21 years of age. Each team, consisting of two people, conducted hourly truck counts at each survey location recording the truck movement at the intersection and the number of truck axles. District staff also participated in the manual counts by auditing counts at high traffic locations to estimate the margin of error of counts for statistical purposes.

Survey sheets also allowed counters to further categorize trucks as bobtails (truck power unit without chassis or trailer), chassis (power unit hauling a chassis without a container) or a container truck (power unit hauling a chassis carrying a container). In this survey, these three categories were classified as Port-related trucks. The District recognizes that the truck classification method may result in some small fraction of non-Port trucks being identified and counted as Port trucks. Further discussion regarding the uncertainty associated with this approach is discussed in Section 5.3.

The primary surveys (survey locations 1 through 36) were conducted on August 18 though 29, 2008 (see Table 4 for schedule). Certain locations such as arterial roads leading to the Port were surveyed on weekdays corresponding to high traffic volumes based on discussions with community residents and Port representatives. For example, arterials leading to the Port were surveyed on Monday because cargo ships arriving on Sunday must wait at the docks until Monday to be unloaded. Two locations were later added to the survey after District staff identified data gaps between the estimated numbers of trucks that enter and exit West Oakland based on the GPS tracking data from the Port of Oakland. 7th Street/I-880 (southbound) and 5th Street/Union Street were surveyed each for a day by STI on December 8 and 10, 2008. Both locations are high traffic intersections near I-880 freeway on-ramps.

Table 4. Schedule of Manual Truck Counts for the Primary Surveys

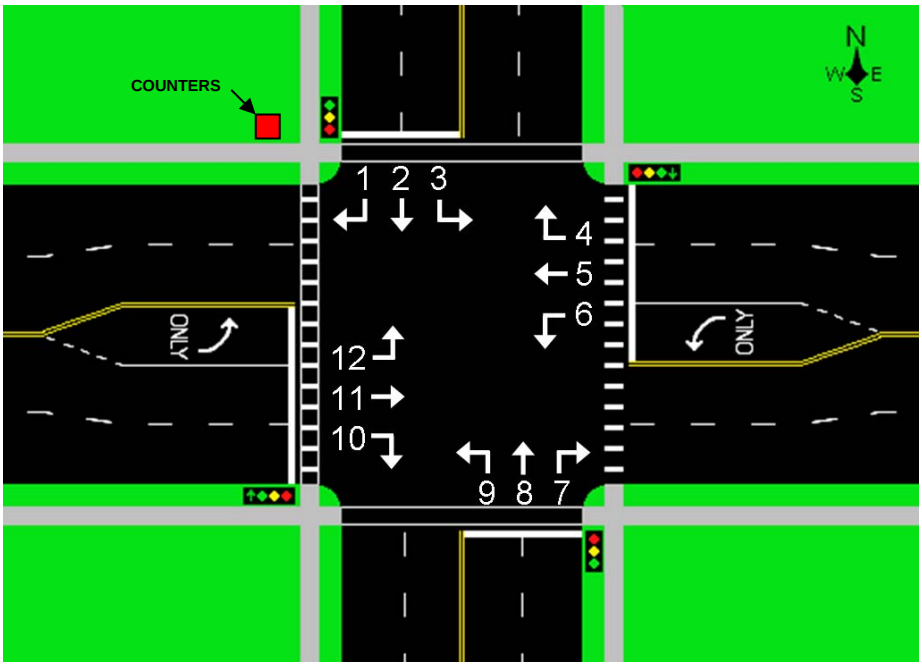
Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Aug 18 - Mandela & West Grand - San Pablo & West Grand - Hollis & Peralta - Hollis & 34th - Poplar & 30th	**Aug 19** - Mandela & West Grand - San Pablo & West Grand - Mandela & 34th - Peralta & 35th - Adeline & 35th	**Aug 20** - Maritime & West Grand - 7th & Frontage - 3rd & Adeline - 3rd & Market	**Aug 21** - 18th & Peralta - 7th & Wood - Chestnut & 28th - Wood & 14th - 14th & Poplar	**Aug 22** - MLK & 34th - 30th & MLK - 27th & Northgate - Market & 18th - Market & 35th	**Aug 23** - Maritime & West Grand - 7th & Frontage - 3rd & Adeline - 3rd/ Market
Aug 25 - Maritime & West Grand - 7th & Frontage - 3rd & Adeline - 3rd/ Market	**Aug 26** - 7th & Adeline - 6th & Market - 7th & Wood - 10th & Union - 9th & Pine	**Aug 27** - 5th & Market - 5th & Adeline - Frontage & West Grand - 7th & Mandela	**Aug 28** - 7th & Adeline - 5th & Market - 7th & Mandela	**Aug 29** - 12th & Brush - 7th & Brush - 6th & Brush - 5th & Broadway - 7th & Harrison - Fallon & Embarcadero	

Surveys were conducted in two shifts representing morning hours from around 7:30 am to 1:00 pm and afternoon hours from 1:00 pm to 6:00 pm. Surveyors arrived at the WOIP office approximately 30 to 45 minutes before their shifts began. At the office, the counters were grouped into teams of two and assigned a survey location for the day. Teams were provided with necessary supplies to complete the survey including survey sheets, clipboards, safety vests, portable chairs, ear plugs, face mask (if necessary), and pen or pencil. The District provided WOEIP with identification cards for use during the survey and handouts containing information on the survey and contact information. STI and Wiltec staff supervised the survey teams.

At the beginning of the shift, teams were driven to their assigned intersection and set up on the northwest corner of the intersection. As illustrated in Figure 5, vehicles have 12 possible turning movements upon entering an intersection, with the southbound right turn always designated as movement 1. From the four corners of the intersections, a vehicle may go straight, turn right, or turn left. One person per team was assigned to record truck movements one through six, corresponding to southbound or westbound traffic. The other team member recorded traffic movement seven through 12 that represent northbound or eastbound traffic. Counters

documented the number of axles per truck and if the trucks were associated with Port activities. For Port trucks, the counter recorded whether the truck was a bobtail, chassis, or container trucks. Survey sheets (see Appendix A) were changed every hour. Section 2.1.2.2 presents a description of the different types of trucks and a guide to identifying Port-related trucks (as provided by CARB) that was used in this survey. The majority of the half day surveys were completed in the morning shift. STI and Wiltec staff relieved the counters on a rotational basis once during each shift. At the end of the shift, the new team was dropped off and set up at the intersection while the previous team returned to the WOEIP office to process the survey sheets.

Figure 5. Vehicle Turning Movement Designations



2.1.2.2 Truck Classification

All counters were required to attend a training course taught by STI and Wiltec on August 12, 2008, at the West Oakland Library that provided information on filling in the survey sheets, proper code of conduct, and identification of truck and axles. Counters were taught to record each truck on the survey sheet based on the number of axles. Truck axles are the supporting shafts that hold the revolving tires. From a profile view of a truck, the number of axles corresponds to the number of visible tires. A single axle was counted in cases where more than two tires are positioned on a single axle. Counters recorded axles based on the classification in Table 5. Counters practiced counting trucks on the intersection of 5th and Adeline Street as part of the training course.

Counters were trained to identify Port trucks from non-drayage trucks. Port trucks can be categorized into three types depending on tractor and trailer articulation with and without a container. The three types of Port trucks counted in this study are bobtail, chassis, and container trucks. Bobtails are three axle tractors that do not have the trailer attached (see Figure 6). For this survey, three axle trucks were recorded as either a bobtail associated with Port activity or other type, such as cement mixer or box truck.

Table 5. Truck Classification by Number of Axles

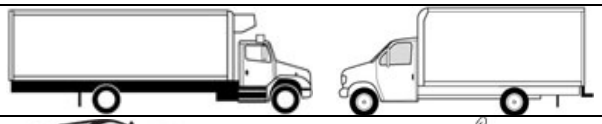
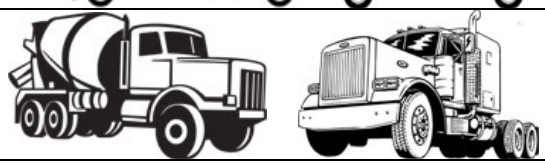
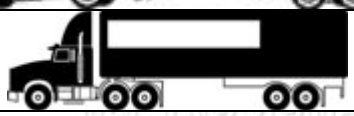
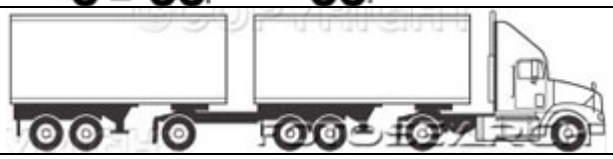
Number of Axles	Example	Representative Truck
2 axles		Box Truck, Courier Van
3 axles		Bobtail truck, Cement Mixer, Package Delivery Van, Flat Bed, Moving Van
4 axles		Car-carrier, Tractor/trailer
5 axles		Port freight truck, gasoline tanker truck
6 or more axles		Tandem tractor/trailer

Figure 6. Bobtail trucks

Chassis trucks are tractors with an attached I-Beam chassis trailer. The I-Beam trailers as shown in Figure 7 are used to secure either 20 foot or 40 foot ribbed containers that are loaded or unloaded to/from cargo ships.

Figure 7. Chassis Truck

The I-Beam chassis is different from a typical flatbed chassis shown in Figure 8. A flatbed chassis is not a container chassis used to transport Port cargo and thus a tractor with a flatbed chassis was recorded based on the number of axles of the truck, but was not counted as a Port-related vehicle.

Figure 8. Flatbed Chassis

The most common type of Port related trucks are container trucks shown in Figure 9. The container trucks typically have five axles with a container loaded on an I-Beam bed chassis trailer. The containers are either 20 feet or 40 feet long with the characteristic vertical ribbing and corner castings (punched holes) on the bottom edge of the container as shown in Figure 9. For trucks with containers, only those trucks with the vertical ribbing and corner castings on the containers were counted as Port trucks.

Figure 9. Examples of Container Trucks with Vertical Ribbing

Container trucks without the typical ribbing and corner castings were not counted as Port related vehicles, but were counted as non-drayage trucks based on the number of axles. Container trailers for non-Port activities are typically 53 feet long with the container built on the chassis as a single unit (see Figure 10). The Port trucks are easily differentiated from the non-drayage trucks based on their size and characteristic vertical ribbing and corner castings on the container.

Figure 10: Examples of Non-Port Container Trucks without Vertical Ribbing

2.2 TASK 2: CONFIRM TRUCK IDLING ACTIVITY

The focus of the idling study was to verify and update the findings from previous studies since the adoption of CARB's idling regulation. CARB regulations prohibit heavy-duty trucks from idling for more than five minutes within California's borders except under certain conditions such as traffic congestion or queuing at Port terminals. The District has sponsored numerous

outreach efforts to inform truck drivers of the new regulation. In addition, WOEIP conducted extensive outreach campaigns in West Oakland to educate truck drivers and residents on the requirements of the regulation. To gather more information on idling activities, the WOEIP report (TIAX, 2003) had community members conduct an idling study at six terminal gate entrances and one weigh station at the Port of Oakland. The study found that most trucks idle while waiting to be processed through the terminal gate. It takes approximately five minutes for a Port truck to be processed before entering the terminal and given the long queue that develops, the study estimated that the combined average idling time from all trucks is approximately 280 hours per day.

The District and contractor, STI, completed a study (Reid, 2007) that documents emission estimation techniques of diesel particulates generated from trucks and construction equipment. As part of that study, District staff, STI, and community members identified 52 truck-based businesses in West Oakland and surveyed these businesses regarding truck idling activities. Reported idling times ranged from 1 to 30 minutes; most facilities reported idling times of 10 minutes or less. However, 28 businesses did not respond to the survey within the project's deadline, so idling times for those facilities were based on limited curb-side observations or assumed to be 10 minutes.[1]

Because of the extensive studies that have already been completed by the Pacific Institute and the District, the focus of this task was to confirm and refine the findings from previous studies. The District, STI, and WOEIP developed a list of 11 targeted facilities (see Table 6). Three of the locations were being resurveyed to either verify or update their reported idling activity. Team One and AV Trucking were included in this survey since they did not complete the previous survey from 2007. Three lunch locations frequented by truck drivers and three Oakland businesses not previously surveyed were also included.

The task required that eight of the businesses fill out surveys that were then confirmed through curbside observations in the field. A sample of the survey sheets is provided in Appendix A. Idling activities at the remaining three lunch stops were estimated based on field observations alone. In August 2008, the District sent letters to the eight businesses requesting their participation in the study. District inspection staff hand delivered surveys to those businesses that did not reply to the initial request after one month. District staff interviewed the remaining businesses that had not completed the survey by December 1, 2008. STI conducted curbside observations in August 2008 at all of the survey locations except at Mayway Corporation, which is fully enclosed by a solid wall and reported to not own or operate a diesel fleet, but uses commercial delivery services instead.

[1] An average idling time of 10 minutes was calculated from survey results and used for facilities that did not report idling information.

Table 6. Truck Idling Survey

Company Name	Street Address	Survey/Observations	Notes
Team One	2515 Magnolia Street	Survey/Observation	Not previously surveyed
Oakland Maritime Support Services (OMSS)	11 Burma Road	Survey/Observation	Verify previous survey
US Postal Service	1675 7th Street	Survey/Observation	Verify previous survey
Pacific Galvanizing, Inc.	715 46th Avenue	Survey/Observation	Not previously surveyed
Horizon Beverage Company	1700 20th Street	Survey/Observation	Not previously surveyed
Tighe Drayage Company (Eighteen Trucking)	2230 Willow Street	Survey/Observation	Verify previous survey
A V Trucking Company	1155 3rd Street # 300	Survey/Observation	Not previously surveyed
Mayway Corporation	1338 Mandela Parkway	Survey only	Not previously surveyed
Lunch location	3rd Street between Myrtle and Market	Observation only	Recommended by community
Lunch location	Maritime Street and 14th	Observation only	Recommended by community
Coffee stand and mini mart	11 Burma Road	Observation only	Recommended by community

2.3 TASK 3: COLLECT TRUCK LICENSE DATA

Emissions rates from trucks depend on the age distribution of the trucks as well as environmental conditions, such as temperature and operating conditions, especially average speed. Age distribution plays a significant role because of recent regulations that significantly reduce criteria pollutant emissions from newer trucks. A common practice is to use older on-road trucks that are near the end of their useful life to serve the Port because of the lower annual mileage, proximity to repair facilities, and the low profit margin in Port business. In ENVIRON's Revised Seaport Air Emission Inventory (2008), the fleet distribution serving the Port of Oakland was primarily between model years 1993 and 1999 (50th percentile truck age is 1997) with almost no trucks newer than 2000 being used. As part of this survey, truck license data were collected to determine current truck age distribution at the Port to get some indication of the vehicle VMT since newer trucks are driven more miles than older trucks.

During the manual truck counts, counters recorded the license plates of at least 10 trucks that entered the survey intersection per hour. The purpose of gathering the license plate data was to develop an age distribution of diesel trucks in West Oakland. Previous studies have shown

significant differences in truck age distributions developed from license plate data collected at the Port of Oakland and at the Port of Los Angeles (ENVIRON, 2008).

While developing the protocol for collecting the license plate data, STI tried using a digital camera, voice recorder, and field sheets to collect the data. However after testing the equipment in the field, STI found that the best approach was to record the license plates manually on a separate log sheet to avoid confrontations with truck drivers who sometimes objected to having their vehicles photographed.

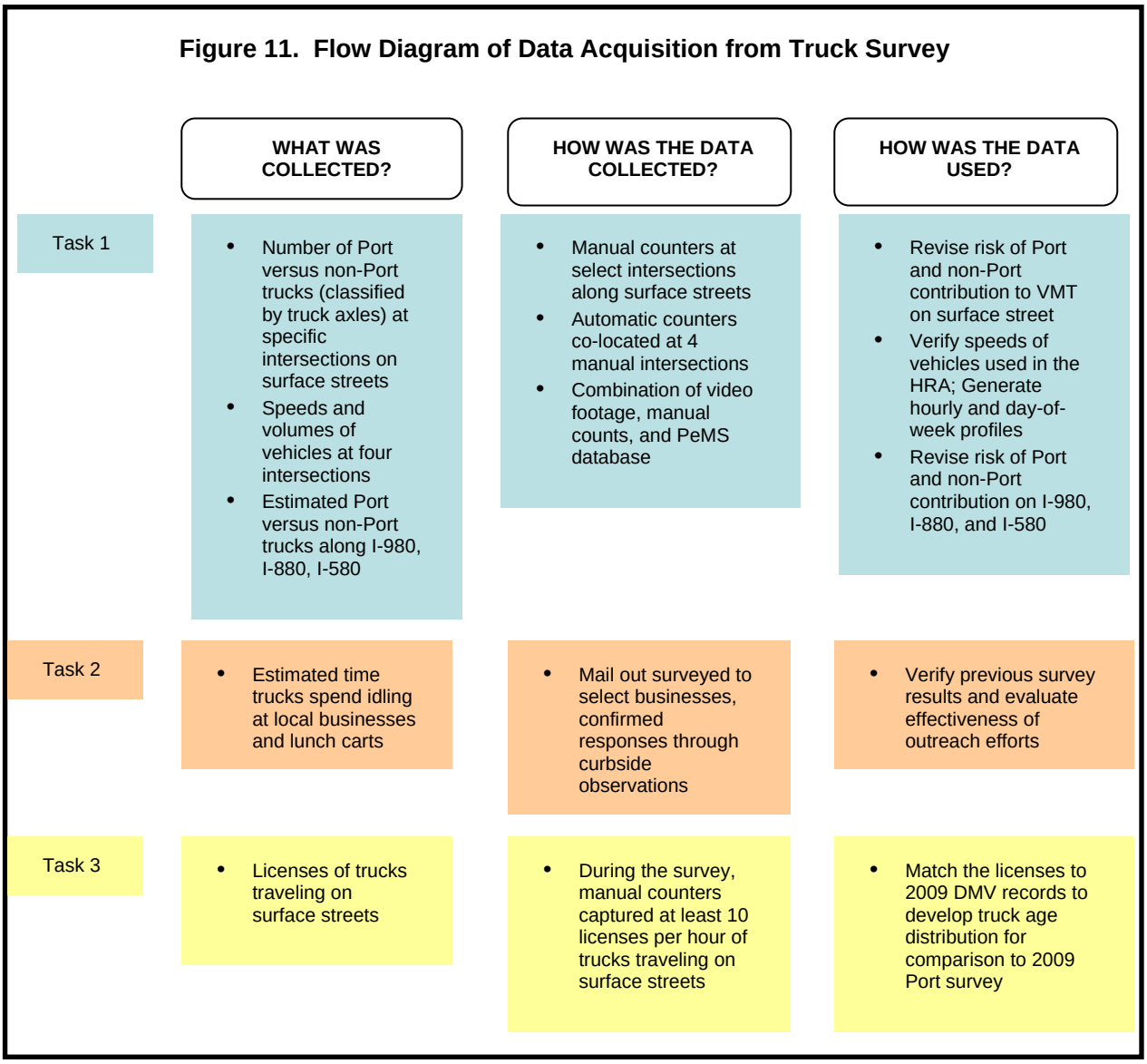
The license numbers were then manually entered into a Microsoft Access database. The final list was provided to CARB staff which accessed the California's Department of Motor Vehicles database for 2007. CARB provided information on the model year, fuel type, manufacturer's maximum gross vehicle weight ratings (GVWR), the number of axles, the city of registration, and zip code of registration. The GVWR is the maximum allowable total weight of the truck when loaded that includes the fuel, passengers, cargo, and trailer. Typically, drayage trucks are in the GVWR class of greater than 33,000 pounds, called heavy heavy-duty trucks.

The license database available to CARB represented a single "snap-shot" of the DMV database in time. A problem encountered in using these data was that many license records were missing, that is there was no match found in the database. Subsequently, the District has acquired "real-time" access to DMV records, which have been used to match a higher percentage of the licenses recorded during the survey. The age distribution and city of registration developed for this survey relied on the records derived by the District and are reflective of DMV's 2009 database. However, the weight information was provided by CARB.

3. DATA ANALYSIS AND COMPILATION OF RESULTS

This section presents the data analysis used to estimate diesel truck activity including the number of diesel vehicles, age distributions, and idling activities. Figure 11 presents a flow diagram of the data that was collected from each task and how that data was used. The results of the survey were compiled by STI and provided to the District for additional processing and analysis. A summary of the results are presented in Section 4.0 as well as comparisons of the results to estimated on-road diesel truck activity from the HRA.

Figure 11. Flow Diagram of Data Acquisition from Truck Survey



3.1 WEST OAKLAND TRAFFIC COUNTS AND VEHICLE SPEED

3.1.1 Surface Street Counts

Manual counts were performed at 38 intersections in West Oakland. Twenty-eight of the surveys were single or half a day counts while the remaining ten intersections were surveyed over multiple days (two or three days). The truck counts presented in this section are reflective of weekday activities between the hours of 7:30 am to 6:00 pm and Saturday activity during this same period at the Port entrances. However, it should be noted that truck traffic varied day to day as indicated from the multiple day counts.

Table 7 presents the total daily weekday manual counts (combined from all 12 possible turning movements) for all intersections that were surveyed. Counts from half-day surveys (noted with *) were doubled to reflect full day counts. The highest total truck traffic (greater than 1,000 trucks) is located near on-ramps to freeways and arterials leading to the Port of Oakland. Of the arterials leading to the Port (locations 1 through 4), Port trucks represent from 51% to 84% of the traffic volume. Port trucks represented about 46% to 80% of the trucks traveling on freeway on-ramps (locations 9, 10, 12, 13, 37, and 38). Sites with moderate to low (greater than 100 trucks but less than 1,000) truck counts are perimeter entrances (locations 16 through 31) into West Oakland and tend to be dominated by non-Port trucks, accounting for 64% to 100% of the total truck counts at these sites. Sites with very low truck counts (< 100) were sites near schools. Of the sites counted that are near schools (locations 33, 34, and 36), non-Port trucks represent 91% to 100% of the total trucks. Poplar and 30th has the most truck traffic in close proximity to a school, with 201 trucks (combined Port and non-Port trucks) counted during a half day survey (or 402 trucks for a daily total).

Table 7. Total Weekday Daily Manual Truck Counts for Surface Streets

Location	Intersection	Date of Survey	Total Number of Port Truck	% of Port Trucks	Total Number of Non-Port Trucks	% of Non-Port Trucks	Total Trucks
1	Maritime & West Grand	8/20/2008	1120	57%	843	43%	1963
		8/25/2008	999	61%	644	39%	1643
2	7th & Frontage	8/20/2008	2404	68%	1124	32%	3528
		8/25/2008	3002	61%	1902	39%	4904
3	3rd & Adeline	8/20/2008	2897	81%	670	19%	3567
		8/25/2008	3720	84%	693	16%	4413
4	3rd & Market	8/20/2008	656	51%	623	49%	1279
		8/25/2008	969	57%	735	43%	1704
5	Mandela & West Grand	8/18/2008	372	24%	1191	76%	1563
		8/19/2008	399	21%	1546	79%	1945
6	San Pablo & West Grand	8/18/2008	67	16%	360	84%	427
		8/19/2008	49	7%	653	93%	702
7	7th & Mandela	8/27/2008	235	33%	487	67%	722
		8/28/2008	223	33%	450	67%	673

Location	Intersection	Date of Survey	Total Number of Port Truck	% of Port Trucks	Total Number of Non-Port Trucks	% of Non-Port Trucks	Total Trucks
8	7th & Adeline	8/26/2008	150	23%	492	77%	642
		8/28/2008	120	20%	491	80%	611
9	5th & Market	8/27/2008	488	46%	584	54%	1072
		8/28/2008	509	52%	477	48%	986
10	Frontage & West Grand	8/27/2008	1954	53%	1743	47%	3697
11	Hollis & Peralta	8/18/2008	17	6%	246	94%	263
12	6th & Market	8/26/2008	923	69%	414	31%	1337
13	5th & Adeline	8/27/2008	2962	80%	736	20%	3698
14	18th & Peralta	8/21/2008	36	21%	138	79%	174
15	7th & Wood	8/21/2008	271	31%	593	69%	864
		8/26/2008	317	32%	662	68%	979
16*	Mandela & 34th	8/19/2008	20	6%	328	94%	348
17*	Hollis & 34th	8/18/2008	16	9%	170	91%	186
18*	Peralta & 35th	8/19/2008	16	5%	304	95%	320
19*	Adeline & 35th	8/19/2008	10	6%	152	94%	162
20*	Market & 35th	8/22/2008	6	2%	302	98%	308
21*	MLK & 34th	8/22/2008	0	0%	216	100%	216
22*	30th & MLK	8/22/2008	0	0%	148	100%	148
23*	27th & Northgate	8/22/2008	38	8%	450	92%	488
24*	Market & 18th	8/22/2008	18	5%	330	95%	348
25*	14th & Poplar	8/21/2008	30	20%	120	80%	150
26*	12th & Brush	8/29/2008	40	14%	256	86%	296
27*	7th & Brush	8/29/2008	74	14%	458	86%	532
28*	6th & Brush	8/29/2008	34	31%	74	69%	108
29*	5th & Broadway	8/29/2008	270	22%	978	78%	1248
30*	7th & Harrison	8/29/2008	334	36%	596	64%	930
31*	Embarcadero & Fallon	8/29/2008	214	28%	556	72%	770
32*	Wood & 14th	8/21/2008	16	5%	308	95%	324
33*	10th & Union	8/26/2008	4	4%	90	96%	94
34*	Poplar & 30th	8/18/2008	36	9%	366	91%	402
35*	4th & Pine	8/26/2008	2	25%	6	75%	8
36*	Chestnut & 28th	8/21/2008	0	0%	46	100%	46
37	5th & Union	12/9/2008	1420	56%	1138	44%	2558
38	7th & I-880	12/8/2008	1088	74%	384	26%	1472

Notes: * Half day surveys were doubled to represent full day counts.
Port trucks included bobtails, Port chassis, and Port container trucks

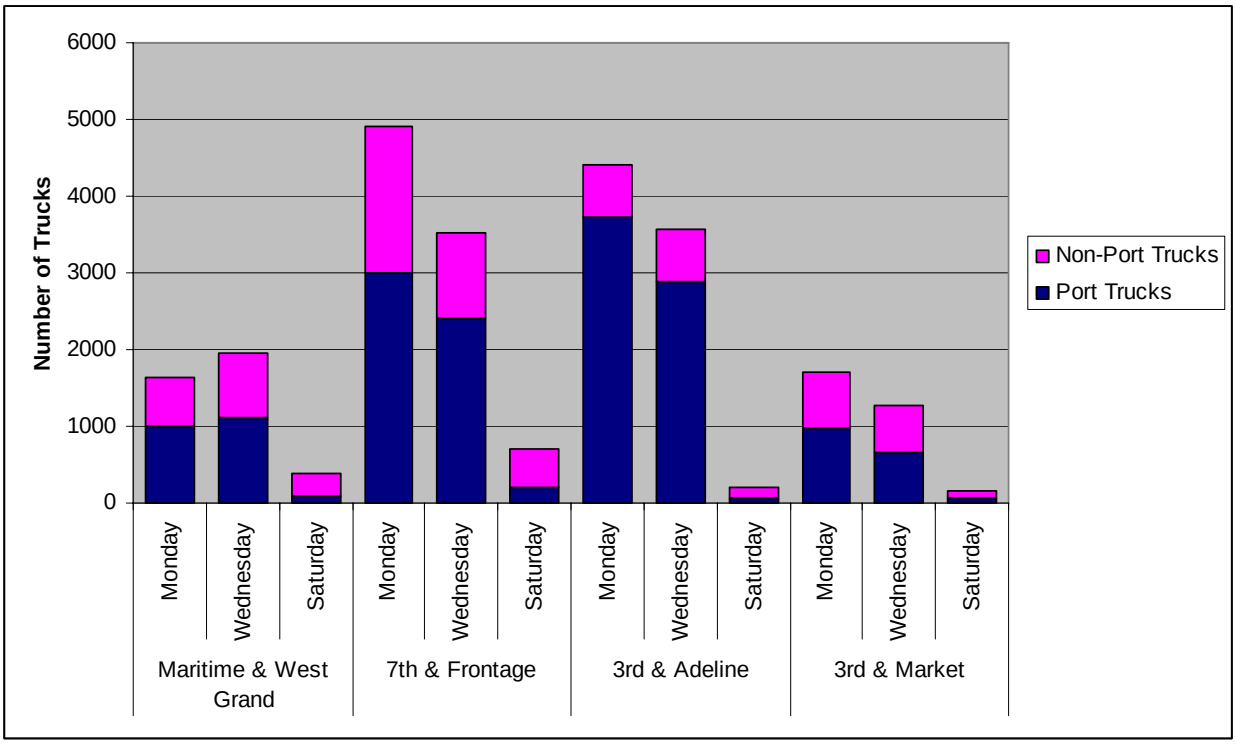
Weekend counts were only performed on Saturday, August 23, 2008 at four arterial roads leading to the Port (locations 1 through 4). Table 8 presents the total daily number of trucks that were counted on Saturday. The counts at these sites were dominated by non-Port trucks that represented 61% to 74% of the total trucks counted at these sites. For Port arterial roads where counts were performed Monday, Wednesday, and Saturday, truck volumes tended to be heaviest on Monday (see Figure 12). Truck volumes along Port arterial roads decreased by 80-95% on

Saturdays, relative to weekday averages. Although Port terminals and gates are closed on Saturday, the survey showed limited goods movement along these roadways, which may be associated with intermodal domestic rail transport.

Table 8. Saturday Manual Truck Counts on Port Arterial Roads

Location	Intersection	Date of Survey	Total Number of Port Truck	% of Port Trucks	Total Number of Non-Port Trucks	% of Non-Port Trucks	Total Trucks
1	Maritime & West Grand	8/23/2008	96	26%	280	74%	376
2	7th & Frontage	8/23/2008	197	28%	499	72%	696
3	3rd & Adeline	8/23/2008	68	33%	140	67%	208
4	3rd & Market	8/23/2008	61	39%	95	61%	156

Figure 12. Port and Non-Port Truck Counts by Day of Week at Port Arterial Roads.



3.1.2 Freeway Counts

Manual freeway counts of I-580, I-880, and I-980 were conducted by STI. Video footage was collected of only I-880 in half hour intervals that were alternated with half hour intervals of manual counting from the West Oakland BART platform. The video footage, however, was not processed due to low visibility that made distinguishing the number of truck axles difficult. Half-day manual counts were collected from I-880 on Monday, Wednesday, and Saturday and

one full day count was collected on Sunday. Manual surveys were performed on a Tuesday for half a day on I-580 and corresponding full day on I-980.

Table 9 presents the hourly weekday and weekend manual counts for all freeways surveyed. Counts collected for less than one hour were linearly extrapolated to reflect hourly counts. For weekday traffic, Port trucks represent approximately 28% to 45% of the trucks traveling on I-880. Non-Port trucks dominated the weekend traffic by representing 76% to 100% of the trucks traveling on I-880. For both I-580 and I-980, Port trucks represent a small fraction (ranging from 0 to 7%) of the overall trucks traveling on these freeways.

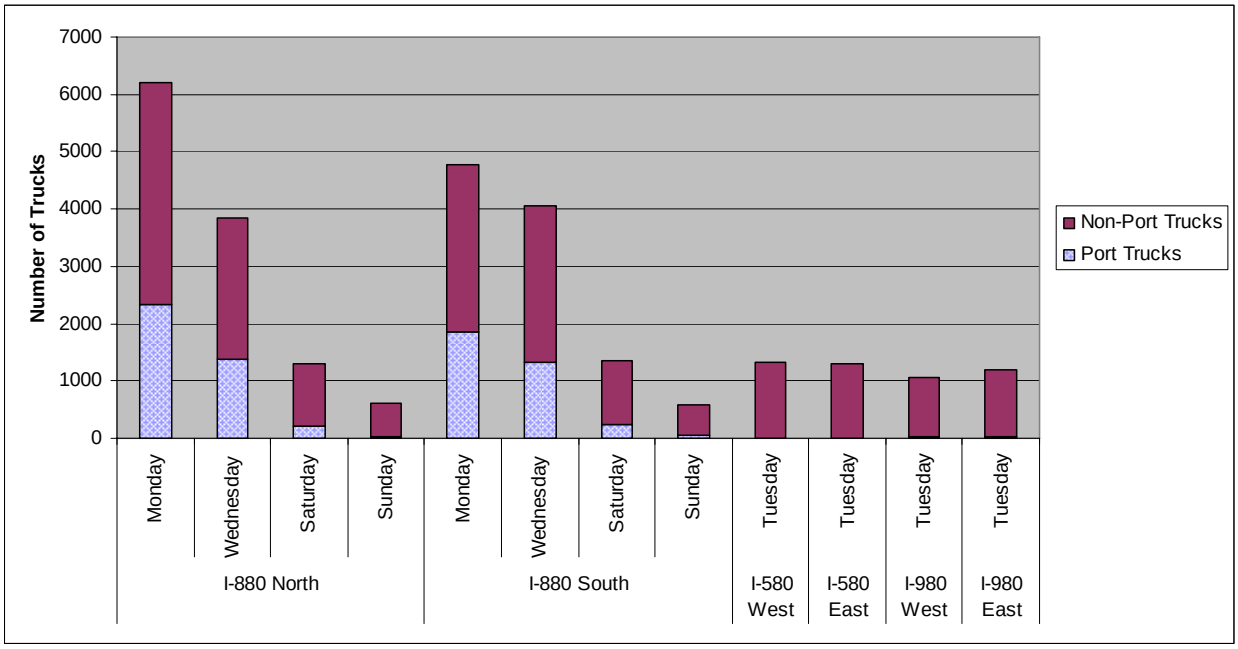
Figure 13 presents the daily traffic counts (7:00 am to 6:00 pm) that were extrapolated from the hourly manual counts. The highest total weekday count of over 6,000 Port and non-Port trucks were recorded on Monday along northbound I-880. Truck volumes on I-880 progressively declined as the week advanced with the lowest overall recorded truck counts occurring on Sunday. Truck volumes on all surveyed freeways were evenly distributed in both directions except for Monday where northbound traffic on I-880 was approximately 20% higher as compared to southbound traffic volumes. Similar to the findings from the surface street survey, a small fraction (ranging from 4% to 18%) of Port trucks were counted on the weekend on I-880 even though the Port terminals and gates are closed. Some of the weekend activity may be associated with intermodal domestic rail transport.

Table 9. Total Hourly Manual Counts for Freeways

Freeway	Traffic Direction	Date of Survey	Start Time	Hourly Number of Port Trucks	% of Port Trucks	Hourly Number of Non-Port Trucks	% of Non-Port Trucks	Total Trucks per Hour
I-880	Northbound	12/8/2008 (Monday)	8:00 AM	142	29%	340	71%	482
			9:00 AM	244	38%	390	62%	634
			10:00 AM	247	43%	332	57%	579
		12/10/2008 (Wednesday)	1:00 PM	208	41%	300	59%	508
			2:00 PM	89	28%	230	72%	319
			3:00 PM	124	40%	188	60%	312
			4:00 PM	80	31%	180	69%	260
		12/13/2008 (Saturday)	8:00 AM	32	18%	146	82%	178
			9:00 AM	22	18%	102	82%	124
			10:00 AM	13	14%	83	86%	96
			11:00 AM	11	15%	61	85%	72
		12/14/2008 (Sunday)	8:00 AM	2	3%	60	97%	62
			9:00 AM	0	0%	64	100%	64
			10:00 AM	0	0%	48	100%	48
			1:00 PM	8	15%	46	85%	54
			2:00 PM	2	3%	72	97%	74
			3:00 PM	2	6%	30	94%	32
	Southbound	12/8/2008 (Monday)	8:00 AM	124	35%	230	65%	354
			9:00 AM	220	45%	274	55%	494
			10:00 AM	164	36%	292	64%	456

Freeway	Traffic Direction	Date of Survey	Start Time	Hourly Number of Port Trucks	% of Port Trucks	Hourly Number of Non-Port Trucks	% of Non-Port Trucks	Total Trucks per Hour
		12/10/2008 (Wednesday)	1:00 PM	148	32%	308	68%	456
			2:00 PM	128	28%	322	72%	450
			3:00 PM	116	34%	226	66%	342
			4:00 PM	88	39%	138	61%	226
		12/13/2008 (Saturday)	8:00 AM	40	23%	136	77%	176
			9:00 AM	28	24%	88	76%	116
			10:00 AM	13	12%	93	88%	106
			11:00 AM	9	10%	81	90%	90
		12/14/2008 (Sunday)	8:00 AM	6	12%	46	88%	52
			9:00 AM	12	17%	58	83%	70
			10:00 AM	6	10%	52	90%	58
			1:00 PM	2	6%	34	94%	36
			2:00 PM	6	10%	54	90%	60
			3:00 PM	3	8%	37	93%	40
I-580	Westbound	5/5/2009 (Tuesday)	8:00 AM	0	0%	81	100%	81
			9:00 AM	1	1%	125	99%	126
			10:00 AM	0	0%	140	100%	140
			11:00 AM	1	1%	133	99%	134
	Eastbound	5/5/2009 (Tuesday)	8:00 AM	0	0%	93	100%	93
			9:00 AM	0	0%	115	100%	115
			10:00 AM	2	2%	107	98%	109
			11:00 AM	2	1%	158	99%	160
I-980	Westbound	5/5/2009 (Tuesday)	9:00 AM	3	3%	93	97%	96
			10:00 AM	2	2%	110	98%	112
			11:00 AM	4	4%	96	96%	100
			1:00 PM	3	3%	109	97%	112
			2:00 PM	4	4%	110	96%	114
			3:00 PM	4	5%	77	95%	81
			4:00 PM	2	4%	54	96%	56
	Eastbound	5/5/2009 (Tuesday)	9:00 AM	2	2%	104	98%	106
			10:00 AM	0	0%	96	100%	96
			11:00 AM	1	1%	102	99%	103
			1:00 PM	1	1%	141	99%	142
			2:00 PM	0	0%	115	100%	115
			3:00 PM	1	1%	118	99%	119
			4:00 PM	6	7%	76	93%	82

Figure 13. Port and Non-Port Truck Counts by Day of Week on Surveyed Freeways.

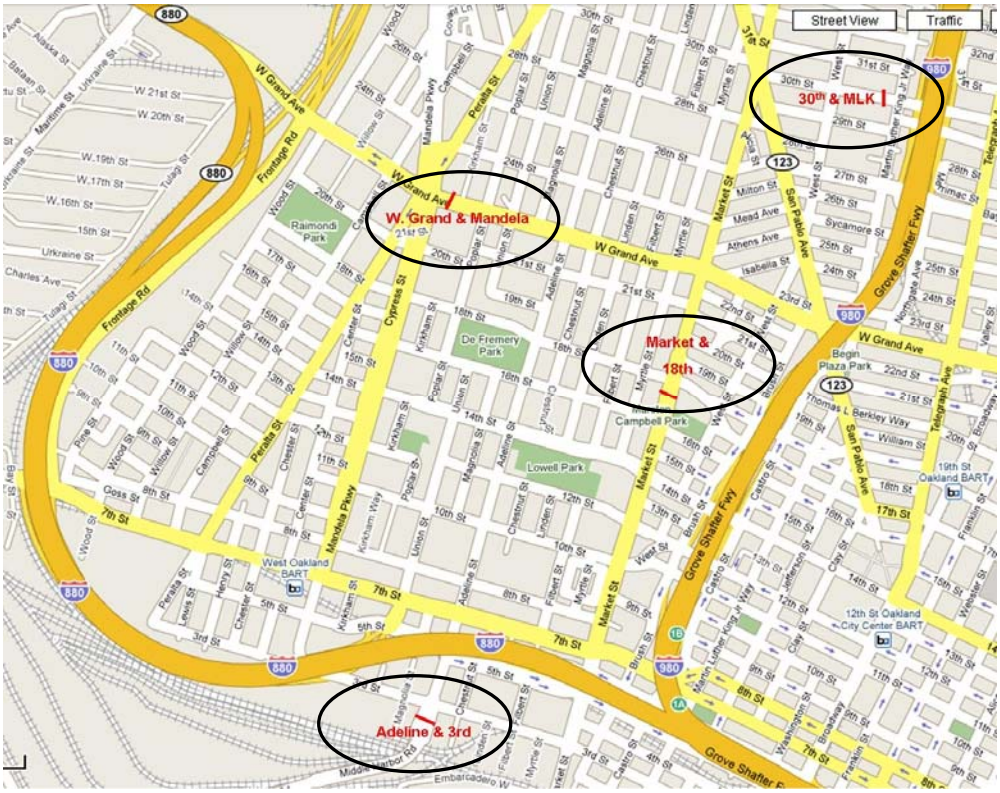


3.1.3 Automatic Counts

Wiltec co-located automatic counters with manual counters at four intersections in West Oakland. The data gathered from the automatic counters included vehicle speeds, total number of vehicles, and vehicle classification by the number of axles. The data collected from the automatic counters were then used to create temporal profiles of truck traffic in West Oakland. It should be noted that there were discrepancies between the automatic counters and the manual counters on the total number of trucks as well as categorizing trucks based on the number of axles (see Appendix B). Because of the uncertainty associated with the automatic counters, the District relied on the manual counts to estimate traffic volumes (and VMT) for West Oakland and used the automatic counters to characterize speeds and diurnal travel patterns for comparison to the HRA assumptions. The automatic counter data were not used to modify the HRA results.

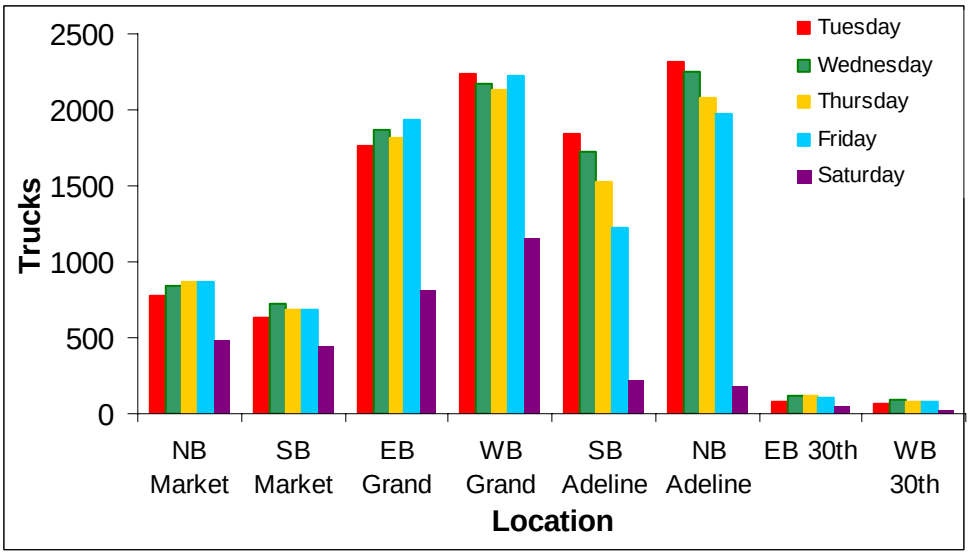
Automatic count data were collected for a five-day period spanning Tuesday through Saturday at all four intersections. The four locations represent two high traffic locations (3rd Street/Adeline Street and Mandela Parkway/West Grand Avenue), one moderate traffic location (Market Street/18th Street), and one low activity residential street (30th Street/ Martin Luther King Drive) (see Figure 14). Figure 15 presents the distribution of truck activity based on the day of the week. Consistent with the manual counts that were conducted over multiple days, there is a steep decline of 34% to 90% in truck traffic on Saturday as compared to the weekdays. Truck counts at Adeline Street, south of 3rd Street, which are heavily influenced by Port activity, showed a gradual declining number of trucks over the course of the week. By Saturday, the traffic at Adeline had declined by 82% to 90% of the weekday traffic counts, which is consistent with the findings from the manual counts. All of the other sites showed consistent traffic activity throughout the weekdays.

Figure 14. Placement of Automatic Counters



Note: Red lines show the approximate locations where automatic counters were installed.

Figure 15. Automatic Truck Counts by Day of Week



Note: NB = Northbound, SB = Southbound, EB = Eastbound, WB = Westbound

The truck traffic patterns over the course of the day derived from the automatic count data are shown in Figure 16. The graph indicates that the majority of the truck traffic occurs between the

hours of 7:00 am to 6:00 pm, approximately the same period for which the manual truck counts were collected. Saturday traffic patterns shown in Figure 17 show a higher hourly variation. Most of the traffic pattern on Saturday consist of two axle trucks and are likely not representative of Port-related activities.

Figure 16. Weekday Percentage of Trucks on Roads per Hour (Tuesday-Friday)

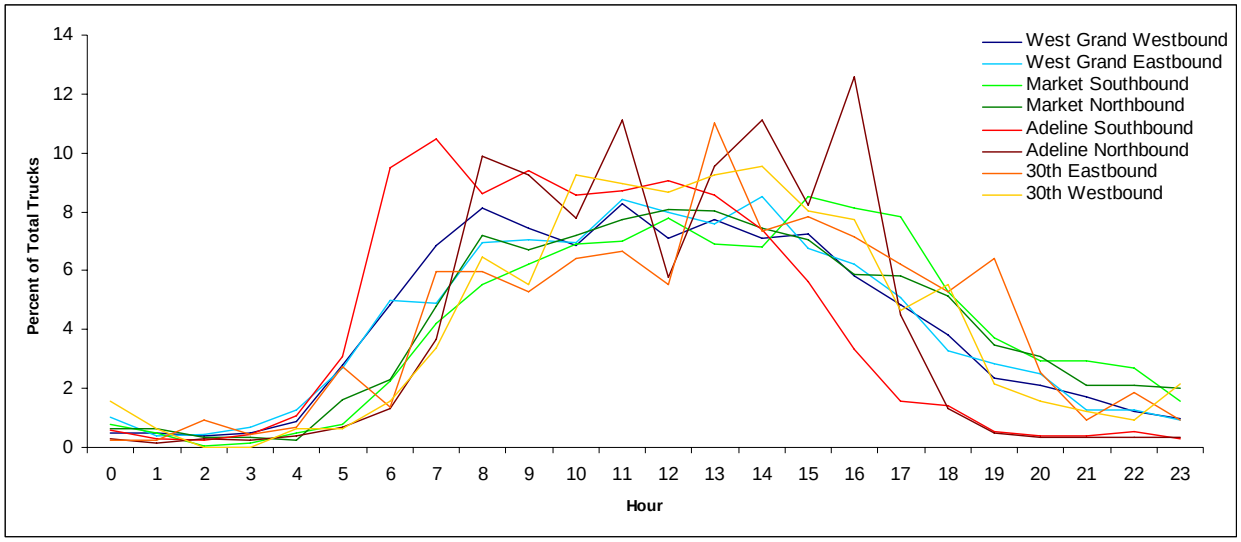
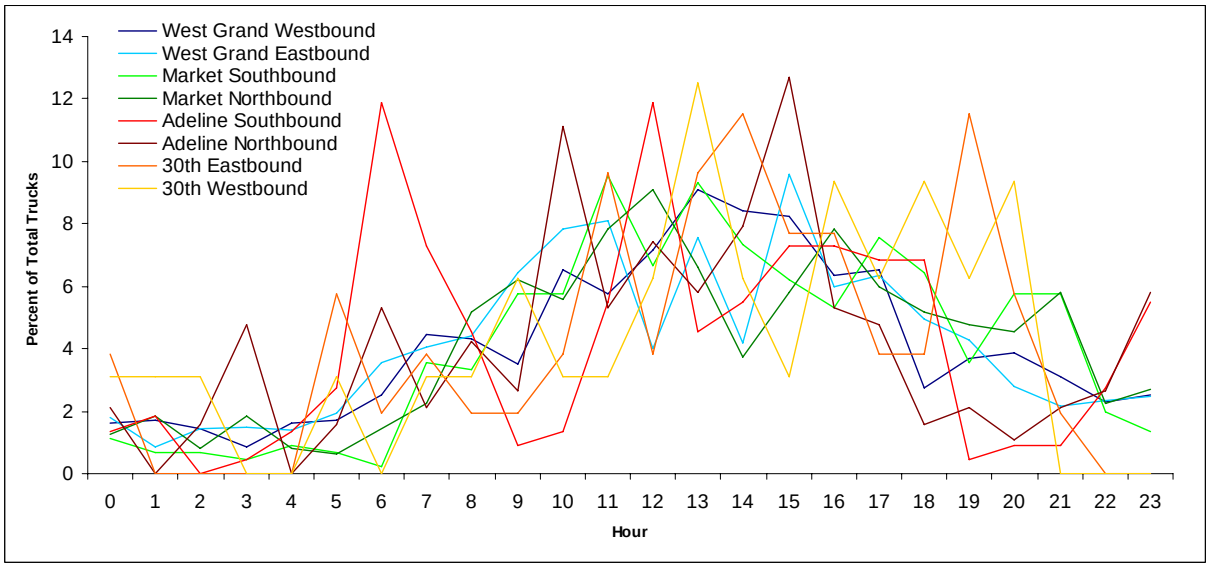
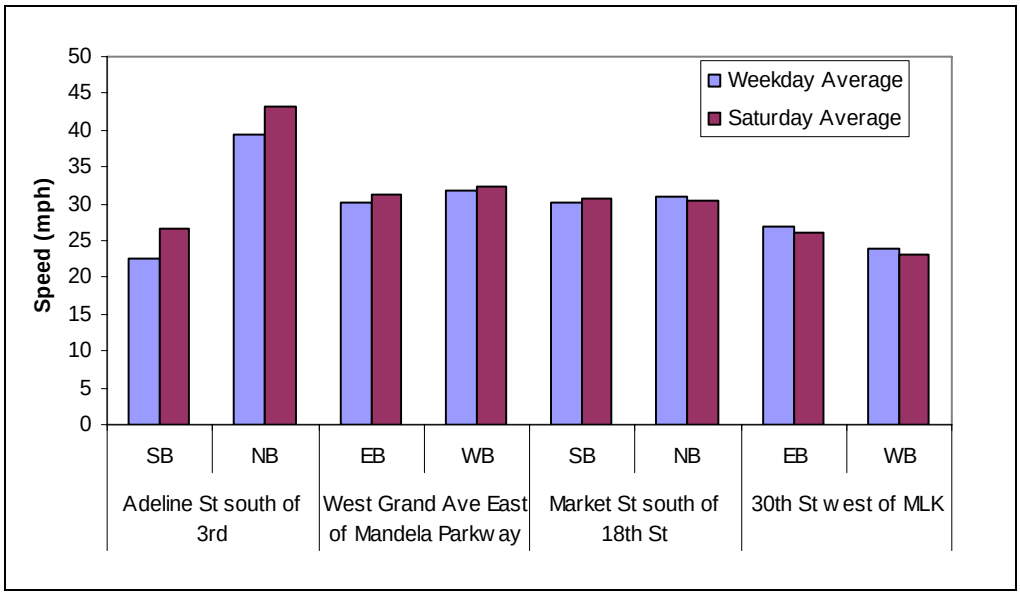


Figure 17. Weekend (Saturday) Percentage of Trucks on Roads per Hour



The automatic counters also registered vehicle speeds in miles per hour (mph) by hour of the day. Speeds varied little by time of day. The speeds were converted to 24-hour averages and also averaged across the four weekdays to produce average weekday and Saturday speeds at each of the four automatic counter locations (see Figure 18). Based on the automatic counter data, there appears to be minimal difference between weekday versus Saturday speeds.

Figure 18. Truck Speeds



Note: SB - southbound, NB – northbound, EB – eastbound, WB – westbound

3.2 TRUCK IDLING

The District conducted additional idling surveys at eight local businesses in West Oakland that were either not previously included in a survey or to confirm their responses from an earlier survey. One of these businesses is no longer in operation, but the remaining seven businesses completed the survey. Table 10 presents a list of surveyed businesses, the reported number of daily truck trips from each business, and the reported idling time per truck. Reported idling times ranged from 0 to 30 minutes, and only one facility reported idling times in excess of 10 minutes. In addition, STI also conducted curbside field observations of idling activities at these businesses to confirm reported idling times as well as at three popular mobile lunch corners on 3rd Street/Market Street, Maritime Street/14th Street, and 11 Burma Road (truck scales). Idling activities observed at the three lunch stops were about five minutes with much of the activity being sporadic and infrequent.

The US Postal Service reported 68 daily truck trips. In follow-up discussions, the Postal Service has stated that they operate a total of 68 trucks, but there are numerous other independent companies that make trips to the distribution center to ship packages. The manual counts conducted at 7th and Wood Street across from the US Postal Service main service truck gates indicated much higher numbers of trucks. Counts tallied a total of 1,843 trucks over two days at the 7th and Wood Street intersection with about 922 daily truck trips to or from the Post Office during the hours of the survey.

Table 10. Truck Idling Survey Results

Location/Company Name	Street Address	Number of Trucks Per Day	Average Idling Time Per Truck
Team One	2515 Magnolia Street	Out of business	n/a
Oakland Maritime Support Services (OMSS)	11 Burma Road	1,400	5-10 min.
US Postal Service	1675 7th Street	> 922[1]	5 min.
Pacific Galvanizing, Inc.	715 46th Avenue	1	3 min.
Horizon Beverage Company	1700 20th Street	5	3-5 min.
Tighe Drayage Company (Eighteen Trucking)	2230 Willow Street	4	0 min.
Mayway Corp.	1338 Mandela Parkway	0	n/a[2]
A V Trucking Company	1155 3rd Street # 300	5	30 min.
Lunch Location	3rd Street between Myrtle and Market	Variable	5 min.
Lunch Location	Maritime and 14th Street	Variable	5 min.
Coffee stand and mini mart	11 Burma Road	Variable	5 min.

Note: The idling times are self-reported by the businesses, but were verified through curbside observations. [1]Based on average manual counts collected on August 21 and 26, 2008 from 7:37 am to 6:00 pm. Self-reported survey results from the Post Office incorrectly responded with the number of trucks owned (68 trucks), instead of daily truck trips. [2] Shipments are sent daily through a commercial carrier.

3.3 TRUCK AGE DISTRIBUTION

As part of Task 1 (manual truck counts), counters recorded at least 10 license plates of trucks per hour during their shift to develop an age distribution of diesel trucks in West Oakland. Additional license plate data was also gathered by STI and WOEIP as they supervised the manual count teams.

A total of 7,324 truck license plates were captured in West Oakland over the course of the truck survey. These license plates were cross-referenced with 2009 California Department of Motor Vehicles (DMV) registration database which provided information on:

- Truck's model year
- Fuel type
- City of registration
- Zip code of registration, and
- Weight (gross vehicle weight rating – GVWR and number of truck axles), if available.

Of the 7,324 licenses, approximately 1,735 licenses are not registered in California. It was assumed that a majority of these vehicles are registered out of state or have since been taken out of service. About 1,141 of the 5,589 California registered licenses were recorded multiple times, which suggests that some fraction of MHD and HHD trucks routinely make local deliveries. All of the 5,589 licenses including duplicates licenses were retained to fully characterize the number of trucks and distances these trucks travel in West Oakland. Inclusion of the duplicate licenses had no impact on the resulting age distribution or median truck age shown here and in Section 4.

Table 11 and Figure 19 present the age distribution for all 5,589 trucks matched in the DMV database. Of the 5,589 matched plates:

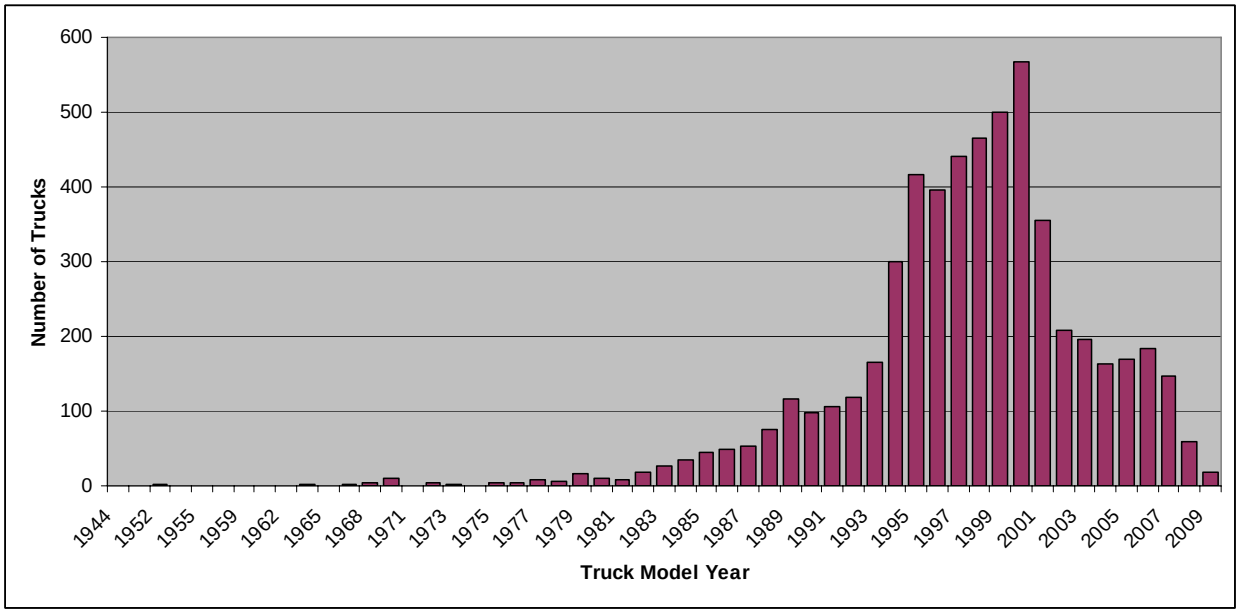
- 5,209 (93%) of the trucks are diesel-powered
- 316 (5.7%) are gasoline-fueled,
- eight (0.1%) are natural gas,
- two (0.03%) are propane, and
- 54 were unknown.

Table 11. Age Distribution and Fuel Type of Trucks Operating in West Oakland

Model Year	Number of Trucks	Fuel Type				
		Unknown	Diesel	Gasoline	Natural Gas	Propane
1944	1	1				
1951	1			1		
1952	3	1	1	1		
1954	1			1		
1955	1	1				
1957	1	1				
1959	1	1				
1960	1		1			
1962	1		1			
1964	2			2		
1965	1			1		
1966	3	2		1		
1968	4			4		
1970	11		9	2		
1971	1		1			
1972	4	1	2	1		
1973	2			2		
1974	1			1		
1975	4		2	2		
1976	4		2	2		
1977	9	1	5	3		
1978	6		1	5		
1979	17	1	12	4		

Model Year	Number of Trucks	Fuel Type				
		Unknown	Diesel	Gasoline	Natural Gas	Propane
1980	10	1	8	1		
1981	8		8			
1982	19		14	5		
1983	26	3	20	3		
1984	35	1	29	5		
1985	45		38	5		2
1986	49		42	7		
1987	53		48	4	1	
1988	76	1	67	8		
1989	116	5	99	12		
1990	97	1	90	6		
1991	107		99	8		
1992	119		113	6		
1993	165	2	154	9		
1994	301	1	288	12		
1995	417	1	399	17		
1996	395	1	382	12		
1997	440	3	422	15		
1998	465	6	443	15	1	
1999	501	3	482	16		
2000	568	3	547	17	1	
2001	355	6	339	10		
2002	208	1	193	14		
2003	196		187	9		
2004	163	1	140	18	4	
2005	169	4	150	15		
2006	183		170	13		
2007	146		128	17	1	
2008	59		55	4		
2009	18		18			
Totals	5,589	54	5,209	316	8	2

Figure 19. Truck Age Distribution Based on License Plates



4. FINDINGS AND COMPARISONS

The results of the West Oakland truck survey are summarized in this section and comparisons are presented to previous findings and assumptions in the HRA. The study objectives under Tasks 1 through 3 were to estimate traffic volumes along local streets and freeways, verify truck idling activities, and develop the age distribution of trucks. Traffic volumes were estimated using a combination of manual counters posted at specific street intersections, video tape footage of truck traffic on I-880, and automatic counters placed on local streets, and the Bay Area freeway network. Figure 20 presents a summary of the key findings that are discussed in this section.

4.1 TRAFFIC VOLUMES ON SURFACE STREETS

To ensure that the study results are typical of average conditions at the Port, the District evaluated the number of vessel calls that occurred over the course of the study. The Port of Oakland reported that the month of August typically has the highest number of vessel calls due to the upcoming holiday season. From August 18th to 29th, the Port reported 66 vessel calls - an average of 5.5 vessels per day. For 2008, a total of 1,928 vessels delivered cargo to the Port - approximately 5.3 vessels per day. Based on the comparison, the District concluded that the two week study is representative of typical operating conditions at the Port. Further discussions regarding the representativeness of the data to annual average operations conditions at the Port are presented in Section 5.3.

Truck volumes were estimated on surface streets of West Oakland by developing a roadway network of frequently used truck routes. A number of trucks were estimated to travel on each route. The District developed 55 unique routes that trucks generally travel to and from the Port of Oakland (see Appendix C). The truck routes were developed using the GPS tracking data collected from approximately 200 trucks that traveled through the Port of Oakland (see Section 1.3) from 2006 through 2007. The District also conducted a short study in 2007 to characterize routes of non-Port trucks. In that study, District staff followed an iterative process of randomly selecting trucks as they entered West Oakland and tracking them until they reached their final destination in West Oakland or merged onto the freeway. The District combined the routes from both studies to develop the detailed roadway network. The manual counts were then used to estimate the number of trucks that travel daily on each route. The manual counts provide the actual number of trucks at each intersection by the time of day and day of the week. The District then estimated the trucks on each route to closely match the intersection counts.

Figure 21 presents the truck volumes during weekday business hours on each route in West Oakland based on the results of the manual survey. A majority of the truck traffic is along main arterial roads leading to or from the Port of Oakland to the I-880 freeway. On surface streets, the District estimates that about 7,200 trucks travel daily (7:00 am to 6:00 pm) through West Oakland including trucks entering and exiting from the I-880 freeway. Port trucks represent much of the traffic; 3,700 Port trucks (51% of the truck traffic) travel daily through West Oakland on surface streets. This finding does not imply that Port trucks are traveling throughout the community on local streets, but that on average, about half of the trucks traveling on the main arterial roads, which make up the bulk of the truck volumes, are Port trucks. Table 12 presents a

Figure 20. Summary of Key Findings from Truck Survey

	DATA COLLECTED	KEY FINDINGS	COMPARISON / CONCLUSIONS
TRUCK VOLUMES	• Truck volumes on surface streets were estimated to match the manual counts at intersections along specific routes	• 7,200 trucks travel daily (7:00 am to 6:00 pm) through West Oakland on surface streets of which 3,700 (51%) are Port trucks	• This survey found significantly fewer trucks on surface streets compared to the HRA • The survey found significantly more Port trucks on surface streets compared to the HRA • Recommend estimating VMT for surface streets using survey results and estimating revised risk
	• Freeway volumes on I-880 were based on manual counts, video footage, and PeMS; Freeway volumes on I-580 and I-980 were estimated using only manual counts	• Daily freeway volumes on I-880 (7:00 am to 6:00 pm) were 9,700 trucks with 37% being Port related • 2,100 to 2,600 trucks travel from 7:00 am to 6:00 pm on I-580 and I-980 with one to two percent being Port trucks.	• The survey recorded more trucks on I-880 than used in the HRA • Truck traffic volumes on I-980 and I-580 were two to three times lower than those of the HRA • Recommend revising health risk for freeways using survey results
TRUCK IDLING	• Idling time at local businesses and lunch carts	• Majority of businesses are complying with five minute idling regulation • Results were consistent with 2007 District survey • Effective outreach being implemented by the community and regulatory agencies	• Effective outreach being implemented by the community and regulatory agencies
TRUCK AGE DISTRIBUTION	• Licenses from trucks traveling on surface streets	• Median model year for all trucks is 1997 • 78% of trucks had model year of 1994 or later • 49% of the trucks were registered in the Bay Area (mostly in Oakland, San Leandro, San Jose, and San Francisco) • 24% of the trucks were registered out of state or are no longer running • 27% of the trucks were within California, but outside of the Bay Area (mostly from Sacramento, Modesto, Stockton, Fresno, and Tracy) • Truck age consistent with Port's findings near terminals	• Truck age consistent with Port's 2008 truck age survey near terminal gates • Continue outreach by the District's incentive/grant program

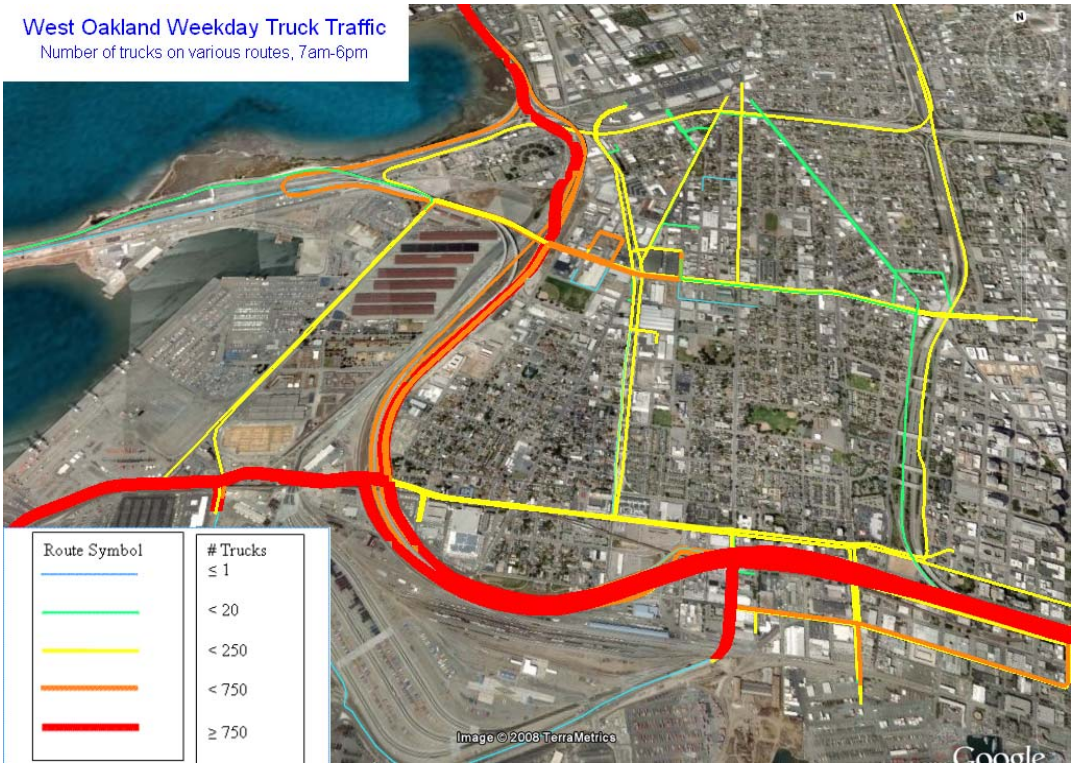
summary of estimated daily traffic volumes on surface streets in West Oakland during daytime business hours.

Table 12. Summary of Daily Truck Traffic Volume on Surface Streets

Types of Trucks	Local Streets and exiting/entering I-880
All Trucks	7,200
Port Trucks Only	3,700

Note: Truck volumes are reflective of daytime business hours from 7:00 am to 6:00 pm

Figure 21. Weekday Truck Volumes on Routes in West Oakland



The District initially attempted to extrapolate the daytime traffic volumes over 24 hours. However, nighttime activity patterns of trucks were not surveyed as part of this study. It is likely that some truck drivers prefer to travel during the evening hours to avoid traffic congestion on the freeways. Without additional survey data on nighttime activity, 24 hour traffic volumes on surface streets and freeways were not estimated.

The District compared the findings from this survey to the estimated traffic volumes used in the HRA. CARB provided the District with a database showing the entire roadway networks used in the HRA that includes speeds, link length, hour, and vehicle miles traveled. The traffic volumes and speeds were predicted using a Transportation Demand Model (TDM) that utilizes population, employment, surveys, income, roadway and transit networks, and transportation

costs to forecast traffic patterns. These activities are assigned to roadway links that represent fleet population and average speeds on a specific freeway, ramp, or major or minor arterial. The estimated VMT (from 7:00 am to 6:00 pm) in the HRA on surface streets for MHD and HHD trucks is approximately 52,400. The dimensions of the West Oakland area are roughly 1.4 miles by 1.7 miles. An individual truck travels approximately one to 1.5 miles with the West Oakland area before exiting the West Oakland boundary. The largest distance traveled by a single truck can be as much as 2.5 miles if they are making local deliveries. By dividing the VMT by the largest distance of 2.5 miles, the VMT used for the HRA corresponds to at least 21,000 trucks travelling daily through West Oakland surface streets. This truck estimate can be significantly higher if one uses a more typical distance of 1.5 miles or less (e.g., typical distance traveled by Port trucks on surface street was less than one mile in the HRA). Regardless of the exact distance traveled by trucks, the estimated surface street traffic volume used in the HRA appears to be at least three times higher than the findings from this survey (7,200 trucks).

To determine if the overestimate is consistent throughout the traffic network used in the HRA, the District compared manual counts recorded at key intersections along West Grand Avenue and Market Street to truck volumes used in the HRA (counts from 7:00 am to 6:00 pm; see Table 13). The number of trucks from the HRA was calculated by dividing the VMT by the distance traveled along each main street. At each intersection, the estimated truck counts from the TDM are consistently higher (from 4 to 22 times higher) than actual counts recorded in this survey. It should be noted that it was not possible to conduct manual counts at all intersections in West Oakland and, consequently, truck survey estimates are not definitive for all of West Oakland and only represent a snapshot of truck traffic during the times and dates in which the survey was conducted. However, even given these caveats, there are clearly significant differences in truck traffic volumes between the HRA and this truck traffic survey.

Table 13. Truck Counts Comparisons along Select Intersections (Counts from 7 a.m. to 6 p.m.)

Main Street	Starting Street to Destination Street	Estimated HRA Truck Count	West Oakland Truck Survey Truck Count
West Grand Ave	Frontage to Mandela	3,025	743 / 628 *
West Grand Ave	Mandela to Frontage	3,025	456 / 718 *
West Grand Ave	Mandela to Adeline	2,300	374
West Grand Ave	Adeline to Mandela	2,050	458
West Grand Ave	Market to San Pablo	1,700	132
West Grand Ave	San Pablo to Market	1,600	239
Market Street	West Grand to 16th	2,000	88
Market Street	16th to West Grand	1,450	172

Note: * Manual counts from 2 intersections: (1) West Grand and Frontage and (2) West Grand and Mandela.

The District also compared the fraction of trucks associated with Port activity from the HRA to those of the truck survey. In the HRA, Port trucks contribute 3% of the diesel emissions[2] on both

[2] In the HRA, Port trucks were estimated to emit 4.9 tons per year of diesel PM traveling on surface streets and 2.8 tons per year on freeways, or 7.7 tons per year out of a total of 265 tons per year from all Port-related sources. (Part I emissions Summary by Category, p. A-2 in Appendix A.)

freeways and surface streets and represent approximately 6%[3] of all heavy heavy duty trucks. This appears to under-estimate the Port's contribution since the survey found that Port trucks represent approximately 51% of all medium heavy and heavy heavy duty trucks on surface streets.

Generally, the HRA estimates of truck volumes were higher than findings from the truck survey, which corroborates the HRA's participant's suspicions regarding traffic volume over-prediction on surface streets using a TDM. It also appears that the Port's contribution on surface streets may have been under-predicted. This is consistent with the recommendation of the HRA report that the District continue to work with the community and the Port to implement further studies in order to reduce the uncertainty associated with estimates of truck activity levels in West Oakland. The District attempted to quantify the impact these differences may have on truck contribution and in particular, the Port's contribution on the overall population-weighted risk. However, before the risk could be estimated, the District had to first estimate the VMT for Port and non-Port trucks on surface streets. These calculations are presented in Section 5.

4.2 TRAFFIC VOLUMES ON FREEWAYS

For the freeway volumes along I-880, the District relied on three data sources including PeMS, which provides automatic measurements of all traffic made at various points on I-880; manual counts made of trucks on the freeway and on freeway entrances and exits; and video footage of I-880 taken from the West Oakland BART platform. For I-980 and I-580, manual truck counts along each freeway were used. The manual counts from I-980 and I-580 were linearly extrapolated to reflect counts from 7:00 am to 6:00 pm. Appendix C presents a more detailed description of how the traffic volumes were estimated on freeways.

Figure 22 presents the estimated truck volumes for each freeway. Approximately 2,100 to 2,600 trucks travel daily (7:00 am to 6:00 pm) on I-580 and I-980. About one to three percent (less than 60 trucks per day) of I-580 and I-980 truck traffic is associated with Port activities. A majority of the Port trucks use the I-880 freeway to access the Port. The District estimates that on average 9,700 trucks (medium heavy duty and heavy heavy duty) travel daily on I-880 (combined from northbound and southbound directions). Of the 9,700 trucks, approximately 37%, or 3,600 trucks, are associated with Port activities.

A previous truck study (TIAX, 2003) sponsored by the WOEIP approximated that 6,300 trucks enter the Port per day from surface streets and freeway ramps in West Oakland. By combining the freeway and surface street estimates from this survey, the District estimates that approximately 7,300 Port trucks travel daily through West Oakland. Overall, the studies compare well. Cargo shipments at the Port have steady declined since the study was completed in August 2008 due to the economic downtown with the highest reported shipment reduction of 6.4% occurring in 2009.

Table 14 presents a comparison of the freeway traffic volumes from this survey and estimates based on data used in the HRA. The freeway volumes on I-580 used in the HRA are consistently

[3] Emissions based on year 2001 as presented in Table II-14 (page 33) of CARB's Proposed Emission Reduction Plan for Ports and Goods Movement in California (March 21, 2006).

three times higher than the survey results. For I-980, the difference is not as large with the HRA estimates being roughly two times higher than the survey. The freeway traffic volumes on I-880 were lower in the HRA compared to the survey. The survey recorded almost twice as many trucks on northbound I-880 and 1.4 times more trucks traveling on southbound I-880.

Figure 22. Estimated Freeway Traffic Volumes around West Oakland

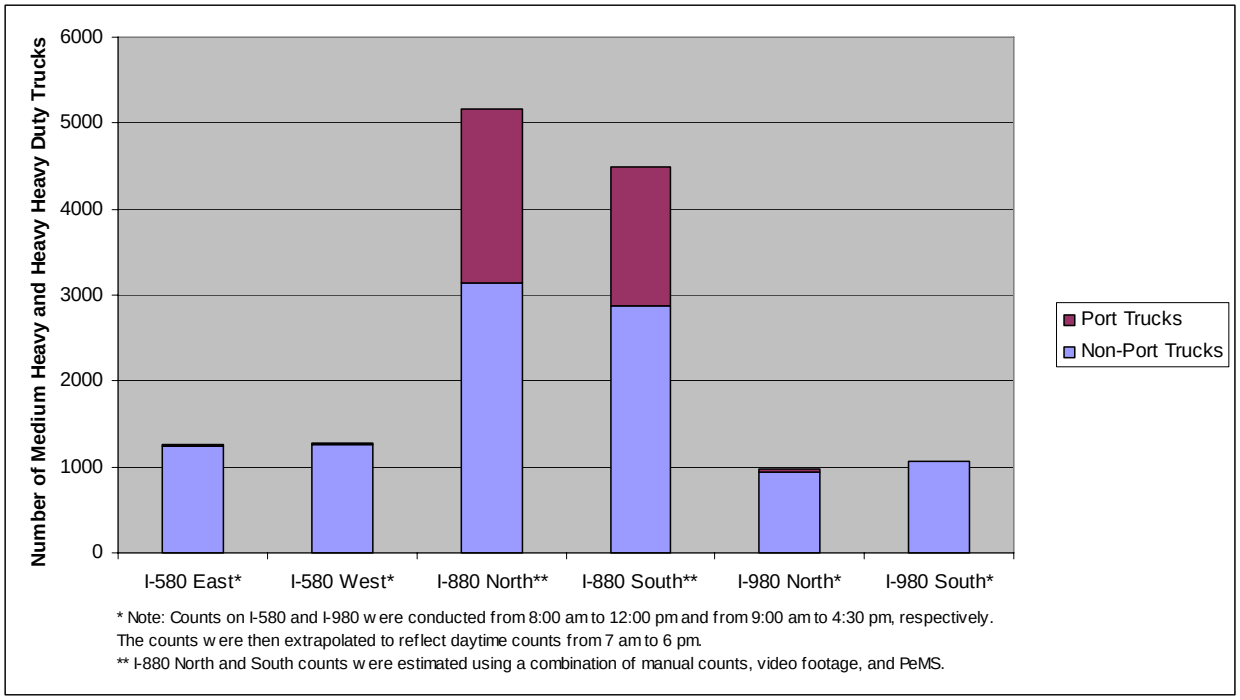


Table 14. Comparison of Freeway MHD and HHD Truck Counts

Description	HRA Estimate (# of Trucks)	Truck Survey Estimate (# of Trucks)
I-580 East*	3,600	1,300
I-580 West*	4,100	1,300
I-880 North	2,400	5,200
I-880 South	3,300	4,500
I-980 North*	2,400	970
I-980 South*	2,100	1,100

* Counts on I-580 were conducted from 8:00 am to 12:00 noon and along I-980 from 9:00 am to 4:30 pm. Each was extrapolated to reflect daytime counts from 7:00 am to 6:00 pm.

The fraction of Port trucks along each freeway varied significantly. The survey found that almost 37% of the trucks on I-880 and less than three percent on I-580 and I-980 are Port trucks. The HRA assumed that approximately 6% of all heavy heavy duty trucks on freeways and surface streets are Port trucks. Generally, the HRA truck volume estimates were higher than findings from the truck survey. However, because individual freeway contributions were in some cases higher or lower than assumptions used in the HRA, the overall net impact on the risk

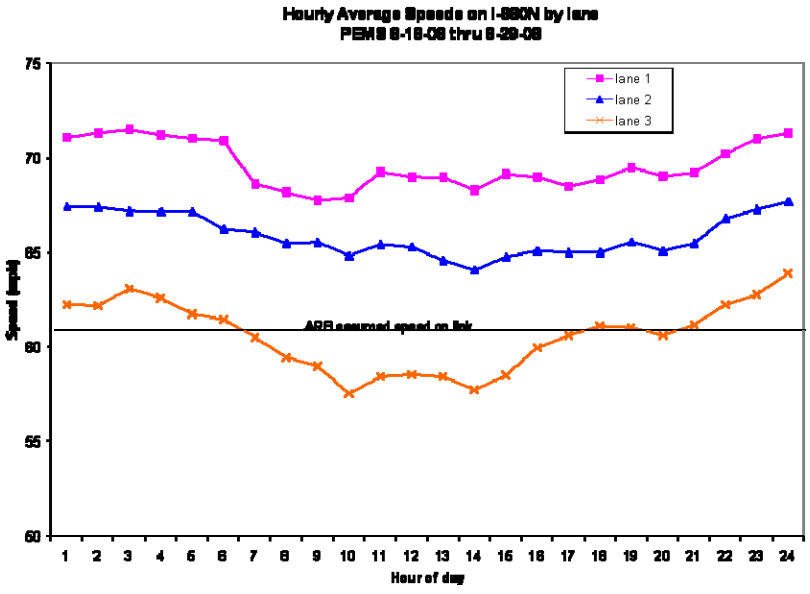
contribution from freeways can not be predicted without further analysis that is addressed in Section 5. It appears that the contribution to overall risk from Port trucks on freeways may have been under-predicted in the HRA. Section 5 estimates the forecasted changes to risk using the freeway volumes determined in this survey.

4.3 TRAFFIC SPEEDS

The District measured average speeds per hour at four intersections using automatic counters and found little variability between intersections or by time of day. The average vehicle speed independent of weekday or weekend activity ranged from 22 to 40 mph with a total average speed of 30 mph on surface streets in West Oakland. The HRA used speed classifications of 10, 15, 18, 20, 25, 30, 45, 55, and 60 miles per hour (mph) to represent a range of vehicle travel modes from idling, to low to moderate roadway, to freeway travel. Two of the four surface street intersections where automatic counters were installed have assigned speeds of 25 mph in the traffic network used in the HRA. This comparison suggests that the HRA's speed classifications for surface streets were relatively consistent with the findings of the truck survey.

For freeway traffic, the District did not collect direct vehicle speed data. The District instead relied on the PeMS database to compare freeway speeds specifically for I-880. PeMS logs average hourly vehicle speed by lane. Figure 23 shows hourly average freeway speed on northbound I-880 by lane from August 18 through 29, 2008. Lane 1 situated the nearest to the median (commonly called the "fast lane" or "passing lane") shows average speed of about 70 mph. Lane 2, the middle lane, has an average speed of 65 mph and Lane 3 ("slow" lane or merging lane) has an average speed of about 60 mph. The PeMS database does not provide vehicle specific speeds so the results may not be reflective of truck speeds. The HRA assigned truck traffic on freeways a speed of about 60 mph, consistent with speeds in Lane 3 of I-880. Based on these comparisons, the speeds used in the HRA are consistent with the findings of the survey and no adjustment to the HRA is recommended.

Figure 23. Hourly Average Speeds on I-880



4.4 TRUCK IDLING

The District received responses from seven local businesses in West Oakland concerning their idling activity. Reported idling times ranged from 0 to 30 minutes, and only one facility reported idling times in excess of 10 minutes. STI also verified the results by conducting curbside field observations of a majority of the businesses and at three popular mobile lunch corners located on 3rd Street/Market Street, Maritime Street/14th Street, and 11 Burma Road (truck scales). The results from these field observations and the survey sheets show that the majority of the businesses are complying with the five minute idling regulation and that the outreach by community members and government entities is effective. The results are also consistent with the earlier STI survey completed in 2007.

In addition to idling activity, the survey also requested information on the number of daily truck trips generated by local businesses. Table 15 show a comparison of the responses received from the survey conducted by STI in 2007 versus the current survey responses. The 2008 responses were consistent with the previous 2007 survey with one exception. The US Postal Service reported 68 daily truck trips in the 2008 survey, in contrast to 1,034 daily truck trips reported in 2007. In follow-up discussions, the Postal Service has stated that they operate a total of 68 trucks, but these trucks make more than one trip per day and there are additional trucks as well that make trips to the distribution center to ship packages. The manual counts conducted at 7th and Wood Street across from the US Postal Service main service truck gates were generally consistent with the 2007 survey. Counts tallied a total of 1,843 trucks over two days at the 7th and Wood Street intersection with about 922 trucks trips to or from the Post Office during the hours of the survey, which excluded activity before 8:00 a.m. The OMSS facility reported an increase of 12% (150 additional truck trips) as compared to 2007. For the other lower activity sites, the number of truck trips was relatively consistent with activity levels from the previous survey.

Table 15. Comparison of Daily Truck Trips for Oakland Businesses

Location/Company Name	Street Address	Current (2008) Daily Truck Trips	2007 Daily Truck Trips
Oakland Maritime Support Services (OMSS)	11 Burma Road	1,400	1,250
US Postal Service	1675 7th Street	> 922*	1,034
Tighe Drayage Company (Eighteen Trucking)	2230 Willow Street	4	3
A V Trucking Company	1155 3rd Street # 300	5	Low Activity Site

* Based on manual counts. Year 2008 survey results from the Post Office incorrectly reported trucks owned (68 trucks), instead of daily truck trips.

Overall, the survey indicates local businesses have been complying with the idling regulation. This compliance can be attributed to the active campaigning initiated by community members including WOEIP and local government. The District has sponsored several educational programs in the Bay Area and contributed to the San Francisco Bay Area Ditching Dirty Diesel

Collaborative. The Alameda County Congestion Management Agency is also sponsoring a Truck Parking Facility Feasibility and Location Study to better understand truck parking requirement in order to reduce traffic congestion in Alameda County. The Port of Oakland is also considering moving truck support services to Port property away from the community.

4.5 TRUCK AGE DISTRIBUTION

During the manual counts, counters recorded a total of 7,324 truck licenses in West Oakland over the course of the truck survey. Licenses from non-California registered and non-operational trucks were removed from the final data set. The remaining 5,589 licenses, which includes duplicate licenses, were cross-referenced with 2009 California Department of Motor Vehicles (DMV) registration database which provided information on each truck's model year, fuel type, city of registration, zip code of registration, and weight (gross vehicle weight rating – GVWR and number of truck axles), if available.

The median and average model year for all trucks and diesel-powered trucks identified during the West Oakland truck survey was 1997, which is identical to the 50th percentile truck age determined in ENVIRON's Seaport Air Emissions Inventory Study (2008) for the Port of Oakland. Approximately 78% of the trucks in this survey have model years of 1994 or later, which under CARB's adopted regulation to control emissions from in-use on-road diesel-fuel heavy-duty drayage trucks would be required to install retrofit devices on their engines if these trucks transport goods from the Port. In addition, drayage truck engines of 1993 or earlier are required to be phased out by 2010.

The weight classifications of the truck where the license plates, truck age, and weight classification were provided are shown in Table 16. A majority of the trucks fit the drayage truck GVWR category of greater than 33,000 pounds.

Table 16. GVWR Distribution

Gross Vehicle Weight Rate (GVWR)	Number of Trucks	% of Trucks
<6000	57	2%
6,000 to <33,000	663	23%
>33,000	2218	75%

A majority of the trucks, approximately 3,576 registered licenses, were found to be registered in the Bay Area. There were 899 trucks registered in Oakland, 289 in San Leandro, 268 in San Francisco, and 289 in San Jose. Of the 2,013 trucks registered outside of the Bay Area (in California), 175 trucks were registered in Sacramento and West Sacramento, 68 in Fresno, 283 trucks in Modesto, 283 in Stockton, and 65 in Tracy.

Following the District's West Oakland Truck Survey, the Port of Oakland conducted an independent truck age survey in October/November 2008 by recording licenses of trucks entering terminal gates. Of the 1,997 unique license plates that were recorded at the Port's terminal gates, 1,817 of the licenses were registered in California and had vehicle model years

available from the 2009 DMV database. Duplicate licenses were removed by the Port prior to comparisons to DMV records. The age distribution and fuel type from the licenses recorded in the Port's truck age survey are shown in Table 17 and Figure 24. The median and average model year from all truck licenses recorded by the Port near terminal gates was 1998 which is one year (1997) newer than the findings from this West Oakland Truck Survey, where duplicates were retained. In a previous Port truck age survey conducted in October 2006 (ENVIRON, 2008), over 80% of the Port trucks had model years from 1993 through 1999. This 2008 Port survey found that 48% of trucks near the terminal gates had model years from 1993 to 1999 and over 37% of the trucks had model years newer than 1999. Figure 25 shows a similar age distribution of trucks surveyed from this West Oakland Truck Survey (with and without duplicate counts) and the Port's 2008 Truck Age Survey near Terminal Gates.

Table 17. Age Distribution and Fuel Type of Trucks Entering or Exiting Port of Oakland Terminal Gates (Port 2008 Truck Age Survey)

Model Year	Number of Trucks	Fuel Type		
		Unknown	Diesel	Gasoline
1970	1		1	
1971	1		1	
1974	1		1	
1975	1		1	
1980	2		2	
1981	4		4	
1982	5		5	
1983	3	1	2	
1984	9		9	
1985	22		22	
1986	16		16	
1987	10		10	
1988	21		20	1
1989	37		37	
1990	29		29	
1991	35		35	
1992	39		39	
1993	71		71	
1994	136		136	
1995	143	1	142	
1996	145		145	
1997	169	1	168	
1998	175	2	173	
1999	209		209	
2000	200	1	199	
2001	111	1	110	
2002	66		66	
2003	51		51	

Model Year	Number of Trucks	Fuel Type		
		Unknown	Diesel	Gasoline
2004	23		23	
2005	22		22	
2006	20		20	
2007	19		19	
2008	4		4	
2009	17		17	
Totals	1,817	7	1,809	1

Figure 24. Age Distribution and Number of Diesel-Powered Trucks Entering or Exiting Terminal Gates (Port 2008 Truck Age Survey)

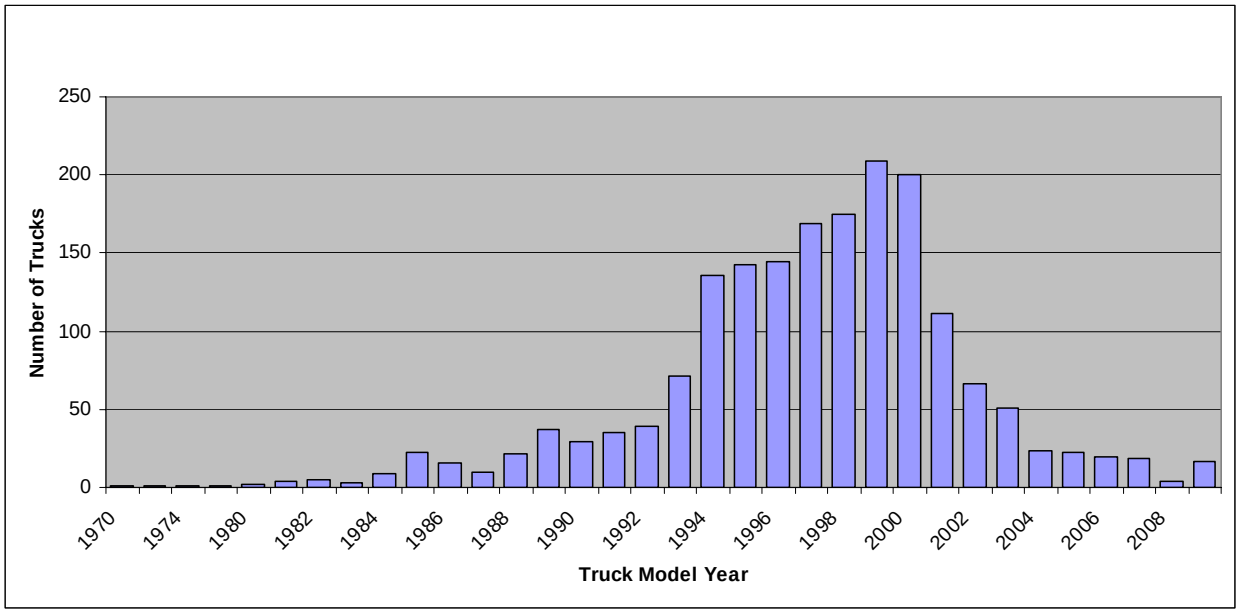
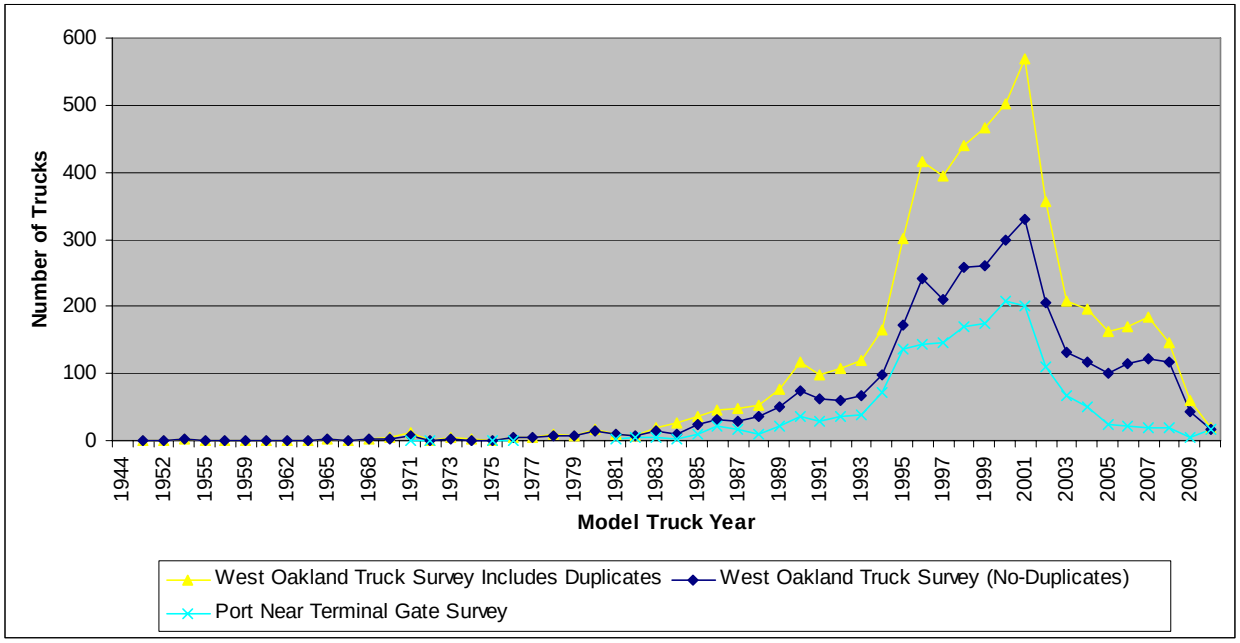


Figure 25. Comparison of Truck Age Distribution from the West Oakland Truck Survey and the Port 2008 Truck Age Survey



5. RE-VISITING THE HRA

One of the recommendations in the West Oakland HRA was to consider revisiting findings from the risk assessment if new information about trucking operations significantly deviates from the assumptions used in the HRA. Based on the results and comparisons in Section 4, the District surmised that sufficient new data was available that would impact the HRA. Rather than conducting a time intensive rerunning of the models, the District instead performed off-model calculations to estimate the change in the risk based on the new data. This section presents re-evaluation of the risk estimates in the HRA based on following changes:

- Decreasing the number of trucks on surface streets;
- Decreasing the number of trucks on freeways I-980 and I-580;
- Increasing the number of Port trucks on surface streets; and
- Increasing the number of Port and non-Port trucks on freeway I-880.

In order to quantify the impact these changes have on the risk estimates in the HRA, the District estimated Port and non-Port truck VMT on surface streets based on the survey results. These estimates were then ratioed against VMT used in the HRA. For freeway estimates, the District used the actual truck counts to ratio the risk from the HRA. Detailed descriptions of these calculations are provided in the following sections.

5.1 ESTIMATING VMT ON SURFACE STREET AND COMPARISONS TO HRA

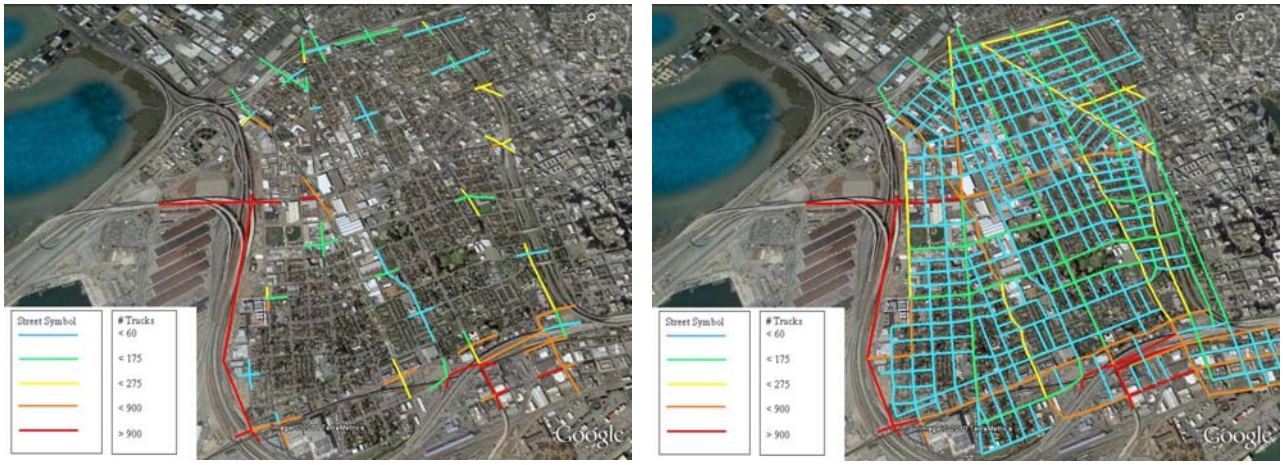
In Section 4.1, the District estimated truck volumes on surface streets based on manual counts and truck routes derived from GPS tracking data in Port trucks and the District's limited truck-following study. The data provided an estimate of most of the traffic volume in West Oakland; however, it did not account for the variable traffic patterns of the entire fleet of non-Port trucks. The GPS data was not used to estimate the VMT. Instead, the District extrapolated the individual manual counts at each street intersection to estimate the VMT on surface streets.

The District estimated VMT in West Oakland for all MHD and HHD trucks and for those assigned to the Port. Figures 26 and 27 present the summed counts of all trucks and Port trucks, respectively, on each block that was surveyed and extrapolated counts to non-surveyed local streets. As discussed in Section 2, the manual truck survey counted MHD and HHD trucks and recorded their movements at 38 street intersections in West Oakland. Although not a random sample, the intersections surveyed included all the streets with two or more lanes in each direction. The counts were categorized into five bins representing highest to lowest activity levels, represented by colors from red through blue. Except for a section of West Grand Ave., the highest trafficked (red) street segments are all entrances and exits to the Port and I-880. Virtually all non-multilane streets had counts in the lowest fifth (blue).

To estimate VMT, individual counts for each street were multiplied by the length of the street as shown in Figures 26 and 27. The District used five trucks per day as the minimum truck traffic for non-surveyed, two lane intersections. For non-surveyed intersections with more than two lanes, 20 trucks per day were assumed. Because the starting point for this method was truck counts at the intersections, the network is approximately balanced (approximately equal portions

of trucks entering and exiting the intersection at any given time) at the major intersections that were surveyed. The VMT excluded traffic in the Port and on the surrounding freeways. VMT was estimated for weekday traffic during the daytime, 7 am – 6 pm, when the counts were conducted. The District estimated a VMT of 7,900 for all trucks by combining the average counts for each bin by the street length. Port trucks within the same boundary had an estimated VMT of 3,050.

Figure 25. Survey Counts of MHD and HHD Trucks at Sampled Intersections (left) and Extrapolated to the Roadway Network (right)



Note: Colors correspond to ranges numbers of trucks: red ≥ 900, orange 275-900, yellow 175-275, green 60-175, and blue < 100.

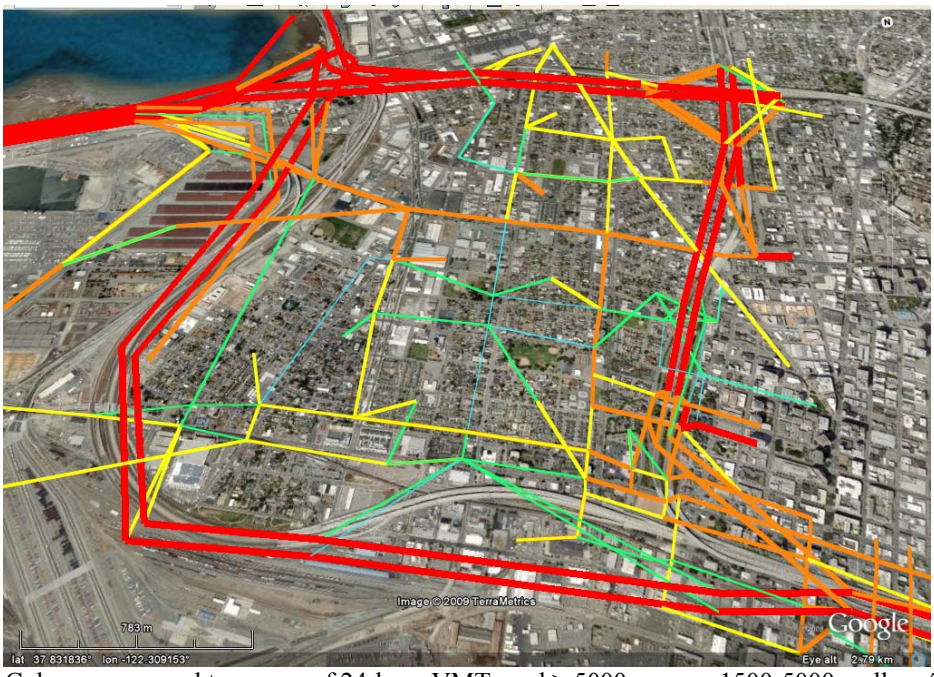
Figure 26. Survey Counts of Port Trucks at Sampled Intersections (left) and Extrapolated to the Roadway Network (right)

Note: Colors correspond to ranges of 24-hour VMT: red ≥ 900, orange 300-900, yellow 100-300, green 20-100, light blue ≤ 20, and blue ≤ 5.

West Oakland has approximately 834 street blocks that if laid end to end would extend for approximately 67 miles. A typical round trip around the periphery of West Oakland is approximately one to 1.5 miles and the distance from the Port to the freeway on-ramp ranges from 0.5 to one mile. From Section 4.1, the District estimates approximately 7,200 trucks and 3,700 Port trucks travel daily through West Oakland on surface streets. As a comparison to the method described above, rough estimate of VMT for all trucks driving on the periphery ranges from 7,200 to 10,800. For Port trucks, the estimated VMT based on such a calculation would be 1,850 to 3,500. Both estimates are consistent with the survey-estimated VMT of 7,900 for all trucks and 3,050 for Port trucks.

The District compared the VMT from the survey to that used for the HRA. CARB provided a database showing the entire roadway network used in the HRA that includes speeds, link length, hour, and VMT used to generate the diesel emissions estimates. The HRA used the Travel Demand Model that utilizes population, employment, surveys, income, roadway and transit networks, and transportation costs to forecast traffic volumes and speeds. These activities are assigned to roadway links that represent fleet population and average speed on a specific freeway, ramp, or major or minor arterial. Not every link represents an actual street; instead, some links represent activity levels anticipated for an area encompassing several city blocks. The roadway network used for the HRA and associated VMT are shown in Figure 28.

Figure 28. Roadway Links and VMT Used in the West Oakland Health Risk Assessment



Note: Colors correspond to ranges of 24-hour VMT: red ≥ 5000, orange 1500-5000, yellow 500-1500, green 100-500, blue < 100.

The HRA predicted an estimated 472,000 VMT per day within West Oakland with a majority of the traffic traveling on freeways. Excluding freeways, 52,400 VMT per day are on surface streets between the hours of 7 a.m. and 6 p.m. Compared to the 7,900 VMT estimated from the survey, it appears that the estimated surface street traffic volume used in the HRA is almost

seven times higher than the findings from the West Oakland truck survey. This comparison corroborates suspicions of the HRA's participants that the traffic volume was over-predicted on surface streets using the Travel Demand Model. The next section discusses adjustments to the risk based on these findings.

5.2 ESTIMATION AND COMPARISON OF RISK

This section synthesizes the surface street VMT and freeway counts derived from the truck survey and compare them to the West Oakland HRA to evaluate their implications for health risk and for setting emission-reduction priorities. Section 4.0 reported two main findings that will impact risk estimates. First, the truck volumes and thus the VMT (Section 5.1) from MHD and HHD trucks, which contribute nearly all the emissions from heavy duty trucks in West Oakland, were overestimated in the HRA. Second, the Port contribution was underestimated. These findings support the concerns raised in the HRA that the emissions from Port trucks might be underestimated since the Port-truck operations within the community were not studied in detail and were assumed to travel on freeways without using minor arterials or secondary roadways. To assess implications for health risk, the analysis below derives ratios of the surface street VMT and freeway truck counts (Section 4.2) derived from this survey to those from the HRA to scale the HRA health risk numbers. Such comparisons were used to adjust the risks, from Port and non-Port on-road trucks on surface streets and freeways, to approximately reflect the findings of this survey.

5.2.1 Adjusted Freeway Risk

The survey collected actual MHD and HHD truck counts on all major freeways surrounding West Oakland. The survey did not include counts of LHD trucks represented by sport utility vehicles and pickup trucks. When the District weighted the VMT of LHD vehicles by their emissions factors, they were found to contribute less than 1% of the total emissions from diesel vehicles on both local streets and freeways and thus re-evaluation of LHD emissions was deemed unwarranted.

On all the major freeways (I-880, I-580, and I-980), manual traffic counts were used to determine Port and non-Port truck volumes. The freeway estimates used to adjust the health risk were strictly taken from the manual counts and did not incorporate the PeMS data or video footage counts. The following discussion provides a step by step process that was used to adjust the HRA data with the survey results in order to revise the risk along freeways from MHD and HHD trucks.

Freeway Step 1: In the first step, the District estimated the volume of trucks used in the HRA that travel on each freeway for the time period corresponding to the survey. CARB provided Transport Demand Model (TDM) data files containing the link identification, link length, name of freeway or street, speed, number of lanes, mile length of the link, time, and VMT within West Oakland for each segment used in HRA. The District used these data to estimate a total VMT and mile length for each freeway by the hour of the day. The truck count was estimated by dividing the total VMT by the mile length for each hour. The truck counts from the HRA were derived to match the hours for which the survey was performed: 7:00 am to 6:00 pm.

Freeway Step 2: The District then estimated the number of MHD and HHD trucks used in the HRA per freeway link. The volume of each type of truck was estimated by multiplying the VMT fraction (see Table 19) of MHD and HHD trucks by the total number of trucks along each link (Step 1). The VMT fraction is generated from the EMFAC model, a statewide model used to estimate on-road motor vehicle emissions. The fraction represents the portion of the VMT attributed to each size category of trucks. Note the emission contributions from LHD diesel were omitted in this process; while LHD truck VMT is significant overall in California, because of their relatively low emission factors, their emission contributions are less than 1% of the total diesel emissions from all vehicles in West Oakland.

Table 18. VMT Fraction of All Trucks Attributed to MHD and HHD Trucks

Vehicle Type	VMT Fraction
MHDT-Diesel	0.255
HHDT-Diesel	0.442

Table 19 presents the estimated MHD and HHD trucks used in the HRA for each freeway for the time period corresponding to the survey. Truck traffic volumes on Freeway I-80 were included in the original HRA but were not counted in this survey. For subsequent analyses, I-80 volumes from the HRA were not changed.

Table 19. Volume of Trucks and Diesel Fraction for each Freeway Based on HRA

Freeway	HRA MHD and HHD Truck Volumes	Fraction of Total Truck Volumes and Emissions Attributed to Each Freeway
580 E	3574	0.13
580 W	4114	0.16
880 N	2447	0.092
880 S	3299	0.12
980 N	2427	0.092
980 S	2138	0.081
80 E	4266	0.16
80 W	4245	0.16
Total Number of Trucks Traveling on Freeways in West Oakland	26,510	100%

Freeway Step 3: The next step was to estimate the fraction of the total truck volumes in West Oakland that is attributed to each freeway. Diesel emissions are estimated based on the number of vehicles and by knowing the fraction of trucks, the fraction of diesel emissions attributed to each freeway is known. The District estimated the fraction of trucks on each freeway by dividing each freeway truck volume by the cumulative truck volume from all freeways in West Oakland. For example, there are 3,574 MHD and HHD trucks on eastbound I-580. The total number of MHD and HHD trucks that travel on all freeways that intersect West Oakland is

26,510 (HRA-based estimate). By dividing the individual freeway volumes by the cumulative truck volumes from all freeways, the fraction of truck volume and likewise the fraction of diesel emissions attributed to I-580 east is 0.13 (3,574/26,510). Table 19 presents the estimated fraction of total truck volume and hence, diesel emissions, for each freeway segment in the HRA.

Freeway Step 4: The next step was to compile the Port (includes chassis, containers, and bobtails) and non-Port truck volumes on each freeway based on the truck survey and compare the results to the HRA truck volumes corresponding to the survey hours. Because surveys were not conducted along I-80, the truck volumes used in the HRA for I-80 were retained in this analysis. For the surveyed freeways, the actual counts on each freeway are shown in Table 20 and are reflective of the hours listed below. CARB's TDM file contained hourly data that the District used to derive truck counts from the HRA corresponding to the same hours in which observations data from the truck survey were collected.

- I-580 freeway: 8:00 am to 12:00 noon
- I-980 freeway: 9:00 am to 4:30 pm
- I-880 freeway: 8:00 am to 8:30 am, 9:00 am to 9:30 am, 10:00 am to 11:00 am, 1:30 pm to 2:00 pm, 2:30 pm to 3:00 pm, and 3:30 pm to 4:30 pm.

Table 20. Truck Volumes Based on Survey, for Survey Hours

Freeways	Number of Port Trucks from Survey	Number of Total Trucks (Port and Non-Port) from Survey
580 E	4	458
580 W	2	463
880 N	721	1840
880 S	576	1617
980 N	21	664
980 S	8	729

Table 21 presents the HRA truck volumes for each freeway for the hours matching the survey (fewer trucks than shown in Table 19 due to the reduced hours).

Table 21. Truck Volumes Based on HRA for Survey Hours

Freeways	Number of Total Trucks (Port and Non-Port) from HRA
580 E	1402
580 W	1616
880 N	872
880 S	1176
980 N	1764
980 S	1556

Freeway Step 5: The District then developed revised diesel emissions based on the survey by scaling the HRA diesel emission fractions. This was done by multiplying the diesel fractions in Table 19 by the ratio of the survey truck volumes (Table 20) to the HRA truck volumes (Table 21) per freeway. The ratios presented in Table 22 are then summed and multiplied by the population-weighted potential cancer risks in West Oakland (see Step 6). The contribution from Port trucks was estimated by scaling the ratios shown in Table 22 by the fraction of trucks that are Port related (Table 20). The fraction of Port trucks along I-80, which was not surveyed, was assumed to be 14%, estimated by using the average Port fraction from all the surveyed freeways.

Table 22. Adjusted HRA Diesel Fractions Based on Survey

Freeways	Adjusted HRA Diesel Fraction for All Diesel Trucks Based on Survey	Diesel Fraction for Port Trucks Based on Survey
580 E	0.044	0.00038
580 W	0.049	0.00021
880 N	0.12	0.046
880 S	0.15	0.052
980 N	0.048	0.0015
980 S	0.052	0.00057
80 E	0.16 (no change from HRA)	0.022*
80 W	0.16 (no change from HRA)	0.022*
Total	0.78	0.14

Note: * Fraction of Port trucks along I-80 was estimated by applying the average percentage of Port trucks observed from all surveyed freeways.

For example, 580 E has an adjusted diesel fraction of 0.044 which was estimated by scaling the HRA diesel fraction of 0.13 (Table 19) by the ratio of surveyed truck volumes (Table 20) to the HRA truck volumes (Table 21) (0.13 x 458/1402). Because of the reduced number of observed trucks on I-580 and I-980, the overall adjusted diesel fraction reflects a reduction of the population-weighted risk from the HRA of 78%.

Freeway Step 6: The final step was to estimate the change in population-weighted risk from the HRA based on the survey results. It should be noted that the adjustment is a rough estimation and does not preclude the possibility of one conducting a more complete and rigorous re-modeling of the emissions in the future. In the HRA, diesel sources were allocated in three parts with Part I including only diesel emissions from Port operations. Part II incorporated sources related to the Union Pacific Railyard and Part III encompassed the remaining sources, not in Part I or II, such as ocean going vessels destined for San Francisco Bay ports (other than the Port of Oakland), on-going heavy-duty trucks not transporting goods to and from the Port, harbor craft and ferries, and local distribution centers. The District had to first determine the portion of the cancer risks in the HRA that is attributed to freeway travel of Port trucks (Part I) and non-Port trucks (Part III). The population-weighted risk in Part III from non-Port trucks traveling on freeways and surface streets was 795 cases per million (Table 7; CARB, 2008). CARB estimates based on the TDM files that approximately 74% of the VMT are associated with freeways and

the remaining 26% are from surface streets. If one assumes a linear increase in miles driven leads to increased emissions and potential risk, then 74% of the 795 cases of cancer in a million or 588 cases in a million, are associated with non-Port truck activity on freeways.

In Part I of the HRA, the population-weighted cancer risk from Port trucks on surface streets, freeways, idling at the gate and terminals, terminal movements, and support services is 42 cases in a million. A similar methodology of scaling the risk based on VMT as applied to non-Port trucks above could not be used for Port sources since detailed VMT information was not available. Instead, the District scaled the cancer risk based on the fraction of diesel emissions associated with Port trucks traveling on freeways. From Part I of the HRA, Port trucking operations emit 20 tons per year (tpy) based on travel to and from surface streets and freeways, and at terminals and gates. About 2.8 tpy of the 20 tpy are from Port trucks traveling on freeways. The fraction of the total diesel emissions attributed to the freeway is then 0.14 (2.8 tpy/20 tpy). Assuming a linear relationship between emission and cancer risk, approximately 14% of the total cancer risk associated with Port activities is due to Port trucks driving on freeways. This equates to population-weighted cancer risk from Port trucks on freeways of 5.9 cases in a million (0.14 x 42 cases in a million). The total population-weighted cancer risk from trucks driving on freeways was estimated by summing the contribution from Port trucks in Part I (5.9 cases in a million) and non-Port trucks in Part III (588 cases in a million) of the HRA for a total cancer risk of 594 cases in a million.

The revised population-weighted cancer risk was estimated by multiplying the total cancer risk attributed to freeways of 594 cases in a million (from the HRA) by the adjusted diesel fraction estimated from the survey findings (see Table 22). The survey found that the cancer risk contribution from freeways was overestimated by 22%. The Districted estimated that the final adjusted population-weighted risk is 462 cases in a million (594 cases in a million x 0.78) for diesel trucks traveling on freeways in West Oakland. In addition, the survey showed a corresponding 11-fold increase from the HRA cancer risk for Port trucks on freeways. Approximately 14% of the total cancer risk from freeways is attributed to Port trucks (see Table 22) or about 67 cases in a million (0.14 x 462 cases in a million).

In most cases, the survey found only nominal amount of Port trucks on local freeways except along I-880 where on average, 37% of the trucks were associated with Port activity. The District's approach of classifying all bobtails, containers, and chassis trucks as being Port related may slightly overestimate the Port's contribution to the overall risk. The District recognizes that these trucks are used by other businesses in the area. However, it is likely that the number of these trucks used by other businesses is small in comparison to the total fleet used in support of Port activity. The uncertainties with this estimate are discussed further in Section 5.3.

5.2.2 Adjusted Surface Street Risk

To adjust the HRA's estimate of population-weighted risk from trucks on surface streets from the HRA, the District used the VMT representing the total distance traveled by all trucks on surface streets in West Oakland. Section 5.1 presents the detailed analysis used to derive the VMT. On surface streets, truck counts were used to estimate volumes at the block level. The VMT estimates were obtained by multiplying the truck volumes at each intersection by the length of

each block. For non-surveyed streets, the District assumed a minimum truck volume of 5 trucks per day on two lane roads and 20 trucks per day on roads with more than two lanes. VMT estimates on surface streets from Port and non-Port trucks were then compared to estimates in the HRA using the following step by step methodology:

Streets Step 1: The first step was to estimate the VMT for MHD and HHD trucks on surface streets used in the HRA. The District summed the VMT corresponding to the hours between 7:00 am to 6:00 pm for all segments designated as surface streets in the TDM file provided by CARB. The District then estimated the portion of the VMT that is attributed to MHD and HHD trucks on surface streets by multiplying the VMT fraction of MHD and HHD trucks (see Freeway Step 1; Table 18) by the total VMT on surface streets. Table 23 shows the estimated VMT by truck classification.

Table 23. Truck Classification VMT on Surface Streets Based on the HRA

Vehicle Type	HRA VMT
MHDT-Diesel	19,139
HHDT-Diesel	33,229
Total VMT for MHD and HHD Trucks	52,368

Streets Step 2: The population-weighted risk in the HRA was then apportioned based on the contributions from Port and non-Port trucks on surface streets. The District had to first determine the portion of the cancer risks in the HRA that is attributed to Port trucks (Part I) and non-Port trucks (Part III) driving on surface streets. As stated in Freeway Step 6, approximately 26% of the VMT in Part III of the HRA are associated with non-Port trucks driving on surface streets of West Oakland. The population-weighted risk in Part III from non-Port trucks traveling on freeways and surface streets was 795 cases per million (Table 7; CARB, 2008). If one assumes a linear increase in miles driven leads to increased emissions and potential risk, then 26% of the 795 cases of cancer in a million or 207 cases in a million, are associated with non-Port truck activity on surface streets.

As previously stated in Freeway Step 6, the methodology of scaling the risk based on VMT as applied to non-Port trucks above could not be used for Port sources since detailed VMT information was not available. Instead, the District scaled the cancer risk based on the fraction of diesel emissions that are attributed to Port trucks driving on surface streets. From Part I of the HRA, Port trucking operations emit 20 tons per year (tpy) based on travel to and from surface streets and freeways, and at terminals and gates. About 4.9 tpy of the 20 tpy are from Port trucks traveling on surface streets. The fraction of the total diesel emissions attributed to the surface streets is then 0.25 (4.9 tpy/20 tpy). Assuming a linear relationship between emission and cancer risk, approximately 25% of the total cancer risk associated with Port activities is due to Port trucks driving on surface streets. This equates to population-weighted cancer risk from Port trucks driving on surface streets of 10.3 cases in a million (0.25 x 42 cases in a million). The total population-weighted cancer risk from trucks driving on surface streets was estimated by summing the contribution from Port trucks in Part I (10.3 cases in a million) and non-Port trucks in Part III (207 cases in a million) of the HRA for a total cancer risk of 217 cases in a million.

Streets Step 3: The final step was to adjust the population-weighted cancer risk from surface streets in the HRA based on the survey results. The revised cancer risk was estimated by multiplying the total cancer risk attributed to surface streets of 217 cases in a million (from the HRA) by the quotient of VMT of the survey finding to the HRA assumptions. From Section 5.1, the District estimated a VMT of 7,900 on surface streets based on the survey. The total VMT for all MHD and HHD trucks on surface streets used in the HRA is 52,368. The final adjusted population-weighted risk for trucks on surface streets is 33 cases in a million; estimated by taking the 217 cases in a million, multiplying by 7,900 VMT from the survey and dividing by the total HRA VMT of 52,368.

To estimate the Port truck contribution to the cancer risk on surface streets, the District scaled the adjusted cancer risk from all trucks of 33 cases in a million estimated above by the quotient of the VMT from Port trucks to all trucks based on the survey. The scaling factor was the ratio of Port truck VMT (3,050 based on the survey results, see Section 5.1) to total VMT from all trucks in the survey (7,900 based on the survey, see Section 5.1). The District found that about 39% of the adjusted population-weighted risk from surface street traffic was attributed to Port trucks or 13 cases in a million (33 cases in a million x 3050/7900).

The adjusted risk estimates for MHD and HHD trucks along freeways and surface streets of West Oakland are presented in Table 24.

Table 24. Adjusted Risk from Freeway and Surface Streets Based on the Survey Results

Freeway and Local Streets	Adjusted Risk (cases per million) from Port Trucks	Adjusted Risk (cases per million) from All Trucks
Freeways (I-580, I-880, I-80, and I-980)	65	462
Surface Streets	13	33

5.2.3 Summary of Adjusted Street Risk

Table 25 presents a summary of the adjusted risk estimates based on the findings from the survey. Part I adjustments in Table 25 were derived from the adjusted risk shown in Table 24 from Port trucks on the freeways and surface streets in combination with off-road Port-related trucking risk that did not change. The unchanged risk includes risk from gate idling on terminal, in terminal truck movement, in terminal idling, and risk from the distribution center (Oakland Maritime Support Services). The unchanged categories sum to a population-weighted potential cancer risk of 25 per million (65 + 13 + 25 = 103). Part II risks did not change. Part III adjustments are the total of all freeway and surface streets in Table 24 minus the risk from on-road Port trucks.

Table 25. Summary of the Adjusted Population Weighted Cancer Risks (Cases per Million) Based on the Survey

Source Category	Part I Port	Part II Union Pacific	Part III Non-Port and Non-UP	Combined
OGV Transiting, Maneuvering, and Anchoring	57	0	23	80
OGV Hoteling	57	0	10	67
Harbor Craft	15	0	78	93
Trucks	**103** (42)	7	**415** (795)	**525** (844)
Cargo Handling Equipment	16	21	7	44
Locomotives	4	15	37	56
Others	0	0	2	2
Total	**252** (192)	43	**572** (951)	**867** (1,186)
% Risk	**29%** (16%)	**5%** (4%)	**66%** (80%)	100%

Note: Revised risks are noted in bold text. The values in parentheses ( ) are the original population-weighted cancer risks presented in Table 7 of the HRA.

Overall, the combined total population-weighted cancer risk for West Oakland was reduced by 27% to 867 cases in a million. The reduced number of predicted cancer cases based on the survey does not imply that the air quality in the area has improved, but confirms the uncertainties noted in the HRA. Cancer risks in West Oakland still remain one of the highest in the Bay Area. Most of the reduction in the combined cancer risk can be attributed to the seven-fold decrease in VMT on surface streets in the HRA based on the findings from the survey. By revising the overall cancer risk, individual source contribution similarly changed with respect to the total combined risk. Diesel emissions from MHD and HHD trucks remain the largest contributor to the overall cancer risk representing over 61% of the total population-weighted risk in West Oakland (see Table 25) based on the survey. This is lower than the on-road heavy duty truck contribution noted in the HRA of 71%.

Conversely, the Port's contribution to the overall risk increased from 16% to 29%. Most of increased cancer risk is attributed to the higher volume of Port trucks traveling on surface streets and on I-880 as determined through the survey. In fact based on the adjusted cancer risk, Port trucks become the highest single contributor to the cancer risk at the Port, responsible for about 41% of the cancer risk from Port operations. The increased risk attributed to Port activity appears to conflict with the understanding that the Port has experienced an economic downturn in the last several years which could have resulted in reduced overall risk from trucks. The explanation lies in a basic assumption of the HRA that all truck trips leaving the Port of Oakland travel on freeways through the community without accessing minor arterials or secondary roadways. The HRA explicitly states that "this approach may underestimate the magnitude of emissions from trucks serving the Port of Oakland, because port-truck operations within the community are not well characterized even through clearly some are occurring." CARB supported the District in designing this survey in order to reduce the uncertainty in the truck

volume estimates. The survey has confirmed concerns discussed in the HRA that the Port's contribution to the population weighted risks were underestimated and conversely, the risks attributed to non-Port and non-Union Pacific trucks were overestimated.

5.3 UNCERTAINTIES

In both the survey and data analysis, several key assumptions were made in order to come to the conclusions presented in Section 5.2. Such assumptions are inherent in efforts to characterize emissions and associated risk in complex settings and can result in uncertainties, under-prediction or over-prediction, in risk estimates. This section identifies some of the major uncertainties associated with methods and assumptions in this survey and assesses their impact on the key findings. The uncertainties have been grouped and are discussed in the following categories:

- Manual Truck Counting Error
- Port Truck Classification
- Seasonal Variation of Truck Traffic
- Non-Surveyed Street Traffic Load

Manual Counting Error

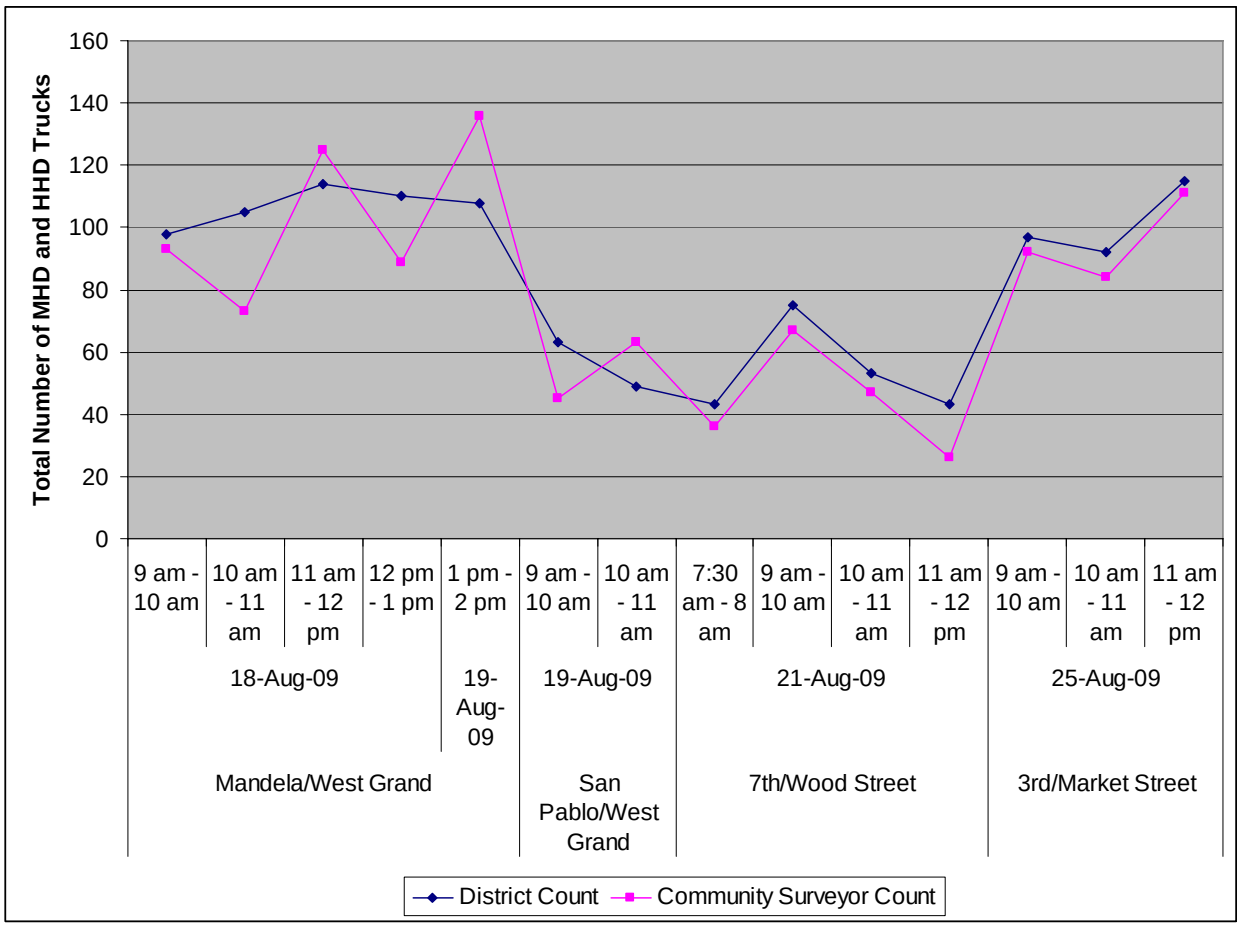
Counters were deployed at designated intersections for five to six hour intervals to count trucks. The counters were trained community members who recorded the number of axles and movements of trucks upon entering an intersection. As with any survey, human errors may occur and the District attempted to minimize the uncertainties associated with the manual counts by arranging to have District personnel serve as secondary counters at high activity intersections. District personnel also attended the same training session as community members. The intersections of Mandela/West Grand, San Pablo/West Grand, 7th/Wood Street, and 3rd/Market Street had secondary counters deployed for durations of one to four hours.

Figure 29 presents a comparison of the total MHD and HHD trucks counted by both District and community surveyors. The results are somewhat variable at the beginning, but for much of the survey, the two counts were relatively consistent. Because only three percent of the manual counts have secondary counts, additional statistical evaluation was not performed. The District recognizes that errors in individual counts are inherent in this process. The effect these differences may have on the results is not known precisely, but it is expected to be minor. Likely any errors of over counting are offset by equal amount of under counting as indicated in the Figure 29. The District believes that the counts are sufficiently accurate for the purpose of this study, which is to improve the roadway emission estimates for West Oakland and adjust the health risk accordingly if significant discrepancies are determined through the survey. The objective of the study is not to focus on counts at individual intersections, but to look at the entire West Oakland area holistically and determine if the study captured the basic travel patterns and traffic volumes for the area.

The District also noted that manual counters likely recorded the same trucks several times in the course of the day as is evident by the numerous duplicate licenses that were captured (see

Section 3.3). This survey meets the District's objective of characterizing the short, local trips that are made by some Port trucks which were not fully represented in the HRA risk estimates. The local trucks are heavily used and are substantial source of diesel emissions in the community. By including the multiple counts from the same trucks, the District is including the impacts from these local truck trips.

Figure 29. Comparisons of Manual Count Results

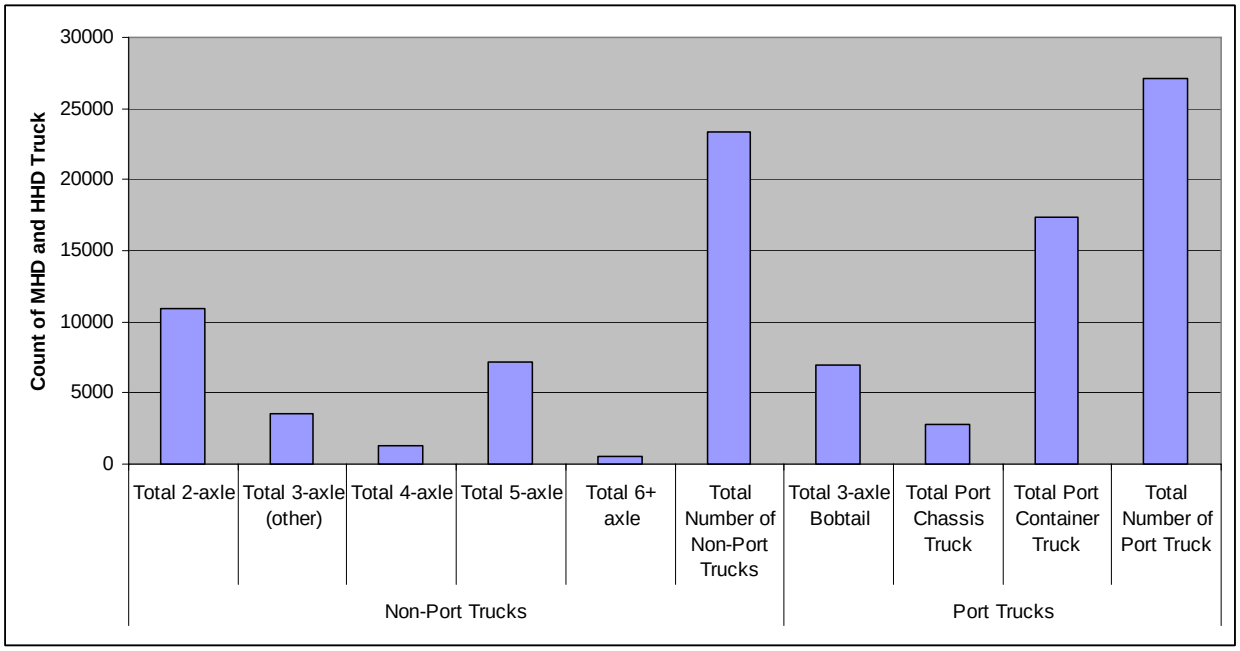


Port Truck Classification

One of the tasks of this survey was to classify trucks as Port or non-Port trucks. In so doing, the District followed CARB's lead when they designed a recent truck survey for the Ports of Los Angeles and Long Beach. In the Los Angeles and Long Beach study and in this study, all bobtails, chassis, and containers were classified as Port trucks. The District recognizes that a portion of bobtail trucks, especially those counted while driving on the freeways, may not be associated with Port activity. Figure 30 presents a breakdown of the total number of trucks that were counted during the survey per category. Bobtails make up a high percentage of the overall traffic in West Oakland representing 14% of all trucks.

The Port likely represents the highest single operation in West Oakland that uses bobtail trucks. There are other businesses in West Oakland that use bobtails including the US Postal Service and the Union Pacific Railyard. The HRA estimated that diesel emissions from Port trucking are approximately 20 tons per year. In comparison, the Union Pacific railyard which may be the second largest single source that uses bobtails has an estimated diesel trucking emissions of 1.9 tons per year (from the HRA) – 10 times lower emissions than the Port. The US Postal Service has a major distribution center in West Oakland that has a fleet of 68 diesel trucks that make approximately 1,000 truck trips per day. The HRA estimated that diesel emissions from all truck-based businesses in West Oakland including the postal facility are 1.9 tpy (Part III emissions inventory) – 10 times lower emissions than the Port. Overall, the Port's diesel emissions overshadow any of the other diesel sources in the area. Allocating a portion of the bobtails to other diesel sources would not result in a significant change in the adjusted risk to the Port.

Figure 30. Total Count of Trucks on Surface Streets by Truck Type



Beside the bobtails, ribbed containers (identified as being Port related in this study) are occasionally used by shipping companies to transport goods. Some commercial businesses use 53 foot long intermodal containers for domestic shipment on rails or by trucks within the United States. These intermodal containers have the characteristic ribbing and corner castings that make them indistinguishable from Port containers. These containers are not used on oceangoing vessels at the Port, but are used occasionally by local businesses to ship domestic cargo at the Union Pacific yard and at least one tenant at the Port stores these containers for their customers. The actual number of businesses that use these containers and the frequency of their shipments are unknown. Overall, this study assumes these containers make-up a small fraction of the total number of container trucks that were counted as Port trucks.

Seasonal Variation of Truck Traffic

The District recognizes that there are seasonal variations in the number of cargo ships that come to the Port and consequently, the number of diesel trucks will also vary by season. The District attempted to verify that during the course of the survey a typical number of ships came to dock consistent with the yearly average. As stated in Section 4.1, the Port of Oakland reported that August typically has the highest number of vessel calls due to the upcoming holiday season. From August 18th to 29th, the Port reported 66 vessel calls - an average of 5.5 vessels per day. For 2008, a total of 1,928 vessels delivered cargo to the Port - approximately 5.3 vessels per day. Based on the comparison, the District concluded that the two week study period of the manual counts on surface streets is representative of typical operating conditions at the Port.

For the freeway counts, the data were collected in December 2008 and May 2009. December generally has the fewest vessel calls and consequently, the freeway counts presented in this survey may be under-representative of annual average traffic volumes on freeways, in which case the adjusted risk for the freeways (and the Port's contribution) may be higher. Port of Oakland staff observed that the "December cargo was at least 14% less than in August" (Anne Whittington, memorandum dated July 1, 2009). The Port reported that in August 2008, 195,000 twenty-foot containers equivalent units (TEUs) passed through the Port. In December 2008, 167,000 TEUs were handled at the Port. The District did not attempt to adjust the risk based on the different survey periods, but speculates that the risk from freeway would increase.

The freeway counts along I-580, I-980, and I-880 occurred on certain days in December 2008 and May 2009. It is unknown whether traffic patterns on these freeways during the survey days are consistent with annual average conditions. The air dispersion modeling that was performed in the HRA used hourly emission estimates and VMT to predict health risks in the West Oakland community. In applying ratios to the health risk estimates, the District is only changing the number of vehicles along each traffic link, but the actual hourly variation in traffic patterns are still intact. Likewise, any seasonal variations that were included in the modeling analysis would still hold true in the adjusted health risk.

Non-Surveyed Street Traffic Load

As discussed in Section 5.1, the District had to estimate the number of trucks that travel on roads that were not surveyed. The District assumed five trucks per day for two lane roads and 20 trucks per day for roads with four lanes. Although there are numerous two-lane roads that were not surveyed in this study, the actual truck traffic that travel on these roads represent a small fraction of the total truck volumes in West Oakland. The survey included counts at all major arterials and most four lane roads. The remaining non-surveyed roads consist mostly of two lane roads and small number of four lane roads that are not frequented by truck traffic, which was confirmed with community members that assisted in designing the truck survey. Overall, counts from non-surveyed roads contributed less than three percent to the VMT on surface streets.

6. CONCLUSIONS

With guidance from CARB, the District initiated this truck survey to address uncertainties that were identified in the HRA. The HRA stated that information used to derive on-road truck emissions inventories associated with the Port of Oakland and trucking operations in the West Oakland community was limited. One of the major assumptions was that all trips leaving the Port of Oakland traveled on freeways through the community without accessing minor arterials or secondary roadways. The HRA report states:

"*This approach may understate the magnitude of emission from trucks serving the Port of Oakland, because port-truck operations within the community are not well characterized even through clearly some are occurring. Since drayage truck emissions were subtracted from the total emissions on the network, any potential underestimate in drayage truck emission in the Part I [Port] inventory implies an equal overestimate in Part III [non-Port and non-Union Pacific] inventories*."

CARB, the Port of Oakland, and the District concurred that the emissions data used in the HRA was the best available information at the time, but noted that, as with any study, additional data may be collected to refine the risk assessment and reduce the uncertainties. The District designed this truck counting survey in consultation with CARB staff to improve the Port truck emissions estimates and overall traffic activity patterns in West Oakland. By conducting the West Oakland Truck Survey, the District was able to develop traffic volumes, idling activity, and truck age distributions representative of actual daytime activity levels. In addition, the survey was designed to help estimate the portion of truck emissions that are due to Port activity.

Overall, the District found many areas where the truck survey findings supported the HRA assumptions with respect to on-road trucks. The survey found reasonable agreement with the West Oakland HRA in the following ways:

- A majority of businesses are complying with the five minute idling regulation;
- Speed classifications for trucks on freeway was consistent with the HRA; and
- Truck age distribution from the survey was consistent with the Port's study near the terminals.

The survey also confirmed suspicions raised in the uncertainty section of the HRA that the overall trucking emissions were overestimated and the fraction of trucking emissions attributed to the Port of Oakland was underestimated. The survey results differed from the HRA with regard to the traffic volumes in the following ways:

- Fewer trucks in total on surface streets, but higher percent of Port trucks;
- Lower number of trucks on freeways I-980 and I-580; and
- Higher number of Port and non-Port trucks on freeway I-880.

Some of the discrepancies may be attributed to differences in survey methods and assumptions when identifying a truck as Port truck (see Section 5.3). However, methodological differences do not bridge the gap between the two study results. Given the comparisons with HRA

assumptions, the District has adjusted the HRA findings to account for the West Oakland truck survey results.

To adjust the risk, the District estimated VMT for Port trucks and non-Port trucks driving on surface streets in West Oakland. For freeway emissions, the District used the direct counts that were recorded during the survey. The District developed ratios based on the differences in truck volumes on surface streets and freeways from the two studies and also considers survey findings relative to the contributions from Port versus non-Port trucks. The adjusted health risk showed a 13% increase in population weighted risk from Port trucks and a corresponding decrease of 14% in the population weighted risk attributed to non-Port and non-Union Pacific activities. Overall, the estimated risk from all trucking operations decreased from 844 cases in a million to 525 cases in a million. Port trucking operations also become the highest contributor to the overall risk from Port activities, responsible for about 41% of the cancer risk from Port operations. The District has critically evaluated these findings and considered potential decline in vessel calls and cargo shipments since the HRA was conducted. The District believes that the trucking operations data for West Oakland in the HRA was limited and likely underestimated the Port's contribution.

The revised health risk estimates indicate that continued emission reduction efforts are critically needed. Truck emissions are the single highest source of diesel emissions in West Oakland, while other sources, such as ships, are also important contributors. The District's initiatives to reduce emissions through incentives and grants should have a significant impact in improving the air quality in West Oakland by targeting grants at trucks, ships, and other sources impacting the community. Compliance with regulations adopted by CARB is an essential mitigation strategy. The District is working with CARB to help enforce CARB diesel regulations. The Port also has a significant role to play in reducing these emissions, and collaborative initiatives that can be established with Port tenants, CARB, and the District, will help with these efforts. The District also will continue to support outreach efforts to businesses to curb idling and support the efforts by Alameda County and the Port of Oakland to move truck services and offer long term parking on Port property.

The study findings show some progress has been made. Local businesses are complying with the idling regulation and older, higher polluting truck engines are being phased out. The Port has also adopted a resolution to ban trucks older than 1993 from entering terminals. All of these measures are steps in the right direction.

These recommendations alone will not achieve the emission reductions required to sufficiently improve health conditions in West Oakland. The District has initiated a Clean Air Communities Initiative program that encompasses a multi-pronged approach to improve air quality for impacted communities such as West Oakland. The program uses a variety of strategies including targeted regulations; focused grant and incentive funding; outreach and communication to community, businesses, and health departments; including air quality in critical land use decisions to protect current and future residents; monitoring local sources; and enforcement of CARB and District regulations. The District will continue to work on additional emission reduction strategies through this program to reduce the potential health risk associated with diesel emissions in West Oakland.

REFERENCES

California Air Resources Board (2000) "Risk reduction plan to reduce particulate matter emissions from diesel-fueled engines and vehicles." Stationary Control Division. Mobile Source Control Division. California Air Resources Board, Sacramento, California, October. Available on the Internet at <http://www.arb.ca.gov/diesel/documents/rrpFinal.pdf>.

California Air Resources Board (2008) "Diesel Particulate Matter Health Risk Assessment for the West Oakland Community". California Air Resources Board, Sacramento, California, December. Available on the Internet at <http://www.arb.ca.gov/ch/communities/ra/westoakland/documents/westoaklandreport.pdf>.

ENVIRON (2008) Revised Port of Oakland 2005 Seaport Air Emissions Inventory. Prepared for the Port of Oakland. March 14, 2008. Available on the internet at: http://www.portofoakland.com/environm/airEmissions.asp

Dowling Associates (2006). West Oakland Truck Study Project (on-call services). Memorandum to Peter Chun, Transportation Engineer at City of Oakland Public Works Agency from Mark Bowman and Kamala Parks. Dated October 17, 2006.

Harding ESE (2001) West Oakland diesel particulate emissions study. Prepared for the City of Oakland, California, by Harding ESE, Project No. 48168-005, September.

Pacific Institute (2003) Reducing diesel pollution in West Oakland. Prepared for the West Oakland Environmental Indicators Project in conjunction with the Coalition for West Oakland Revitalization, November.

PeMS, 2008. https://pems.eecs.berkeley.edu. Contact: Dr. Karl Petty, Berkeley Transportation Systems, Inc.

Reid S.B. (2008) Documentation for the West Oakland Truck Survey. Technical memorandum prepared for the Bay Area Air Quality Management District, San Francisco, CA, by Sonoma Technology, Inc., Petaluma, CA, STI-907036, December 17, 2008.

Reid S.B. (2007) Documentation of emission estimation techniques for sources of diesel particulate matter (DPM) associated with distribution centers and construction projects in West Oakland, California. Technical memorandum prepared for the Bay Area Air Quality Management District, San Francisco, CA, by Sonoma Technology, Inc., Petaluma, CA, STI-907006-3174-TM, May.

TIAX. (2003). Container Truck Traffic Assessment and Potential Mitigation Measures for the West Oakland Diesel Truck Emissions Reduction Initiative. Prepared for Pacific Institute, Oakland, CA. Technical Report TR-03-176. September 14, 2003.

The Tioga Group and Dowling Associates. (2008). Truck Driver Interview Survey Results – ACCMA Truck Parking Study. Draft #6 – Tasks 2-4 Technical Memorandum. Prepared for Alameda County Congestion Management Agency (ACCMA), January 26, 2008.

Appendix A

Truck Survey Log Sheets

APPENDIX A

Appendix A presents the truck survey log sheets and idling questionnaire that were used during the manual counts. There are two versions of log sheets that were used depending on whether the counter, situated on the northwestern corner of an intersection, was observing trucks coming from north and east or the south and west. The north and east directions used log sheet version 1 while the south and west direction used version 2.

TRUCK-BASED BUSINESS SURVEY

Facility Name:_____

Facility Address:_____

Contact Person/Title:_____

Phone:_____ E-mail:_____

Facility Information: Business Type:_____

Size (acres):_____ # Employees:_____

Number of loading docks:_____

Facility Operations: Start Time:_____ End Time:_____

Days per week:_____ Weeks per year:_____

Please provide the information shown in the tables below for all diesel-powered trucks and equipment (such as forklifts and cargo handling equipment) operating at this facility. Truck activity should be reported according to the classifications shown on the back of this page. (Note: providing a range of values is acceptable if exact values are not known).

Diesel-powered truck information

Number of Axles	Number of Trucks per Day	Number that have TRUs*	Truck Age Range	Avg. Idle Time per Truck (min.)	Estimated On-site Distance Traveled	TRUs* On-Site Run Time (min.)
2						
3						
4						
5						
6+						

Note: TRU = transport refrigeration unit

Diesel-powered off-road equipment information (if applicable)

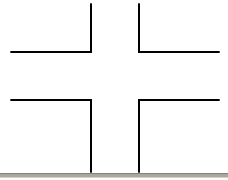
Equipment Type	Number of Equipment	HP	Engine Year	Days per week Operated	Avg. Hours per Day	Start Hour	Fuel Consumed (gal/day)	% Time at Idle	% Time Under Load

WEST OAKLAND
TRUCK SURVEY LOG SHEETS (1)

Location:_____

Cross Street:_____

(Label diagram with street names, your location, and direction of traffic flow) ⟶



SURVEY DATE (DD/MM/YEAR):_____ **SURVEYOR:**_____

DAY OF THE WEEK (circle one): Mon Tue Wed Thu Fri Sat **START TIME:**_____**AM/PM** **END TIME:**_____**AM/PM**

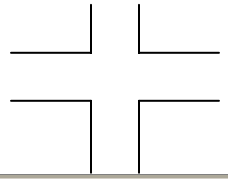
Direction	2-axle 	3-axle (other) 	3-axle Bobtail 	4-axle 	5-axle 	6+ axles (tandem) 	Port Chassis Truck 	Port Container Truck 
⇧								
⇨								
⇩								
⇦								
⇩								
⇨								

WEST OAKLAND
TRUCK SURVEY LOG SHEETS (2)

Location:_____

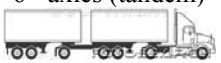
Cross Street:_____

(Label diagram with street names, your location, and direction of traffic flow) ⟶



SURVEY DATE (DD/MM/YEAR):_____ **SURVEYOR:**_____

DAY OF THE WEEK (circle one): Mon Tue Wed Thu Fri Sat **START TIME:**_____**AM/PM** **END TIME:**_____**AM/PM**

Direction	2-axle 	3-axle (other) 	3-axle Bobtail 	4-axle 	5-axle 	6+ axles (tandem) 	Port Chassis Truck 	Port Container Truck 
⟵								
⟱								
⟶								
⟵								
⟹								
⟱								

Appendix B

Uncertainty Association with Automatic Counters

APPENDIX B

At four of the sites in West Oakland, both automatic and manual truck counts were performed (see Table B-1). Overall, the automatic truck counts at these sites were 1.2 to 15.3 times higher than the manual counts. Automatic truck counts were binned by the number of axles (e.g., 2-axle long, 2-axle/6 tire, 3-axle single, 4-axle single, etc.), and examination of the data showed that a significant number of trucks were being counted in the smallest "2-axle long" truck classification. Removal of this category from the automatic count totals brought the automatic truck counts and manual counts into much closer agreement, with the automatic counts being only 2% to 33% higher than the manual counts. This finding suggests that the automatic counters may have difficulty distinguishing between small 2-axle trucks and light-duty vehicles. The significance of the 2-axle long category varies for each site, depending on the mix of trucks counted at a given site. For example, at the 3rd and Adeline site, larger trucks (port trucks and other 3+-axle trucks) dominate the truck counts and removing the "2-axle long" category has a minor effect (see Figure B-1). However, non-port sites, such as the intersection of Mandela and West Grand, have a higher fraction of small truck (<3 axles) traffic. Therefore, removing the "2-axle long" category has a larger effect on this site than at a port site like 3rd and Adeline (see Figure B-2). Because of the uncertainty of the counts and truck classifications, the automatic counter data were only used to discern daily traffic patterns and vehicles speeds.

Table B-1. Summary of Truck Counts by Manual and Automatic Counters

Intersection	Beginning Hour	Ending Hour	Manual Totals	Automatic Totals	Modified Automatic Totals
3rd & Adeline – Sat.	8 AM	6 PM	56	249	44
3rd & Adeline – Wed.	8 AM	6 PM	2513	3264	2817
Mandela & West Grand	7 AM	6 PM	955	3119	1076
Market & 18th	8 AM	12 PM	104	423	106
30th & MLK	8 AM	12 PM	3	46	4

Figure B-1. Hourly truck counts near the intersection of 3rd and Adeline.

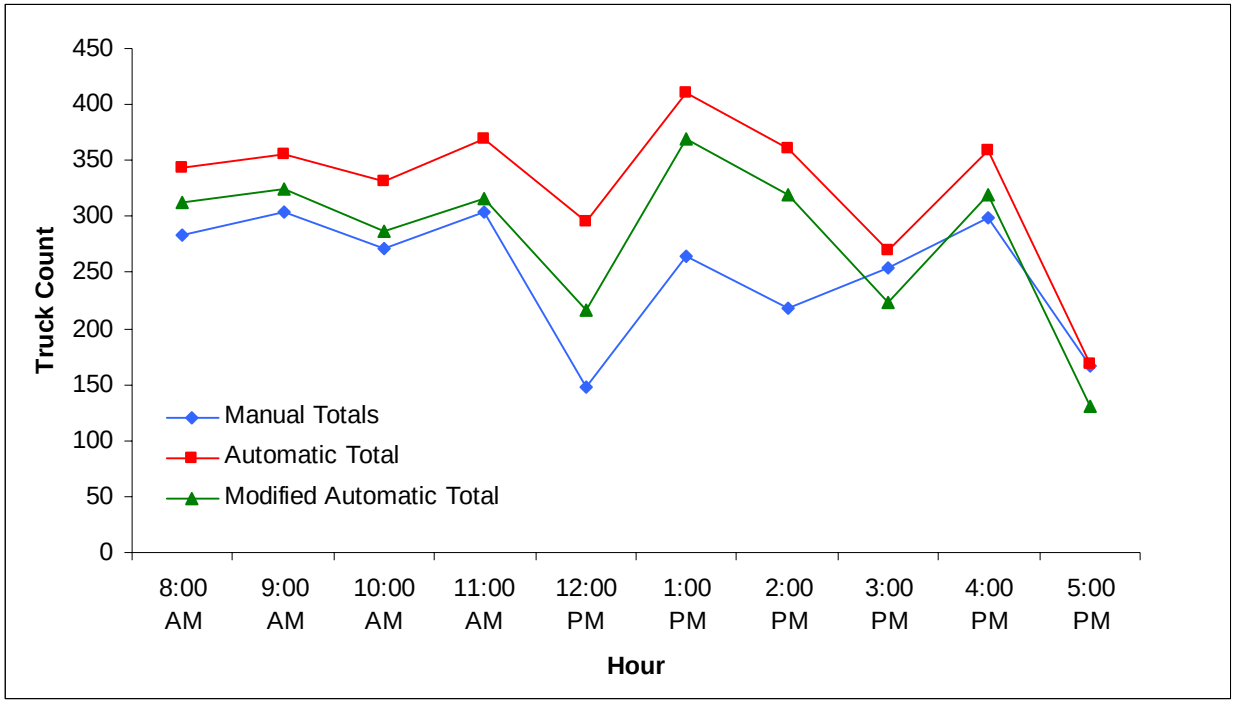
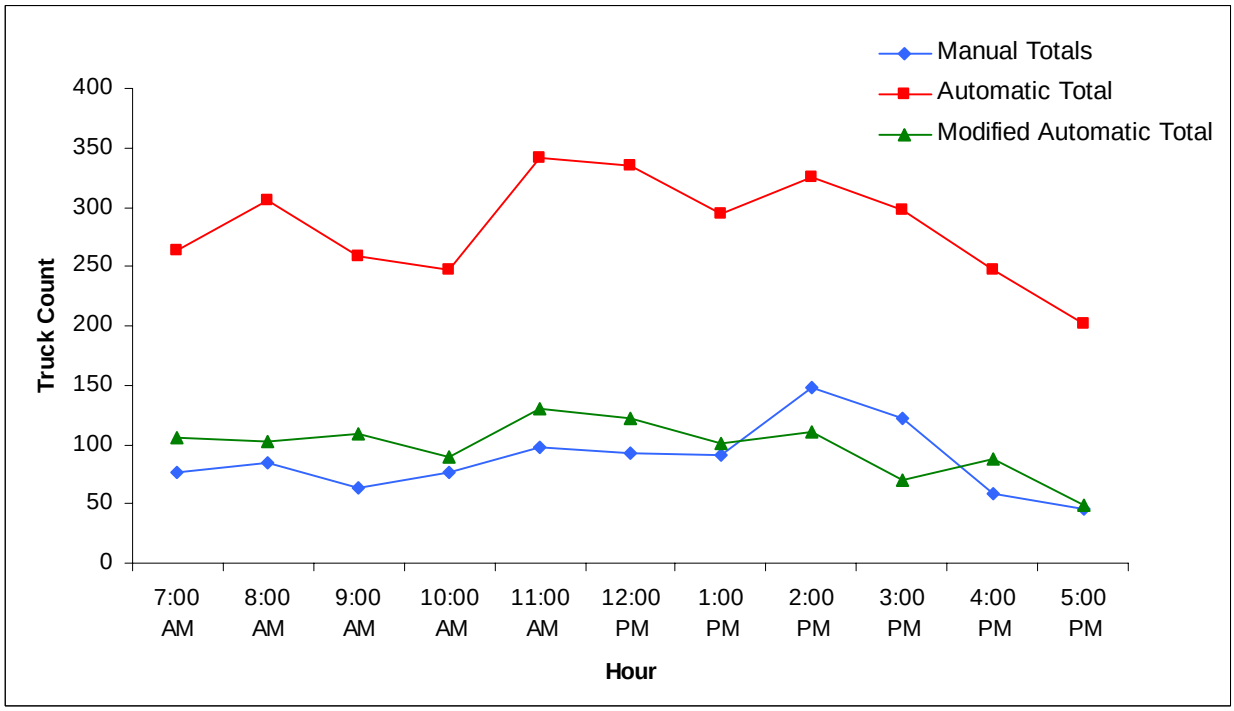


Figure B-2. Hourly truck counts near the intersection of Mandela and West Grand



Appendix C

Developing Truck Routes and Freeway Volumes

APPENDIX C

I. Traffic Volumes along Surface Streets

Truck volumes were estimated on surface streets of West Oakland by developing a roadway network of frequently used truck routes and then estimating the number of trucks that travel on each route. The District developed unique routes that trucks generally travel to and from the Port of Oakland. The truck routes were developed using the GPS tracking data collected from approximately 200 trucks that travel to and from the Port of Oakland (see Section 1.3) from 2006 through 2007. The GPS tracking units in the driver's cell phone were used to relay truck positions every two minutes; however, some of the transmissions were sporadic and intermittent. Because the cell phone needed to be operational and charged, transmissions ranged from less than 10 minutes to over a year.

In order to develop Port truck routes, the District developed a program that used the three previous or succeeding observations to deduce the likely route when trucks exited or entered the Port. For trucks to be positively identified as traveling along a certain route, three successive GPS readings must align along the route. The District also conducted a short study in 2007 to characterize routes of non-Port trucks. In that study, District staff followed an iterative process of randomly selecting trucks as they entered West Oakland and tracking them until they reached their final destination in West Oakland or merged onto the freeway. The District combined the routes from both studies to develop the 55 unique routes that make up the roadway network. Table C-1 presents a list and description of the routes and also shows the number of occasions that a truck may have traveled on the route ("any") and the number of times that a truck was positively identified as traveling along the route ("unique").

Table C-1. List of Possible Truck Routes

File name	GPS Counts		Description
	any*	Unique*	
Routes Into Southern Port Area			
sproute1.kml	2284	308	I-880 N, off on 7th St @ Market, turn on Adeline
sproute2.kml	1730	62	I-880 N, off on 7th St, turn on Market, then 3rd, then into Adeline Port entrance
sproute3.kml	425	62	7th Street into south Port via 7th and Frontage entrance
Sproute4.kml	860	143	I-80 south to 7th St off ramp, into Port
Sproute5.kml	1141	357	I-80 south, off on 5th St exit, turn on Adeline into Port
Sproute6.kml	1510	7	I-880 north, off at 7th & Frontage, into Port, into south Port @ Maritime
Sproute7.kml	751	25	Gas station @ 5th and Adeline, into Port @ Adeline
sproute8.kml	3592	1468	I-880 north, off at 7th, into Port, into south Port @ middle harbor
sproute9.kml	2129	807	I-80 south to 7th St off ramp, into Port via 7th St-Middle Road
sproute10.kml	877	61	Parking lot near W Grand, W Grand to Mandela, down Mandela to 7th, over to Adeline, into south Port.
sproute11.kml	2450	321	I-80, off at W. Grand Ave, into north Port @ Maritime, along Maritime, then 7th, into south Port at Middle Harbor
sproute12.kml			I-880, off at Broadway, turn on 3rd to Adeline into Port @ Adeline
sprouteh.kml	1113	479	Start at Howard terminal, go up to 3rd Street, over to Adeline

File name	GPS Counts		Description
	any*	Unique*	
sproutnp.kml	9362	6993	Any route from north port into south
sptf1.kml			W. Grand Ave, into north Port @ Maritime, down Maritime and into south Port.
Routes Exiting Southern Port Area			
Sprout1.kml	3539	1593	South Port, out Adeline, turn on 5th onto I-880 south
Sprout2.kml	1815	21	South Port, 7th St, onto I-880 south
Sprout3.kml	1593	717	South Port, out 7th, onto I-80 north
Sprout4.kml	1718	766	South Port, out Adeline to 5th, onto I-80 north
Sprout5np.kml	1964	126	South Port, out Adeline exit to 7th, left on 7th to north Port
Sprout6.kml	2501	251	South Port, into north Port on middle harbor, 7th St exit onto I-880 south
Sprout7np.kml	2007	126	South Port, out Adeline exit to 5th, onto I-880 N, off at 7th, into north Port
sprout8.kml	915	79	South Port into north port along Maritime. Maritime and W. Grand exit to frontage road then I-80 north
Sprout9h.kml	653	50	South Port, out and along 7th St to Market, south into Howard Terminal
sprouth.kml	949	280	South Port, Adeline, 3rd, into Howard Terminal
sproutnp.kml	10390	389	South Port into north Port
sproutf3.kml			Along Embarcadero to Market to 3rd, into Port @ Adeline
Spoutf1.kml			Out Adeline to 7th, to Mandela, to W Grand, to Union. St. on Union.
Spoutf2.kml			To 3rd to Broadway, to 5th & Broadway I-880 south
Routes Into Northern Port Area			
Nprout7np.kml	1648	111	North of Port, out Maritime exit to W. Grand, onto Frontage road, back into north Port @ 7th
nproute1.kml	3182	1753	I-80, off at W. Grand Ave, into Port @ Maritime
nproute11.kml	7305	414	I-880 N, off at W Grand, into north Port @ Maritime
nproute2.kml	922	217	From Bay Bridge, into Port @ Maritime
nproute3.kml	7622	851	I-880 north, off at 7th and Frontage, into Port
nproute3h.kml	1266	46	Howard, turn on 3rd, Adeline to 7th, into north Port @ 7th and Frontage
nproute4.kml	1162	36	Along 7th Street into Port via 7th and Frontage entrance
nproute4h.kml	1986	108	Howard, turn on 3rd, Adeline to 5th, onto I-880 north, into north Port @ 7th and Frontage
nproute5.kml	720	30	W. Grand Ave into Port @ Maritime
nproute5h.kml	2449	129	Howard, Market, turn on 5th, onto I-880, off at 7th and Frontage, into Port
nproute6.kml	2456	218	I-80 to Frontage Road and W Grand, then into Port
nproute6h.kml	1365	135	Howard, turn on 3rd, turn on Adeline into south Port, along Maritime to north Port.
nproute7.kml	4142	1641	I-80 south to 7th St off ramp, into north Port
nproute8.kml	1595	86	South Port, out Adeline, onto I-880 north, off at 7th, into north Port.
nproute9.kml	696	8	Adeline to W Grand, then into north Port @ Maritime
nprouteh.kml	1337	74	Howard, Market, left on 7th, into north Port
nproutnp.kml	2331	960	Hypothetic route along northern area of the Port
nproutsp.kml	12017	10836	South Port into north Port
Routes into Howard Terminal			
hroute1.kml	520	208	From I-880 N, off at 7th and Market, down Market into Howard
hroute2.kml	738	253	I-880 south, off on 5th, turn on Market to Howard Terminal.
hroute4.kml	665	102	I-880 south, off on 5th, turn on Adeline then 3rd then Market to Howard Terminal.
hroute5.kml	568	83	I-80 south, onto I-880, off at 5th, Adeline, 3rd, Market, into Howard

File name	GPS Counts		Description
	any*	Unique*	
hroute7np.kml	566	107	North Port, out 7th and along 7th, turn on Market, into Howard
hroute8.kml	477	54	I-80s, off at W. Grand, to Mandela, to 7th, over to Market, to Howard
hroutesp.kml	644	176	Route to Howard terminal from south Port, via 3rd St
hroutenp	657	402	North Port, out 7th, onto i-880 south, off at 5th, Adeline, 3rd, Market, into Howard

* **Unique** means those instances where that route was the only route the truck could have been on. **Any** means that the truck might have been on that route, but could also have been on others.

The roadway network and the GPS transmissions alone are not sufficient to estimate the total truck volumes on each route. Instead, the District used the manual counts to estimate the number of trucks that travel daily on each route. The manual counts indicate the actual number of trucks at each intersection correlated by the time of day and day of the week. A statistical program was written to approximate traffic density on each street route to closely match the survey results at each intersection.

II. Freeway Volumes

West Oakland contains portions of four major freeways including I-580, I-980, I-880, and I-80 and the eastern span of the Bay Bridge. The District conducted manual counts on I-580, I-980, and I-880. For I-580, half a day counts were performed and found minimal Port truck activity. For I-980, a full day of counting was conducted and only marginally more Port trucks were counted as compared to I-580. On both freeways, Port trucks represented one to two percent of the truck traffic. Additional data analysis was not performed on these two freeways since many of the PeMS sensors along these routes were in operable at the time of the survey.

The District estimated the number of trucks traveling on the most heavily used freeway, I-880, which is directly upwind of West Oakland and nearest to Port activity. For the freeway estimate, the District only included trucks traveling on I-880 that did not enter or exit into West Oakland. The District used three data sources for this estimate including the PeMS data (2008), which are automatic measurements of all traffic made at various points on I-880; manual counts made of trucks on the freeway and on freeway entrances and exits; and video footage of I-880 taken from the West Oakland BART platform.

The PeMS network (see Figure C-1) includes all major freeways in the Bay Area; however, a majority of the sensors along the I-880 corridor in West Oakland are nonfunctioning or inaccurate. When functioning, the PeMS processes 30-second loop detector data from freeway segments across California. Figure C-1 shows the locations and conditions of the PeMS sensors along I-880. For estimating northbound I-880 traffic, the District used data from sensors 401333 and 400218. The readings from these sensors were verified as accurate through comparisons to video footage collected from the West Oakland BART platform on December 8 and 10, 2008.

Sensor 401333 includes trucks that enter from 5th and Union on-ramp or exit off of 7th and Frontage. Manual counts were conducted on the 5th and Union Street intersection on December 8 and 9, 2008. The counts from these two days were averaged and then subtracted from the total sensor reading from 401333. The other sensor, 400218, located just north of 7th and Frontage

exit was used to adjust the reading from sensor 401333 to account for the loss of trucks exiting to the Port. Sensor 400218 ceased operations in August 2008 and thus, readings collected in August were assumed to be consistent with December.

Figure C-1. Status of PeMS Network and Usable Sensors Data

Note: Pin cushion locations of PeMS sensor location, truck on ramp and exits are shown with blue trucks, movie camera represents location where video footage was collected.

For southbound I-880, a similar methodology was used based on readings from sensor 401339, located south of the 5th and Union Street exit, but also south of 7th and Frontage on-ramp. In comparison to the video footage, the lane sensors on 2 and 3 were accurate except for the sensor on lane 4 where the readings were incorrect. The District had to approximate the traffic on lane 4 by comparing the up freeway sensor 400454 to sensor 401339. By comparing traffic from lanes 2 through 4 from sensor 400454 to readings from lanes 2 and 3 from sensor 401339, the District was able to estimate lane 4 traffic. The traffic count from sensor 401339 was further adjusted by accounting for trucks entering I-880 from 7th and Frontage Street on-ramp. Based on the manual counts, approximately a quarter of the trucks on I-880 entered from this ramp.