DRAFT – 10/1/07

Toxic Air Contaminant Emissions Inventory and Dispersion Modeling Report for the Colton Rail Yard, Bloomington, California

prepared for:

Union Pacific Railroad Company

October 2007

prepared by:

Sierra Research, Inc.
1801 J Street
Sacramento, California 95811
(916) 444-6666

Toxic Air Contaminant Emission Inventory and Air Dispersion Modeling Report for the Colton Rail Yard Bloomington, California

prepared for:

Union Pacific Railroad Company

October 2007

prepared by:

Sierra Research, Inc.
1801 J Street
Sacramento, CA 95811

and

Robert G. Ireson, Ph.D.
Air Quality Management Consulting
161 Vista Grande
Greenbrae, CA 94904

SUMMARY

In accordance with the 2005 California Air Resources Board (CARB)/Railroad Statewide Agreement (MOU), Union Pacific Railroad Company (UPRR) has prepared a facility-wide emission inventory for the Colton Rail Yard (Yard) in Bloomington, California. The inventory quantifies emissions of specified toxic air contaminants (TACs) (including Diesel particulate matter [DPM]) from stationary, mobile, and portable sources at the Yard. The inventory was prepared in accordance with CARB's *Rail Yard Emission Inventory Methodology* guidelines (July 2006) and UPRR's *Emission Inventory Protocol* (May 2006).

The Colton Yard is a locomotive servicing facility. Activities at Colton include receiving inbound trains, building and departing outbound trains, locomotive refueling, locomotive servicing, and sand tower operations. Facilities and equipment include a locomotive shop, a service track, a locomotive wash, a sand tower, Diesel fuel storage tanks, various oil storage tanks, and a wastewater treatment plant.

Emission sources at the Yard include, but are not limited to, locomotives, heavy-heavy-duty (HHD) Diesel-fueled delivery trucks, heavy equipment, fuel storage tanks, and an emergency generator. Emissions were calculated on a source-specific and facility-wide basis for the 2005 baseline year.

An air dispersion modeling analysis was also conducted for the Yard. The purpose of the analysis was to estimate ground-level concentrations of DPM and other TACs, emitted from Yard operations, at receptor locations near the Yard. Emission sources included in the modeling analysis were locomotives and Diesel-fueled heavy equipment. The air dispersion modeling was conducted using the AERMOD Gaussian plume dispersion model and meteorological data from the Ontario International Airport. The meteorological data were processed using the AERMET program. The modeling analysis was conducted in accordance with the *Health Risk Assessment Guidance for Rail Yard and Intermodal Facilities* (July 2006) and UPRR's *Modeling Protocol* (August 2006).

Toxic Air Contaminant Emission Inventory
and Air Dispersion Modeling Report
for the
Colton Rail Yard
Bloomington, California

TABLE OF CONTENTS

Page

LIST OF APPENDICES

LIST OF TABLES

Page

LIST OF FIGURES

Page

Toxic Air Contaminant Emission Inventory and Air Dispersion Modeling Report for the Colton Rail Yard Bloomington, California

PART I. INTRODUCTION

In accordance with the 2005 California Air Resources Board (CARB)/Railroad Statewide Agreement (MOU), Union Pacific Railroad Company (UPRR) has prepared a facility-wide emission inventory for the Colton Rail Yard[1] (Yard) in Bloomington, California.. The inventory quantifies emissions of specified toxic air contaminants (TACs) (including Diesel particulate matter [DPM]) from stationary, mobile, and portable sources at the Yard. The inventory was prepared in accordance with CARB's *Rail Yard Emission Inventory Methodology* guidelines (July 2006) and UPRR's *Emission Inventory Protocol* (May 2006).

An air dispersion modeling analysis was also conducted for the Yard. The purpose of the analysis was to estimate ground-level concentrations of DPM and other TACs, emitted from Yard operations, at receptor locations near the Yard. Emission sources included in the modeling analysis were locomotives and Diesel-fueled heavy equipment. The air dispersion modeling was conducted using the AERMOD Gaussian plume dispersion model and meteorological data from the Ontario International Airport. The meteorological data were processed using the AERMET program. The modeling analysis was conducted in accordance with the *Health Risk Assessment Guidance for Rail Yard and Intermodal Facilities* (July 2006) and UPRR's *Modeling Protocol* (August 2006).

[1] The Yard is referred to by a variety of names, including the West Colton Yard. In this report, the facility will be called the Colton Yard, for consistency with the MOU.

PART II. FACILITY DESCRIPTION

A. Facility Name and Address

Union Pacific Railroad Company
Colton Rail Yard
19100 Slover Avenue
Bloomington, CA 92316

B. Facility Contact Information

Brock Nelson
Director of Environmental Operations – West
Union Pacific Railroad Company
10031 Foothills Boulevard
Roseville, CA 95747
Phone: (916) 789-6370
Fax: (402) 233-3162
banelson@up.com

C. Main Purpose of the Facility

The Colton Yard is a classification yard. The primary function of a classification yard is to "break" arriving trains into sections based on their final destinations, and to build new trains that then depart for the desired destinations. This is accomplished by pushing the connected cars of an arriving train from the Receiving Yard over a "hump" (a raised section of track). Cars are decoupled at the top of the hump and gravity allows the cars roll into the "bowl." The bowl is a large area with a number of parallel tracks. A computer controls switching each car into the appropriate track within the bowl. Yard switcher locomotives build new trains by pulling sections of cars out of the bowl, connecting them to others with the same destination(s), and moving them to the Departure Yard, thereby creating a new outbound train.

There is also a locomotive service facility at the Yard that performs both basic service and scheduled and unscheduled maintenance and load testing. In 2005, all service and maintenance was performed at the service track, while a new locomotive shop facility was constructed at the east end of the Yard.

D. Types of Operations Performed at the Facilities

Activities at the Colton Yard include receiving inbound trains, building and departing outbound trains, locomotive refueling, locomotive servicing, locomotive maintenance, locomotive washing, and sand tower operations. There are a number of tanks at the facility that are used to store liquid petroleum products such as Diesel fuel, gasoline, lubricating oils, and recovered oil.

Within the Yard, the primary locomotive activities are associated with arriving and departing trains and servicing the locomotives that power these trains. Arriving and departing trains' locomotives are fueled in the locomotive service area after arrival, and are sent back into the Yard or to other yards after service. A locomotive maintenance shop also performs periodic and unscheduled maintenance on locomotives.

Facilities and equipment at the Colton Yard include a locomotive shop,[2] a locomotive service track, a locomotive wash area, a wheel shop,[3] a sand tower, a railcar repair shop, Diesel fuel storage tanks, various oil storage tanks, and a wastewater treatment plant.

E. Facility Operating Schedule

The Colton Yard operates 24 hours per day, 365 days per year.

F. General Land Use Surrounding the Facility

The Colton Yard covers a narrow area approximately 2¼ miles in length (tracks and train pushback areas extend both east and west of the main Yard) and 1/3 mile in width, at the widest part. The Yard is located adjacent to and directly south of the I-10 freeway. Land use north of the Yard includes commercial, industrial, and residential areas. There are several truck distribution centers just north of the I-10. The nearest residential area is

[2] In 2005, the locomotive shop was under construction. Prior to the opening of the new shop, locomotive maintenance was done at the Service Track.
[3] In 2005, the wheel shop was under construction and not operational.

located at the west end of the Yard, just north of the I-10, approximately 500 feet from the Yard boundary. Land use to the south of the Yard includes residential and industrial areas. There are a number of truck distribution centers and a bulk fuel storage plant in this area. The nearest residential area is located at the west end of the Yard about 350 feet from the Yard's southern boundary. Bloomington Junior High School is located south of the Yard, just east of Cedar Avenue. Land uses to the east and west include commercial and residential areas. There are also a number of schools in these areas. The location of specific receptors is further discussed in Part IX.

PART III. MAP AND FACILITY PLOT PLAN

Figure 1
Location Map

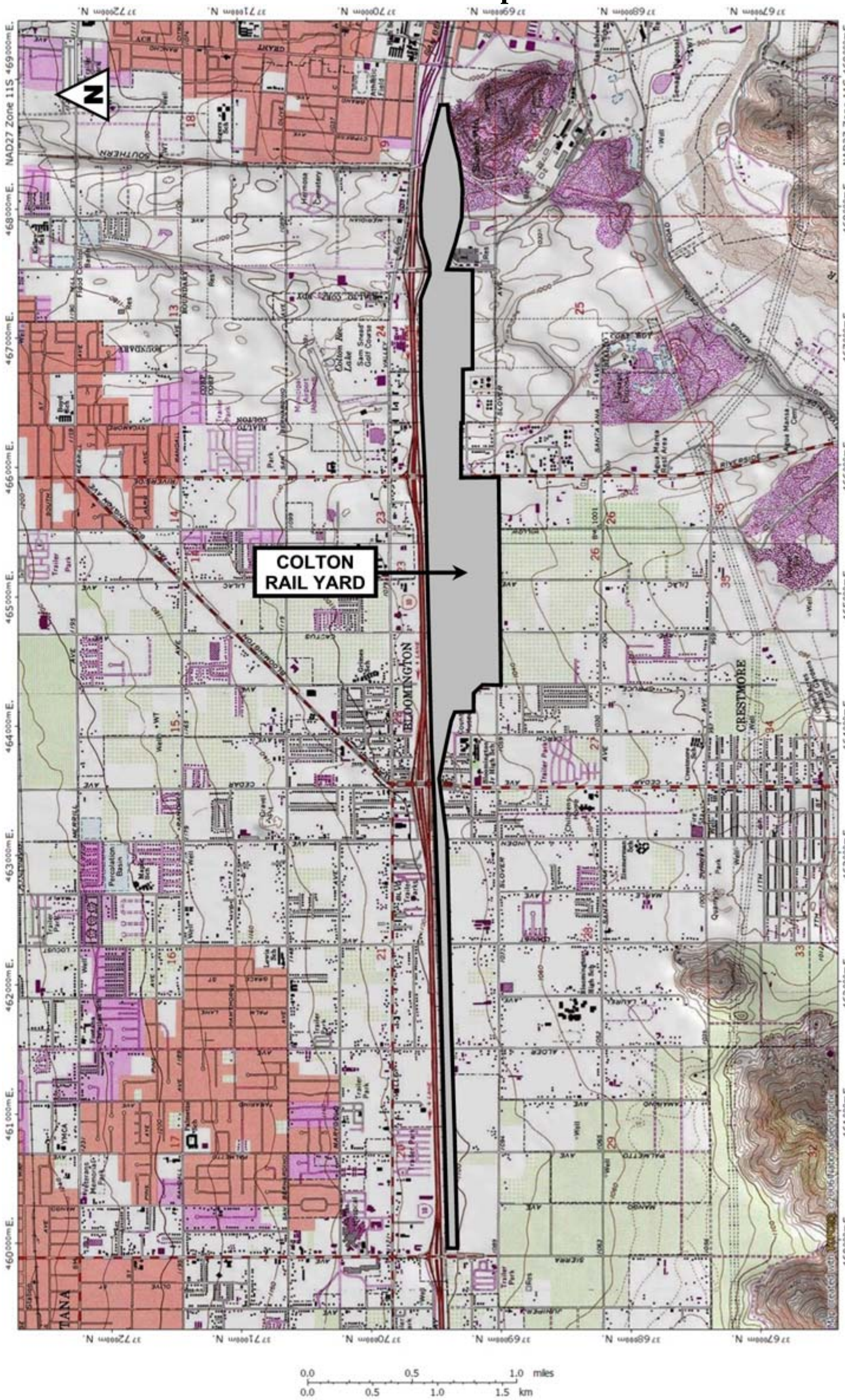


Figure 2
Colton Rail Yard Layout

PART IV. <u>COVERED SOURCES</u>

This emission inventory quantifies toxic air contaminant (TAC) emissions from the stationary, mobile, and portable sources located or operating at the Colton Yard. Sources include, but are not limited to, locomotives, yard trucks of various vehicle weight classes, heavy-heavy duty (HHD) Diesel-fueled delivery trucks, Diesel-fueled heavy equipment, various storage tanks, a wastewater treatment plant, and an emergency generator. Site-specific equipment inventories are included in Part V below.

Per the UPRR *Emission Inventory Protocol*, stationary point sources that are exempt from local air district rules have been identified, but not included in the detailed emission inventory. Also, de minimis sources, based on weighted risk, have been identified in the inventory, but have not been further discussed or included in the modeling analysis. De minimis sources are the individual sources that represent less than 3% of the facility-total weighted-average site health risk (determined separately for cancer risk and non-cancer chronic health hazard). Total exclusions for all de minimis sources did not exceed 10% of the facility-total weighted average site cancer risk or chronic health hazard. De minimis sources are further discussed in Part VIII of this report.

PART V. SITE-SPECIFIC INVENTORIES

As discussed in Part IV above, there are a number of mobile, stationary, and portable emissions sources operating at the Colton Rail Yard. The mobile sources include locomotives, heavy-heavy duty (HHD) Diesel-fueled delivery trucks, and heavy equipment. The stationary emission sources include storage tanks, a sand tower, a wastewater treatment plant, heaters, and an emergency generator. Portable equipment operating at the Yard includes welders, air compressors, steam cleaners, and pressure washers. Each source group is further discussed below.

A. Locomotives

Locomotive activities at the Yard fall into several categories. "Road power" (locomotives used on inbound and outbound freight and passenger trains) activities include hauling through trains on the main line; pulling arriving trains into the Receiving Yard and departing trains out of the Departure Yard; and moving locomotives to and from the Service Track and Ready Track. Operations within the Yard include the use of 12 medium-horsepower switcher locomotives: two sets of three locomotives push inbound trains over the Hump into the Bowl; and three sets of two locomotives work the east end of the Bowl and the Departure Yard to build new outbound trains. Locomotive servicing and maintenance activities are performed on both road power and switcher locomotives, and include idling associated with refueling, sanding, oiling, and waiting to move to outbound trains. Additional periods of idling and operation at higher throttle settings occur during load test events that follow specific maintenance tasks.

Table 1 provides the number of locomotives in operation (arrivals, departures, and through traffic) at the Yard during 2005 by locomotive model group and type of train, including both working and non-working units. Through trains, including both freight trains and Amtrak passenger trains, as well as through power moves,[4] use the main line

[4] Power moves are a group of locomotives with no attached railcars, whose objective is either to move locomotives to locations where they are needed, or to take malfunctioning units to service facilities. In general, only one or two locomotives in the consist are in operation during power moves.

passing by the facility. All terminating trains arrive in the Receiving Yard. All originating trains depart from the Departure Yard.

Table 1
Locomotive Models (Road Power) Identified at Colton Rail Yard

Locomotive Model Group	Train Type[a]				
	Through Trains	Freight Trains	Local Trains	Power Moves Through	Power Moves In Yard
Switch[b]	2	65	64	0	22
GP3x	15	227	177	0	75
GP4x	1450	5607	1889	76	1079
GP50	160	364	13	3	43
GP60	972	12328	6337	48	5105
SD7x	8116	10284	154	94	900
SD90	131	232	20	5	51
Dash7	6	132	0	0	3
Dash8	1908	3493	72	29	475
Dash9	4191	13149	269	60	988
C60A	38	70	0	1	11
Unknown	162	463	62	4	56
Total	17151	46414	9057	320	8808

Notes:
a. Includes all locomotives identified on an arriving, a departing, or a through train, including both working and non-working units.
b. Does not include switcher locomotives used for Yard operations.

B. Diesel-Fueled Trucks (Yard Trucks)

UPRR operates a variety of on-road Diesel-fueled trucks (Yard trucks) that are used for various activities in and around the Yard. Table 2 shows the equipment specifications for the Diesel-fueled Yard trucks.

Table 2 Equipment Specifications for Diesel-Fueled Yard Trucks[a] Colton Rail Yard				
Equipment ID	Make	Model	Model Year	Vehicle Class
69496	Chevy	CK 3500	1998	LDT
69499	Chevy	CK 3500	1998	LDT
1915-73119	Ford	F-450	2003	LHDT1
9007E	Ford	F-800	1992	MHD
9009E	Ford	F-800	1992	MHD
9031E	Ford	F-800	1992	MHD
9018E	Ford	F-800	1992	MHD
Unknown	International	Unknown	1987	HHD
64274	Ford	LT8000	1989	HHD
1915-9038E	Ford	LT9000	1997	HHD

Notes:
a. Vehicle specifications provided by UPRR personnel.

C. <u>HHD Diesel-Fueled Delivery Trucks</u>

A variety of HHD Diesel-fueled trucks operate at Colton each day. The HHD trucks deliver Diesel fuel, gasoline, various oils, sand, and soap to the Yard. The trucks are owned by independent operators. Therefore, a fleet distribution is not available. For emission calculations, the EMFAC 2007 model default fleet distribution for HHD Diesel-fueled trucks operating in Los Angeles County was used.

D. <u>Heavy Equipment</u>

Diesel-fueled heavy equipment is used in Yard operations at Colton. The heavy equipment is used for non-cargo-related activities at the Yard, such as locomotive maintenance, handling of parts and Company material, derailments, etc. Table 3 provides detailed information for the heavy equipment used at Colton.

Table 3 Equipment Specifications for Heavy Equipment Colton Rail Yard				
Equipment Type	Make/Model	Model Year	Rating (hp)	No. of Units
Rail Cleaner	Unknown	2003	125	1
Rerailer	Cline	1987	183	1
Crane	Lorain LRT-250	1997	145	1
Forklift	Toyota 6EDU45	1999	79	1
Total				**4**

E. Tanks

There are a number of tanks at the Colton Yard that are used to store liquid petroleum and other products such as Diesel fuel, gasoline, lubricating oils, recovered oil, and soap. Table 4 provides detailed information for all storage tanks located at the facility.

As shown in Table 4, all storage tanks at the facility, except the four gasoline storage tanks (tanks 1172, 1187, 1189, and 1498) are exempt from South Coast Air Quality Management District (SCAQMD) permitting requirements per Rule 219(m). Since these storage tanks are exempt from local air district rules, the emissions from these tanks are not included in the inventory or the dispersion modeling analysis, consistent with the UPRR inventory protocol.

Table 4 Storage Tank Specifications Colton Rail Yard			
Tank No.	Tank Location	Material Stored	Tank Capacity (gallons)
1149[a]	Service Track	Lube Oil	1,000
1151[a]	Service Track	Lube Oil	15,700
1152[a]	Service Track	Lube Oil	15,700
1153[a]	Service Track	Diesel	15,700
1154[a]	Service Track	Diesel	15,700
1155[a]	Service Track	Journal Box Oil	7,500
1156[a]	Service Track	Journal Box Oil	7,500
1157[a]	One Spot	Used Oil	400
1158[a]	WWTP	Stormwater	275,000
1159[a]	WWTP	Stormwater	275,000
1160[a]	WWTP	Used Oil	2,000
1161[a]	WWTP	Sludge	5,000
1168[a]	Locomotive Wash	Used Oil	25,000
1169[a]	Locomotive Servicing	Used Oil	25,000
1172	Locomotive Servicing	Gasoline	500
1174[a]	Locomotive Wash	Soap	2,500
1175[a]	Locomotive Wash	Soap Mix Tank	350
1176[a]	Locomotive Wash	Soap Mix Tank	350
1177[a]	Locomotive Wash	Recycled Water	20,000
1178[a]	Locomotive Wash	Water	10,000
1179[a]	MOW Compound	Used Oil	500
1180[a]	Locomotive Servicing	Radiator Fluid	7,500
1187	One Spot	Gasoline	500
1189	Departure Yard/Trim Tower	Gasoline	500
1498	One Spot	Gasoline	500

Notes:
a. Exempt from permitting requirements per SCAQMD Rule 219(m).

F. Sand Tower

Locomotives use sand for traction and braking. The sand tower system located at the Colton Yard consists of a storage system and a transfer system to dispense sand into locomotives. The storage system includes a pneumatic delivery system and a storage silo. The transfer system includes a pneumatic transfer system, an elevated receiving silo, and a moving hopper and gantry system. The system is equipped with a baghouse for emissions control.

G. Wastewater Treatment Plant

The Colton Yard also has a wastewater treatment plant (WWTP). Equipment at the WWTP includes oil/water separators, pumps, and storage tanks. Operation of the oil/water separators results in fugitive emissions of VOC.

H. Emergency Generator

An emergency generator is located in the bowl area of the Colton Yard to provide emergency lighting when electrical service from the local power provider is disrupted. The generator is a 50 horsepower, Diesel-fueled unit.

I. Boilers and Heaters

There are two natural gas-fired boilers and one natural gas-fired heater at the Colton Yard. Equipment specifications for the boilers and heater are shown in Table 5.

Rule 219(b)(2) exempts from permitting requirements boilers and process heaters that have a maximum heat input rate of 2 MMBtu/hr or less and are equipped to be heated exclusively with natural gas, methanol, or liquefied petroleum gas or any combination thereof that does not include an internal combustion engine. As shown in Table 5, the heater and boiler located at the locomotive wash area are exempt from permitting per Rule 219(b)(2). Since these units are exempt from local air district rules, the emissions from these units are not included in this inventory or in the dispersion modeling analysis, consistent with the UPRR inventory protocol.

Table 5 Equipment Specifications for Heater and Boilers Colton Rail Yard			
Unit Type	Location	Fuel Type	Rating (MMBtu/hr)
Heater[a]	Locomotive Wash	Natural Gas	0.14
Boiler[a]	Locomotive Wash	Natural Gas	1.995
Boiler[b]	Locomotive Shop	Natural Gas	2.5

Notes:
a. Exempt from permitting requirements per SCAQMD Rule 219(b)(2).
b. Unit was installed in 2006. Since the unit did not operate in 2005, emissions from this unit are not included in the inventory or dispersion modeling analysis.

The boiler at the locomotive shop is not exempt from permitting requirements per Rule 219. However, this unit was not installed until 2006 and therefore did not operate in 2005. Since the unit did not operate in 2005, emissions from this unit are not included in the emission inventory or dispersion modeling analysis for the Yard.

J. Portable Equipment and Steam Cleaners

A variety of portable equipment is used at the Yard. Equipment specifications for the welders and miscellaneous portable equipment are shown in Table 6.

Internal combustion engines with a rated capacity of 50 brake horsepower or less are exempt from permitting requirements by SCAQMD Rule 219(b)(1). As shown in Table 6, all welders and miscellaneous portable equipment operated at the Yards have a rated capacity of less than 50 hp, and therefore are exempt from permitting requirements. Since these units are exempt from local air district rules, the emissions from these units are not included in this inventory or in the dispersion modeling analysis, consistent with the UPRR inventory protocol.

Table 6
Portable Equipment Specifications
Colton Rail Yard

Equipment Location	Equipment Type	Number of Units	Fuel Type	Rated Capacity (hp)
Receiving Yard	Welder[a]	1	Gasoline	16
Receiving Yard	Welder[a]	1	Gasoline	12.5
Receiving Yard	Welder[a]	1	Gasoline	13
One Spot	Welder[a]	5	Gasoline	13
One Spot	Welder[a]	2	Gasoline	10
Departure Yard	Welder[a]	1	Gasoline	12.5
Departure Yard	Welder[a]	2	Gasoline	13
Service Track	Welder[a]	3	Gasoline	13
One Spot	Air Compressor [b]	1	Gasoline	8
One Spot	Air Compressor [b]	1	Gasoline	11
Bridge Department	Air Compressor [b]	1	Diesel	42
Service Track	Pressure Washer[c]	4	Propane	0.325[d]

Notes:
a. Exempt from permitting requirements per SCAQMD Rule 219(e)(8) and Rule 219(b)(1).
b. Exempt from permitting requirements per SCAQMD Rule 219(b)(1).
c. Exempt from permitting requirements per SCAQMD Rule 219(b)(2).
d. Rating for these units is in MMBtu/hr.

Combustion equipment with a maximum rating of 2 MMBtu/hr or less that are equipped to be fired exclusively with natural gas, methanol, or liquefied petroleum gas are exempt from permitting requirements per SCAQMD Rule 219(b)(2). As shown in Table 6, the propane-fueled pressure washers have a rated capacity of less than 2 MMBtu/hr and are fired exclusively with natural gas. Therefore, these units are exempt from permitting requirements. Since these units are exempt from local air district rules, the emissions from these units are not included in this inventory or in the dispersion modeling analysis, consistent with the UPRR inventory protocol.

In addition to the portable equipment listed in Table 6, two portable steam cleaners are used at the Yard. Equipment specifications for steam cleaners are shown in Table 7.

Table 7 Equipment Specifications for Steam Cleaners Colton Rail Yard				
Equipment Location	Make	Emission Unit	Fuel Type	Rating (MMBtu/hr or hp)
Locomotive Shop[a]	Hydroblaster	Pump	Electric	NA
		Heater	Propane	0.36
Wheel Shop[a]	Hydroblaster	Pump	Electric	NA
		Heater	Propane	0.36

Notes:

a. Exempt from permitting requirements per SCAQMD Rule 219(d)(5) and Rule 219(b)(2).

b. Prior to completion of the locomotive shop and the wheel shop, steam cleaning would have been done at the Service Track.

SCAQMD Rule 219(d)(5) exempts equipment that is used exclusively for steam cleaning from permitting requirements, provided that the equipment is also exempt per Rule 219(b)(2). Rule 219(b)(2) exempts from permitting requirements boilers and process heaters that have a maximum heat input rate of 2 MMBtu/hr or less and are equipped to be heated exclusively with natural gas, methanol, or liquefied petroleum gas or any combination thereof that does not include an internal combustion engine. As shown in Table 7, the steam-cleaning units at the Colton Yard are exempt from permitting per Rule 219(d)(5). Since these units are exempt from local air district rules, the emissions from these units are not included in this inventory or in the dispersion modeling analysis, consistent with the UPRR inventory protocol.

PART VI. ACTIVITY DATA

Emissions from mobile sources are based on the number and type of equipment, equipment size, load factor, and operation during the 2005 baseline year. Since fuel consumption data were not available, the default load factors, from the OFFROAD2007 model, and operating data were used for emission calculations. Emissions from stationary and portable sources were based on the number and type of equipment, equipment size, and operation during the 2005 baseline year. For sources where operating data weren't available, an average operating mode (AOM) was developed based on employee interviews.

A. Locomotives

Locomotive emissions were based on the number, model distribution, and operating conditions (idling, throttle notch, and speeds of movements, etc). Table 8 summarizes the activity data for locomotives operating on trains at the Colton Yard, including the number of trains and number of working locomotives per consist, as well as their idle and operating time, and speed on arrival or departure. In general, arriving trains enter the Receiving Yard and stop while the railcars are detached from the locomotive. After the railcars have been detached, the locomotives move to the Service Track for refueling and service, and then to the Ready Track. On departure, locomotive consists move from the Ready Track to the appropriate end of an outbound train in the Departure Yard. The train departs after completion of the Federal Railroad Administration (FRA) mandated safety inspections (e.g., air pressure and brakes) and the arrival of the train crew. Most terminating and originating freight trains follow the main line at the east or west end of the Yard. A fraction of these trains arrive from or depart toward Palmdale to the north, and were identified by their train symbols. Emission calculations and modeling assigned these specific trains to routes in the Yard that use the main line leg at the east end of the Yard that turns to the north toward Palmdale.

In some cases, trains that are nominally "through" trains (arriving and departing under the same train symbol and date) add or drop cars or locomotives at the Colton Yard, or stop for a crew change at Cedar Avenue (east end of the Receiving Yard). These trains are counted separately, as the idling period is shorter prior to departure, and the locomotive consist is not disconnected nor moved to the service track. The data showed that non-local (line haul) freight trains arriving from and departing to the east used predominately newer high-horsepower SD-70 and Dash 9 locomotives, while both locals and freight trains arriving from and departing to the west used a mix of older medium- and high-horsepower and newer high-horsepower locomotives. Therefore, these two separate groups were assigned different locomotive model distributions in the emission calculations.

Power moves are groups of locomotives, with no attached railcars, that are moved between yards to provide road power for departing trains or to move malfunctioning locomotives to service areas. Although power moves may have as many as 10 or more locomotives, typically only one or two locomotives are actually operating. For emission calculations, power moves were assumed to have 1.5 operating locomotives (except for power moves involving just one locomotive).[5] In addition to road power, two three-locomotive "hump sets" and three two-locomotive "trim sets" operate in the Yard to move sections of inbound trains, spot them in the appropriate areas for handling, and subsequently reconnect these sections and move them to the appropriate outbound train areas. All of the hump and trim set locomotives are medium-horsepower (GP-4x) units that operate approximately 23 hours per day in the Yard.

[5] UP personnel report that although the train data records for power moves may show all locomotives "working," in actuality all locomotives except for one at the front and rear end (and more commonly only one at the front end) are shut down as they are not needed to pull a train that consists only of locomotives. Assuming 1.5 working locomotives per power move may slightly overestimate the actual average number of working locomotives per power move.

Table 8
Train Activity Summary[a]
Colton Rail Yard

Train Type	East Bound		West Bound		Arrival/Departing Speed (mph)	Idle Time (hrs)
	No. of Trains	Locomotives per Consist	No. of Trains	Locomotives per Consist		
Through Trains – Mainline	792	3.11	4,378	2.96	20	0.0
Through Trains – In Yard	95	3.11	178	2.96	10	0.5
Through Trains – Crew Change	149	3.11	4,017	2.96	N/A	0.167
Freight Trains Arriving	822	3.39	4,505	4.11	10	0.125
Freight Trains Departing	4,521	3.84	1,570	3.00	10	1.0
Local Trains Arriving	1,412	3.08	110	2.96	10	0.125
Local Trains Departing	24	2.46	1,213	2.96	10	1.0
Power Moves Through	14	3.21	49	4.39	20	0.0
Power Moves Arriving	546	3.62	1,071	2.52	10	0.0
Power Moves Departing	524	3.12	1,314	2.49	10	0.0

Notes:

a. Data reflect the number of operating locomotives; locomotives that are being transported, but are not under power, are not shown.

b. In addition to the activities described above, 12 switcher locomotives operate in the Yard. All switchers operate 23 hours per day.

A separate database provided information on each locomotive handled by the Service Track at the Yard. Based on detailed information on the reason and type of service or maintenance performed, separate counts of service and maintenance activities were developed, as detailed in Table 9. Routine service of locomotives involves idling and short movements in the service area associated with sanding, refueling, oiling, and other service activities prior to their movement to the Ready Track. Some locomotive service events occur elsewhere in the Yard, with little or no idling, as only simple service items and refueling are involved. Depending on the type of maintenance, load testing is performed prior to and/or after maintenance. The number of these test events was determined based on the service codes for each locomotive maintenance event in the database. The specific nature (duration and throttle setting) of such load testing events is described in Table 9.

Table 9
Locomotive Service and Shop Releases and Load Tests
Colton Rail Yard

Activity	Number of Events	Idling per event (min)	Throttle Notch 1 time (min)	Throttle Notch 8 time (min)
Locomotive Service	18,532	90	0	0
Ready Track	18,532	90	0	0
Yard Service	4,448	0	0	0
Planned Maintenance Pre-Test	661	2	0	8
Planned Maintenance Post-Test	661	10	10	10
Quarterly Maintenance Test	832	2	0	8
Unscheduled Maintenance Diagnostic	18	5	0	10
Unscheduled Maintenance Post-Test	1,048	10	10	10

B. Diesel-Fueled Trucks (Yard Trucks)

Emissions from the on-road Diesel-fueled trucks operating at the Yard are based on the engine model year, annual vehicle miles traveled (VMT), and the amount of time spent idling. Table 10 summarizes the activity data for the on-road Diesel-fueled trucks operating at the Yard.

Table 10 Activity Data for Diesel-Fueled Yard Trucks Colton Rail Yard						
Equipment ID	Make/Model	Model Year	Vehicle Class	Annual VMT[a]	Idling Time[b] (min/day)	(hr/yr)
69496	Chevy CK 3500	1998	LDT	17,060	15	91
69499	Chevy CK 3500	1998	LDT	20,042	15	91
1915-73119	Ford F-450	2003	LHDT1	5,250	15	91
9007E	Ford F-800	1992	MHD	3,353	15	91
9009E	Ford F-800	1992	MHD	3,053	15	91
9031E	Ford F-800	1992	MHD	9,929	15	91
9018E	Ford F-800	1992	MHD	10,114	15	91
Unknown	International	1987	HHD	156	15	91
64274	Ford LT8000	1989	HHD	18,197	15	91
1915-9038E	Ford LT9000	1997	HHD	16,001	15	91

Notes:
a. Annual VMT based on the current odometer reading and the age of the vehicle.
b. Idling time (min/day) is an engineering estimate based on personal observation.

C. HHD Diesel-Fueled Delivery Trucks

HHD Diesel-fueled trucks deliver Diesel fuel, gasoline, various oils, sand, and soap to the Yard. The annual number of delivery truck trips for liquid products was calculated based on the facility product throughput and a tanker truck capacity of 8,000 gallons per truck. The annual number of sand delivery truck trips was based on the annual sand throughput and a truck capacity of 20 tons per truck. The VMT per trip was estimated from aerial photos of the Yard. Activity data for the HHD delivery trucks are summarized in Table 11.

Table 11 **Summary of HHD Delivery Truck Activity Data** **Colton Rail Yard**					
Delivery Type	Number of HHD Truck Trips[a,b]	VMT per HHD Truck Trip (mi/trip)[c]	Annual VMT (mi/yr)	Idling Time (min/trip)[d]	Idling Time (hr/yr)
Gasoline	2	0.33	0.66	10	0.33
Lube Oil	57	0.58	33.06	10	9.50
Used Oil	24	0.58	13.92	10	4.00
Soap	18	0.71	12.78	10	3.00
Sand	195	0.58	113.10	30	97.50

Notes:

a. Number of truck trips for liquid products based on the material throughput and a tanker truck volume of 8,000 gallons per truck.
b. Number of sand truck trips based on sand throughput and a truck capacity of 20 tons per truck.
c. VMT per trip estimated from aerial photos of the Yard.
d. Engineering estimate based on personal communication with UPRR staff.

D. Heavy Equipment

Emissions from heavy equipment operating at the Yard are based on the number and type of equipment, equipment model year, equipment size, and the annual hours of operation. Activity data for heavy equipment are summarized in Table 12.

Table 12 **Activity Data for Heavy Equipment** **Colton Rail Yard**					
Equipment Type	Make/Model	Model Year	Rating (hp)	No. of Units	Hours of Operation (hr/yr per unit)[a]
Rail Cleaner	Unknown	2003	125	1	5
Rerailer	Cline	1987	183	1	*365*[b]
Crane	Lorain LRT-250	1997	145	1	260
Forklift	Toyota 6EDU45	1999	79	1	312

Notes:

a. Information provided by UPRR staff.
b. Items in italics are engineering estimates.

E. Tanks

Emissions from the non-exempt storage tanks Yards are based on the size of the tank, material stored, and annual throughput. Activity data for the non-exempt tanks are shown in Table 13.

Table 13
Activity Data for Non-Exempt Storage Tanks[a]
Colton Rail Yard

Tank No.	Tank Location	Material Stored	Tank Capacity (gal)	Tank Dimensions (ft)	Annual Throughput (gal/yr)[a]
1172	Locomotive Servicing	Gasoline	500	5 x 4.2	500
1187	One Spot	Gasoline	500	5 x 4.2	3,440
1189	Departure Yard/Trim Tower	Gasoline	500	5 x 4.2	3,875
1498	One Spot	Gasoline	500	5 x 4.2	2,664

Notes:
a. See Part V.E for a discussion of storage tank permitting exemptions.

F. Sand Tower

Emissions from the sand tower are based on the annual sand throughput. The 2005 sand throughput for the Colton Yard was 3,885 tons.

G. Wastewater Treatment Plant

Emissions from the WWTP are based on the annual wastewater flow rate. In 2005, the wastewater flow rate at the Colton Yard was 8,636,710 gallons.

H. Emergency Generator

Emissions from the emergency generator at the Yard are based on the rated capacity of the unit and the annual hours of operation. In 2005, the generator was operated 20 hours.

PART VII. EMISSIONS

A. Calculation Methodology and Emission Factors

Emission calculations were based on the site-specific equipment inventory, equipment activity data, and the source-specific emission factors. The calculation methodology and emission factors for each specific source type are further discussed below. Emissions were calculated in accordance with CARB Guidelines (July 2006) and the UPRR *Emission Inventory Protocol* (May 2006).

1. Locomotives

Emissions were calculated for UPRR-owned and -operated locomotives, as well as "foreign" locomotives[6] operating in the rail yard, and through trains on the main line. Procedures for calculating emissions followed the methods described in Ireson et al. (2005).[7] A copy of Ireson et al is contained in Appendix A-6.

Emissions from locomotive activities were calculated based on the number of working locomotives,[8] time spent in each notch setting, and locomotive model-group distributions, with model groups defined by manufacturer and engine type. A separate calculation was performed for each type of locomotive activity, including line-haul locomotive operations, switcher locomotive operations, consist movements, locomotive refueling, and pre- and post-locomotive service and maintenance testing. Speed, movement duration, and throttle notch values were obtained from UPRR personnel for the Colton Yard for different types of activities. Movement durations were calculated from distance traveled and speed. Detailed counts of locomotive by model, tier, and train type are

---

[6] Foreign locomotives are locomotives not owned by UPRR, including passenger trains and locomotives owned by other railroads that are brought onto the UPRR system via interchange.

[7] Ireson, R.G., M.J. Germer, L.A. Schmid (2005). "Development of Detailed Rail yard Emissions to Capture Activity, Technology, and Operational Changes." Proceedings of the USEPA 14[th] Annual Emission Inventory Conference, *http://www.epa.gov/ttn/chief/conference/ei14/session8/ireson.pdf*, Las Vegas NV, April 14, 2006.

[8] Emission estimates are based on the total number of working locomotives. Therefore, the total number of locomotives used in the emission calculations will be slightly lower than the total number of locomotives shown in Table 1. See Appendix A for detailed emission calculations

shown in Appendix A-1 and A-2. Maps detailing the principal locomotive routes at the Yard are contained in Appendix A-5.

Notch-specific emission factors were assembled from a number of sources. These included emission factors presented in CARB's *Roseville Rail Yard Study* (October, 2004), as well as EPA certification data, and other testing performed by Southwest Research Institute on newer-technology locomotives.

For line haul operations, yard-specific average consist composition (number of units, number of units operating, model distribution, locomotive tier distribution, fraction equipped with auto start/stop technology[9]) was developed from UPRR data for different train types. Movement speed, duration, and notch estimates were developed for arriving, departing, through train, and in-yard movements. All road power movements within the Yard were assumed to be at 10 mph in throttle notches 1 and 2 (50% each). Idle duration was estimated based on UPRR operator estimates for units not equipped with auto start/stop. Units that were equipped with AESS/ZTR technology were assumed to idle for 30 minutes per extended idle event, with other locomotives idling for the remaining duration of the event. Numbers of arrivals and departures were developed from UPRR data. Emissions were calculated separately for through trains, intermodal train arrivals and departures, non-intermodal arrivals and departures, local trains, and power moves.

In addition to the line-haul locomotives discussed above, 12 "captive" switcher locomotives (i.e., locomotives dedicated to moving sections of rail cars within the Yard) operated within the facility boundaries during 2005. Two sets of three switcher locomotives (trim sets) push inbound trains over the Hump into the Bowl; and three sets of two switcher locomotives (hump sets) work the east end of the Bowl and the Departure Yard to build new outbound trains. Each switcher locomotive operates approximately 23 hours per day. Based on information from UPRR personnel, the trim sets were assumed

[9] There are two primary types of auto start/stop technology—"Auto Engine Start Stop" (AESS), which is factory-installed on recent model high-horsepower units; and the ZTR "SmartStart" system (ZTR), which is a retrofit option for other locomotives. Both are programmed to turn off the Diesel engine after 15 to 30 minutes of idling, provided that various criteria (air pressure, battery charge, and others) are met. The engine automatically restarts if required by one of the monitored parameters. We assume that an AESS/ZTR-equipped locomotive will shut down after 30 minutes of idling in an extended idle event.

to operate on the full EPA switcher duty cycle, while the hump sets were assumed to be "pushing" in notch 2 (2 hours/day) and dynamic brake (11hours per day) through the Receiving Yard to the Hump, and returning to the west end of the Receiving Yard in notch 1 and 2 (50% each, 10 hours/day).

Data regarding the sulfur content of 2005 UPRR Diesel fuel deliveries within and outside of California were not available. To develop locomotive emission factors for different types of activities, estimates of fuel sulfur content were developed, and base case emission factors from the primary information sources (e.g., EPA certification data, with an assumed nominal fuel sulfur content of 3,000 ppm) were adjusted based on the estimated sulfur content of in-use fuels. Fuel sulfur content reportedly affects the emission rates for Diesel particulate matter from locomotives. The sulfur content in Diesel fuel varies with the type of fuel produced (e.g., California on-road fuel, 49-state off-road fuel, 49-state on-road fuel), the refinery configuration at which it is produced, the sulfur content of the crude oil being refined, and the extent to which it may be mixed with fuel from other sources during transport. As a result, it is extremely difficult to determine with precision the sulfur content of the fuel being used by any given locomotive at a specific time, and assumptions were made to estimate sulfur content for different types of activities.

To estimate the fuel sulfur content for UPRR locomotives in California during 2005, the following assumptions were made:

- "Captive" locomotives and consists in use on local trains (e.g., commuter rail) used only Diesel fuel produced in California.
- Trains arriving and terminating at California railyards (with the exception of local trains) used fuel produced outside of California, and arrive with remaining fuel in their tanks at 10% of capacity.
- On arrival, consists were refueled with California Diesel fuel, resulting in a 90:10 mixture of California and non-California fuel, and this mixture is representative of fuel on departing trains as well as trains undergoing load testing (if conducted at a specific yard).

- The average composition of fuel used in through trains bypassing a yard, and in trains both arriving and departing from a yard on the same day is 50% California fuel and 50% non-California fuel.

In 2005, Chevron was Union Pacific Railroad's principal supplier of Diesel fuel in California. Chevron's California refineries produced only one grade ("low sulfur Diesel," or LSD) in 2005. Quarterly average sulfur content for these refineries ranged from 59 ppm to 400 ppm, with an average of 221 ppm.[10] This value is assumed to be representative of California fuel used by UPRR. Non-California Diesel fuel for 2005 is assumed to have a sulfur content of 2,639 ppm. This is the estimated 49-state average fuel sulfur content used by the U.S. Environmental Protection Agency in its 2004 regulatory impact analysis in support of regulation of nonroad Diesel engines (USEPA, 2004).

To develop emission inventories for locomotive activity, an initial collection of locomotive model- and notch-specific emissions data was adjusted based on sulfur content. Although there is no official guidance available for calculating this effect, a draft CARB document provides equations to calculate the effect of sulfur content on DPM emission rates at specific throttle settings, and for 2-stroke and 4-stroke engines (Wong, undated). These equations can be used to calculate adjustment factors for different fuels as described in Appendix A-7. The adjustment factors are linear in sulfur content, allowing emission rates for a specific mixture of California and non-California fuels to be calculated as a weighted average of the emission rates for each of the fuels. Adjustment factors were developed and used to prepare tables of emission factors for two different fuel sulfur levels: 221 ppm for locomotives operated on California fuel; and 2,639 ppm for locomotives operating on non-California fuel. These results are shown in Tables 14 and 15. Sample emission calculations are shown in Appendix A-3 and A-4. The calculations of sulfur adjustments and the Wong Technical Memo are shown in Appendix A-7.

---

[10] Personal communication from Theron Hinckley of Chevron Products Company to Jon Germer of UPRR and Rob Ireson, December 13, 2006.

Table 14
Locomotive Diesel Particulate Matter Emission Factors (g/hr)
Adjusted for Fuel Sulfur Content of 221 PPM
Colton Rail Yard

Model Group	Tier	Throttle Setting										Source[a]
		Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8	
Switchers	N	31.0	56.0	23.0	76.0	129.2	140.6	173.3	272.7	315.6	409.1	CARB and ENVIRON
GP-3x	N	38.0	72.0	31.0	110.0	174.1	187.5	230.2	369.1	423.5	555.1	CARB and ENVIRON
GP-4x	N	47.9	80.0	35.7	134.3	211.9	228.6	289.7	488.5	584.2	749.9	CARB and ENVIRON
GP-50	N	26.0	64.1	51.3	142.5	282.3	275.2	339.6	587.7	663.5	847.2	CARB and ENVIRON
GP-60	N	48.6	98.5	48.7	131.7	266.3	264.8	323.5	571.6	680.2	859.8	CARB and ENVIRON
GP-60	0	21.1	25.4	37.6	75.5	224.1	311.5	446.4	641.6	1029.9	1205.1	KCS7332
SD-7x	N	24.0	4.8	41.0	65.7	146.8	215.0	276.8	331.8	434.7	538.0	CARB and ENVIRON
SD-7x	0	14.8	15.1	36.8	61.1	215.7	335.9	388.6	766.8	932.1	1009.6	CARB and ENVIRON
SD-7x	1	29.2	31.8	37.1	66.2	205.3	261.7	376.5	631.4	716.4	774.0	NS2630[c]
SD-7x	2	55.4	59.5	38.3	134.2	254.4	265.7	289.0	488.2	614.7	643.0	UP8353[c]
SD-90	0	61.1	108.5	50.1	99.1	239.5	374.7	484.1	291.5	236.1	852.4	EMD 16V265H
Dash 7	N	65.0	180.5	108.2	121.2	306.9	292.4	297.5	255.3	249.0	307.7	CARB and ENVIRON
Dash 8	0	37.0	147.5	86.0	133.1	248.7	261.6	294.1	318.5	347.1	450.7	CARB and ENVIRON
Dash 9	N	32.1	53.9	54.2	108.1	187.7	258.0	332.5	373.2	359.5	517.0	SWRI 2000
Dash 9	0	33.8	50.7	56.1	117.4	195.7	235.4	552.7	489.3	449.6	415.1	Average of CARB & CN2508[a]
Dash 9	1	16.9	88.4	62.1	140.2	259.5	342.2	380.4	443.5	402.7	570.0	CSXT595[b]
Dash 9	2	7.7	42.0	69.3	145.8	259.8	325.7	363.6	356.7	379.7	445.1	BNSF 7736[b]
C60-A	0	71.0	83.9	68.6	78.6	237.2	208.9	247.7	265.5	168.6	265.7	CARB and ENVIRON

Notes:
a. USEPA Regulatory Support Document, "Locomotive Emissions Regulation," Appendix B, 12/17/97, as tabulated by CARB and ENVIRON.
b. Base emission rates provided by ENVIRON as part of the BNSF analyses for the Railyard MOU (Personal communication from Chris Lindhjem to R. Ireson, 2006) based on data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to C. Lindhjem, 2006).
c. SwRI final report "Emissions Measurments – Locomotives" by Steve Fritz, August 1995.
d. Manufacturers' emissions test data as tabulated by CARB.
e. Base SD-70 emission rates taken from data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to R. Ireson, 2006).
f. Average of manufacturer's emissions test data as tabulated by CARB and data from the AAR/SwRI Exhaust Plume Study, tabulated and calculated by ENVIRON.

Table 15
Locomotive Diesel Particulate Matter Emission Factors (g/hr)
Adjusted for Fuel Sulfur Content of 2,639 PPM
Colton Rail Yard

Model Group	Tier	Throttle Setting										Source[a]
		Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8	
Switchers	N	31.0	56.0	23.0	76.0	136.9	156.6	197.4	303.4	341.2	442.9	CARB and ENVIRON
GP-3x	N	38.0	72.0	31.0	110.0	184.5	208.8	262.2	410.8	457.9	601.1	CARB and ENVIRON
GP-4x	N	47.9	80.0	35.7	134.3	224.5	254.6	330.0	543.7	631.6	812.1	CARB and ENVIRON
GP-50	N	26.0	64.1	51.3	142.5	299.0	306.5	386.9	653.9	717.3	917.4	CARB and ENVIRON
GP-60	N	48.6	98.5	48.7	131.7	282.1	294.9	368.5	636.1	735.4	931.0	CARB and ENVIRON
GP-60	0	21.1	25.4	37.6	75.5	237.4	346.9	508.5	714.0	1113.4	1304.9	KCS7332
SD-7x	N	24.0	4.8	41.0	65.7	155.5	239.4	315.4	369.2	469.9	582.6	CARB and ENVIRON
SD-7x	0	14.8	15.1	36.8	61.1	228.5	374.1	442.7	853.3	1007.8	1093.2	CARB and ENVIRON
SD-7x	1	29.2	31.8	37.1	66.2	217.5	291.5	428.9	702.6	774.5	838.1	NS2630[c]
SD-7x	2	55.4	59.5	38.3	134.2	269.4	295.9	329.2	543.3	664.6	696.2	UP8353[c]
SD-90	0	61.1	108.5	50.1	99.1	253.7	417.3	551.5	324.4	255.3	923.1	EMD 16V265H
Dash 7	N	65.0	180.5	108.2	121.2	352.7	323.1	327.1	293.7	325.3	405.4	CARB and ENVIRON
Dash 8	0	37.0	147.5	86.0	133.1	285.9	289.1	323.3	366.4	453.5	593.8	CARB and ENVIRON
Dash 9	N	32.1	53.9	54.2	108.1	215.7	285.1	365.6	429.3	469.7	681.2	SWRI 2000
Dash 9	0	33.8	50.7	56.1	117.4	224.9	260.1	607.7	562.9	587.4	546.9	Average of CARB & CN2508[a]
Dash 9	1	16.9	88.4	62.1	140.2	298.2	378.1	418.3	510.2	526.2	751.1	CSXT595[b]
Dash 9	2	7.7	42.0	69.3	145.8	298.5	359.9	399.8	410.4	496.1	586.4	BNSF 7736[b]
C60-A	0	71.0	83.9	68.6	78.6	272.6	230.8	272.3	305.4	220.3	350.1	CARB and ENVIRON

Notes:

1. USEPA Regulatory Support Document, "Locomotive Emissions Regulation," Appendix B, 12/17/97, as tabulated by CARB and ENVIRON.
2. Base emission rates provided by ENVIRON as part of the BNSF analyses for the Railyard MOU (Personal communication from Chris Lindhjem to R. Ireson, 2006) based on data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to C. Lindhjem, 2006).
3. SwRI final report "Emissions Measurments – Locomotives" by Steve Fritz, August 1995.
4. Manufacturers' emissions test data as tabulated by CARB.
5. Base SD-70 emission rates taken from data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to R. Ireson, 2006).
6. Average of manufacturer's emissions test data as tabulated by CARB and data from the AAR/SwRI Exhaust Plume Study, tabulated and calculated by ENVIRON.

2. Diesel-Fueled Trucks (Yard Trucks)

Emission estimates for the Diesel-fueled Yard trucks are based on the vehicle class, vehicle model year, annual VMT within the Yard, and amount of time the vehicles spend idling. Vehicle-specific emission factors, calculated using the EMFAC2007 model, are shown in Table 16. Per CARB guidelines, the emissions from idling and traveling modes have been separated because different source treatments (point or volume sources) will be used in the air dispersion modeling analysis for these modes. Detailed emission factor derivation calculations and EMFAC2007 output are contained in Appendix B.

3. HHD Diesel-Fueled Delivery Trucks

Emission factors for the HHD Diesel-fueled delivery trucks were obtained from CARB's EMFAC2007 model. Per CARB guidelines, the emissions from idling and traveling modes have been separated because different source treatments (point or volume sources) will be used in the air dispersion modeling analysis for these modes. A fleet average emission factor for traveling exhaust emissions was calculated using the EMFAC2007 model with the BURDEN output option. Since the fleet distribution is not known, the EMFAC2007 default distribution for Los Angeles County was used. Idling emission factors were calculated using the EMFAC2007 model with the EMFAC output option. The emission factors for the HHD Diesel-fueled trucks are shown in Table 17. Detailed emission factor derivation calculations and the EMFAC2007 output are contained in Appendix C.

4. Heavy Equipment

Emission factors for heavy equipment were calculated using OFFROAD2007 model. The emission factors for heavy equipment are shown in Table 18. Detailed emission factor derivation calculations and OFFROAD2007 output are contained in Appendix D.

Table 16
Emission Factors for Diesel-Fueled Yard Trucks
Colton Rail Yard

Owner/ID	Make/Model	Model Year	Vehicle Class	Traveling Emission Factors (g/mi)[a]					Idling Emissions Factors (g/hr)[a,b]				
				ROG	CO	NOx	DPM	SOx	ROG	CO	NOx	DPM	SOx
69496	Chevy CK 3500	1998	LDT	0.12	1.13	1.60	0.06	0.06	0.00	0.00	0.00	0.00	0.00
69499	Chevy CK 3500	1998	LDT	0.12	1.13	1.60	0.06	0.06	0.00	0.00	0.00	0.00	0.00
1915-73119	Ford F-450	2003	LHDT1	0.33	1.70	6.70	0.08	0.04	3.17	26.30	75.05	0.75	0.34
9007E	Ford F-800	1992	MHD	0.94	9.70	18.46	1.25	0.16	3.17	26.30	75.05	1.40	0.34
9009E	Ford F-800	1992	MHD	0.94	9.70	18.46	1.25	0.16	3.17	26.30	75.05	1.40	0.34
9031E	Ford F-800	1992	MHD	0.94	9.70	18.46	1.25	0.16	3.17	26.30	75.05	1.40	0.34
9018E	Ford F-800	1992	MHD	0.94	9.70	18.46	1.25	0.16	3.17	26.30	75.05	1.40	0.34
Unknown	International	1987	HHD	12.31	41.26	31.86	5.72	0.22	22.84	61.55	82.94	4.28	0.55
64274	Ford LT8000	1989	HHD	12.06	40.31	31.60	5.42	0.24	19.45	58.49	85.53	3.43	0.55
1915-9038E	Ford LT9000	1997	HHD	6.92	16.99	31.05	2.26	0.24	12.41	49.53	110.27	1.93	0.55

Notes:
a. Emission factors calculated using the EMFAC2007 model with the BURDEN output options.
b. Idling emission factors calculated using the EMFAC2007 model with the EMFAC output option.
c. See Table 2 for vehicle specifications.
d. Diesel PM_{10} (DPM) is a TAC.

Table 17 **Emission Factors for HHD Diesel-Fueled Delivery Trucks**[a] **Colton Rail Yard**					
	Fleet Average Emission Factors				
Operating Mode	ROG	CO	NOx	DPM[d]	SOx
Traveling (g/mi)[b]	6.40	17.23	28.68	2.47	0.24
Idling (g/hr)[c]	16.16	52.99	100.38	2.85	0.55

Notes:
a. See Part V for vehicle specifications.
b. Emission factors calculated using the EMFAC2007 model with the BURDEN output option. The default fleet distribution for Los Angeles County was used.
c. Emission factors calculated using the EMFAC2007 model with the EMFAC output option. The default fleet distribution for Los Angeles County was used.
d. Diesel PM_{10} (DPM) is a TAC.

Table 18 **Emission Factors for Heavy Equipment** **Colton Rail Yard**								
Equipment Type	Make/Model	Model Year	Emission Factors (g/hp-hr)[a]					
			ROG[b]	CO	NOx	DPM	SOx	
Rail Cleaner	Unknown	2003	0.52	2.96	5.32	0.25	0.06	
Rerailer	Cline	1987	1.64	5.52	13.04	0.77	0.06	
Crane	Lorain LRT-250	1997	1.27	3.55	8.35	0.58	0.06	
Forklift	Toyota 6EDU45	1999	1.85	4.60	8.36	1.06	0.06	

Notes:
a. Emission factors from the OFFROAD2007 model.
b. Evaporative emissions for these sources are negligible.

5. Tanks

VOC emissions from the non-exempt storage tanks were calculated using USEPA's TANKS program. CARB's speciation database was used to determine the fraction of each TAC in the total VOC emissions from each gasoline storage tank. All TACs listed in the most recent version of the Emission Inventory Criteria and Guidelines Report for the Air Toxics "Hot Spots" Program were included. The TAC emission factors for gasoline storage are shown in Table 19. The TANKS output and the relevant sections of CARB's speciation database are included in Appendix E.

Table 19 **TAC Emission Factors for Gasoline Storage Tank** **Colton Rail Yard**		
CAS	Chemical Name[b]	Organic Fraction of VOC (by weight)[a]
540841	2,2,4-trimethylpentane	0.0129
71432	Benzene	0.0036
110827	Cyclohexane	0.0103
100414	Ethylbenzene	0.0012
78784	Isopentane	0.3734
98828	Isopropylbenzene (cumene)	0.0001
108383	m-Xylene	0.0034
110543	n-Hexane	0.0154
95476	o-Xylene	0.0013
106423	p-Xylene	0.0011
108883	Toluene	0.0170
Total		**0.44**

Notes:

a. The organic fraction information is from CARB's speciation database. Data are from the "Headspace vapors 1996 SSD etoh 2.0% (MTBE phaseout)" option.

b. Emissions were calculated only for chemicals that were in both CARB's speciation database and the AB2588 list.

6. Sand Tower

Emission factors for the sand tower operations are from USEPA's AP-42 document. The sand transfer system consists of two parts: pneumatic transfer and gravity transfer. The pneumatic transfer system is similar to those used to unload cement at concrete batch plants. The gravity feed system is similar to the sand and aggregate transfer operations at concrete batch plants. Therefore, emissions will be calculated using the AP-42 emission factors for concrete batch plants. As previously discussed, the system is equipped with a baghouse; therefore, emission factors for a controlled system were used. These emission factors are shown in Table 20.

Table 20 **Emission Factors for Sand Tower Operations** **Colton Rail Yard**		
	Emission Factors (lb/ton)	
Pollutant[a]	Pneumatic Transfer[b]	Gravity Transfer[c]
PM_{10}	0.00034	0.00099

Notes:
a. There are no TAC emissions from this source.
b. Emission factor from AP-42, Table 11.12-5, 6/06. Factor for controlled pneumatic cement unloading to elevated storage silo was used. The unit is equipped with a fabric filter.
c. Emission factor from AP-42, Table 11.12-5, 6/06. Factor for sand transfer was used.

7. Wastewater Treatment Plant

Emission factors for the WWTP are from the *Comprehensive Air Emission Inventory and Regulatory Analysis Report for the Colton Yard* (Trinity Consultants, May 30, 2003). Emission rates were calculated by Trinity Consultants using USEPA's WATER9 program. The emission rates are shown in Table 21.

Table 21 **Emission Factors for the Wastewater Treatment Plant** **Colton Rail Yard**	
Pollutant	Emission Rate (grams/sec)[a]
Benzene	3.16×10^{-6}
Bromomethane	1.21×10^{-5}
Chloroform	6.18×10^{-6}
Ethylbenzene	1.96×10^{-5}
Methylene Chloride	1.08×10^{-4}
Toluene	4.34×10^{-5}
Xylene	7.80×10^{-5}
Total	$\mathbf{2.70 \times 10^{-4}}$

Notes:
a. Emission rates from *Comprehensive Air Emission Inventory and Regulatory Analysis for the Colton Yard*, Trinity Consultants, May 30, 2003.

8. Emergency Generator

Emission factors for the emergency generator are from AP-42, Table 3.3.-1 (10/96). The emission factors are shown in Table 22.

Table 22 Emission Factors for the Diesel-Fueled Emergency Generator Colton Rail Yard				
Emission Factors (g/hp-hr)[a]				
ROG	CO	NOx	DPM[b]	SOx
1.14	3.03	14.06	1.00	0.93

Notes:
a. Emission factors from AP-42, Table 3.3-1, 10/96.
b. Diesel PM_{10} (DPM) is a TAC.

B. TAC Emissions by Source Type

TAC emission calculations for each source type were based on the site-specific equipment inventory (shown in Part V of this report), equipment activity data (shown in Part VI of this report), and the source-specific emission factors shown in Part VII.A above. As discussed above, there are no TAC emissions from the sand tower. Detailed emission calculations for each source group are contained in Appendix F.

1. Locomotives

Emissions from locomotive operations were based on the emission factors shown in Tables 14 and 15, the number of events, the number of locomotives per consist, duration, and duty cycle of different types of activity. Table 23 shows the duty cycles assumed for different types of activities.

For locomotive models and tiers for which specific emission factors were not available, the emissions for the next lower tier were used, or the next higher tier if no lower tier data were available. Emission factors for the "average locomotive" for different types of activity were developed from the emission factors and the actual locomotive model and technology distributions for that activity. Separate distributions were developed for the following types of activity: through trains (including through power moves); westbound

Table 23 Locomotive Duty Cycles Colton Rail Yard	
Activity	Duty Cycle
Through Train Movement	N2- 100%
Movements within the Yard	N1 – 50%, N2- 50%
Hump Set Pushing	N2 – 2 hrs/day, DB[a] – 11 hrs/day
Hump Set Movement from Hump to West End of the Receiving Yard	N1 – 50%, N2- 50%
Trim Set Operations	USEPA Switch Duty Cycle[b]

Notes:
a. DB (Dynamic braking) is a throttle setting available on medium- and high-horsepower locomotives in which the coils on the traction motors are energized to effectively turn them into electrical generators, similar to downshifting to provide engine braking in a car. The electricity generated is dissipated by resistance grids on top of the locomotives. The track through the Receiving Yard to the Hump at Colton has a slight downgrade, and braking is needed to maintain the slow speeds necessary for safe decoupling and routing of individual cars into the Bowl.
b. USEPA (1998) Regulatory Support Document

terminating freight trains and eastbound originating freight trains; eastbound terminating freight trains, westbound originating freight trains, and local trains; arriving and departing power moves; hump and trim sets (yard operations); locomotives in the Service Track; and locomotives undergoing load tests. Table 24 shows the DPM emission estimates for the different types of activities.

Table 24 DPM Emissions from Locomotives Colton Rail Yard	
Activity	DPM Emissions (tpy)
Through Trains and Power Moves	0.51
Freight Trains	2.45
Local Trains	0.47
Power Moves in Yard	0.14
Hump Operations	4.74
Trim Operations	5.28
Crew Changes	0.07
Service Movements	0.06
Service Idling	2.14
Load Testing	0.44
Total	**16.30**

Notes:
a. See Table 1 for equipment specifications.
b. See Tables 8 and 9 for activity data.
c. See Tables 14 and 15 for emission factors.
d. Emissions from Yard operations are based on 12 switcher locomotives operating 23 hours per day each. The switcher specific duty cycles are discussed in Part VII.A.1.
e. See Appendices A-3 and A-4 for detailed emission calculations. The calculations of sulfur adjustments are shown in Appendix A-7.

2. Diesel-Fueled Trucks (Yard Trucks)

Emission estimates for Diesel-fueled Yard trucks are based on vehicle class, vehicle model year, annual VMT within the Yard, and amount of time the vehicles spend idling. Table 25 shows the DPM emission estimates for Diesel-fueled Yard trucks operating at Colton in 2005.

Table 25 **DPM Emissions from Diesel-Fueled Yard Trucks** **Colton Rail Yard**			
Pollutant	Emissions (tpy)		
	Traveling Mode	Idling Mode	Total
DPM	0.19	0.002	0.19

Notes:
a. See Table 2 for equipment specifications.
b. See Table 10 for activity data.
c. See Table 16 for emission factors.

3. HHD Diesel-Fueled Delivery Trucks

DPM emission estimates for the HHD Diesel-fueled delivery trucks are based on the number of truck trips, the annual VMT within the Yard, and the amount of idling time. Table 26 shows the DPM emission estimates for the Diesel-fueled HHD trucks operating at the Yard in 2005.

Table 26 **DPM Emissions from HHD Diesel-Fueled Delivery Trucks** **Colton Rail Yard**			
Pollutant	DPM Emissions (tpy)[a]		
	Traveling Mode	Idling Mode	Total
DPM	0.000	0.000	0.000

Notes:
a. Due to the small number of deliveries and limited VMT, emissions from HHD Diesel-fueled delivery trucks are negligible.
b. See Part V for equipment specifications.
c. See Table 11 for activity data.
d. See Table 17 for emission factors.

4. Heavy Equipment

Emission estimates for the heavy equipment are based on the number and type of equipment, the equipment model, and the hours of operation. Table 27 shows the DPM emission estimates for the Diesel-fueled heavy equipment operating at Colton in 2005.

Table 27 DPM Emissions from Heavy Equipment Colton Rail Yard				
Equipment Type	Make/Model	Model Year	No of Units	DPM Emissions (tpy)
Rail Cleaner	Unknown	2003	1	0.00
Rerailer	Cline	1987	1	0.03
Crane	Lorain LRT-250	1997	1	0.01
Forklift	Toyota 6EDU45	1999	1	0.01
Total			**4**	**0.05**

Notes:
a. See Table 3 for equipment specifications.
b. See Table 12 for activity data.
c. See Table 18 for emission factors.

5. Tanks

TAC emissions from the gasoline storage tanks were calculated using USEPA's TANKS program and CARB's speciation database. The TAC emissions for each gasoline storage tank at Colton are shown in Table 28.

6. Sand Tower

As previously discussed, there are no TAC emissions from the sand tower operations. PM_{10} emission estimates from the sand tower are shown in Appendix F.

7. Wastewater Treatment Plant

TAC emission estimates for the WWTP are based on emission rates from the *Comprehensive Air Emission Inventory and Regulatory Analysis Report for the Colton Yard* (Trinity Consultants, May 30, 2003) and the annual wastewater flow rate. Table 29 shows the TAC emissions from Colton WWTP during 2005.

Table 28 TAC Emissions from Gasoline Storage Tanks Colton Rail Yard						
		TAC Emissions (tpy)				
CAS	Chemical Name	Tank 1172	Tank 1187	Tank 1189	Tank 1498	Total
540841	2,2,4-trimethylpentane	1.29×10^{-3}	1.52×10^{-3}	1.55×10^{-3}	1.46×10^{-3}	5.81×10^{-3}
71432	Benzene	3.59×10^{-4}	4.22×10^{-4}	4.31×10^{-4}	4.05×10^{-4}	1.62×10^{-3}
110827	Cyclohexane	1.02×10^{-3}	1.20×10^{-3}	1.23×10^{-3}	1.16×10^{-3}	4.62×10^{-3}
100414	Ethylbenzene	1.18×10^{-4}	1.38×10^{-4}	1.41×10^{-4}	1.33×10^{-4}	5.30×10^{-4}
78784	Isopentane	3.72×10^{-2}	4.37×10^{-2}	4.47×10^{-2}	4.20×10^{-2}	1.68×10^{-1}
98828	Isopropylbenzene (cumene)	1.10×10^{-5}	1.29×10^{-5}	1.32×10^{-5}	1.24×10^{-5}	4.94×10^{-5}
108383	m-Xylene	3.42×10^{-4}	4.02×10^{-4}	4.11×10^{-4}	3.86×10^{-4}	1.54×10^{-3}
110543	n-Hexane	1.54×10^{-3}	1.80×10^{-3}	1.84×10^{-3}	1.73×10^{-3}	6.92×10^{-3}
95476	o-Xylene	1.28×10^{-4}	1.50×10^{-4}	1.53×10^{-4}	1.44×10^{-4}	5.75×10^{-4}
106423	p-Xylene	1.07×10^{-4}	1.25×10^{-4}	1.28×10^{-4}	1.20×10^{-4}	4.80×10^{-4}
108883	Toluene	1.70×10^{-3}	1.99×10^{-3}	2.04×10^{-3}	1.91×10^{-3}	7.64×10^{-3}
Total		$\mathbf{4.38 \times 10^{-2}}$	$\mathbf{5.15 \times 10^{-2}}$	$\mathbf{5.26 \times 10^{-2}}$	$\mathbf{4.95 \times 10^{-2}}$	$\mathbf{1.97 \times 10^{-1}}$

Notes:

a. See Table 4 for equipment specifications.
b. See Table 13 for activity data.
c. See Table 19 for emission factors.

Table 29 **TAC Emissions from the Wastewater Treatment Plant** **Colton Rail Yard**	
Pollutant	Emissions (tpy)
Benzene	1.68×10^{-4}
Bromomethane	6.41×10^{-4}
Chloroform	3.28×10^{-4}
Ethylbenzene	1.04×10^{-3}
Methylene Chloride	5.72×10^{-3}
Toluene	2.31×10^{-3}
Xylene	4.14×10^{-3}
Total	**1.43×10^{-2}**

Notes:
a. See Part V for equipment description.
b. See Part VI for activity data.
c. See Table 21 for emission factors.

8. Emergency Generator

Emission estimates for the emergency generator are based on the size of the unit and the hours of operation. Table 30 shows the DPM emission estimates for the Diesel-fueled emergency generator operating at the Yard in 2005.

Table 30 **DPM Emissions from the Emergency Generator** **Colton Rail Yard**	
Equipment Type/Location	DPM Emissions (tpy/yr)
Emergency Generator – Bowl Area	0.001

Notes:
a. See Part V for equipment specifications.
b. See Part VI for activity data.
c. See Table 22 for emission factors.

C. Facility Total Emissions

Facility-wide DPM emissions are shown in Table 31. Facility-wide TAC emissions, excluding DPM, are shown in Table 32.

Table 31 Facility-Wide Diesel Particulate Emissions Colton Rail Yard	
Source	Emissions (tpy)
Locomotives[a]	16.30
Diesel-Fueled Yard Trucks[b]	0.19
HHD Diesel-Fueled Delivery Trucks[c]	0.00
Heavy Equipment[d]	0.05
Emergency Generator[e]	0.001
Total	**16.54**

Notes:
a. See Table 24.
b. See Table 25.
c. See Table 26.
d. See Table 27.
e. See Table 30.

Table 32 Facility-Wide TAC Emissions (excluding DPM) Colton Rail Yard				
		Emissions (tpy)		
CAS	Chemical Name	Gasoline Tanks[a]	WWTP[b]	Total
540841	2,2,4-trimethylpentane	5.81×10^{-3}	-	5.81×10^{-3}
71432	Benzene	1.62×10^{-3}	1.68×10^{-4}	1.78×10^{-3}
	Bromomethane	-	6.41×10^{-4}	6.41×10^{-4}
67663	Chloroform	-	3.28×10^{-4}	3.28×10^{-4}
110827	Cyclohexane	4.62×10^{-3}	-	4.62×10^{-3}
100414	Ethylbenzene	5.30×10^{-4}	1.04×10^{-3}	1.57×10^{-3}
78784	Isopentane	1.68×10^{-1}	-	1.68×10^{-1}
98828	Isopropylbenzene (cumene)	4.94×10^{-5}	-	4.94×10^{-5}
	Methylene Chloride	-	5.72×10^{-3}	5.72×10^{-3}
108383	m-Xylene	1.54×10^{-4}	-	1.54×10^{-3}
110543	n-Hexane	6.92×10^{-3}	-	6.92×10^{-3}
95476	o-Xylene	5.75×10^{-4}	-	5.75×10^{-4}
106423	p-Xylene	4.80×10^{-4}	-	4.8×10^{-4}
108883	Toluene	7.64×10^{-3}	2.31×10^{-3}	9.95×10^{-3}
1330207	Xylene (total)	-	4.14×10^{-3}	4.14×10^{-3}
Total		$\mathbf{1.97 \times 10^{-1}}$	$\mathbf{1.43 \times 10^{-2}}$	$\mathbf{2.12 \times 10^{-1}}$

Notes:
a. See Table 28.
b. See Table 29.

PART VIII. RISK SCREENING CALCULATIONS

As discussed in Part IV of this report and agreed upon with the CARB, de minimis sources, based on weighted health risk, were identified in the inventory, but were not included in the modeling analysis. De minimis sources are the individual source categories that represent less than 3% of the facility-total weighted-average site health impacts (determined separately for cancer risk and non-cancer chronic health hazard). Total exclusions for all de minimis sources did not exceed 10% of the facility-total weighted-average site health impacts.

The OEHHA unit risk factor for each pollutant was multiplied by the annual emissions of that pollutant to generate a risk index value for each source. Each source-specific risk index was divided by the facility total risk index to get the fractional contribution to the total risk for each source. The cancer risk, the non-cancer health hazard index, and the fractional contribution to the cancer risk and non-cancer chronic health hazard for each source are summarized in Table 33. Detailed cancer risk and non-cancer health hazard index calculations are in Appendix G.

Table 33
Summary of Weighted Risk by Source Category
Colton Rail Yard

Source	Cancer Risk		Non-Cancer Chronic Health Hazard	
	Risk Index Value	Percent of Total Risk	Health Hazard Index Value	Percent of Total Hazard
Locomotives	4.89×10^{-3}	98.54	8.15×10^{1}	56.42
Diesel-Fueled Yard Trucks	5.72×10^{-5}	1.15	9.53×10^{-1}	0.66
HHD Diesel-Fueled Delivery Trucks	2.49×10^{-7}	0.01	4.15×10^{-3}	0.00
Heavy Equipment	1.44×10^{-5}	0.29	2.41×10^{-1}	0.17
WWTP	1.23×10^{-8}	0.00	8.06	5.58
Sand Tower[a]	0.00	0.00	0.00	0.00
Gasoline Storage Tanks	4.69×10^{-8}	0.00	5.37×10^{1}	37.17
Emergency Generator	3.30×10^{-7}	0.01	5.50×10^{-3}	0.00
Total	**4.96×10^{-3}**	**100**	**1.44×10^{2}**	**100**

Notes:
a. There are no TAC emissions from the sand tower.

Sources that represent less than 3% each of the facility-total weighted-average cancer risk and non-cancer chronic health hazard, as shown in Table 33, are de minimis. Table 34 lists the de minimis sources for the Colton Yard.

Table 34
Summary of De Minimis Sources
Colton Rail Yard

De Minimis Sources for Cancer Risk	De Minimis Sources for Non-Cancer Chronic Health Hazard
Diesel-Fueled Yard Trucks HHD Diesel-Fueled Delivery Trucks Heavy Equipment WWTP Sand Tower Gasoline Storage Tanks Emergency Generator	Diesel-Fueled Yard Trucks HHD Diesel-Fueled Delivery Trucks Heavy Equipment Sand Tower Emergency Generator

Sources that are de minimis for both cancer risk and non-cancer chronic health hazard (i.e., yard trucks, delivery trucks, heavy equipment, and emergency generator) are not included in the dispersion modeling analysis. At the request of CARB, heavy equipment was included in the dispersion modeling analysis, notwithstanding its de minimis risk contribution.

PART IX. AIR DISPERSION MODELING

An air dispersion modeling analysis was conducted for the Colton Yard. The purpose of the analysis was to estimate ground-level concentrations of DPM and other TACs, emitted from Yard operations, at receptor locations near the Yard. Air dispersion modeling was conducted in accordance with the *Health Risk Assessment Guidance for Rail Yard and Intermodal Facilities* (July 2006) and UPRR's *Modeling Protocol* (August 2006). Each aspect of the modeling is further described below.

A. Model Selection and Preparation

1. Modeled Sources and Source Treatment

As discussed in Part VIII, only sources that represent more than 3% of the facility-total weighted-average site health impacts (determined separately for cancer risk and non-cancer chronic health hazard) were included in the dispersion modeling analysis. At the request of CARB, heavy equipment was included as well, notwithstanding its de minimis risk contribution. Emissions from mobile sources, heavy equipment, and moving locomotives were simulated as a series of volume sources along their corresponding travel routes and work areas. Idling and load testing of locomotives were simulated as a series of point sources within the areas where these events occur. The elevation for each source was interpolated from a 50 m grid of USGS terrain elevations. Table 35 shows the sources that were included in the modeling analysis and treatment used for each source. Assumptions used to spatially allocate emissions from locomotive operations within the Yard are included in Appendix A-4. Assumptions used to spatially allocate emissions from non-locomotive sources are contained in Appendix H. Figures 3 through 5 show how each source was located in the Yard for the dispersion modeling analysis.

Table 35 Source Treatment for Air Dispersion Modeling Colton Rail Yard	
Source	Source Treatment
Gasoline Storage Tanks	Point
WWTP	Point
Locomotives (idling and load testing)	Point
Locomotives (traveling)	Volume
Heavy Equipment (idling)	Volume
Heavy Equipment (traveling)	Volume
Notes: a. See Figures 3 through 5 for source locations.	

2. Model Selection

Selection of air dispersion models depends on many factors, including the type of emissions source (point, line, or volume) and type of terrain surrounding the emission source. The USEPA-approved guideline air dispersion model, AERMOD, was selected for this project. AERMOD is recommended by the USEPA as the preferred air dispersion model, and is the recommended model in the CARB's *Health Risk Assessment Guidance for Rail Yard and Intermodal Facilities* (July 2006).

AERMOD is a steady-state,[11] multiple-source, Gaussian dispersion model designed for use with emission sources situated in terrain where ground elevations can exceed the release heights of the emission sources (i.e., complex terrain).[12] AERMOD was used with meteorological data from the Ontario International Airport. AERMOD used these parameters to select the appropriate dispersion coefficients.

Standard AERMOD control parameters were used, including stack-tip downwash, non-screening mode, non-flat terrain, and sequential meteorological data check. Following USEPA guidance, the stack-tip downwash option adjusted the effective stack height

[11] The term "steady-state" means that the model assumes no variability in meteorological parameters over a one-hour time period.
[12] Federal Register, November 9, 2005; Volume 70, Number 216, Pages 68218-68261.

Figure 3
Placement of Locomotive Movements in the Dispersion Modeling Analysis
Colton Rail Yard

Figure 4
Placement of Locomotive Idling in the Dispersion Modeling Analysis
Colton Rail Yard

Figure 5
Placement of Switcher Locomotive and Heavy Equipment Operations in the Dispersion Modeling Analysis
Colton Rail Yard

downward following the methods of Briggs (1972) for stack exit velocities less than 1.5 times the wind speed at stack top.

Two AERMET preprocessors (Stages 1 and 2, and Stage 3) were used to prepare meteorological data for use in AERMOD. Albedo and Bowen ratio[13] were estimated in multiple wind direction sectors surrounding the Yard, while surface roughness from similar sectors around the meteorological monitoring site was used in the model. This separation was based on the fact that atmospheric turbulence induced by surface roughness around the meteorological monitoring tower affects the resulting wind speed profile used by AERMOD to represent conditions at the Yard, while the albedo and Bowen ratio around the Yard are more appropriate to characterize land use conditions surrounding the area being modeled.

As suggested by the USEPA (2000), for purposes of determining albedo and Bowen ratio the surface characteristics were specified in sectors no smaller than a 30-degree arc. Specifying surface characteristics in narrower sectors becomes less meaningful because of expected wind direction variability during an hour, as well as the encroachment of characteristics from the adjacent sectors with a one-hour travel time. Use of weighted-average[14] characteristics by surface area within a 30-degree (or wider) sector made it possible to have a unique portion of the surface significantly influence the properties of the sector that it occupies. The length of the upwind fetch for defining the nature of the turbulent characteristics of the atmosphere in each sector surrounding the source location was 3 kilometers as recommended by Irwin (1978) and USEPA's *Guideline on Air Quality Models*.[15]

---

[13] The albedo of a specified surface is the ratio of the radiative flux reflected from the surface to the radiative flux incident on the surface. Flux is the amount of energy per unit time incident upon or crossing a unit area of a defined flat plane. For example, the albedo for snow and ice varies from 80% to 85% and the albedo for bare ground from 10% to 20%. Bowen ratio is the ratio of heat energy used for sensible heating (conduction and convection) of the air above a specified surface to the heat energy used for latent heating (evaporation of water or sublimation of snow) at the surface. The Bowen ratio ranges from 0.1 for the ocean surface to more than 2.0 for deserts; negative values are also possible.

[14] Weighting was based on wind direction frequency, as determined from a wind rose.

[15] USEPA (1986), and published as Appendix W to 40 CFR Part 51 (as revised).

3. Modeling Inputs

Modeling was based on the annual average emissions for each source as discussed in Part VII B above. Diurnal and/or seasonal activity scalars were applied to locomotive activities. The following profiles were used in the modeling. See Appendix A-3 for the profiles used and Appendix I for a description of the methods used to develop them.

- A seasonal/diurnal activity profile was calculated for locomotive idling based on the number of arrivals and departures in each hour of the day and the number of arriving and departing trains in each season. Each hourly factor was based on the number of arrivals and departures in that hour and the number of departures in the following hour. This approach captures the idling times for consists prior to departure. These factors were applied to consist idling for arriving and departing trains.
- A seasonal/diurnal activity profile was calculated for in-yard locomotive movements of road power using the same approach as for idling. In this case, however, only the number of arriving and departing trains in a single hour was used for that hour's factor.
- A seasonal profile was used for switching operations based on the same seasonal profile developed for train activity. No diurnal profile was used as hump and trim sets operate throughout the day.
- A seasonal profile was applied to locomotive service and load test emissions based on monthly service release data.

The volume source release heights and vertical dispersion parameters (σ_z) were those used by CARB for the Truck Stop Scenario in Appendix VII of the Diesel Risk Reduction Plan for mobile vehicles and equipment other than locomotives. For locomotives, the release height and σ_z values used were those developed by CARB for daytime and nighttime locomotive movements in the Roseville Risk Assessment modeling. Stack parameters used to create the AERMOD input file for locomotive operations are shown in Table 36. Table 37 summarizes the modeling inputs used to create the AERMOD input file for each non-locomotive source at the Yard.

Table 36
Locomotive Modeling Inputs
Colton Rail Yard

Source	Point/Idling Source Parameters				Volume Source Parameters		
	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Temp (° K)	σ_z (m)	σ_y[e] (m)	Release Height (m)
Locomotives (idling and load tests)[a]							
Road power at all yards-SD7x[b]	4.6	0.625	3.1	364	-	-	-
Load tests – N1[c]	4.6	0.625	8.0	420	-	-	-
Load tests – N8[c]	4.6	0.625	36.6	589	-	-	-
Yard locomotives	4.6	0.305	7.5	342	-	-	-
Locomotives (traveling)[d]							
Day[e]	-	-	-	-	2.6	20-50	5.6
Night[e]	-	-	-	-	6.79	20-50	14.6

Notes:

a. Stack parameters for stationary locomotives were taken from the CARB Roseville modeling analysis.
b. Idling road power stack parameters are those of the most prevalent locomotive model (SD-7x).
c. Load test stack parameters are those of the most prevalent locomotive model (SD-7x).
d. All locomotive movements for road power and yard locomotives while working are the day and night volume source parameters for moving locomotives from the CARB Roseville modeling analysis.
e. Lateral dispersion coefficient (σ_y) for moving locomotive volume sources was set to values between 20 and 50 m, depending on the spacing of sources in different areas of the Yard and proximity to Yard boundaries.

Table 37
Non-Locomotive Modeling Inputs
Colton Rail Yard

Source	Point/Idling Source Parameters				Volume Source Parameters		
	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Temp (° K)	σ_z (m)	σ_y[b] (m)	Release Height (m)
Rerailer[a]	-	-	-	-	1.39	20-50	4.15
Rail Cleaner[a]	-	-	-	-	1.39	20-50	4.15
Forklifts[a]					1.39	20-50	4.15

Notes:

a. Low-level sources treated as volume sources using the release height and vertical dispersion parameter (σ_z) from the CARB Diesel Risk Reduction Plan (Sept. 13, 2000), Appendix VII, Table 2 (Truck stop scenario).

b. Low-level source lateral dispersion parameter (σ_y) set to a value between 20 and 50 meters based on spacing between sources and proximity to the Yard. boundary.

4. Meteorological Data Selection

The Yard does not monitor meteorological variables on site. Data from the Ontario International Airport were used for this project.

To the extent that airflow patterns are spatially variable due to elevated terrain and land-sea effects near the coast, judgment was exercised to select the monitoring stations that are most representative of conditions at the Colton Yard.

Because rail yards, especially emissions from locomotives, tend to be aligned linearly along the main track routes, the directions of prevailing surface winds were important to achieve representativeness of model predictions in the near field. For longer transport distances (e.g., 1 to 10 km), surface winds were still the primary consideration, with atmospheric stability also playing an important role. Due to the relatively low release heights and limited plume rise of rail yard sources, modeled concentrations are relatively insensitive to mixing heights, temperatures, and vertical temperature and wind profiles.

The selection of Ontario for surface winds data was largely dependent on the limited availability of data from other stations for the same years for which upper air data were available. There are four SCAQMD surface stations in the general vicinity of the Yard for which historical (1981) data are available, but only in a form useable in AERMOD's predecessor, ISCST3.

AERMET, the meteorological preprocessor for AERMOD, required at a minimum data from one surface National Weather Service (NWS) station, Ontario International Airport for the Yard, and one upper air NWS station, Miramar Marine Corps Air Station in San Diego. Missing hourly surface data from Ontario International Airport were replaced by the last previous values available in the same dataset.

Eleven years worth of meteorological data from Ontario, for years 1990 through 2000, were processed with AERMET to assure that an adequate number of years of acceptable data completeness and quality would be available for AERMOD modeling. It is expected that year-to-year variability would not cause significant differences in the modeled health impacts, and hence there is no need to subject the full set of receptors to more than one year of meteorological data. The meteorological data from 1999 were selected for the rail yard dispersion modeling because it was one of the two years recorded after the anemometer height was adjusted, and it was the year with the most conservative (i.e., largest) distances of impact from a specified source.

5. Model Domain and Receptor Grids

A domain size of 20 km by 20 km and coarse receptor grid of 500 m x 500 m were used for the modeling analysis. A fine grid of 50 m x 50 m surrounding the Yard was used for modeling within 300 m of the fence line. A medium-fine grid of 100 m x 100 m was used for receptors between 300 and 600 m of the fence line around the fine grid network, and a medium grid of 200 m x 200 m was used for receptor distances between 600 and 1000 m.

All receptors were identified by UTM coordinates. United States Geological Survey (USGS) 7.5 Minute digital elevation model (DEM) data were used to identify terrain heights at each receptor. Figures 6 and 7 show the outline of the Yard, along with the coarse and fine receptor grids.

Sensitive receptors, consisting of hospitals, schools, day-care centers, and elder care facilities, within a 1-mile radius of the Yard, were identified. Table 38 lists the address, elevations, and UTM coordinates for each sensitive receptor. Figure 8 shows the outline of the Yard and the location of each sensitive receptor identified in Table 38.

Table 38
Sensitive Receptor Locations[a]
Colton Rail Yard

Receptor	Address	Elevation (m)	UTM-E (m)	UTM-N (m)
Bloomington High School	10750 Laurel Ave, Bloomington, CA 92316	323.7	461799	3768829
Bloomington Middle School	18829 Orange St, Bloomington, CA 92316	326.4	463706	3769419
Citrus High School	9820 Citrus Ave., Fontana, CA 92335	343.5	458274	3770556
Colton Community Day School	10435 Cedar Ave., Bloomington, CA 92316	329.2	463431	3769425
Colton High School	777 West Valley Blvd., Colton, CA 92324	306.9	469039	3769820
Colton Middle School	670 West Laurel St., Colton, CA 92324	321.0	469217	3771020
Crestmore Elementary School	18870 Jurupa Ave, Bloomington, CA 92316	307.2	463807	3767822
Cypress Elementary School	9751 Cypress Ave., Fontana, CA 92335	349.6	459139	3770700
Ernest Garcia Elementary School	1390 W. Randall Ave., Colton, CA 92324	338.6	467938	3771442
Gerald A. Smith Elementary School	9551 Linden Ave, Bloomington, CA 92316	349.9	463033	3771049
Harry S. Truman Middle School	16224 Mallory Dr., Fontana, CA 92334	344.7	458487	3770559
Jurupa Hills Elementary School	10755 Oleander Ave., Fontana, CA 92337	324.9	458780	3768832
Mary B. Lewis Elementary School	18040 San Bernardino Ave, Bloomington, CA 92316	350.5	462124	3770855
Palmetto Elementary School	9325 Palmetto Ave., Fontana, CA 92335	361.2	460618	3771454
Paul Rogers Elementary School	955 West Laurel St., Colton, CA 92324	327.1	468560	3771244
Randall Pepper Elementary School	16613 Randall Ave., Fontana, CA 92335	360.3	459306	3771456
Ruth Grimes Elementary School	1609 S Spruce Ave, Bloomington, CA 92316	332.2	464270	3770132
Ruth O. Harris Middle School	11150 Alder Ave., Bloomington, CA 92316	318.2	461391	3768017
Samuel W. Simpson Elementary School	1050 S Lilac Ave, Rialto, CA 92376	343.5	465023	3771246
Slover Mountain High	325 Hermosa Ave, Colton, CA 92324	318.8	468192	3770021
Sycamore Hills Elementary School	11036 Mahogany Dr., Fontana, CA 92337	322.5	460680	3768216
Ulysses Grant Elementary School	550 West Olive St., Colton, CA 92324	314.6	469420	3770611
Walter Zimmerman Elementary School	11050 Linden Ave, Bloomington, CA 92316	314.2	463001	3768224
William G. Jehue Middle School	1500 N Eucalyptus Ave, Colton, CA 92324	347.5	466847	3771442
Woodrow Wilson Elementary School	750 South Eighth St., Colton, CA 92324	288.0	469827	3768658
Bell Daycare	18302 Marygold Ave, Bloomington, CA 92316	344.7	462632	3770447
Bloomington Christian Pre-School	9904 Bloomington Ave, Bloomington, CA 92316	340.2	463805	3770438

Table 38 **Sensitive Receptor Locations**[a] **Colton Rail Yard**				
Receptor	Address	Elevation (m)	UTM-E (m)	UTM-N (m)
Ezzell Family Child Care	10701 Cedar Ave, Bloomington, CA 92316	324.3	463422	3769010
Little Angels	18584 Valley Blvd, Bloomington, CA 92316	337.4	463210	3770052
Mulberry Child Care & Preschl	960 Bloomington Ave, Bloomington, CA 92316	341.7	464093	3770726
Rialto Jack Simonson Center	1243 S Riverside Ave, Rialto, CA 92376	338.0	465843	3770968
Vision Family Daycare	1844 De Anza Dr, Colton, CA 92324	336.2	467154	3770890
Williams Family Child Care	925 S Riverside Ave, Rialto, CA 92376	347.2	465842	3771594
Arrowhead Regional Medical Center	400 N Pepper Ave, Colton, CA 92324	326.1	467459	3770190
Crestview Convalescent Hospital	1471 S Riverside Ave, Rialto, CA 92376	331.0	465854	3770428
Kaiser Foundation Clinic	9961 Sierra Ave., Fontana, CA 92335	344.7	459995	3770193

Notes:
a. UTM Coordinates are in Zone 11, NAD 83.

Figure 6
Coarse Modeling Grid
Colton Rail Yard

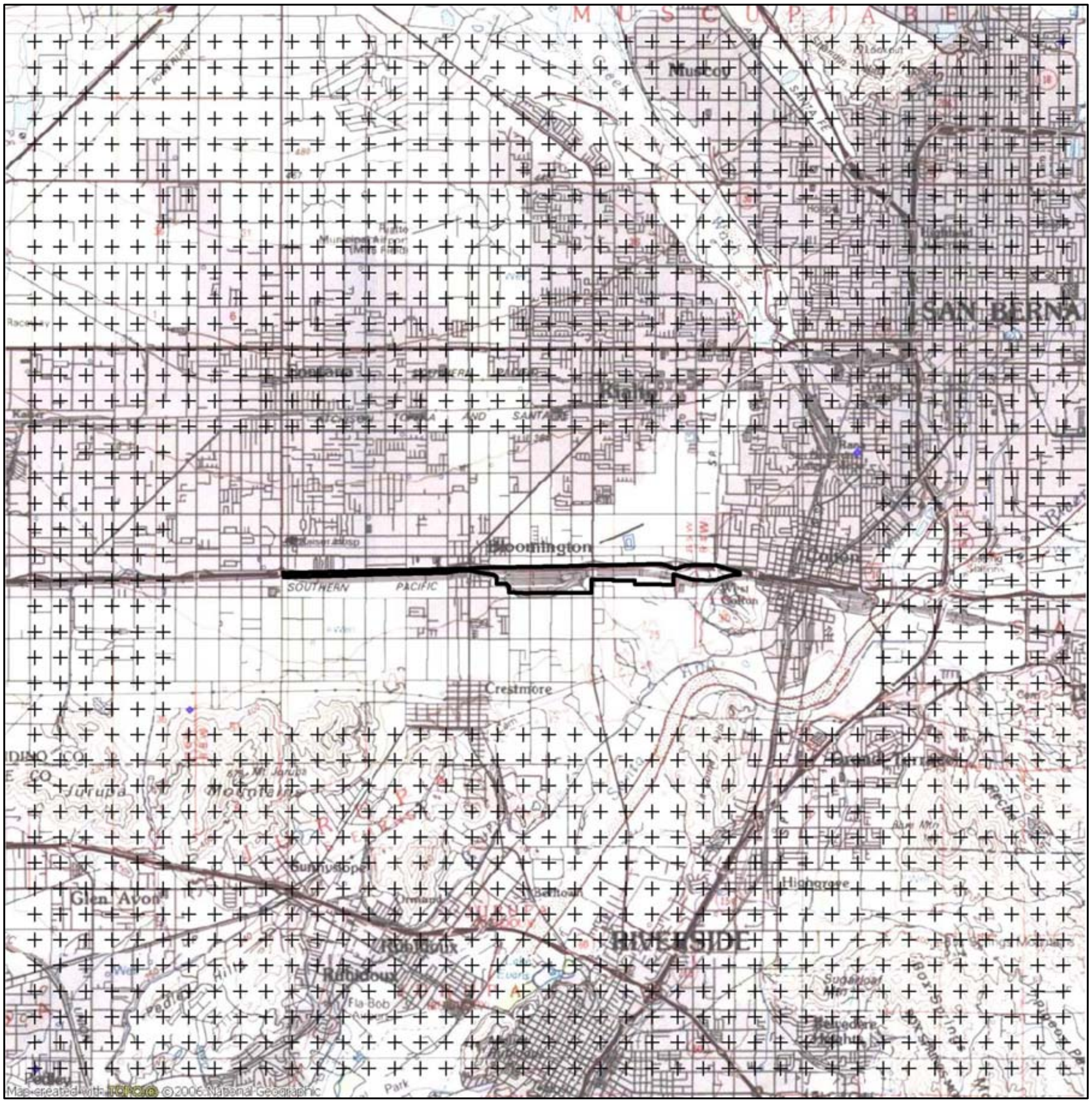


Figure 7
Fine Modeling Grid
Colton Rail Yard

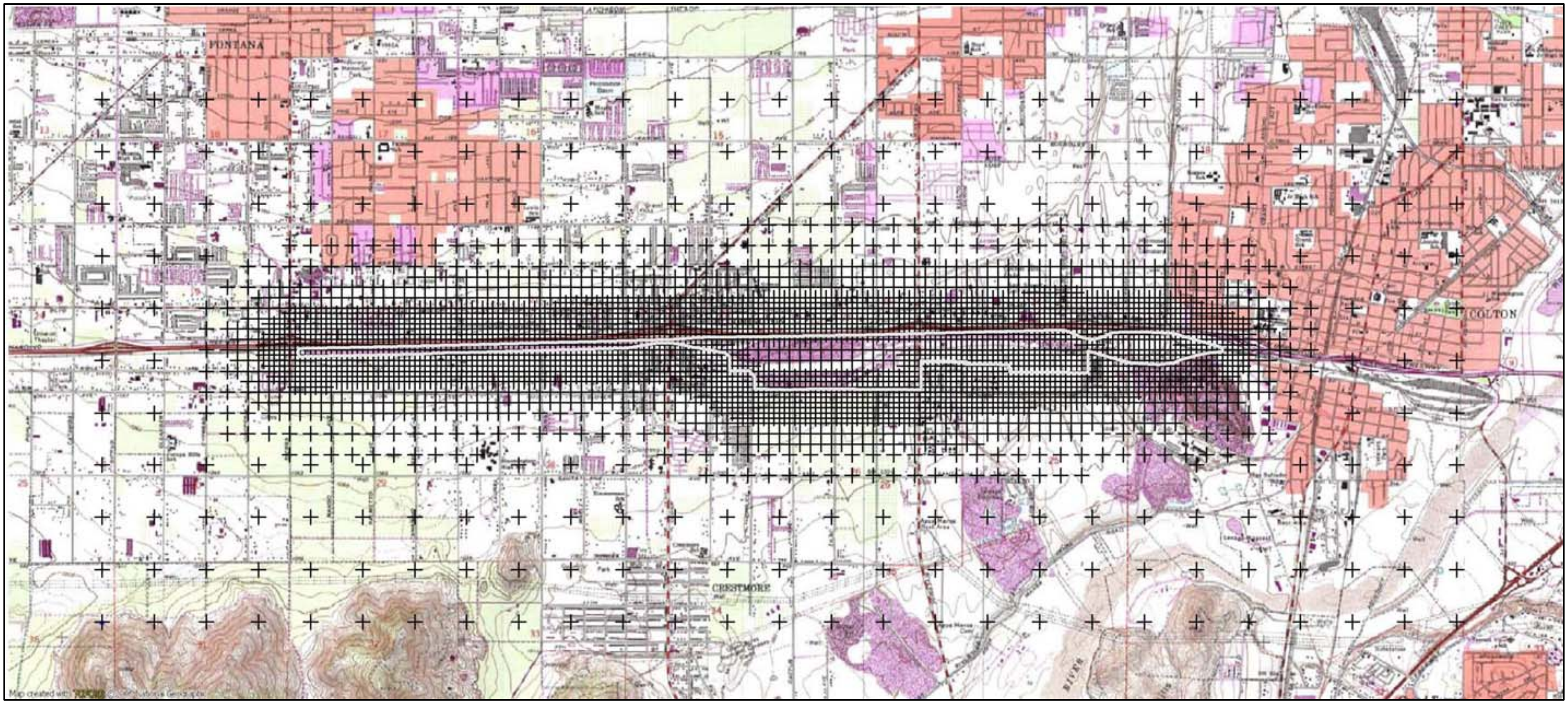
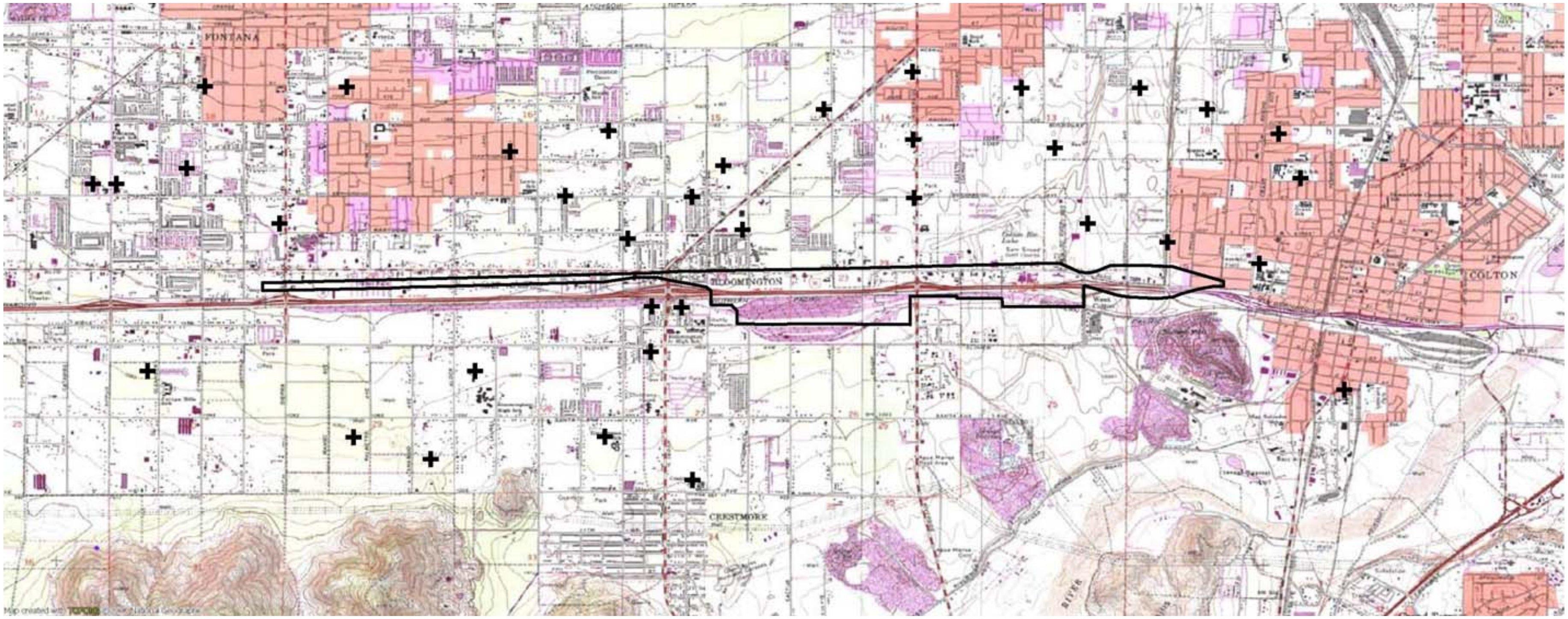


Figure 8
Sensitive Receptors
Colton Rail Yard



6. Dispersion Coefficients

Dispersion coefficients are used in air dispersion models to reflect the land use over which the pollutants are transported. The area surrounding the Yard was divided into sectors to characterize the albedo and Bowen ratio. The area surrounding the Ontario International Airport meteorological monitoring station was similarly divided into sectors to characterize surface roughness. These parameters were provided along with the meteorological data to the AERMET software. The resulting meteorological input file allows AERMOD to select appropriate dispersion coefficients during its simulation of air dispersion. AERMOD also provides an urban input option to use the overall size of the Standard Metropolitan Statistical Area that contains the emission source (i.e., the Yard) in accounting for the urban heat island effect on the nocturnal convective boundary layer height. If the option is not selected, AERMOD defaults to rural dispersion coefficients. If the urban option is selected, but no surface roughness is specified (not to be confused with the surface roughness parameters already specified for sectors around the meteorological monitoring station and input to AERMET), AERMOD assigns a default "urban" surface roughness of 1 meter. For the Colton Yard, AERMOD was run with the urban option. Based on CARB and USEPA guidance,[16] namely "*For urban areas adjacent to or near other urban areas, or part of urban corridors, the user should attempt to identify that part of the urban area that will contribute to the urban heat island plume affecting the source,*" the area encompassed by the county of Riverside was considered to determine the urban heat island effect on the nocturnal convective boundary layer height. Although the Colton Yard is located within San Bernardino County, the more densely populated areas upwind (to the southwest and south) of the Yard are in Riverside County, so the Riverside County population was assumed to be representative of conditions at the Yard. The population of this county is approximately 1,545,000,[17] and the surface roughness that characterizes this area was set to the URBANOPT default of 1 m. See Appendix J for additional discussion of this issue.

---

[16] AERMOD Implementation Guide**,** September 27, 2005, *http://www.epa.gov/scram001/7thconf/aermod/aermod_implmtn_guide.pdf*

[17] County of Riverside. http://www.city-data.com/county/Riverside_County-CA.html..

7. Building Downwash

Building downwash effects were considered for the Yard. Stack-tip downwash adjusted the effective stack height downward following the methods of Briggs (1972) when the stack exit velocity was less than 1.5 times the wind speed at stack top. The locomotives are the only structures in the Yard of sufficiently large size and close enough proximity to the modeled emission sources (i.e., their own stacks) to be entered into the Building Profile Input Program (BPIP) with one set of dimensions for a "standard" locomotive (24.2 m. long x 4.0 m. wide x 4.6 m. high).

B. Modeling Results

The AERMOD input and output files have been provided to CARB in an electronic format.

C. Demographic Data

Demographic data files have been provided to CARB in an electronic format. See Appendix K for a description of the data.

PART X. <u>REFERENCES</u>

Briggs, G.A. (1972). *Discussion on Chimney Plumes in Neutral and Stable Surroundings*. Atmos. Environ. 6:507-510.

CARB (2000). *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles.* (Available at *http://www.arb.ca.gov/diesel/documents/rrpapp.htm*)

CARB (2004). *Roseville Rail Yard Study.* (Available at *http://www.arb.ca.gov/diesel/documents/rrstudy/rrstudy101404.pdf*)

CARB (2006). *Health Risk Assessment Guidance for Rail Yards and Intermodal Facilities.* (Available at *http://www.arb.ca.gov/railyard/hra/071806hra_guideline.pdf*)

CARB (2006). *EMFAC 2007Model.* (Available at *http://www.arb.ca.gov/msei/onroad/latest_version.htm*)

CARB (2006). *OFFROAD2007 Model*. (Available at *http://www.arb.ca.gov/msei/offroad/offroad.htm*)

CARB (2006). *Rail Yard Emission Inventory Methodology*. (Available at *http://www.arb.ca.gov/railyard/hra/071806hra_eim.pdf)*

Ireson, R.G., M.J. Germer, L.A. Schmid (2005). *Development of Detailed Rail yard Emissions to Capture Activity, Technology, and Operational Changes*. Proceedings of the USEPA 14th Annual Emission Inventory Conference, Las Vegas NV, April 14, 2006. (Available at *http://www.epa.gov/ttn/chief/conference/ei14/session8/ireson.pdf*)

Irwin, J.S. (1978). *Proposed Criteria for Selection of Urban Versus Rural Dispersion Coefficients*. Staff Report. Meteorology and Assessment Division, U.S. Environmental Protection Agency, Research Triangle Park, NC. (Air Docket Reference No. II-B-8 for the Fourth Conference on Air Quality Modeling).

Nappo, C. J. et al. (1982). *The Workshop on the Representativeness of Meteorological Observations*, June 1981, Boulder, CO. Bulletin Amer. Meteor. Soc., Vol. 63, No. 7, pp. 761-764. American Meteorological Society, Boston, MA.

Trinity Consultants (2003). *Comprehensive Air Emission Inventory and Regulatory Analysis for the Colton Yard.*

USEPA (1986). *Guideline on Air Quality Models (Revised).* U.S. EPA-45/2-78-027R, Office of Air Quality Planning and Standards, Research Triangle Park, NC.

USEPA (1987a). *Supplement A to the Guideline on Air Quality Models (Revised).* Office of Air Quality Planning and Standards, Research Triangle Park, NC.

USEPA (1987b). *Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD)*. Office of Air Quality Planning and Standards, and Office of Research and Development, Research Triangle Park, NC.

USEPA (1995). *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources.* (Available at *http://www.epa.gov/ttn/chief/ap42/)*

USEPA (1998). *Locomotive Emission Standards -- Regulatory Support Document.* (Available at *http://www.epa.gov/otaq/regs/nonroad/locomotv/frm/locorsd.pdf*).

USEPA (2000). *Meteorological Monitoring Guidance for Regulatory Modeling Applications*. Publication No. EPA-454/R-99-005. Office of Air Quality Planning & Standards, Research Triangle Park, NC. (PB 2001-103606) (Available at *http://www.epa.gov/scram001/)*

USEPA (2004). *Final Regulatory Impact Analysis: Control of Emissions from Non-Road Diesel Engines.* U.S. EPA 420-R-04-007. Office of Air Quality Planning and Standards, Assessment and Standards Division, Research Triangle Park, NC.

USEPA (2005). *AERMOD Implementation Guide.* (Available at *http://www.epa.gov/scram001/7thconf/aermod/aermod_implmtn_guide.pdf*).

Wong, W (undated). *Changes to the Locomotive Inventory*. Draft OFFROAD Modeling Change Technical Memo.

APPENDIX A

LOCOMOTIVE DATA

APPENDIX A-1

LOCOMOTIVE MODEL, TIER, AND AUTO-START/STOP TECHNOLOGY FREQUENCY BY TRAIN TYPE

Appendix A-1
Locomotive Model, Tier, and Auto Start/Stop Technology Frequency by Train Type

Through Trains

EB Arrivals 887

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	0	0	266	19	177	10	48	0	257	313	1	27
Pre Tier 0	**Yes**	0	0	0	0	1	0	0	0	0	20	0	0
Tier 0	**No**	0	0	13	0	40	506	10	0	34	147	12	0
Tier 0	**Yes**	0	0	0	0	3	1	0	0	0	28	0	0
Tier 1	**No**	0	0	0	0	0	105	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	410	0	0	0	102	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	56	0	0	0	150	0	0

EB Departures 887

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	0	0	266	19	177	10	48	0	257	313	1	27
Pre Tier 0	**Yes**	0	0	0	0	1	0	0	0	0	20	0	0
Tier 0	**No**	0	0	13	0	40	506	10	0	34	147	12	0
Tier 0	**Yes**	0	0	0	0	3	1	0	0	0	28	0	0
Tier 1	**No**	0	0	0	0	0	105	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	410	0	0	0	102	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	56	0	0	0	150	0	0

WB Arrivals 4556

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	0	12	979	102	530	65	43	5	1258	1208	6	115
Pre Tier 0	**Yes**	0	1	0	0	3	0	0	0	0	86	0	0
Tier 0	**No**	0	0	37	2	137	3113	12	0	209	494	18	0
Tier 0	**Yes**	1	0	0	0	6	14	0	0	0	139	0	0
Tier 1	**No**	0	0	0	0	0	615	0	0	0	4	0	0
Tier 1	**Yes**	0	0	0	0	0	2517	0	0	0	357	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	421	0	0	0	965	0	0

Appendix A-1
Locomotive Model, Tier, and Auto Start/Stop Technology Frequency by Train Type

WB Departure 4456

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	0	12	979	102	530	65	43	5	1258	1208	6	115
Pre Tier 0	**Yes**	0	1	0	0	3	0	0	0	0	86	0	0
Tier 0	**No**	0	0	37	2	137	3113	12	0	209	494	18	0
Tier 0	**Yes**	1	0	0	0	6	14	0	0	0	139	0	0
Tier 1	**No**	0	0	0	0	0	615	0	0	0	4	0	0
Tier 1	**Yes**	0	0	0	0	0	2517	0	0	0	357	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	421	0	0	0	965	0	0

Freight Trains

EB Arrivals 882

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	3	14	490	6	1465	4	5	1	36	33	0	13
Pre Tier 0	**Yes**	1	8	1	0	3	0	0	0	0	2	0	0
Tier 0	**No**	0	0	11	0	363	65	0	0	4	36	5	0
Tier 0	**Yes**	0	1	0	0	9	0	0	0	0	36	0	0
Tier 1	**No**	0	0	0	0	0	13	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	40	0	0	0	100	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	3	0	0	0	13	0	0

EB Depatures 4521

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	2	30	1645	142	2421	42	76	7	1248	876	1	94
Pre Tier 0	**Yes**	0	10	2	0	3	0	0	0	0	83	0	0
Tier 0	**No**	1	0	51	1	597	2292	13	0	240	1166	29	0
Tier 0	**Yes**	1	1	0	0	24	10	0	0	0	928	0	0
Tier 1	**No**	0	0	0	0	0	388	0	0	0	51	0	0
Tier 1	**Yes**	0	0	0	0	0	1982	0	0	0	2284	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	152	0	0	0	484	0	0

Appendix A-1
Locomotive Model, Tier, and Auto Start/Stop Technology Frequency by Train Type

WB Arrivals 4505

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	1	22	1793	146	2633	59	72	119	1363	1566	2	265
Pre Tier 0	**Yes**	2	7	2	0	4	0	0	0	0	83	0	0
Tier 0	**No**	0	0	66	2	658	2205	13	0	253	1115	20	0
Tier 0	**Yes**	1	4	0	0	31	9	0	0	0	878	0	0
Tier 1	**No**	0	0	0	0	0	388	0	0	0	49	0	0
Tier 1	**Yes**	0	0	0	0	0	1894	0	0	0	2088	0	1
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	180	0	0	0	530	0	0

WB Depatures 1570

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	12	32	897	8	2769	1	2	4	29	34	0	28
Pre Tier 0	**Yes**	10	19	1	0	4	0	0	0	0	0	0	0
Tier 0	**No**	1	0	28	0	675	45	0	0	6	8	1	0
Tier 0	**Yes**	1	3	0	0	12	0	0	0	0	4	0	0
Tier 1	**No**	0	0	0	0	0	4	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	32	0	0	0	7	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	10	0	0	0	22	0	0

Local Trains

EB Arrivals 1412

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	10	27	838	3	2559	0	3	0	25	41	0	19
Pre Tier 0	**Yes**	10	19	0	0	2	0	0	0	0	3	0	0
Tier 0	**No**	0	0	21	0	560	28	4	0	3	40	0	0
Tier 0	**Yes**	1	2	0	0	12	0	0	0	0	13	0	0
Tier 1	**No**	0	0	0	0	0	4	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	27	0	0	0	50	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	11	0	0	0	7	0	0

Appendix A-1
Locomotive Model, Tier, and Auto Start/Stop Technology Frequency by Train Type

EB Departures 24

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	0	1	25	1	19	0	0	0	6	0	0	0
Pre Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 0	**No**	0	0	1	0	4	0	0	0	0	0	0	0
Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	1	0	0	0	0	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	1	0	0	0	0	0	0

WB Arrivals 110

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	0	5	45	1	165	0	0	0	9	6	0	3
Pre Tier 0	**Yes**	0	3	0	0	1	0	0	0	0	0	0	0
Tier 0	**No**	0	0	0	0	38	10	0	0	0	9	0	0
Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	5	0	0
Tier 1	**No**	0	0	0	0	0	1	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	7	0	0	0	14	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	1	0	0	0	3	0	0

WB Departures 1213

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	3	40	718	4	2158	0	2	0	8	13	0	15
Pre Tier 0	**Yes**	10	27	0	0	2	0	0	0	0	0	0	0
Tier 0	**No**	0	1	20	0	473	21	1	0	1	15	0	0
Tier 0	**Yes**	3	2	0	0	14	0	0	0	0	5	0	0
Tier 1	**No**	0	0	0	0	0	3	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	14	0	0	0	13	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	5	0	0	0	1	0	0

Appendix A-1
Locomotive Model, Tier, and Auto Start/Stop Technology Frequency by Train Type

Power Moves Through

EB Arrivals 14

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	0	0	12	0	8	0	1	0	4	2	0	0
Pre Tier 0	**Yes**	0	0	0	0	1	0	0	0	0	0	0	0
Tier 0	**No**	0	0	0	0	1	4	0	0	0	2	0	0
Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**No**	0	0	0	0	0	1	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	5	0	0	0	4	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0

EB Departures 14

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	0	0	12	0	8	0	1	0	4	2	0	0
Pre Tier 0	**Yes**	0	0	0	0	1	0	0	0	0	0	0	0
Tier 0	**No**	0	0	0	0	1	4	0	0	0	2	0	0
Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**No**	0	0	0	0	0	1	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	5	0	0	0	4	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0

WB Arrives 49

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	0	0	47	3	22	0	4	0	16	17	0	4
Pre Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	2	0	0
Tier 0	**No**	0	0	1	0	6	24	0	0	4	11	1	0
Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**No**	0	0	0	0	0	7	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	23	0	0	0	6	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	5	0	0	0	12	0	0

Appendix A-1
Locomotive Model, Tier, and Auto Start/Stop Technology Frequency by Train Type

WB Departures 49

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	0	0	47	3	22	0	4	0	16	17	0	4
Pre Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	2	0	0
Tier 0	**No**	0	0	1	0	6	24	0	0	4	11	1	0
Tier 0	**Yes**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 1	**No**	0	0	0	0	0	7	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	23	0	0	0	6	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	5	0	0	0	12	0	0

<u>Power Moves In Yard</u>

EB Arrivals 546

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	6	28	422	12	761	0	5	1	108	40	0	15
Pre Tier 0	**Yes**	3	18	1	0	2	0	0	0	0	8	0	0
Tier 0	**No**	2	1	9	0	186	56	1	0	15	45	3	0
Tier 0	**Yes**	3	1	0	0	6	0	0	0	0	33	0	0
Tier 1	**No**	0	0	0	0	0	10	0	0	0	2	0	0
Tier 1	**Yes**	0	0	0	0	0	65	0	0	0	94	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	3	0	0	0	10	0	0

EB Departures 386

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	1	0	213	7	356	3	9	0	112	57	0	5
Pre Tier 0	**Yes**	0	1	1	0	3	0	0	0	0	7	0	0
Tier 0	**No**	0	0	6	0	117	42	3	0	19	57	3	0
Tier 0	**Yes**	0	0	0	0	3	0	0	0	0	31	0	0
Tier 1	**No**	0	0	0	0	0	16	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	65	0	0	0	58	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	4	0	0	0	7	0	0

Appendix A-1
Locomotive Model, Tier, and Auto Start/Stop Technology Frequency by Train Type

WB Arrivals 1071

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	0	6	165	7	1464	7	12	0	71	60	0	12
Pre Tier 0	**Yes**	1	2	0	0	1	0	0	0	0	2	0	0
Tier 0	**No**	0	0	4	0	405	97	0	0	10	45	4	0
Tier 0	**Yes**	0	0	0	0	45	4	0	0	0	49	0	0
Tier 1	**No**	0	0	0	0	0	11	0	0	0	2	0	0
Tier 1	**Yes**	0	0	0	0	0	92	0	0	0	95	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	12	0	0	0	16	0	0

WB Departures 968

Technology	ZTR/AESS	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
Pre Tier 0	**No**	1	3	128	6	1238	6	3	1	77	64	0	9
Pre Tier 0	**Yes**	1	2	0	0	0	0	0	0	0	5	0	0
Tier 0	**No**	0	0	7	0	347	153	1	0	14	35	1	0
Tier 0	**Yes**	3	1	0	0	43	2	0	0	0	15	0	0
Tier 1	**No**	0	0	0	0	0	24	0	0	0	0	0	0
Tier 1	**Yes**	0	0	0	0	0	131	0	0	0	32	0	0
Tier 2	**No**	0	0	0	0	0	0	0	0	0	0	0	0
Tier 2	**Yes**	0	0	0	0	0	22	0	0	0	39	0	0

APPENDIX A-2

LOCOMOTIVE MODEL DISTRIBUTION
BY TRAIN TYPE GROUPS

Appendix A2
Locomotive Model Distribution by Train Type Groups

Through Freight Trains and Through Power Moves

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.00000	0.00073	0.07978	0.00759	0.04509	0.00459	0.00587	0.00031	0.09392	0.09422	0.00043
Pre Tier 0	Yes	0.00000	0.00006	0.00000	0.00000	0.00031	0.00000	0.00000	0.00000	0.00000	0.00661	0.00000
Tier 0	No	0.00000	0.00000	0.00312	0.00012	0.01126	0.22314	0.00135	0.00000	0.01511	0.04001	0.00190
Tier 0	Yes	0.00006	0.00000	0.00000	0.00000	0.00055	0.00092	0.00000	0.00000	0.00000	0.01022	0.00000
Tier 1	No	0.00000	0.00000	0.00000	0.00000	0.00000	0.04454	0.00000	0.00000	0.00000	0.00024	0.00000
Tier 1	Yes	0.00000	0.00000	0.00000	0.00000	0.00000	0.18080	0.00000	0.00000	0.00000	0.02870	0.00000
Tier 2	No	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Tier 2	Yes	0.00000	0.00000	0.00000	0.00000	0.00000	0.02949	0.00000	0.00000	0.00000	0.06895	0.00000

EB Departing and WB Arriving Freight Trains

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.00008	0.00146	0.09673	0.00810	0.14220	0.00284	0.00416	0.00355	0.07346	0.06871	0.00008
Pre Tier 0	Yes	0.00006	0.00048	0.00011	0.00000	0.00020	0.00000	0.00000	0.00000	0.00000	0.00467	0.00000
Tier 0	No	0.00003	0.00000	0.00329	0.00008	0.03531	0.12653	0.00073	0.00000	0.01387	0.06418	0.00138
Tier 0	Yes	0.00006	0.00014	0.00000	0.00000	0.00155	0.00053	0.00000	0.00000	0.00000	0.05081	0.00000
Tier 1	No	0.00000	0.00000	0.00000	0.00000	0.00000	0.02183	0.00000	0.00000	0.00000	0.00281	0.00000
Tier 1	Yes	0.00000	0.00000	0.00000	0.00000	0.00000	0.10906	0.00000	0.00000	0.00000	0.12301	0.00000
Tier 2	No	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Tier 2	Yes	0.00000	0.00000	0.00000	0.00000	0.00000	0.00934	0.00000	0.00000	0.00000	0.02853	0.00000

WB Departing and EB Arriving Freight and Locals

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.00178	0.00756	0.19150	0.00146	0.58059	0.00032	0.00076	0.00032	0.00718	0.00807	0.00000
Pre Tier 0	Yes	0.00197	0.00483	0.00013	0.00000	0.00076	0.00000	0.00000	0.00000	0.00000	0.00032	0.00000
Tier 0	No	0.00006	0.00006	0.00515	0.00000	0.13430	0.01074	0.00032	0.00000	0.00089	0.00686	0.00038
Tier 0	Yes	0.00032	0.00051	0.00000	0.00000	0.00299	0.00000	0.00000	0.00000	0.00000	0.00400	0.00000
Tier 1	No	0.00000	0.00000	0.00000	0.00000	0.00000	0.00159	0.00000	0.00000	0.00000	0.00000	0.00000
Tier 1	Yes	0.00000	0.00000	0.00000	0.00000	0.00000	0.00769	0.00000	0.00000	0.00000	0.01169	0.00000
Tier 2	No	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Tier 2	Yes	0.00000	0.00000	0.00000	0.00000	0.00000	0.00197	0.00000	0.00000	0.00000	0.00292	0.00000

Appendix A2
Locomotive Model Distribution by Train Type Groups

Power Moves to and from Yard

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.00097	0.00448	0.11242	0.00388	0.46263	0.00194	0.00351	0.00024	0.04458	0.02677	0.00000
Pre Tier 0	Yes	0.00061	0.00279	0.00024	0.00000	0.00073	0.00000	0.00000	0.00000	0.00000	0.00267	0.00000
Tier 0	No	0.00024	0.00012	0.00315	0.00000	0.12780	0.04216	0.00061	0.00000	0.00703	0.02205	0.00133
Tier 0	Yes	0.00073	0.00024	0.00000	0.00000	0.01175	0.00073	0.00000	0.00000	0.00000	0.01551	0.00000
Tier 1	No	0.00000	0.00000	0.00000	0.00000	0.00000	0.00739	0.00000	0.00000	0.00000	0.00048	0.00000
Tier 1	Yes	0.00000	0.00000	0.00000	0.00000	0.00000	0.04276	0.00000	0.00000	0.00000	0.03380	0.00000
Tier 2	No	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Tier 2	Yes	0.00000	0.00000	0.00000	0.00000	0.00000	0.00497	0.00000	0.00000	0.00000	0.00872	0.00000

Yard Switchers

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Pre Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 0	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Locomotives Serviced

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.00335	0.01232	0.18261	0.00724	0.26657	0.00270	0.00546	0.00032	0.05224	0.03906	0.00011
Pre Tier 0	Yes	0.00157	0.00416	0.00043	0.00000	0.00065	0.00000	0.00000	0.00000	0.00000	0.00324	0.00000
Tier 0	No	0.00059	0.00005	0.00643	0.00000	0.07099	0.08045	0.00157	0.00000	0.01194	0.04176	0.00140
Tier 0	Yes	0.00108	0.00205	0.00059	0.00000	0.00205	0.00022	0.00000	0.00000	0.00000	0.02539	0.00000
Tier 1	No	0.00000	0.00000	0.00000	0.00000	0.00000	0.01086	0.00000	0.00000	0.00000	0.00108	0.00000
Tier 1	Yes	0.00000	0.00000	0.00000	0.00000	0.00000	0.07067	0.00000	0.00000	0.00000	0.06494	0.00000
Tier 2	No	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00454	0.00000
Tier 2	Yes	0.00000	0.00000	0.00000	0.00000	0.00000	0.00702	0.00000	0.00000	0.00000	0.01226	0.00000

Appendix A2
Locomotive Model Distribution by Train Type Groups

Locomotives Load Tested

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	**No**	0.00000	0.02346	0.19794	0.00686	0.23741	0.00057	0.01030	0.00000	0.05435	0.04291	0.00000
Pre Tier 0	**Yes**	0.00000	0.00915	0.00172	0.00000	0.00114	0.00000	0.00000	0.00000	0.00000	0.00744	0.00000
Tier 0	**No**	0.00000	0.00000	0.01030	0.00000	0.06293	0.08238	0.00286	0.00000	0.01430	0.05149	0.00229
Tier 0	**Yes**	0.00000	0.00172	0.00172	0.00000	0.00172	0.00000	0.00000	0.00000	0.00000	0.02002	0.00000
Tier 1	**No**	0.00000	0.00000	0.00000	0.00000	0.00000	0.00744	0.00000	0.00000	0.00000	0.00057	0.00000
Tier 1	**Yes**	0.00000	0.00000	0.00000	0.00000	0.00000	0.07666	0.00000	0.00000	0.00000	0.04977	0.00000
Tier 2	**No**	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00229	0.00000
Tier 2	**Yes**	0.00000	0.00000	0.00000	0.00000	0.00000	0.00915	0.00000	0.00000	0.00000	0.00915	0.00000

APPENDIX A-3

SAMPLE CALCULATIONS

Appendix A-3 - Sample Calculations

Activity Types

Description	Activity Code	Number of Events/Year	Locomotives per Consist	Emission Factor Group	Locomotives per Consist Working	Fraction of Calif. Fuel
Thru EB	1	792	3.107	1	3.107	0.50
Thru EB Setouts	2	95	3.107	1	3.107	0.50
Thru WB	3	4378	2.957	1	2.957	0.50
Thru WB Setouts	4	178	2.957	1	2.957	0.50
Freight Train EB Arrivals	5	822	3.387	3	3.387	0.00
Freight Train EB Departures	6	4521	3.844	2	3.844	0.90
Freight Train WB Arrivals	7	4505	4.112	2	4.112	0.00
Freight Train WB Departures	8	1570	2.999	3	2.999	0.90
Local Train EB Arrivals	9	1412	3.075	3	3.075	1.00
Local Train EB Departures	10	24	2.458	3	2.458	1.00
Local Train WB Arrivals	11	110	2.964	3	2.964	1.00
Local Train WB Departures	12	1213	2.961	3	2.961	1.00
Power Moves Thru EB Arrivals	13	14	3.214	1	1.500	0.50
Power Moves Thru EB Departures	14	14	3.214	1	1.500	0.50
Power Moves Thru WB Arrivals	15	49	4.388	1	1.500	0.50
Power Moves Thru WB Departures	16	49	4.388	1	1.500	0.50
Power Moves EB Arrivals	17	546	3.617	4	1.500	0.00
Power Moves EB Departures	18	524	3.124	4	1.500	0.90
Power Moves WB Arrivals	19	1071	2.522	4	1.500	0.00
Power Moves WB Departures	20	1314	2.494	4	1.500	0.90
Hump Set Return to Receiving Yard West End	21	7300	3.000	5	3.000	1.00
Hump Set Push Notch 2	22	1460	3.000	5	3.000	1.00
Hump Set Push DB	23	8030	3.000	5	3.000	1.00
Trim Sets	24	25185	2.000	5	2.000	1.00
Consist Movements in Service Track	25	5080	3.648	5	1.500	0.90
Crew Changes on EB Thru	26	149	3.107	1	3.107	0.50
Crew Changes on WB Thru	27	4017	2.957	1	2.957	0.50

Appendix A-3 - Sample Calculations

Emission Factors Weighted by Model/Tier/ZTR Fractions - DPM g/hr per Locomotive

Consist Groups	Group ID	Idle-NonZTR	Idle-All	DB	N1	N2	N3	N4	N5	N6	N7	N8
California Fuel (221 ppm S)												
Thru Trains and Power Moves	1	20.38	28.91	54.85	48.76	98.42	221.07	281.99	362.07	546.04	624.04	720.65
Freight Train WB Arrival and EB Departure	2	23.58	31.54	66.59	50.86	110.15	227.84	279.15	372.62	525.34	591.06	702.33
Freight Train EB Arrival, WB Departure and Locals	3	41.98	43.06	81.86	44.71	122.36	245.22	264.09	336.26	556.18	694.46	863.99
Power Moves In Yard	4	35.80	39.04	77.02	47.36	116.52	241.32	271.17	351.11	550.11	676.72	829.75
Hump and Trim Sets	5	47.94	47.94	80.04	35.70	134.30	211.93	228.61	289.68	488.55	584.17	749.94
47-State Fuel (2639 ppm S)												
Thru Trains and Power Moves	1	20.38	28.91	54.85	48.76	98.42	241.55	313.20	407.31	612.70	705.09	820.26
Freight Train WB Arrival and EB Departure	2	23.58	31.54	66.59	50.86	110.15	250.30	309.83	417.61	591.31	677.56	810.03
Freight Train EB Arrival, WB Departure and Locals	3	41.98	43.06	81.86	44.71	122.36	260.64	294.03	382.41	619.57	754.55	940.41
Power Moves In Yard	4	35.80	39.04	77.02	47.36	116.52	258.99	301.62	397.51	614.59	745.77	916.78
Hump and Trim Sets	5	N/A -- Hump and trim sets operate on 100% California Fuel										

Note: Idle-NonZTR is the average per-locomotive idle emission rate for the fraction of locomotives not equipped with ZTR/Auto start-stop technology

Locomotive Model Distributions

Thru Trains and Power Moves

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	**No**	0.0000	0.0007	0.0798	0.0076	0.0451	0.0046	0.0059	0.0003	0.0939	0.0942	0.0004
Pre Tier 0	**Yes**	0.0000	0.0001	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0066	0.0000
Tier 0	**No**	0.0000	0.0000	0.0031	0.0001	0.0113	0.2231	0.0014	0.0000	0.0151	0.0400	0.0019
Tier 0	**Yes**	0.0001	0.0000	0.0000	0.0000	0.0006	0.0009	0.0000	0.0000	0.0000	0.0102	0.0000
Tier 1	**No**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0445	0.0000	0.0000	0.0000	0.0002	0.0000
Tier 1	**Yes**	0.0000	0.0000	0.0000	0.0000	0.0000	0.1808	0.0000	0.0000	0.0000	0.0287	0.0000
Tier 2	**No**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	**Yes**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0295	0.0000	0.0000	0.0000	0.0690	0.0000

Freight Train WB Arrival and EB Departure

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	**No**	0.0001	0.0015	0.0967	0.0081	0.1422	0.0028	0.0042	0.0036	0.0735	0.0687	0.0001
Pre Tier 0	**Yes**	0.0001	0.0005	0.0001	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0047	0.0000
Tier 0	**No**	0.0000	0.0000	0.0033	0.0001	0.0353	0.1265	0.0007	0.0000	0.0139	0.0642	0.0014
Tier 0	**Yes**	0.0001	0.0001	0.0000	0.0000	0.0016	0.0005	0.0000	0.0000	0.0000	0.0508	0.0000
Tier 1	**No**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0218	0.0000	0.0000	0.0000	0.0028	0.0000
Tier 1	**Yes**	0.0000	0.0000	0.0000	0.0000	0.0000	0.1091	0.0000	0.0000	0.0000	0.1230	0.0000
Tier 2	**No**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	**Yes**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0093	0.0000	0.0000	0.0000	0.0285	0.0000

'reight Train EB Arrival, WB Departure and Locals

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0018	0.0076	0.1915	0.0015	0.5806	0.0003	0.0008	0.0003	0.0072	0.0081	0.0000
Pre Tier 0	Yes	0.0020	0.0048	0.0001	0.0000	0.0008	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000
Tier 0	No	0.0001	0.0001	0.0052	0.0000	0.1343	0.0107	0.0003	0.0000	0.0009	0.0069	0.0004
Tier 0	Yes	0.0003	0.0005	0.0000	0.0000	0.0030	0.0000	0.0000	0.0000	0.0000	0.0040	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0016	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0077	0.0000	0.0000	0.0000	0.0117	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0020	0.0000	0.0000	0.0000	0.0029	0.0000

Power Moves In Yard

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0010	0.0045	0.1124	0.0039	0.4626	0.0019	0.0035	0.0002	0.0446	0.0268	0.0000
Pre Tier 0	Yes	0.0006	0.0028	0.0002	0.0000	0.0007	0.0000	0.0000	0.0000	0.0000	0.0027	0.0000
Tier 0	No	0.0002	0.0001	0.0032	0.0000	0.1278	0.0422	0.0006	0.0000	0.0070	0.0221	0.0013
Tier 0	Yes	0.0007	0.0002	0.0000	0.0000	0.0118	0.0007	0.0000	0.0000	0.0000	0.0155	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0074	0.0000	0.0000	0.0000	0.0005	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0428	0.0000	0.0000	0.0000	0.0338	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0050	0.0000	0.0000	0.0000	0.0087	0.0000

Hump and Trim Sets

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Pre Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 0	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Appendix A-3 - Sample Calculations

Track Segment	Segment Number	Length (mi)
Main Line 1	1	2.224
Main Line 2	2	0.136
Main Line 3	3	1.822
Main Line 4	4	0.363
Main Line 5	5	0.173
Main Line 6	6	0.332
Main Line 7	7	0.120
Main Line 8	8	0.352
Receiving Yard West End Entrance	11	0.117
Receiving Yard West End	12	0.467
Receiving Yard Middle	13	0.934
Receiving Yard East End	14	0.467
Receiving Yard East End Entrance	15	0.241
Receiving Yard to Hump	16	0.363
Hump to Service 1	17	0.221
Hump to Service 2	18	0.113
Hump to Service 3	19	0.315
Hump to Service 4	20	0.075
Service Track Entrance	21	0.204
Service Track	22	0.246
Service Track East End	23	0.063
Service Track to Ready Track East 1	24	0.076
Service Track to Ready Track East 2	25	0.053
Ready Track East	26	0.154
Ready Track West	27	0.154
Ready Track West Entrance	28	0.087
Service Track Wye East Entrance	31	0.087
Service Track Wye East Leg	32	0.065
Service Track Wye South Lead	33	0.073
Service Track Wye West Leg	34	0.068
Service Track Wye North Leg	35	0.058
Service Track Wye West Entrance	36	0.114
Service Track to Departure Yard	41	0.244
Departure Yard South - Middle	42	0.326
Departure Yard South - East End	43	0.238
Departure Yard South - East Entrance	44	0.209
Bowl to Departure Yard South	45	0.224
Departure Yard North - West End	46	0.252
Departure Yard North - Middle	47	0.252
Departure Yard North - East End	48	0.291

Appendix A-3 - Sample Calculations

Track Segment	Segment Number	Length (mi)
Departure Yard North - East Entrance	49	0.205
Bowl North 1	51	0.222
Bowl North 2	52	0.230
Bowl North 3	53	0.686
Bowl South 1	54	0.160
Bowl South 2	55	0.331
Bowl South 3	56	0.658
Main Line Leg to Palmdale 1	61	0.057
Main Line Leg to Palmdale 2	62	0.040
Main Line Leg to Palmdale 3	63	0.045
Main Line Leg to Palmdale 4	64	0.050
Cedar (Crew Change Location)	71	0.172

* Note: Approximately 5% of consists for south bound trains use the "Y" to turn to be facing south

Appendix A-3 - Sample Calculations

Movement Type	Activity Code	Segment Number	Speed (mph)	Duty Cycle Number	Non-ZTR Idle Time (hrs)	ZTR Idle Time (hrs)	Fraction of Segment or Time Moving
EB Through Trains	1	1	20	1	0.000	0.000	1.000
"	1	2	20	1	0.000	0.000	1.000
"	1	3	20	1	0.000	0.000	1.000
"	1	4	20	1	0.000	0.000	1.000
"	1	5	20	1	0.000	0.000	1.000
"	1	6	20	1	0.000	0.000	1.000
"	1	7	20	1	0.000	0.000	1.000
"	1	8	20	1	0.000	0.000	1.000
EB Through Trains with Setouts	2	11	10	2	0.000	0.000	1.000
"	2	12	10	2	0.000	0.000	1.000
"	2	13	10	2	0.000	0.000	1.000
"	2	14	10	2	0.000	0.500	1.000
"	2	15	10	2	0.000	0.000	1.000
"	2	16	10	2	0.000	0.000	1.000
"	2	51	10	2	0.000	0.000	1.000
"	2	52	10	2	0.000	0.000	1.000
"	2	53	10	2	0.000	0.000	1.000
"	2	46	10	2	0.000	0.000	1.000
"	2	47	10	2	0.000	0.000	1.000
"	2	48	10	2	0.000	0.000	1.000
"	2	49	10	2	0.000	0.000	1.000
"	2	6	10	2	0.000	0.000	1.000
"	2	7	10	2	0.000	0.000	1.000
"	2	8	10	2	0.000	0.000	1.000
WB Through Trains	3	1	20	1	0.000	0.000	1.000
"	3	2	20	1	0.000	0.000	1.000
"	3	3	20	1	0.000	0.000	1.000
"	3	4	20	1	0.000	0.000	1.000
"	3	5	20	1	0.000	0.000	1.000
"	3	6	20	1	0.000	0.000	1.000
"	3	7	20	1	0.000	0.000	1.000
"	3	8	20	1	0.000	0.000	1.000
WB Through Trains with Setouts	4	11	10	2	0.000	0.000	1.000
"	4	12	10	2	0.000	0.500	1.000
"	4	13	10	2	0.000	0.000	1.000
"	4	14	10	2	0.000	0.000	1.000
"	4	15	10	2	0.000	0.000	1.000
"	4	16	10	2	0.000	0.000	1.000

Movement Type	Activity Code	Segment Number	Speed (mph)	Duty Cycle Number	Non-ZTR Idle Time (hrs)	ZTR Idle Time (hrs)	Fraction of Segment or Time Moving
"	4	51	10	2	0.000	0.000	1.000
"	4	52	10	2	0.000	0.000	1.000
"	4	53	10	2	0.000	0.000	1.000
"	4	46	10	2	0.000	0.000	1.000
"	4	47	10	2	0.000	0.000	1.000
"	4	48	10	2	0.000	0.000	1.000
"	4	49	10	2	0.000	0.000	1.000
"	4	6	10	2	0.000	0.000	1.000
"	4	7	10	2	0.000	0.000	1.000
"	4	8	10	2	0.000	0.000	1.000
EB Arriving Freight Trains	5	11	10	2	0.000	0.000	1.000
"	5	12	10	2	0.000	0.000	1.000
"	5	13	10	2	0.000	0.000	1.000
"	5	14	10	2	0.000	0.125	1.000
"	5	-15	10	2	0.000	0.000	1.000
"	5	-16	10	2	0.000	0.000	1.000
"	5	-17	10	2	0.000	0.000	1.000
"	5	-18	10	2	0.000	0.000	1.000
"	5	-19	10	2	0.000	0.000	1.000
"	5	-20	10	2	0.000	0.000	1.000
"	5	-21	10	2	0.000	0.000	1.000
EB Departing Freight Trains	6	-26	10	2	0.000	0.000	1.000
"	6	-25	10	2	0.000	0.000	1.000
"	6	-24	10	2	0.000	0.000	1.000
"	6	-41	10	2	0.000	0.000	1.000
"	6	-42	10	2	0.000	0.000	1.000
"	6	-43	10	2	0.000	0.000	1.000
"	6	-44	10	2	0.000	0.000	1.000
"	6	-44	10	2	0.000	0.000	0.500
"	6	43	10	2	0.250	0.250	0.250
"	6	-44	10	2	0.000	0.000	0.500
"	6	49	10	2	0.250	0.250	0.500
"	6	48	10	2	0.000	0.000	0.250
"	6	49	10	2	0.000	0.000	0.500
"	6	6	10	2	0.000	0.000	1.000
"	6	7	10	2	0.000	0.000	1.000
"	6	8	10	2	0.000	0.000	0.700
"	6	61	10	2	0.000	0.000	0.300

Movement Type	Activity Code	Segment Number	Speed (mph)	Duty Cycle Number	Non-ZTR Idle Time (hrs)	ZTR Idle Time (hrs)	Fraction of Segment or Time Moving
"	6	62	10	2	0.000	0.000	0.300
"	6	63	10	2	0.000	0.000	0.300
"	6	64	10	2	0.000	0.000	0.300
WB Arriving Freight Trains	7	8	10	2	0.000	0.000	0.750
"	7	64	10	2	0.000	0.000	0.250
"	7	63	10	2	0.000	0.000	0.250
"	7	62	10	2	0.000	0.000	0.250
"	7	61	10	2	0.000	0.000	0.250
"	7	7	10	2	0.000	0.000	1.000
"	7	6	10	2	0.000	0.000	1.000
"	7	49	10	2	0.000	0.000	1.000
"	7	48	10	2	0.000	0.000	1.000
"	7	47	10	2	0.000	0.000	1.000
"	7	46	10	2	0.000	0.000	1.000
"	7	53	10	2	0.000	0.000	1.000
"	7	52	10	2	0.000	0.000	1.000
"	7	51	10	2	0.000	0.000	1.000
"	7	16	10	2	0.000	0.000	1.000
"	7	15	10	2	0.000	0.000	1.000
"	7	14	10	2	0.000	0.000	1.000
"	7	13	10	2	0.000	0.000	1.000
"	7	12	10	2	0.000	0.125	1.000
"	7	-11	10	2	0.000	0.000	1.000
"	7	-12	10	2	0.000	0.000	1.000
"	7	-13	10	2	0.000	0.000	1.000
"	7	-14	10	2	0.000	0.000	1.000
"	7	-15	10	2	0.000	0.000	1.000
"	7	-16	10	2	0.000	0.000	1.000
"	7	-17	10	2	0.000	0.000	1.000
"	7	-18	10	2	0.000	0.000	1.000
"	7	-19	10	2	0.000	0.000	1.000
"	7	-20	10	2	0.000	0.000	1.000
"	7	-21	10	2	0.000	0.000	1.000
WB Departing Freight Trains	8	-27	10	2	0.000	0.000	1.000
"	8	-26	10	2	0.000	0.000	1.000
"	8	-25	10	2	0.000	0.000	1.000
"	8	-24	10	2	0.000	0.000	1.000
"	8	-41	10	2	0.000	0.000	1.000

Appendix A-3 - Sample Calculations

Movement Type	Activity Code	Segment Number	Speed (mph)	Duty Cycle Number	Non-ZTR Idle Time (hrs)	ZTR Idle Time (hrs)	Fraction of Segment or Time Moving
"	8	-45	10	2	0.000	0.000	1.000
"	8	46	10	2	0.500	0.500	0.500
"	8	53	10	2	0.000	0.000	1.000
"	8	52	10	2	0.000	0.000	1.000
"	8	51	10	2	0.000	0.000	1.000
"	8	16	10	2	0.000	0.000	1.000
"	8	15	10	2	0.000	0.000	1.000
"	8	14	10	2	0.000	0.000	1.000
"	8	13	10	2	0.000	0.000	1.000
"	8	12	10	2	0.000	0.000	1.000
"	8	11	10	2	0.000	0.000	1.000
EB Arriving Local Trains	9	11	10	2	0.000	0.000	1.000
"	9	12	10	2	0.000	0.000	1.000
"	9	13	10	2	0.000	0.000	1.000
"	9	14	10	2	0.000	0.125	1.000
"	9	-15	10	2	0.000	0.000	1.000
"	9	-16	10	2	0.000	0.000	1.000
"	9	-17	10	2	0.000	0.000	1.000
"	9	-18	10	2	0.000	0.000	1.000
"	9	-19	10	2	0.000	0.000	1.000
"	9	-20	10	2	0.000	0.000	1.000
"	9	-21	10	2	0.000	0.000	1.000
EB Departing Local Trains	10	-26	10	2	0.000	0.000	1.000
"	10	-25	10	2	0.000	0.000	1.000
"	10	-24	10	2	0.000	0.000	1.000
"	10	-41	10	2	0.000	0.000	1.000
"	10	-42	10	2	0.000	0.000	1.000
"	10	-43	10	2	0.000	0.000	1.000
"	10	-44	10	2	0.000	0.000	1.000
"	10	-44	10	2	0.000	0.000	0.500
"	10	43	10	2	0.250	0.250	0.250
"	10	-44	10	2	0.000	0.000	0.500
"	10	49	10	2	0.250	0.250	0.500
"	10	48	10	2	0.000	0.000	0.250
"	10	49	10	2	0.000	0.000	0.500
"	10	6	10	2	0.000	0.000	1.000
"	10	7	10	2	0.000	0.000	1.000
"	10	8	10	2	0.000	0.000	1.000

Appendix A-3 - Sample Calculations

Movement Type	Activity Code	Segment Number	Speed (mph)	Duty Cycle Number	Non-ZTR Idle Time (hrs)	ZTR Idle Time (hrs)	Fraction of Segment or Time Moving
WB Arriving Local Trains	11	8	10	2	0.000	0.000	1.000
"	11	7	10	2	0.000	0.000	1.000
"	11	6	10	2	0.000	0.000	1.000
"	11	49	10	2	0.000	0.000	1.000
"	11	48	10	2	0.000	0.000	1.000
"	11	47	10	2	0.000	0.000	1.000
"	11	46	10	2	0.000	0.000	1.000
"	11	53	10	2	0.000	0.000	1.000
"	11	52	10	2	0.000	0.000	1.000
"	11	51	10	2	0.000	0.000	1.000
"	11	16	10	2	0.000	0.000	1.000
"	11	15	10	2	0.000	0.000	1.000
"	11	14	10	2	0.000	0.000	1.000
"	11	13	10	2	0.000	0.000	1.000
"	11	12	10	2	0.000	0.125	1.000
"	11	-11	10	2	0.000	0.000	1.000
"	11	-12	10	2	0.000	0.000	1.000
"	11	-13	10	2	0.000	0.000	1.000
"	11	-14	10	2	0.000	0.000	1.000
"	11	-15	10	2	0.000	0.000	1.000
"	11	-16	10	2	0.000	0.000	1.000
"	11	-17	10	2	0.000	0.000	1.000
"	11	-18	10	2	0.000	0.000	1.000
"	11	-19	10	2	0.000	0.000	1.000
"	11	-20	10	2	0.000	0.000	1.000
"	11	-21	10	2	0.000	0.000	1.000
WB Departing Local Trains	12	-27	10	2	0.000	0.000	1.000
"	12	-26	10	2	0.000	0.000	1.000
"	12	-25	10	2	0.000	0.000	1.000
"	12	-24	10	2	0.000	0.000	1.000
"	12	-41	10	2	0.000	0.000	1.000
"	12	-45	10	2	0.000	0.000	1.000
"	12	46	10	2	0.500	0.500	0.500
"	12	53	10	2	0.000	0.000	1.000
"	12	52	10	2	0.000	0.000	1.000
"	12	51	10	2	0.000	0.000	1.000
"	12	16	10	2	0.000	0.000	1.000
"	12	15	10	2	0.000	0.000	1.000

Movement Type	Activity Code	Segment Number	Speed (mph)	Duty Cycle Number	Non-ZTR Idle Time (hrs)	ZTR Idle Time (hrs)	Fraction of Segment or Time Moving
"	12	14	10	2	0.000	0.000	1.000
"	12	13	10	2	0.000	0.000	1.000
"	12	12	10	2	0.000	0.000	1.000
"	12	11	10	2	0.000	0.000	1.000
EB Power Moves Thru	13	-1	20	1	0.000	0.000	1.000
"	13	-2	20	1	0.000	0.000	1.000
"	13	-3	20	1	0.000	0.000	1.000
"	13	-4	20	1	0.000	0.000	1.000
"	13	-5	20	1	0.000	0.000	1.000
"	13	-6	20	1	0.000	0.000	1.000
"	13	-7	20	1	0.000	0.000	1.000
"	13	-8	20	1	0.000	0.000	1.000
WB Power Moves Thru	15	-1	20	1	0.000	0.000	1.000
"	15	-2	20	1	0.000	0.000	1.000
"	15	-3	20	1	0.000	0.000	1.000
"	15	-4	20	1	0.000	0.000	1.000
"	15	-5	20	1	0.000	0.000	1.000
"	15	-6	20	1	0.000	0.000	1.000
"	15	-7	20	1	0.000	0.000	1.000
"	15	-8	20	1	0.000	0.000	1.000
EB Power Moves Arriving	17	-11	10	2	0.000	0.000	1.000
"	17	-12	10	2	0.000	0.000	1.000
"	17	-13	10	2	0.000	0.000	1.000
"	17	-14	10	2	0.000	0.000	1.000
"	17	-15	10	2	0.000	0.000	1.000
"	17	-16	10	2	0.000	0.000	1.000
"	17	-17	10	2	0.000	0.000	1.000
"	17	-18	10	2	0.000	0.000	1.000
"	17	-19	10	2	0.000	0.000	1.000
"	17	-20	10	2	0.000	0.000	1.000
"	17	-21	10	2	0.000	0.000	1.000
EB Power Moves Departing	18	-26	10	2	0.000	0.000	1.000
"	18	-25	10	2	0.000	0.000	1.000
"	18	-24	10	2	0.000	0.000	1.000
"	18	-41	10	2	0.000	0.000	1.000
"	18	-42	10	2	0.000	0.000	1.000
"	18	-43	10	2	0.000	0.000	1.000
"	18	-44	10	2	0.000	0.000	1.000

Appendix A-3 - Sample Calculations

Movement Type	Activity Code	Segment Number	Speed (mph)	Duty Cycle Number	Non-ZTR Idle Time (hrs)	ZTR Idle Time (hrs)	Fraction of Segment or Time Moving
"	18	-6	10	2	0.000	0.000	1.000
"	18	-7	10	2	0.000	0.000	1.000
"	18	-8	10	2	0.000	0.000	1.000
WB Power Moves Arriving	19	-8	10	2	0.000	0.000	1.000
"	19	-7	10	2	0.000	0.000	1.000
"	19	-6	10	2	0.000	0.000	1.000
"	19	-44	10	2	0.000	0.000	1.000
"	19	-43	10	2	0.000	0.000	1.000
"	19	-42	10	2	0.000	0.000	1.000
"	19	-41	10	2	0.000	0.000	1.000
"	19	-24	10	2	0.000	0.000	1.000
"	19	-25	10	2	0.000	0.000	1.000
"	19	-26	10	2	0.000	0.000	1.000
"	19	-27	10	2	0.000	0.000	1.000
"	19	-28	10	2	0.000	0.000	1.000
"	19	-21	10	2	0.000	0.000	1.000
WB Power Moves Departing	20	-27	10	2	0.000	0.000	1.000
"	20	-28	10	2	0.000	0.000	1.000
"	20	-20	10	2	0.000	0.000	1.000
"	20	-19	10	2	0.000	0.000	1.000
"	20	-18	10	2	0.000	0.000	1.000
"	20	-17	10	2	0.000	0.000	1.000
"	20	-16	10	2	0.000	0.000	1.000
"	20	-15	10	2	0.000	0.000	1.000
"	20	-14	10	2	0.000	0.000	1.000
"	20	-13	10	2	0.000	0.000	1.000
"	20	-12	10	2	0.000	0.000	1.000
"	20	-11	10	2	0.000	0.000	1.000
Consist Movements in Service and Ready Tracks	25	-22	10	2	0.000	0.000	1.000
"	25	-31	10	2	0.000	0.000	0.500
"	25	-32	10	2	0.000	0.000	0.500
"	25	-33	10	2	0.000	0.000	0.500
"	25	-34	10	2	0.000	0.000	0.500
"	25	-35	10	2	0.000	0.000	0.250
"	25	-31	10	2	0.000	0.000	0.250
"	25	-23	10	2	0.000	0.000	0.750
"	25	-24	10	2	0.000	0.000	0.750
"	25	-25	10	2	0.000	0.000	0.750

Appendix A-3 - Sample Calculations

Movement Type	Activity Code	Segment Number	Speed (mph)	Duty Cycle Number	Non-ZTR Idle Time (hrs)	ZTR Idle Time (hrs)	Fraction of Segment or Time Moving
"	25	-26	10	2	0.000	0.000	0.750
"	25	-36	10	2	0.000	0.000	0.250
"	25	-21	10	2	0.000	0.000	0.250
"	25	-28	10	2	0.000	0.000	0.250
"	25	-27	10	2	0.000	0.000	0.250
EB Through Train Crew Changes	26	71	10	2	0.000	0.167	0.000
WB Through Train Crew Changes	27	71	10	2	0.000	0.167	0.000

Notes

(1) Segment numbers listed as negative values are in-yard power moves from arriving trains to service or from service to departing trains
(2) Non-ZTR Idling is the duration of an idle event when units without ZTR continue to idle after ZTR-equipped units have shut down
(3) Idling All is the duration of idling during which all locomotives continue to idle
(4) Fraction of Segment Moving is the fraction of the length of the segment over which the movement occurs or the fraction of events moving on this route
(5) All intermodal arriving trains, including those arriving and departing, are assumed to be distributed evenly between the three parts of the intermodal yard (west, center, and east)
(6) 50% of departing intermodal trains are assumed to depart from the Desert Yard, and the other 50% from the three parts of the intermodal yard
(7) 50% of other trains arriving or departing are assumed to use the Desert Yard, and the other 50% use the manifest yard (both arrivals and departures)
(8) All other trains both arriving and departing are assumed to use the manifest yard

Appendix A-3 - Sample Calculations

Yard Operations	Activity Code	Segment Number	Duty Cycle Number	Non-ZTR Idle Time (hrs)	ZTR Idle Time (hrs)	Working Time or Fraction (hrs)
Hump Set Movement from Hump to Receiving West End	21	11	4	0.000	0.000	0.045
"	21	12	4	0.000	0.000	0.180
"	21	13	4	0.000	0.000	0.361
"	21	14	4	0.000	0.000	0.180
"	21	15	4	0.000	0.000	0.093
"	21	16	4	0.000	0.000	0.140
Hump Set Push - Notch 2	22	11	5	0.000	0.000	0.200
"	22	12	5	0.000	0.000	0.800
Hump Set Push - Dynamic Brake	23	13	6	0.000	0.000	0.466
"	23	14	6	0.000	0.000	0.233
"	23	15	6	0.000	0.000	0.120
"	23	16	6	0.000	0.000	0.181
Trim Set Operations (Yard Wide)	24	53	3	0.000	0.000	0.250
"	24	56	3	0.000	0.000	0.250
"	24	45	3	0.000	0.000	0.100
"	24	42	3	0.000	0.000	0.100
"	24	43	3	0.000	0.000	0.075
"	24	44	3	0.000	0.000	0.025
"	24	46	3	0.000	0.000	0.050
"	24	47	3	0.000	0.000	0.050
"	24	48	3	0.000	0.000	0.075
"	24	49	3	0.000	0.000	0.025

Duty Cycles (Percent of Time by Notch)	Duty Cycle Number	Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8
Through Trains and Power Moves	1	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
In Yard Movement	2	0.0%	0.0%	50.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Trim Sets	3	59.8%	0.0%	12.4%	12.3%	5.8%	3.6%	3.6%	1.5%	0.2%	0.8%
Hump Set Movement from Hump to Receiving West End	4	10.0%	0.0%	45.0%	45.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Hump Set Push - Notch 2	5	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Hump Set Push - Dynamic Brake	6	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Appendix A-3 - Sample Calculations

Emission Factors Weighted by Model/Tier/ZTR Fractions - DPM g/hr per Locomotive

Locomotive Model Group	Group ID	Idle-NonZTR	Idle-All	DB	N1	N2	N3	N4	N5	N6	N7	N8
California Fuel (221 ppm S)												
Service	1	31.52	36.57	72.43	47.36	114.81	230.95	268.86	351.95	529.91	624.49	760.23
LoadTest	2	32.02	37.26	72.46	46.93	114.53	228.49	266.4	350.76	525.37	616.69	753.34
47-State Fuel (2639 ppm S)												
Service	1	31.52	36.57	72.43	47.36	114.81	249.95	298.82	396.91	593.63	697.91	852.37
LoadTest	2	32.02	37.26	72.46	46.93	114.53	247.18	296.1	395.6	588.49	689.06	844.16

Note: Idle-NonZTR is the average per-locomotive idle emission rate for the fraction of locomotives not equipped with ZTR/Auto start-stop technology

Service and Shop Activity

Duration of Activity per Locomotive (minutes)

Activity	Number of Locomotives	Fraction of Calif. Fuel	Idle-NonZTR	Idle-All	DB	N1	N2	N3	N4	N5	N6	N7	N8
Service - Inbound & Service	18532	0.00	0	90	0	0	0	0	0	0	0	0	0
Service - Post Service	18532	0.90	60	30	0	0	0	0	0	0	0	0	0
Pre-Maintenance Load Test	661	0.90	0	2	0	0	0	0	0	0	0	0	8
Post-Maintenance Load Test	661	0.90	0	10	0	10	0	0	0	0	0	0	10
Quarterly Maintenance Load Test	832	0.90	0	2	0	0	0	0	0	0	0	0	8
Unscheduled Mtc Diagnostic Test	18	0.90	0	5	0	0	0	0	0	0	0	0	10
Unscheduled Mtc Post Test	1048	0.90	0	10	0	10	0	0	0	0	0	0	10

Locomotive Model Distributions
Locomotives Serviced

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	**No**	0.0034	0.0123	0.1826	0.0072	0.2666	0.0027	0.0055	0.0003	0.0522	0.0391	0.0001
Pre Tier 0	**Yes**	0.0016	0.0042	0.0004	0.0000	0.0007	0.0000	0.0000	0.0000	0.0000	0.0032	0.0000
Tier 0	**No**	0.0006	0.0001	0.0064	0.0000	0.0710	0.0805	0.0016	0.0000	0.0119	0.0418	0.0014
Tier 0	**Yes**	0.0011	0.0021	0.0006	0.0000	0.0021	0.0002	0.0000	0.0000	0.0000	0.0254	0.0000
Tier 1	**No**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0109	0.0000	0.0000	0.0000	0.0011	0.0000
Tier 1	**Yes**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0707	0.0000	0.0000	0.0000	0.0649	0.0000
Tier 2	**No**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0045	0.0000
Tier 2	**Yes**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0070	0.0000	0.0000	0.0000	0.0123	0.0000

Locomotives Load Tested

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0000	0.0235	0.1979	0.0069	0.2374	0.0006	0.0103	0.0000	0.0544	0.0429	0.0000
Pre Tier 0	Yes	0.0000	0.0092	0.0017	0.0000	0.0011	0.0000	0.0000	0.0000	0.0000	0.0074	0.0000
Tier 0	No	0.0000	0.0000	0.0103	0.0000	0.0629	0.0824	0.0029	0.0000	0.0143	0.0515	0.0023
Tier 0	Yes	0.0000	0.0017	0.0017	0.0000	0.0017	0.0000	0.0000	0.0000	0.0000	0.0200	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0074	0.0000	0.0000	0.0000	0.0006	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0767	0.0000	0.0000	0.0000	0.0498	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0023	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0092	0.0000	0.0000	0.0000	0.0092	0.0000

Example 1 -- WB Arriving Freight Trains

Parameter	Value
Activity Code	7
Number of Events	4505
Locomotives per Consist on Train	4.112
Moves	1.5
Emission Factor Group	2
Fraction of California Fuel	0.00

Route Followed	Segment Number	Length (miles)	Speed (mph)	Power Move	Non-ZTR Idle (hrs)	ZTR Idle (hrs)	Fraction of Segment Moving	Locomotive Hours Moving	Locomotive Hours NonZTR Idle	Locomotive Hours ZTR Idle
Main Line 8	8	0.352	10	N	0	0	0.75	488.58	0.00	0.00
Main Line Leg to Palmdale 4	64	0.050	10	N	0	0	0.25	23.10	0.00	0.00
Main Line Leg to Palmdale 3	63	0.045	10	N	0	0	0.25	20.89	0.00	0.00
Main Line Leg to Palmdale 2	62	0.040	10	N	0	0	0.25	18.68	0.00	0.00
Main Line Leg to Palmdale 1	61	0.057	10	N	0	0	0.25	26.58	0.00	0.00
Main Line 7	7	0.120	10	N	0	0	1	221.67	0.00	0.00
Main Line 6	6	0.332	10	N	0	0	1	615.56	0.00	0.00
Departure Yard North - East Entrance	49	0.205	10	N	0	0	1	379.99	0.00	0.00
Departure Yard North - East End	48	0.291	10	N	0	0	1	538.71	0.00	0.00
Departure Yard North - Middle	47	0.252	10	N	0	0	1	466.01	0.00	0.00
Departure Yard North - West End	46	0.252	10	N	0	0	1	466.01	0.00	0.00
Bowl North 3	53	0.686	10	N	0	0	1	1270.38	0.00	0.00
Bowl North 2	52	0.230	10	N	0	0	1	426.14	0.00	0.00
Bowl North 1	51	0.222	10	N	0	0	1	411.77	0.00	0.00
Receiving Yard to Hump	16	0.363	10	N	0	0	1	672.79	0.00	0.00
Receiving Yard East End Entrance	15	0.241	10	N	0	0	1	445.65	0.00	0.00
Receiving Yard East End	14	0.467	10	N	0	0	1	865.34	0.00	0.00
Receiving Yard Middle	13	0.934	10	N	0	0	1	1730.68	0.00	0.00
Receiving Yard West End	12	0.467	10	N	0	0.125	1	865.34	0.00	2315.57
Receiving Yard West End Entrance	-11	0.117	10	Y	0	0	1	216.85	0.00	0.00
Receiving Yard West End	-12	0.467	10	Y	0	0	1	865.34	0.00	0.00
Receiving Yard Middle	-13	0.934	10	Y	0	0	1	1730.68	0.00	0.00
Receiving Yard East End	-14	0.467	10	Y	0	0	1	865.34	0.00	0.00
Receiving Yard East End Entrance	-15	0.241	10	Y	0	0	1	445.65	0.00	0.00
Receiving Yard to Hump	-16	0.363	10	Y	0	0	1	672.79	0.00	0.00
Hump to Service 1	-17	0.221	10	Y	0	0	1	409.10	0.00	0.00
Hump to Service 2	-18	0.113	10	Y	0	0	1	209.32	0.00	0.00
Hump to Service 3	-19	0.315	10	Y	0	0	1	583.81	0.00	0.00
Hump to Service 4	-20	0.075	10	Y	0	0	1	139.05	0.00	0.00
Service Track Entrance	-21	0.204	10	Y	0	0	1	378.46	0.00	0.00

Note: 75% of WB arriving freight trains arrive via the Main Line East; 25% come via Palmdale

Total								*16470.26*	*0.00*	*2315.57*

Emission Factors	**Group ID**	**Idle-NonZTR**	**Idle-All**	**DB**	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**
Arriving IM Trains - CA Fuel	2	23.58	31.54	66.59	50.86	110.15	227.84	279.15	372.62	525.34	591.06	702.33
Arriving IM Trains - 47-State Fuel	2	23.58	31.54	66.59	50.86	110.15	250.30	309.83	417.61	591.31	677.56	810.03
CA Fuel Fraction Adjusted Rates		*23.58*	*31.54*	*66.59*	*50.86*	*110.15*	*250.3*	*309.83*	*417.61*	*591.31*	*677.56*	*810.03*
Duty Cycle Moving	2	0.00	0.00	0.00	0.50	0.50	0.00	0.00	0.00	0.00	0.00	0.00
Weighted g/hr emissions		0.00	0.00	0.00	25.43	55.08	0.00	0.00	0.00	0.00	0.00	0.00

	Moving	**Idle-NonZTR**	**Idle-All**
Emission Rate (g/hr)	80.51	23.58	31.54
Locomotive Hours	16470.26	0.00	2315.57
Total Emissions (g/yr)	**1325938**	**0**	**73033**

Example 2 -- Quarterly Maintenance Load Testing

Number of Quarterly Maintenance Load Tests	832
Fraction of Calif. Fuel	0.9

Emission Factors (g/hr)	**Group ID**	**Idle-NonZTR**	**Idle-All**	**DB**	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**
Load Test - CA Fuel	2	32.02	37.26	72.46	46.93	114.53	228.49	266.40	350.76	525.37	616.69	753.34
Load Test - 47-State Fuel	2	32.02	37.26	72.46	46.93	114.53	247.18	296.1	395.6	588.49	689.06	844.16
CA Fuel Fraction Adjusted Rates		*32.02*	*37.26*	*72.46*	*46.93*	*114.53*	*230.36*	*269.37*	*355.24*	*531.68*	*623.93*	*762.42*

								Duration (minutes)				
Activity	**Number of Locomotives**	**Idle-NonZTR**	**Idle-All**	**DB**	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**
Quarterly Maintenance Load Test	832	0	2	0	0	0	0	0	0	0	0	8
Emissions (g)												
Notch-Specific		0.0	1033.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	84578.0

Total Emissions (g/yr)	**85611**

APPENDIX A-4

METHODOLOGY FOR ESTIMATING LOCOMOTIVE EMISSIONS AND GENERATING AERMOD EMISSION INPUTS

Appendix A-4

Methodology for Estimating Locomotive Emissions and Generating AERMOD Emission Inputs

Overview

This appendix describes the general procedures followed for developing locomotive emission inventories for the Union Pacific Railroad (UPRR) rail yards under the Memorandum of Understanding with the California Air Resources Board. It also describes the procedure by which the emission inputs are prepared for both locomotive and non-locomotive sources are used in AERMOD dispersion modeling.

EMISSION CALCULATIONS

This section describes the details of the development of activity inputs, emission factors, and emission estimates for locomotive operations. Separate procedures are followed for estimating activity associated with locomotives on trains, locomotive consist movements within a yard, service and shop activity (if occurring at a specific yard), and yard switching operations within a yard. Emission factors are developed for each of the types of locomotive activity based on the model and technology distribution of locomotives involved in each activity. Emission estimates are then developed for the activities and specific areas of a yard in which each activity occurs. The data used to calculate these emissions are included in the Appendix A-3 Excel workbook, which includes a "Sample Calculations" worksheet showing the linkages between the various activities, emission factors, and operating characteristics data.

Train Activity

Train activity data for emissions calculations include a number of separate components:

- The number of trains arriving, departing, or passing through a yard, broken down by type of train;
- The average composition of working locomotives in each consist[1], including the fraction of locomotives of different models, emissions technology tier, and automatic idling control equipment[2];
- The identification of routes followed for different types of train activities; and

[1] The term "consist" refers to the group of locomotives (typically between one and four) that provide power for a specific train.
[2] Two types of automatic idling control equipment are in use, known as ZTR SmartStart (typically retrofit equipment on low horsepower units) and AESS (typically factory installed on newer high horsepower units). Both are programmed to automatically shut off the engines of parked idling locomotives after a specified period of time, and to restart the unit if any of a number of operating parameters (battery state, air pressure, coolant temperature, etc.) reach specified thresholds.

- Identification of the speeds and throttle settings for different types of train activities in different locations.

The primary source of information for estimating train activity is a database identifying the arrival and departure of locomotives at a specific yard. This database identifies locomotives by their ID numbers and models, the status on the train (working or not working), and the specific train to which they are connected. From these data, the total numbers of trains of different types are identified based on train symbols, train dates, train origination and termination indicators, and dates and times of arrival and departure. For each type of train and activity, the average number of locomotives per consist is calculated along with the distribution of locomotive models, emission technology tiers, and automatic idling control equipment. A separate database of UPRR locomotives is consulted based on locomotive ID to determine the tier and date of any retrofits of automatic idling controls to complete the development of these model distributions. The activity data so derived are shown on the "Activities" worksheet in the Appendix A-3 Excel workbook, and the model and technology distributions are shown on the "Consist Emissions" worksheet.

The types of trains to be identified can vary from yard to yard. For all yards, through trains (which bypass the yard itself on mainline tracks adjacent to the yard) are identified. Depending on the yard, trains entering or departing from the yard can be of several types, including:

- Intermodal trains;
- Automobile trains;
- "Manifest" or freight trains;
- Local trains; and
- Power moves.

Power moves are trains consisting only of locomotives that are either arriving at the yard to be serviced or used for departing trains, or departing from the yard to be serviced at another location or used for trains departing from another location. The routes followed by each type of train on arrival and departure are identified in consultation with UPRR yard personnel, along with estimates of average speeds and duty cycles (fraction of time spent at different throttle settings) for different areas.

Specific track subsections are identified by UTM coordinates digitized from georeferenced aerial photographs. The segments identified and their lengths are shown on the "Track Segments" worksheet of Appendix A-3. For each train type, direction, and route, a listing of track segments, segment lengths, and duty cycles is developed. Duty cycles are shown on the "Consist Emissions" worksheet of Appendix A-3, and the segment speeds, duty cycles, idling durations are shown on the "Movements and Yard Operations" worksheet. This listing, along with the number of locomotives per consist and number of trains of each type, allows the number of locomotive hours in each duty cycle to be calculated for each section of track. For arriving and departing trains, estimates of the duration of idling were developed in consultation with UPRR personnel.

These idling periods were divided into two parts: the assumed amount of time that all locomotives in a consist would idle on arrival or departure, and the amount of time that only locomotives not equipped with automatic idle controls would idle. Idling periods were assigned to a segment of the arrival or departure track one fifth of the length of the track at the appropriate end.

Service and Shop Activity

If there is a service track and/or shop at a yard, locomotives (including both road power from trains as well as yard switchers) undergo a variety of activities at these locations. If present at a yard, details of the service and shop activity, model distributions, and emission factors are shown on the "Service and Shop" worksheet of Appendix A-3. Specific locomotive activities involve idling while awaiting or undergoing routine service (cleaning, refueling, oiling, sanding, and other minor maintenance), movement and idling between service and maintenance areas, and stationary load testing associated with specific types of maintenance events. A database of service events at individual yards identifies the number of service events during the year, the locomotive ID and model, and the nature of servicing performed. Routine servicing involves periods of idling prior to and during service, and additional idling prior to movement of consists to departing trains in the yard. Estimates of the duration of idling associated with servicing are developed in consultation with UPRR personnel. As was done for trains, these idling periods were separated into two parts: the average total duration of idling by all locomotives, and the average duration of additional idling by locomotives not equipped with automatic idling controls.

The database also specifically identifies load test events and the type of maintenance with which the load testing is associated. These types include planned maintenance at different intervals (e.g., quarterly, semiannual) as well as unscheduled maintenance that may involve both diagnostic load testing prior to maintenance and post-maintenance load testing. The duration of load test events in each throttle setting depends on the equipment available and types of maintenance performed at the yard. Estimates of these durations, as well as the identification of load testing activity by type of load test and the time and duration of any additional idling and movements, are developed in consultation with UPRR personnel.

A total number of events (servicing and load testing by location and type) are developed from these data, as are locomotive model and technology distributions for all locomotives serviced and for those specific locomotives undergoing load testing (if applicable). From these event counts and durations, the total number of hours of locomotive idling and higher throttle setting operation in different portions of the service areas are calculated for each of the two model distributions.

Yard Switcher Activity

In each yard, there are routine jobs assigned to individual switchers or sets of switchers. These activities are generally not tracked from hour to hour, but they occur routinely within yard boundaries during specified work shifts. Similarly, the specific yard switcher locomotive IDs assigned to these jobs are not routinely tracked, but these yard jobs are generally assigned to a specific model of low horsepower locomotive. From the assigned yard switcher jobs and shifts, and in consultation with UPRR personnel, an estimate of the hours per day of switcher operation in a yard are developed, along with the specific times of day when these activities occur (time of day assignments were made only if operation was less than 24 hour per day). Duty cycles for switching operation are also developed in consultation with local UPRR personnel. Depending on the type of activity and type of trains being handled in a yard, duty cycle estimates may vary. In the absence of more detailed information, the USEPA switcher duty cycle is assumed to be representative of each switcher's operation[3]. The total number of locomotive hours of operation for each model are calculated and assigned to the areas in which the units work. In some cases, yard jobs are assigned to specific areas within the yard and specific models of locomotives. In these cases, the switcher activities are assigned specifically to these areas of the yard.

Emission Factor Development

The locomotive model and technology group distributions derived in the development of activity data are grouped by type or types of activity with consideration for the level and nature of the activity. For example, a single distribution is used for through trains of all types, including power moves, while consist model distributions for different types of trains within a yard may be treated as separate distributions if they are handled in different areas of a yard. As shown in Part VII of this report, model-group-specific emission factors by throttle setting were developed based on emission test data and sulfur content adjustment factors. From these emission factors and the locomotive model and technology distributions for different types of trains and activities, weighted average emission factors are calculated for the "average" locomotive for that train type or activity on a gram per hour basis. For each train type or activity, two separate idle emission rates are calculated. The first is the straight weighted average emission rate for all locomotives, while the second is the weighted average only for the fraction of locomotives without automatic idle controls. Mathematically,

$$\overline{Q}(l) = \sum_{i=1}^{11}\sum_{j=1}^{4}\sum_{k=1}^{2} F(i,j,k) \cdot Q(i,j,l)$$

for l corresponding to idle through N8, and

$$\overline{Q}(l^*) = \sum_{i=1}^{11}\sum_{j=1}^{4} F(i,j,1) \cdot Q(i,j,l^*)$$

[3] USEPA (1998). Locomotive Emission Standards -- Regulatory Support Document. (Available at *www.epa.gov/otaq/regs/nonroad/locomotv/frm/locorsd.pdf*).

for idling emission rate during periods when only locomotives without automatic idle controls are idling

where

$\overline{\overline{Q}}(l)$ = weighted average emission factor for throttle setting l

$Q(i,j,l)$ = the base g/hr emission factor of a particular model group/technology class and throttle setting

$F(i,j,k)$ = the fraction of locomotives of a particular model group/technology class

i = model group index (Switcher, GP-3x, etc.)

j = technology tier index (pre-Tier 0, Tier 0, Tier 1, Tier 2)

k = automatic idle control status index (with or without)

l = throttle setting (idle, N1, . . ., N8)

l^* = index for idle throttle of locomotives without automatic idle controls.

Thus, for each defined locomotive model distribution, gram per hour emission factors are generated for each throttle setting.

Emission Calculations – Locomotive Movements

From the train activity analysis, the following data are available for each segment of track: track length of segment $L(i)$; speed $V(i)$; movement duty cycle $\mathbf{D}(i)$ (a vector of fractions of time spent in each throttle setting); number of trains of each type $N(j)$; and number of working locomotives per consist for each train type $C(j)$. For each type of train j, there is a set of throttle-specific emission factors $Q_j(l)$ for the "average" locomotive used on that train type. If a particular type of train or consist movement can follow multiple paths within the yard, the activity is allocated to sequences of track segments representing each such path. Total annual emissions $q_{tot}(i)$ for each segment are then calculated as

$$q_{tot}(i) = \frac{L(i)}{V(i)} \cdot \sum_j N(j) \cdot C(j) \sum_l D(i,l) \cdot Q_j(l) .$$

Emission Calculations – Locomotive Idling

Locomotive idling is calculated in a similar manner for road power and locomotives in service. For each train type and for service events, activity data provide a number of annual events $N(i)$, duration of idling by locomotives with ($T_{all}(i)$) and without ($T_{nZTR}(i)$) automatic idle control, and gram per hour emission rates for the "average" locomotive $Q_{all}(i)$, and the "average" locomotive excluding those with automatic idle controls $Q_{nZTR}(i)$. Total annual emissions are calculated as

$$q_{idle} = \sum_i N(i) \cdot C(i) \cdot (T_{all}(i) \cdot Q_{all}(i) + T_{nZTR}(i) \cdot Q_{nZTR}(i)) .$$

If a particular type of activity occurs at multiple locations within the yard (e.g., on multiple arrival or departure tracks), then the idling time is allocated to different segments of track as appropriate so that segment-specific emissions are obtained.

Emission Calculations – Load Testing

Load testing emissions are calculated separately for each throttle setting (idle, N1, and N8) using the weighted average emission factors for the load-tested units, the number of load tests of different types, and the duration of testing in each throttle setting for each type of test.

Emission Calculations – Yard Switcher Operations

Activity data provide the number and model group information for yard switchers, and the number of operating hours per day. Model-group-specific emission factors are multiplied by the duty cycle to generate weighted average gram per hour emissions for idling and for combined emissions from operation in notch 1 through notch 8. Emissions are calculated directly from the number of units, hours per day working, and duty cycle weighted emission factors for both idle and non-idle throttle settings during work shifts.

AERMOD EMISSION INPUT PREPARATION

Emissions from both locomotives and from other emission sources in a yard are allocated to multiple individual point or volume sources in AERMOD inputs. In addition to each type of activity's emission rates, the locations of emissions, the release parameters, and other inputs (e.g., building downwash parameters, temporal variation in emissions, etc.) are required by AERMOD. Emission inputs are prepared sequentially for different types of activities and the areas within which they occur. The source elevation for each point or volume source is interpolated from a high-resolution terrain file.

Locomotive Movements

For each type of locomotive movement, emissions calculated for each track segment are uniformly allocated to a series of evenly spaced volume sources along that track segment. The maximum spacing between sources is specified and the number of sources to be used for each segment is calculated from the segment length. The raw emission rate value in the AERMOD inputs (g/sec) is based directly on the annual emission total for the segment divided by the number of sources on that segment. For locomotive movements, separate day and night release parameters are needed. Therefore, each source is duplicated (but with a different source ID and parameters) in the AERMOD inputs, with temporal profile inputs (EMISFACT HROFDY) that use day time parameters from 0600-1800 and night time parameters for 1800-0600.

Locomotive Idling and Load Testing

Locomotive idling and load testing emissions are allocated to track segments in the same manner as locomotive movements, but as point, rather than volume, sources. Each source location may have up to three separate sources identified, with different stack parameters used for idle, notch 1, and notch 8. Building downwash inputs are assigned from a pre-prepared set of records for a typical locomotive's dimensions and the orientation of the track segment on which the emissions occur.

Yard Switcher Operations

Yard switcher operations are allocated to areas within the yard based on the estimated time spent working in each area. As for locomotive movements, yard switcher emissions for a specific area are allocated uniformly to a number of volume sources on defined segments. Day and night operations are handled similarly to train and consist movements, with EMISFACT HROFDY records used to switch day and night volume source release parameters. Depending on their magnitude and distance from yard boundaries, the "working idling" emissions for yard switching may be added to the non-idle emissions from volume sources, or treated as a series of point sources, using stack parameters for the specific model group being used. If treated as point sources, building downwash inputs are prepared as for other locomotive idling and load testing.

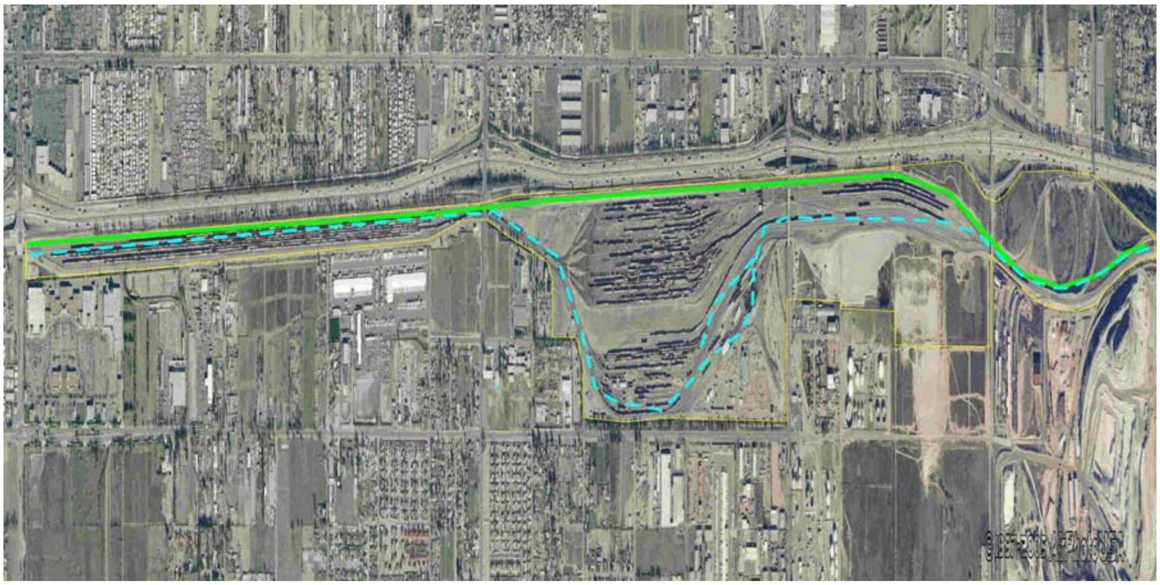
APPENDIX A-5

PRINCIPLE LOCOMOTIVE ROUTES

Appendix A-5

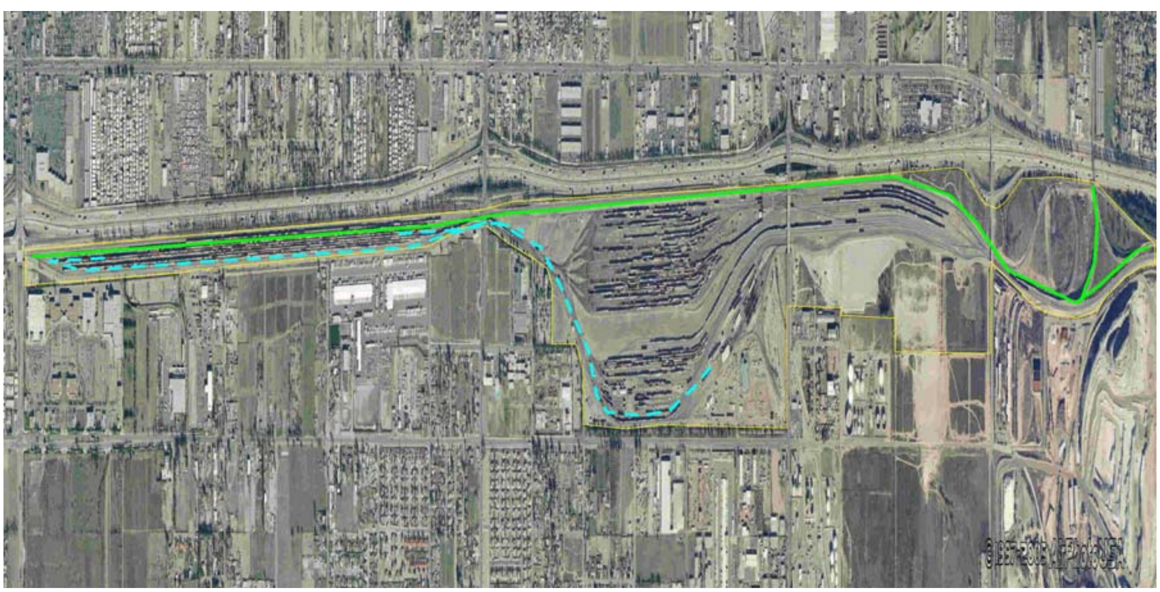
Principle Locomotive Routes

Through Trains, Through Power Moves, and Power Moves Arriving and Departing



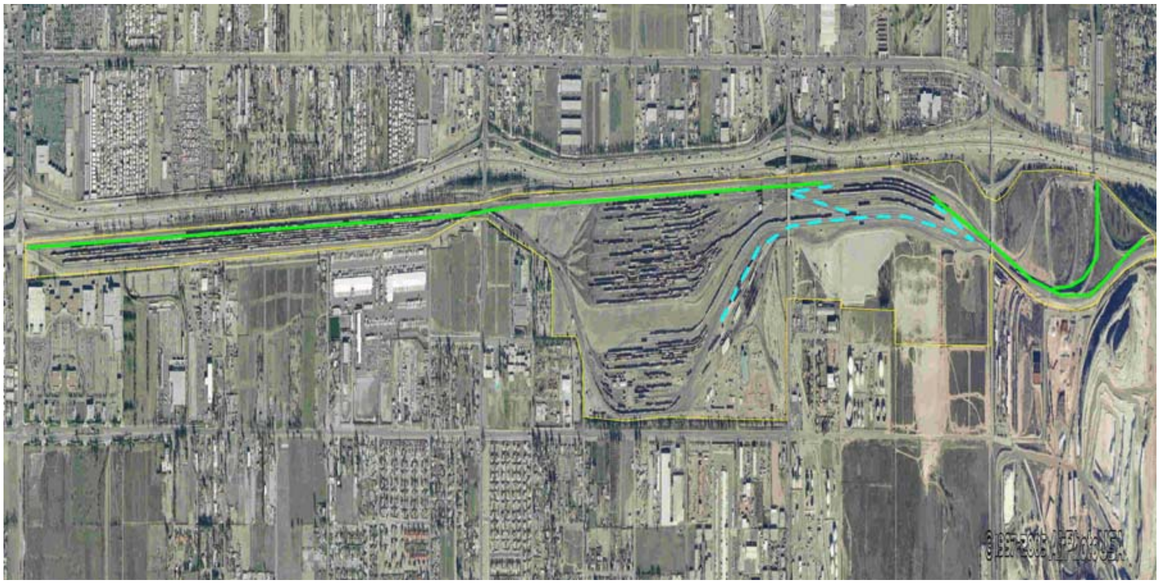
Green = Through trains and through power moves
Dashed blue = Power moves arriving and departing from Service Track

Terminating Trains and Power Moves from Receiving Yard to Service Track

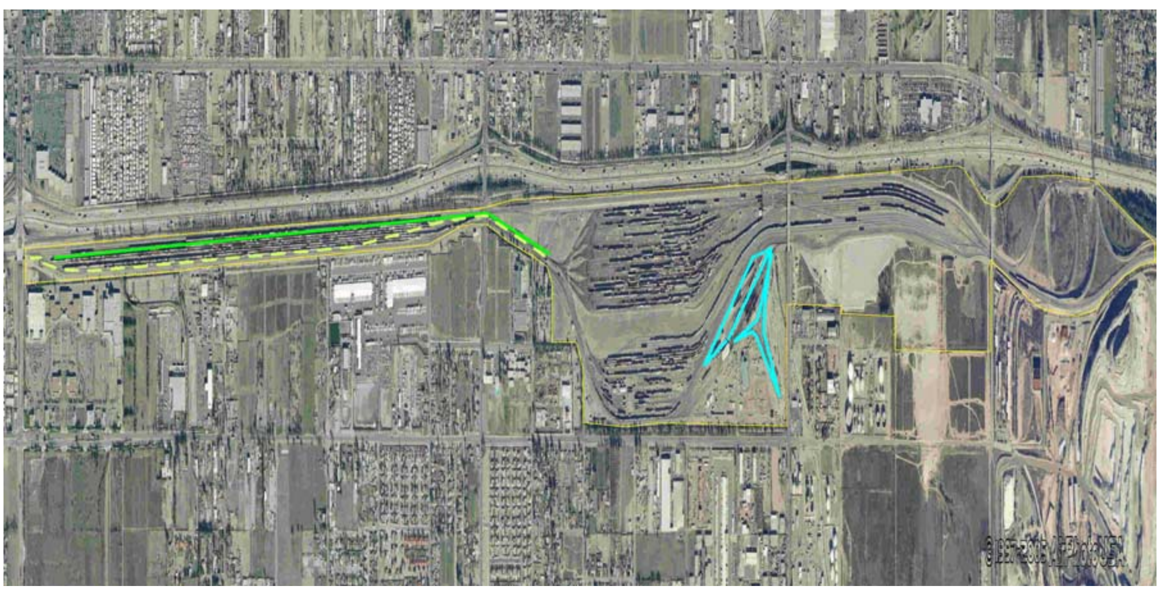


Green = Terminating EB and WB trains
Dashed blue = Power moves to Service Track

Originating Trains and Power Moves from Ready Track


Green = Departing EB and WB trains
Dashed blue = Power moves from Ready Track

Hump Push and Return Movements and Movements in Service Track


Solid green = Hump set push movement
Dashed light green = Hump set return route
Light blue = Movements through Service Track to Ready Track

Notes:
1. Vertical scale has been expanded for clarity.

APPENDIX A-6

IRESON ET AL

Development of Detailed Railyard Emissions to Capture Activity, Technology and Operational Changes

Robert G. Ireson
Air Quality Management Consulting, 161 Vista Grande, Greenbrae, CA 94904
rob@AQMconsulting.com

M. J. (Jon) Germer and Lanny A. Schmid
Union Pacific Railroad Company, 1416 Dodge St., Omaha NE 68179
mjgermer@up.com

ABSTRACT

Railyard operations involve a variety of complex activities, including inbound and outbound train movements, classification (i.e., separating cars from inbound trains for redirection to multiple destinations, and building new trains), and servicing locomotives. Standard locomotive duty cycles provide long-term average activity patterns for locomotive operations, but they are not appropriate for the specialized activities that occur within railyards or at locations such as ports, and emission densities in such areas can be high relative to those of line haul activities. There are significant emission rate differences between locomotive models, and differences in the types of service for which specific models are used. Data for throttle-specific emissions, activity levels, and locomotive models and operating practices can be used to provide more accurate emissions estimates for such operations. Such data are needed to quantify actual emissions changes in these high activity areas. A calculation scheme has been developed to generate detailed emission inventories based on the types of data that are collected for managing rail operations. This scheme allows improved accuracy in emissions estimation, and also provides a more reliable basis for bottom-up tracking of emissions changes over time. Factors that can be addressed include: changes in the distribution of locomotive models and control technology levels (e.g., increasing fractions of Tier 0, 1, and 2 locomotives) for both line haul and local operations; actual in-yard idling duration and reductions associated with auto-start-stop technologies; fuel quality effects; and detailed operating practices for switching and train-building operations. By providing detailed disaggregation of activity and emissions data, the method also makes it possible to quantify and evaluate the effects of specific emission reduction alternatives.

INTRODUCTION

Freight movement by rail is a key component of the U.S. transportation infrastructure. The combination of rail's low rolling resistance and the fuel-efficient turbocharged diesel engines used in modern locomotives make rail the most efficient mode of transport from both an emissions and economic perspective. Railyards located strategically through the nation's rail network are used to assemble and direct goods movement to their destinations. Railyards may handle dozens of trains per day, each powered by a "consist" of several locomotives. While in railyards, these locomotives are serviced and regrouped into new consists as needed for specific departing trains. In addition to train arrivals and departures and locomotive servicing, so-called "classification" yards separate rail cars in inbound trains into segments with different destinations, and build new trains with a common destination. This work is accomplished by switcher locomotives (typically of lower horsepower than the locomotives used for "line-haul" operations). Some railyards also have major locomotive repair facilities whose activities include load testing of locomotives prior to or after maintenance. Collectively, the locomotive operations associated with these activities can result in relatively high localized emission densities.

The Union Pacific Railroad (UPRR) is the largest railroad in North America, operating throughout the western two-thirds of the United States. It operates a number of railyards throughout its system, including the J. R. Davis Yard in Roseville, California. The Davis Yard is UPRR's largest classification yard in the western U.S. It is approximately one-quarter mile wide and four miles long, and is visited by over 40,000 locomotives per year. The California Air Resources Board (CARB) recently completed a detailed dispersion modeling study to estimate concentrations of diesel particulate matter in the vicinity of the railyard.[1] UPRR cooperated closely with CARB in this study, including the identification, retrieval and analysis of data needed to assemble a detailed emission inventory for railyard operations. This effort produced the most detailed emission inventory for railyard operations to-date, including empirically developed train counts, locomotive model distributions, locomotive service and maintenance activities, and dedicated on-site switching operations. The results of this effort have been further adapted to allow UPRR to track the effect of locomotive fleet modernization, freight volume, and operational changes on emissions, and to identify opportunities for further emission reductions at the Davis Yard.

RAILYARD ACTIVITY ESTIMATION

At state and national levels, locomotive emissions have been estimated using locomotive fleet population data and average locomotive emission factors, expressed in g/bhp-hr, in conjunction with fuel efficiency estimates and fuel consumption. For freight locomotives, the emission factors are typically derived using both a switching duty cycle and a line haul duty cycle, each of which gives the fraction of operating time locomotives spend at different throttle settings, referred to as notch positions.[2] These throttle settings (see Table 1) include idle, notches 1 through 8, and dynamic braking (in which the locomotive traction motors are used to generate power which is dissipated through resistor grids). While this approach can provide reasonable estimates for larger regions, neither the overall locomotive fleet composition nor the standard duty cycles accurately reflect the specific activities that occur within an individual railyard. The g/bhp-hr emission factors vary substantially between throttle settings and between locomotive models. Other confounding factors include: speed limits within yards (which preclude the high throttle settings used for line-haul activity outside of yards); locomotive load (consists commonly move within yards with only one locomotive pulling and no trailing cars); and time spent either shut down or idling. Classification activities are carried out with duty cycles that are unique to yard operations and may vary from yard to yard. To develop more accurate emissions estimates, it is necessary to explicitly identify railyard activities at the level of individual locomotives.

Table 1. Locomotive Duty Cycles.

	Throttle Position (Percent Time in Notch)									
Duty Cycle	**D.B.**	**Idle**	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**
EPA Line-Haul	12.5	38.0	6.5	6.5	5.2	4.4	3.8	3.9	3.0	16.2
EPA Switch	0.0	59.8	12.4	12.3	5.8	3.6	3.6	1.5	0.2	0.8
Trim Operations	0.0	44.2	5.0	25.0	2.3	21.5	1.5	0.6	0.0	0.0
Hump Pull-Back	0.0	60.4	12.5	12.4	5.9	3.6	3.6	1.5	0.0	0.0
Hump Push	0.0	0.0	0.0	100	0.0	0.0	0.0	0.0	0.0	0.0
Consist Movement	0.0	0.0	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0
Load Tests:										
10-Minute	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	80.0
15-Minute	0.0	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.7
30-Minute	0.0	33.3	33.3	0.0	0.0	0.0	0.0	0.0	0.0	33.3

To accomplish this, UPRR reviewed the types of databases available for its operations to identify where explicit emission-related activity information could be generated for the Davis Yard. UPRR operates approximately 7000 locomotives over a network spanning 23 states. Large amounts of data are generated and retained by UPRR for management purposes. These include tracking the location and status of capital assets (e.g., locomotives and rail cars), tracking performance of specific activities, and managing operations. These databases can be queried for data records specific to the Davis Yard, but their content does not directly relate to emissions. Where possible, data providing a complete record of emissions-related events (e.g., locomotive arrivals and departures) were identified and retrieved. Where 100 percent data for an activity could not be obtained (e.g., locomotive model number for each arriving locomotive), distributions were developed based on available data. In some cases, data are not available for specific types of emission events (e.g., the duration of idling for individual trains prior to departure). In these cases, UPRR yard personnel were consulted to derive estimates of averages or typical operating practices.

Railyard Operations – Inbound and Outbound Trains

The majority of locomotive activity in a railyard arises from inbound and outbound freight traffic. Following arrival, consists are decoupled from their trains in receiving areas and are either taken directly to outbound trains, or more commonly, are sent through servicing which can include washing, sanding, oiling, and minor maintenance prior to connecting to outbound trains. Some fraction of trains arriving at a yard simply pass through, possibly stopping briefly for a crew change. UPRR maintains a database that, when properly queried, can produce detailed information regarding both arriving and departing trains. Table 2 lists some of the key parameters that are available in this database. In this study, 12 months of data were obtained for all trains passing through the Davis Yard. The extracted data (over 60,000 records) included at least one record for every arriving and departing train, and each record contained specific information about a single locomotive, as well as other data for the train as a whole. The data were processed using a commercial relational database program and special purpose FORTRAN code to identify individual train arrivals and departures and train and consist characteristics.

Table 2. Selected Train Database Parameters.

	Used to Identify				
Parameter	Identification of Train Events	Location in Railyard	Consist Composition	Temporal Profile	Train Characteristics
Train Symbol	X	X			
Train Section	X				
Train Date	X				
Arrival or Departure	X	X			
Originating or Terminating	X	X			
Direction		X			
Crew Change?		X			
Arrival & Departure Times				X	
# of Locomotives			X		
# of Working Locomotives			X		
Trailing Tons					X
Locomotive ID #			X		
Locomotive Model			X		

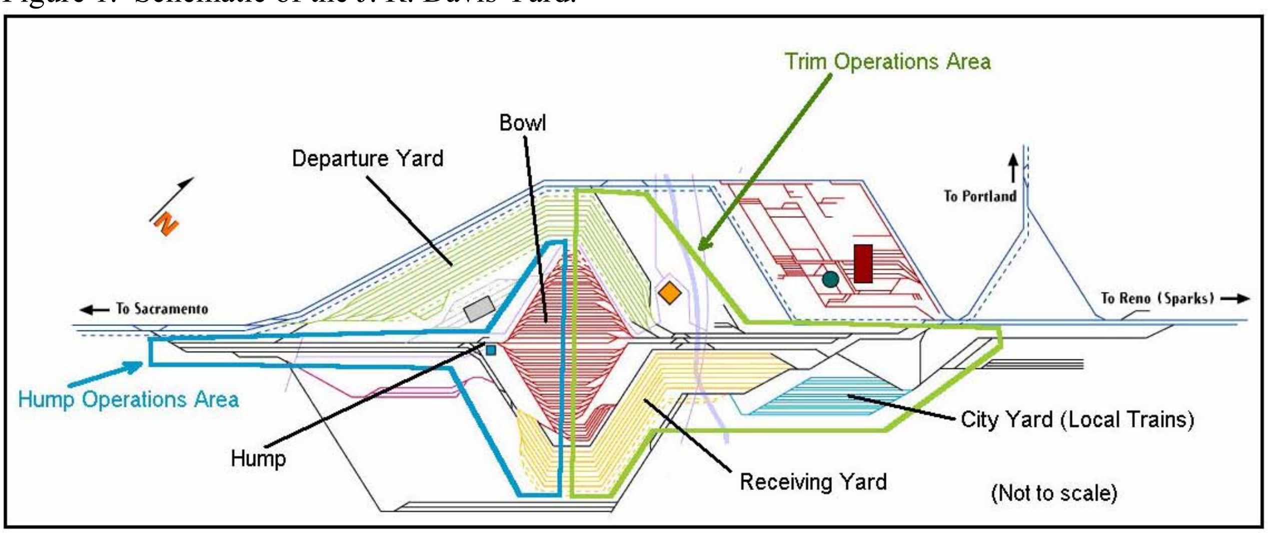
The parameters listed in Table 2 were used to calculate the number of trains by time of day arriving or departing from each area of the yard, as well as average composition of their consists (number of locomotives and distribution of locomotive models). The combination of train symbol, train segment, and train date provided a unique identifier for a single arrival or departure, and the individual locomotive models were tabulated to generate model distributions. Where necessary, working horsepower and total horsepower were used to estimate the number of working locomotives in the consist.

Emission calculations associated with inbound and outbound trains included both periods of movement within the yard boundaries and locomotive idling while consists we connected to their trains. Based on train direction and the location of its arrival or departure, moving emissions were based on calculations of time at different throttle settings based on distance traveled and estimated speed profiles, considering speed limits on different tracks. Yard operators provided estimates for the average duration of such idling for both inbound and outbound trains.

Railyard Operations – Classification

On arrival, inbound trains are “broken” into sections of rail cars destined for different outgoing trains. Figure 1 shows a schematic diagram of the Davis Yard including a large central “bowl” consisting of a large number of parallel tracks connected by automated switching controls to a single track to the west. Trains are pulled back to the west and then pushed to the “hump,” a slightly elevated portion of track just west of the bowl. As cars pass over the hump, they are disconnected and roll by gravity into the appropriate track in the bowl. Dedicated special purpose locomotives, known as “hump sets,” are used in this operation. Unlike most locomotives, these units have continuously variable throttles, rather than discrete throttle notch settings, to allow precise control of speed approaching the hump. Switching locomotives, known as “trim sets” are responsible for retrieving the train segments or trains being “built” in the bowl and moving them to the appropriate outbound track. The Davis Yard operates a fixed number of hump sets and trim sets at any given time, with backup sets standing by for shift changes and possible breakdowns.

Figure 1. Schematic of the J. R. Davis Yard.



Emission calculations for hump and trim operations were based on the number of working hump and trim sets at any given time, plus assumed idling times of standby units. For the hump sets, yard operators provided estimates of average pull-back and pushing times, and the duty cycles associated with these operations. For pull-back, based on distance and speed limits, the EPA switcher duty cycle, excluding notch 7 and 8 was used. Pushing is conducted at the equivalent of notch 2. For the trim sets, speed limits within the Yard preclude any high throttle setting operation, but there is a greater time spent in mid-throttle settings than reflected in the EPA switcher cycle. A revised duty cycle was developed for these units based on the EPA switcher duty cycle, with high throttle fractions (notches 7 and 8) excluded, but with increased notch 1 and notch 4 operating time. These duty cycles are also shown in Table 1.

Railyard Operations – Consist Movement, Service, Repair and Testing

After disconnecting from inbound trains, consists move to one of several servicing locations for refueling and other maintenance, following designated routes in the yard. Typically, one locomotive in each consist will pull the others, with throttle settings at notch 1 or 2. Based on distance and speed limits, movement times were estimated for each route, and emissions calculated using the number of locomotives following each route.

While being serviced, locomotives may be either idling or shut down. Locomotives must be idling while oil and other routine checks are performed. In addition, since locomotive engines are water-cooled and do not use antifreeze, they are commonly left idling during cold weather conditions. New idling reduction technologies known as SmartStart and AESS provide computer-controlled engine shut down and restart as necessary, considering temperature, air pressure, battery charge, and other parameters. Yard personnel provided estimates of the average potential duration of idling associated with different servicing events. Databases for service and maintenance activities maintained by UPRR provide details on the number and types of service events at different locations in the yard. As for train activity, these data were processed with a commercial relational database program and special purpose FORTRAN code to characterize and tabulate service events. These results were used in conjunction with data for the number of inbound and outbound consists to estimate total idling emissions for different service event types and locations. Following service, consists are dispatched to outbound trains. The same procedures were followed for estimating idle time, number of locomotives moving to each outbound area of the yard, and the duration of each movement for emission calculations.

In addition to routine service, the databases include service codes indicating periodic inspections of various types, as well as major maintenance activities requiring load testing of stationary locomotives. Several types of load tests are conducted, including planned maintenance pre- and post-tests, quarterly maintenance tests, and unscheduled maintenance diagnostic and post-repair tests. Depending on the test type and locomotive model, these tests include some period of idling, notch 1 operation, and notch 8 operation. Data are not collected on the exact duration of individual tests, so estimates of average duration for each throttle setting were provided by shop personnel, as shown in Table 1. The number of tests of each type for each locomotive model group were tabulated based on the service codes in the database for each service event.

Trends in Activity and Technology

The initial study was based on data from December 1999 through November 2000. Since that time, UPRR's locomotive fleet modernization program as well as changes in freight volumes have occurred. A subsequent data retrieval for the period from May 2003 through April 2004 was made, and emission calculations updated. A number of significant changes occurred over this 40-month period. The distribution of locomotive models in line-haul operation showed a substantial shift from older, lower horsepower units to new high horsepower units. The average number of locomotives per consist remained the same at about 3, but the higher horsepower allowed an increase in train capacity (trailing tons per train). The decrease in older units also resulted in a decrease in the frequency of major maintenance load testing. In addition to updating activity inputs (number of locomotives by model) for emission calculations, calculations were modified to reflect the penetration of new and retrofit technologies in the locomotive fleet, including SmartStart and AESS idling controls and Tier 0 and Tier 1 locomotives. UPRR data identifying the specific technologies installed on individual locomotives were matched with locomotive ID numbers in the train and servicing data retrievals to obtain a specific count of the number of locomotives of each model for which emissions reductions were achieved by these technologies. Historical temperature data for the Roseville area were used to estimate the fraction of time computer controls would require idling when the locomotive would otherwise be shut down.

EMISSION FACTORS

Data Sources

The study of the J. R. Davis Yard focused on diesel exhaust particulate matter emissions. At present, there is no unified database of emission test results for in-use locomotives. Appendix B of the USEPA's Regulatory Support Document for setting new emission standards for locomotives[2] contains a compilation of notch-specific emission factors. These data were supplemented by test data reported by Southwest Research Institute[3,4], as well as test data provided by locomotive manufacturers to assemble emission factors for each of 11 locomotive model groups.

There are dozens of specific locomotive model designations, and emissions tests are not available for all of them. However many models are expected to have nearly identical emission characteristics. Depending on their intended use, locomotives of different models may have different configurations (e.g., number of axles), but share a common diesel engine. For this project, 11 locomotive model groups were defined based on their engine models (manufacturer, horsepower, number of cylinders, and turbo- or super-charging of intake air). Table 3 lists these model groups and some of the typical locomotive models assigned to each group.

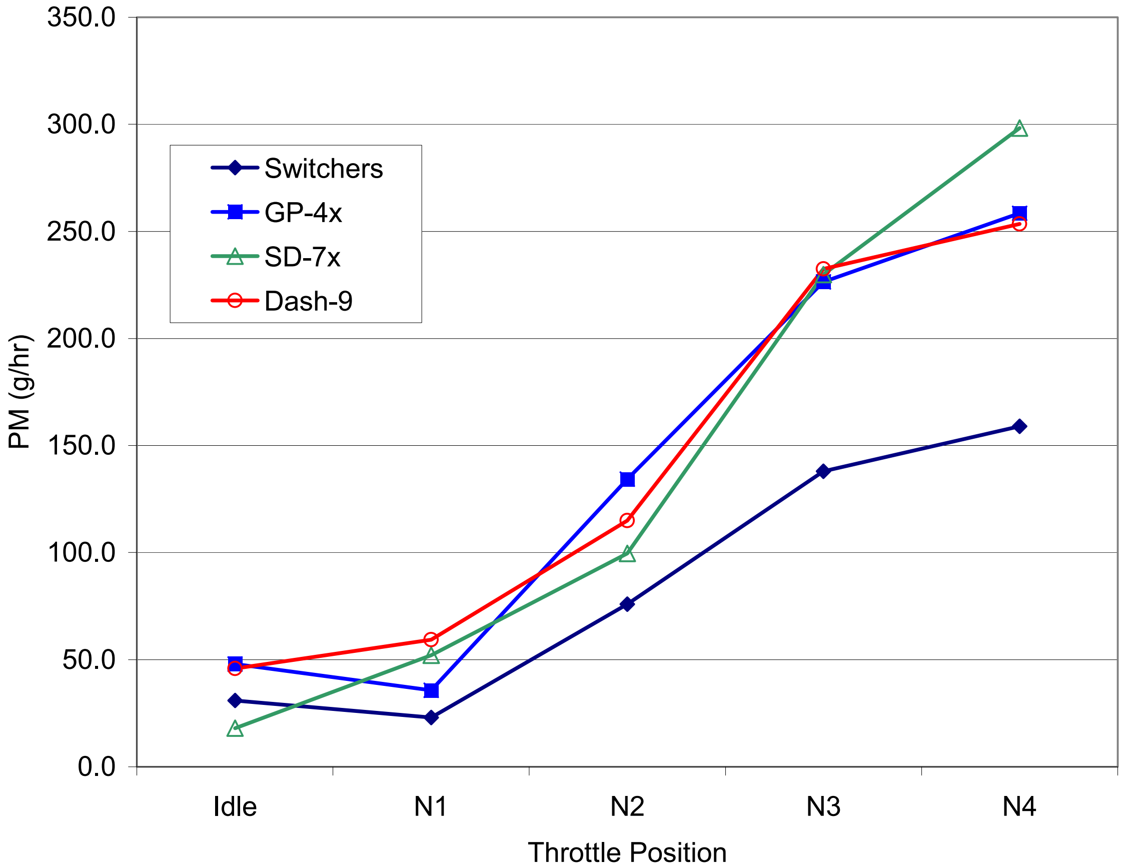
Table 3. Locomotive Model Groups

Model Group	Engine Family	Representative Models
Switchers	EMD 12-645E	GP-15, SW1500
GP-3x	EMD 16-645E	GP-30, GP-38
GP-4x	EMD 16-645E3B	GP-40, SD-40-2, SD-45-2
GP-50	EMD 16-645F3B	GP-50, SD-50M
GP-60	EMD 16-710G3A	GP-60, SD-60M
SD-7x	EMD 16-710G3B	SD-70MAC, SD-75
SD-90	EMD 16V265H	SD-90AC, SD-90-43AC
Dash-7	GE7FDL (12 cyl)	B23-7, B30-7, C36-7
Dash-8	GE7FDL (12 or 16 cyl)	B39-8, B40-8, C41-8
Dash-9	GE7FDL (16 cyl)	C44-9, C44AC
C60-A	GE7HDL	C60AC

Emission Factors and Fuel Effects

Figure 2 shows particulate matter (PM) emission factors for several of the more common locomotive model groups at the low to intermediate throttle settings typical of yard operations. As shown in the figure, emission rates generally increase with throttle setting. However, the older 3000 hp GP-4x series shows emissions comparable to (and in some cases, higher than) the newer 4000 to 4500 hp SD-7x and Dash-9 models. Due to the relatively large fraction of time locomotives spend at low throttle settings while in railyards, the relative differences in emission rates between models at these settings can significantly affect emissions estimates if locomotive model distributions change over time.

Figure 2. Locomotive PM Emission Factors (g/hr).

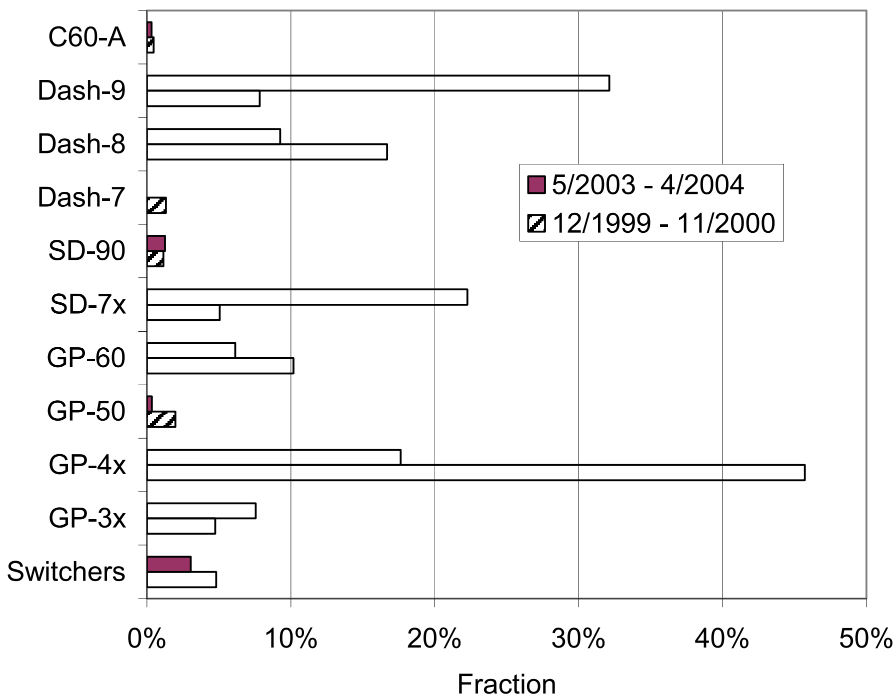


The emission factors used were based on tests using fuel typical of national off-road diesel. Initial emission estimates were derived by multiplying model-specific g/hr emission rates by the total hours of operation and locomotive model fraction for each activity within the yard. At the Davis Yard, over half of the diesel fuel dispensed to locomotives meets California on-road diesel fuel specifications (so-called "CARB diesel"). To account for the effect of fuel quality on emissions, estimates of the fraction of locally dispensed fuel burned by locomotives in different yard activities were developed. These ranged from 100 percent for hump and trim sets to zero percent for inbound line-haul units prior to refueling. These fractions were multiplied by the fraction of CARB diesel dispensed at the yard and an estimate of 14 percent reduction in PM emissions for locomotives burning CARB diesel to develop fuel effects adjustments for individual activities.

EMISSION TRENDS

Using the procedures described in the preceding sections, emissions estimates were developed for the December 1999 to November 2000 period, and the May 2003 to April 2004 period. During this period, significant changes in the UPRR locomotive fleet occurred, with the addition of new locomotives and the retirement of older units. Figure 3 shows the locomotive model distributions for all servicing events at the Davis Yard during these two periods. Service events include both the line-haul and local units arriving and departing on trains (which make up the bulk of these events), as well as the hump and trim sets. A significant increase in the relative fraction of high horsepower SD-7x and Dash-9 units is seen, and a corresponding decrease in the fraction of older GP-4x, GP-50, GP-60, Dash-7 and Dash-8 models. In addition to the fleet modernization, tabulations of specific emission control technologies on units serviced at the Davis Yard showed substantial penetration of new and retrofit technologies. Approximately 31 percent of locomotives serviced at the yard were equipped with computer-controlled shut-down and restart technology, resulting in reduced idling times. Also, approximately 27 percent of servicings were for Tier 0 locomotives, and approximately 25 percent were Tier 1 units. Although the Tier 0 and Tier 1 technologies are not expected to substantially reduce PM emissions, their nitrogen oxides emissions are lower. A few prototype Tier 2 units were observed in 2003 – 2004 data, and their reduced PM emissions will show benefits in the future.

Figure 3. Changes in Locomotive Model Distributions.



The freight volume passing through the yard also changed between these periods. Table 4 lists the percent change in the number of arriving and departing trains, locomotives, and trailing tons (a measure of freight volume). The number of trains and locomotives showed little change, however the trailing tons increased by approximately 15 percent, implying that the average train weight (and correspondingly, the required consist horsepower) increased. This is a result of the increased availability of high horsepower units in the UPRR fleet. A higher fraction of trains bypass the yard, either not stopping, or stopping only for crew changes.

Table 4. Percent Change in Yard Activity Levels from 12/1999 – 11/2000 to 5/2003 – 4/2004.

	Trains	**Locomotives**	**Trailing Tons**
Arrivals	-5.2%	-3.5%	--
Departures	-7.0%	-7.3%	--
Throughs (Bypassing the yard)	8.0%	6.8%	--
Total Arrivals and Departures	-0.3%	-0.9%	15.1%

The newer locomotive fleet also affected the level of load testing activity required. Table 5 lists the percent change in the number of load tests of different types, and the corresponding change in total locomotive testing time at idle, notch 1, and notch 8. The extended 30-minute post-maintenance tests were substantially reduced, and total hours of testing were reduced for the various throttle settings between 12 and 43 percent.

Table 5. Percent Change in Load Test Activity from 12/1999 – 11/2000 to 5/2003 – 4/2004.

10-Minute Tests	-18.9%
15-Minute Tests	14.6%
30-Minute Tests	-43.2%
Total Tests	-12.3%
Idling Hours	-20.6%
Notch 1 Hours	-43.2%
Notch 8 Hours	-12.0%

The combined net result of these changes is shown in Table 6. Between November 2000 and April 2003, total estimated PM emissions in the yard decreased by approximately 15 percent. Reductions in idling and movement emissions of about 20 percent were calculated, due to the combination of a newer, lower emitting locomotive fleet and the computer-controlled shutdown technologies (both retrofits and standard equipment on newer units). Hump and trim emissions were reduced by about 6 percent, and load testing emissions by about 14 percent.

Table 6. Emissions Changes from 12/1999 – 11/2000 to 5/2003 – 4/2004.

	Estimated Emissions (tons per year)		**Percent Change**
	12/1999 – 11/2000	**5/2003 – 4/2004**	
Idling and Movement of Trains	5.2	4.2	-20.3%
Idling and Movement of Consists	8.5	6.8	-20.2%
Testing	1.5	1.3	-14.1%
Hump and Trim	7.0	6.6	-5.7%
Total	22.3	18.9	-15.3%

CONCLUSIONS

Because of the unique features of each individual railyard, top-down methods (e.g., based only on tons of freight handled or number of arriving locomotives) cannot provide reliable estimates of railyard emissions. Yard-specific data are needed. In-yard activity patterns (and emissions) will vary between yards depending on factors such as: the type of yard (e.g., hump or flat switching classification yards, or intermodal facilities); the presence and capabilities of service tracks or locomotive repair shops; the types of freight handled; the location of the yard in the rail network; and yard configuration. The development of procedures for retrieving and analyzing activity data and locomotive characteristics for a specific railyard is a substantial improvement of alternatives based on top-down estimation. By obtaining disaggregate data for the range of specific activities occurring within railyards, it is possible to reliably estimate historical trends in emissions, as well as to evaluate the potential effects of operational changes and new technologies. Railyard operations cannot be treated in isolation, since these yards are only one component of complex national level systems. Nevertheless, the ability to assess the details of yard operations and their emissions provides an improved basis for environmental management decisions at both local and larger scales.

REFERENCES

1. Hand, R.; Di, P.; Servin, A.; Hunsaker, L.; Suer, C. *Roseville Rail Yard Study*, California Air Resources Board, Stationary Source Division, Sacramento, CA, October 14, 2004.

2. U. S. Environmental Protection Agency. *Locomotive Emission Standards – Regulatory Support Document*, U. S. Environmental Protection Agency, Office of Mobile Sources, April 1998.

3. Fritz, S. “Emissions Measurements – Locomotives”, SwRI Project No. 08-5374-024, Prepared for the U.S. Environmental Protection Agency by Southwest Research Institute, San Antonio, TX, August 1995.

4. Fritz, S. “Diesel Fuel Effects on Locomotive Exhaust Emissions”, SwRI Proposal No. 08-23088C, Prepared for the California Air Resources Board by Southwest Research Institute, San Antonio, TX, October 2000.

KEY WORDS

Emission inventories
Locomotives
Railyards
Diesel

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the assistance of numerous UPRR staff who assisted in data retrieval and interpretation, and in providing information on operating practices, including Deb Schafer, Punky Poff, Rob Cohee, Jim Diel, and Brock Nelson. In addition we acknowledge the contributions of Ron Hand of the California Air Resources Board.

APPENDIX A-7

SULFUR ADJUSTMENT CALCULATIONS

Appendix A-7

Development of Adjustment Factors for Locomotive DPM Emissions Based on Sulfur Content

Wong (undated) provides equations for estimating g/bhp-hr emission rates for 4-Stroke (GE) and 2-Stroke (EMD) locomotives. Rather than using these statistically derived estimates for absolute emissions when model- and notch-specific emission factors are available, we used these equations to develop *relative* emission rate changes for different sulfur levels. The basic form of the equation is

$$q = a \cdot S + b$$

Where,

q is the predicted g/bhp-hr emission rate of a locomotive at a specific throttle setting and sulfur content;

a and b are coefficients specific to a locomotive type (2- or 4-stroke) and throttle notch; and

S is the fuel sulfur content in ppm.

Thus, to calculate the emission adjustment factor for a specific fuel sulfur content, it is necessary to calculate the nominal emission rate q_0 for the baseline fuel sulfur content S_0, and the emission rate q_i for the fuel of interest with sulfur content S_i. This adjustment factor k_i is simply

$$k_i = 1 \quad \frac{(q_0 \quad q_i)}{q_0},$$

Where, q_0 and q_i are calculated using the equation above. Tables 1 and 2 give the values of the a and b coefficients for 4-stroke and 2-stroke locomotives. For throttle settings below notch 3, sulfur content is not expected to affect emission rates. The baseline emission rates from which actual emissions are estimated were derived from emission tests of different locomotive models. Although full documentation of fuels is not available for all of these tests, they are assumed to be representative of actual emissions of the different models running on 3,000 ppm sulfur EPA non-road Diesel fuel. For the purposes of modeling 2005 emissions, these factors are needed to adjust the baseline emission factors to emission factors representative of two fuels – 221 ppm and 2639 ppm. Table 3 shows the resulting correction factors for these two fuels by notch and engine type. To generate locomotive model-, throttle-, tier-, and fuel-specific emission factors, the base case (nominal 3,000 ppm S) emission factors in Table 4 were multiplied by the corresponding correction factors for throttle settings between notch 3 and notch 8.

Table 1 **Sulfur Correction Coefficients for 4-Stroke Engines**		
Throttle Setting	***a***	***b***
Notch 8	0.00001308	0.0967
Notch 7	0.00001102	0.0845
Notch 6	0.00000654	0.1037
Notch 5	0.00000548	0.1320
Notch 4	0.00000663	0.1513
Notch 3	0.00000979	0.1565

Table 2 **Sulfur Correction Coefficients for 2-Stroke Engines**		
Throttle Setting	***a***	***b***
Notch 8	0.0000123	0.3563
Notch 7	0.0000096	0.2840
Notch 6	0.0000134	0.2843
Notch 5	0.0000150	0.2572
Notch 4	0.0000125	0.2629
Notch 3	0.0000065	0.2635

Table 3 DPM Emission Adjustment Factors for Different Fuel Sulfur Levels				
Throttle Setting	**4-Stroke (GE)**		**2-Stroke (EMD)**	
	2,639 ppm S	**221 ppm S**	**2,639 ppm S**	**221 ppm S**
Notch 8	0.9653	0.7326	0.9887	0.9131
Notch 7	0.9662	0.7395	0.9889	0.9147
Notch 6	0.9809	0.8526	0.9851	0.8852
Notch 5	0.9867	0.8974	0.9821	0.8621
Notch 4	0.9860	0.8924	0.9850	0.8844
Notch 3	0.9810	0.8536	0.9917	0.9362

Table 4
Base Case Locomotive Diesel Particulate Matter Emission Factors (g/hr)
(3,000 PPM Sulfur Assumed)

Model Group	Tier	Throttle Setting Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8	Source
Switchers	N	31.0	56.0	23.0	76.0	138.0	159.0	201.0	308.0	345.0	448.0	EPA RSD[1]
GP-3x	N	38.0	72.0	31.0	110.0	186.0	212.0	267.0	417.0	463.0	608.0	EPA RSD[1]
GP-4x	N	47.9	80.0	35.7	134.3	226.4	258.5	336.0	551.9	638.6	821.3	EPA RSD[1]
GP-50	N	26.0	64.1	51.3	142.5	301.5	311.2	394.0	663.8	725.3	927.8	EPA RSD[1]
GP-60	N	48.6	98.5	48.7	131.7	284.5	299.4	375.3	645.7	743.6	941.6	EPA RSD[1]
GP-60	0	21.1	25.4	37.6	75.5	239.4	352.2	517.8	724.8	1125.9	1319.8	SwRI[2] (KCS733)
SD-7x	N	24.0	4.8	41.0	65.7	156.8	243.1	321.1	374.8	475.2	589.2	SwRI[3]
SD-7x	0	14.8	15.1	36.8	61.1	230.4	379.8	450.8	866.2	1019.1	1105.7	GM EMD[4]
SD-7x	1	29.2	31.8	37.1	66.2	219.3	295.9	436.7	713.2	783.2	847.7	SwRI[5] (NS2630)
SD-7x	2	55.4	59.5	38.3	134.2	271.7	300.4	335.2	551.5	672.0	704.2	SwRI[5] (UP8353)
SD-90	0	61.1	108.5	50.1	99.1	255.9	423.7	561.6	329.3	258.2	933.6	GM EMD[4]
Dash 7	N	65.0	180.5	108.2	121.2	359.5	327.7	331.5	299.4	336.7	420.0	EPA RSD[1]
Dash 8	0	37.0	147.5	86.0	133.1	291.4	293.2	327.7	373.5	469.4	615.2	GE[4]
Dash 9	N	32.1	53.9	54.2	108.1	219.9	289.1	370.6	437.7	486.1	705.7	SWRI 2000
Dash 9	0	33.8	50.7	56.1	117.4	229.2	263.8	615.9	573.9	608.0	566.6	Average of GE & SwRI[6]
Dash 9	1	16.9	88.4	62.1	140.2	304.0	383.5	423.9	520.2	544.6	778.1	SwRI[2] (CSXT595)
Dash 9	2	7.7	42.0	69.3	145.8	304.3	365.0	405.2	418.4	513.5	607.5	SwRI[2] (BNSF 7736)
C60-A	0	71.0	83.9	68.6	78.6	277.9	234.1	276.0	311.4	228.0	362.7	GE[4] (UP7555)

Notes:
1. EPA Regulatory Support Document, "Locomotive Emissions Regulation," Appendix B, 12/17/97, as tabulated by ARB and ENVIRON
2. Base emission rates provided by ENVIRON as part of the BNSF analyses for the Railyard MOU (Personal communication from Chris Lindhjem to R. Ireson, 2006) based on data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to C. Lindhjem, 2006).
3. SwRI final report "Emissions Measurments – Locomotives" by Steve Fritz, August 1995.
4. Manufacturers' emissions test data as tabulated by ARB.
5. Base SD-70 emission rates taken from data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to R. Ireson, 2006).
6. Average of manufacturer's emissions test data as tabulated by ARB and data from the AAR/SwRI Exhaust Plume Study, tabulated and calculated by ENVIRON..

OFFROAD Modeling Change Technical Memo

SUBJECT: Changes to the Locomotive Inventory

LEAD: Walter Wong

Summary

The statewide locomotive emission inventory has not been updated since 2002. Using the Booz-Allen Hamilton's (BAH) study (Locomotive Emission Study) published in 1992 as a guideline (summary of inventory methodology can be found in Appendix A), staff updated the locomotive inventory.

The history of locomotive emission inventory updates began in 1992 using the results from the BAH report as the baseline inventory. In 2003, staff began updating the emissions inventory by revising the growth assumptions used in the inventory. The revised growth factors were incorporated into the ARB's 2003 Almanac Emission Inventory. With additional data, staff is proposing further update to the locomotive inventory to incorporate fuel correction factors, add passenger train data and Class III locomotives. Changes from updated locomotive activity data have made a significant impact on the total inventory (see Table 1).

Table 1. Impact of Changes on Statewide Locomotive Inventory

	Pre 2003 ARB Almanac Inventory (tons/day)			Revised Inventory (tons/day)			Difference (tons/day)		
Year	HC	NOx	PM	HC	NOx	PM	HC	NOx	PM
1987	7.2	158.8	3.6	7.2	158.8	3.6	0.0	0.0	0.0
2000	7.2	144.8	2.8	9.8	207.2	4.7	2.6	62.4	1.9
2010	7.2	77.8	2.8	9.5	131.9	4.2	2.3	54.1	1.4
2020	7.2	77.8	2.8	9.4	134.6	4.1	2.2	56.8	1.3

Reasons For Change

During the 2003 South Coast's State Implementation Plan (SIP) development process, industry consultants approached Air Resources Board (ARB) staff to refine the locomotive emissions inventory. Specifically, their concerns were related to the growth factors and fuel correction factors used in the inventory calculations. This document outlines how the locomotive emissions inventory was updated and the subsequent changes made to address industry's concerns.

Background : Baseline 1987 Locomotive Emissions Inventory (BAH report)

Locomotive operations can be characterized by the type of service performed. For emission inventory purposes, locomotives are classified into five different service types as defined in BAH's report.

Line-haul/intermodal – Intermodal locomotives generally operate at higher speeds and with higher power than other types and incorporate modern, high-speed engines.

Mixed/bulk – Mixed locomotives are the most common and operate with a wide range of power. They also perform line-haul duties.

Local/Short Haul – Local locomotives perform services that are a mixture of mixed freight and yard service. They operate with lower power and use older horsepower engines.

Yard/Switcher – Yard operations are used in switching locomotives and characterized by stop and start type movements. They operate with smaller engines and have the oldest locomotive engines.

Passenger – Passenger locomotives are generally high speed line haul type operations.

Categories of railroads are further explained by a precise revenue-based definition found in the regulations of the Surface Transportation Board (STB). Rail carriers are grouped into three classes for the purposes of accounting and reporting:

Class I –Carriers with annual operating revenues of $250 million or more

Class II – Carriers with annual operating revenues of less than $250 million but in excess of $20 million

Class III – Carriers with annual operating revenues of less than $20 million or less, and all switching companies regardless of operating revenues.

The threshold figures are adjusted annually for inflation using the base year of 1991.

The 1987 locomotive inventory as shown in Table 2 is taken from the BAH report prepared for the ARB entitled "Locomotive Emission Study" completed in 1992 (http://www.arb.ca.gov/app/library/libcc.php). Information was gathered from many sources including ARB, the South Coast Air Quality Management District, the California Energy Commission, the Association of American Railroads (AAR), locomotive and large engine manufacturers, and Southwest Research Institute. Railroad companies, such as Southern Pacific, Union Pacific, and Atchison, Topeka and Santa Fe (ATSF), provided emission factors, train operation data, and throttle position profiles for trains operating in their respective territories. Southwest Research Institute provided emission test data.

Table 2. 1987 Locomotive Inventory in Tons Per Day, Statewide, BAH report

TYPE	HC	CO	NOX	PM	SOX
Line-Haul/Intermodal	3.97	12.89	86.21	1.97	6.36
Short-Haul/Local	0.96	3.06	21.30	0.46	1.59
Mixed	1.51	4.85	37.34	0.81	2.76
Passenger	0.10	0.22	3.24	0.07	0.30
Yard/Switcher	0.62	1.57	10.69	0.24	0.58
Total	7.16	22.59	158.78	3.55	11.59

The assumed average fuel sulfur content is 2700 parts per million (ppm) obtained from the BAH report.

Current Growth Estimates

Prior to the 2003 South Coast SIP update, growth factors were based on employment data in the railroad industry. Staff believes that the use of historic employment data, which translates to a decline in emissions in future years, may be masking actual positive growth in locomotive operations. It may be assumed that the number of employees is declining due to increased efficiency.

<u>Changes to the Locomotive Inventory</u>

Summary of Growth in Emission Based on BAH Report

Growth is estimated based on train operation type and by several operating characteristics.

> <u>Increased Rail Lube and Aerodynamics</u> – this arises from reduction in friction and will help reduce power requirements.

Introduction of New Locomotives – older locomotive units will be replaced by newer models.

Changes in Traffic Level – the increase or decrease in railroad activity

In the BAH report, projected emission estimates for years 2000 and 2010 were based on the factors shown in Tables 3 and 4. A substantial part of the locomotive emission inventory forecast is based upon projections of rail traffic levels. BAH projected future rail traffic level as a function of population and economic growth in the state. BAH also projected growth in emission only to 2010.

Table 3. Changes in Emissions from 1987-2000 (Exhibit 4 p. 11 of the 8/92 Locomotive Emission Study Supplement) (1987 Base Year)

Train Operation Type	Increased Rail Lube and Aerodynamics	Introduction of New Locomotive	Changes in Traffic Levels	Cumulative Net Growth in Emissions
Intermodal	-7.0%	-8.0%	17.0%	2.0%
Mixed & Bulk	-7.0%	-8.0%	2.0%	-13.0%
Local	-3.0%	-3.0%	-2.0%	-8.0%
Yard	0.0%	-1.0%	-25.0%	-26.0%
Passenger	-7.0%	-8.0%	10.0%	-5.0%

Table 4. Changes in Emissions from 2001-2010 (Exhibit 4 p. 11 of the 8/92 Locomotive Emission Study Supplement) (2000 Base Year)

Train Operation Type	Increased Rail Lube and Aerodynamics	Improved Dispatching and Train Control	Introduction of New Locomotive	Changes in Traffic Levels	Cumulative Net Growth in Emissions
Intermodal	-2.0%	-3.0%	-8.0%	25.0%	12.0%
Mixed & Bulk	-2.0%	-3.0%	-8.0%	0.0%	-13.0%
Local	-1.0%	0.0%	-12.0%	-10.0%	-23.0%
Yard	0.0%	0.0%	-10.0%	-15.0%	-25.0%
Passenger	-2.0%	-3.0%	-8.0%	15.0%	2.0%

BAH added “Improved Dispatching and Train Control” to differentiate these impacts from the “Increased Rail Lubing” which helps to improve fuel efficiency from locomotive engines. Since train control techniques are emerging from the signal company research work, these assumed changes will not impact emission until year 2000.

Based on industry's input, staff recommends several changes to the locomotive emissions inventory. These include modifying growth factors, making adjustments to control factors reflecting the U. S. EPA regulations that went into effect in year 2000, incorporating fuel correction factors, adding smaller class III railroad and industrial locomotive, and updating passenger data.

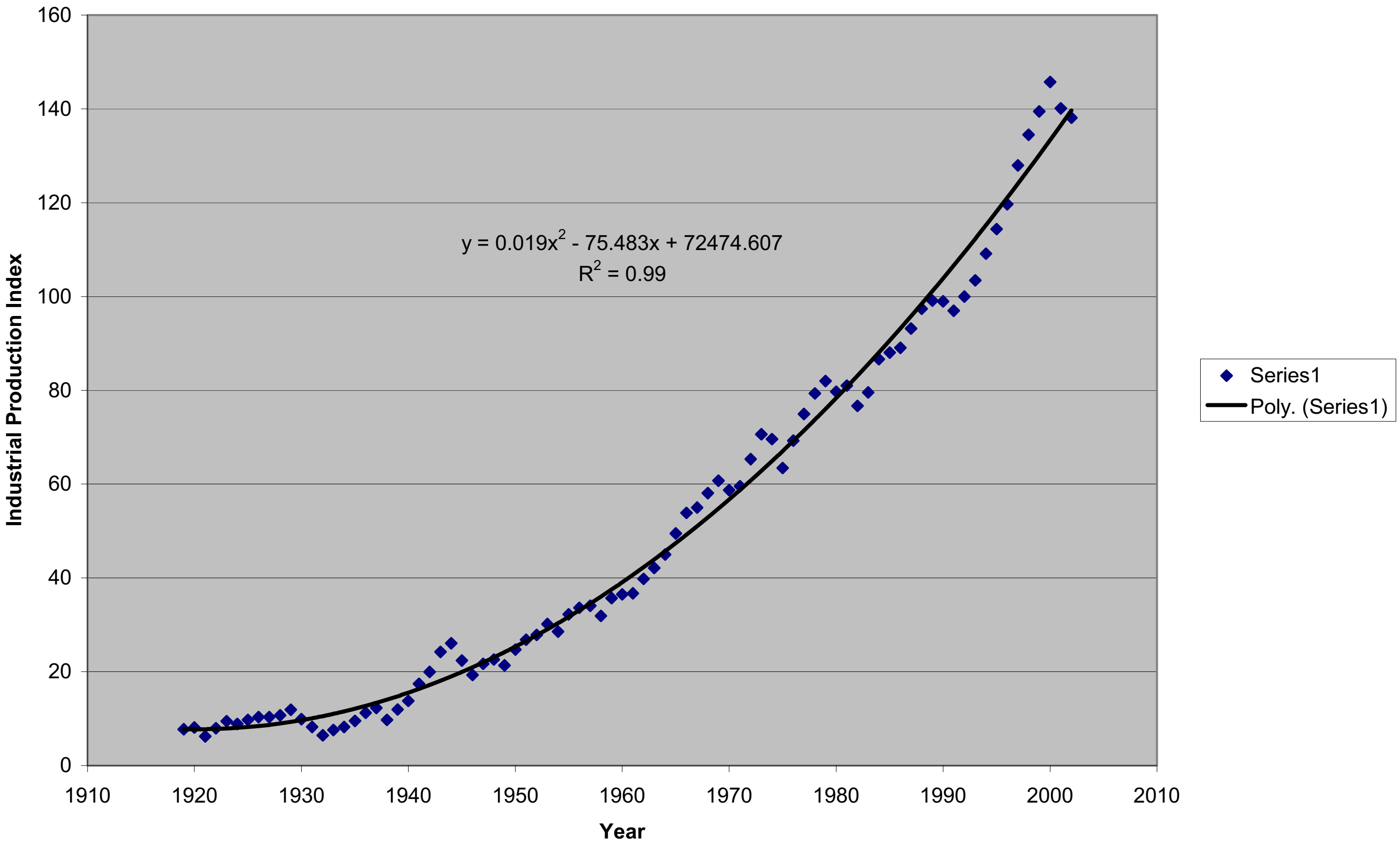
Revised Growth in Emissions

Staff revised the growth factors for locomotives based on new data that better reflect locomotive operations. This includes U.S. industrial production and various railroad statistics available from the AAR.

Based on historic data recently obtained from U.S. industrial productions and the AAR, the changes in traffic levels were revised. A better estimate for changes in traffic levels for locomotives can be made to the line-haul class of railroad, which are the intermodal and mixed and bulk type of locomotives, using industrial production and AAR's data.

Industrial production data is considered to be a surrogate for changes in traffic levels of the line-haul locomotive. It is assumed that railroad activity would increase in order to accommodate the need to move more product. Industrial production is the total output of U.S. factories and mines, and is a key economic indicator released monthly by the Federal Reserve Board. U.S. industrial production historical data from 1920 to 2002 was obtained and analyzed from government sources. Figure 1 shows the historical industrial production trend (Source : http://www.research.stlouisfed.org/fred2/series/INDPRO/3/Max). Statistical analysis was used to derive a polynomial equation to fit the data.

Figure 1. Long-term Industrial Production



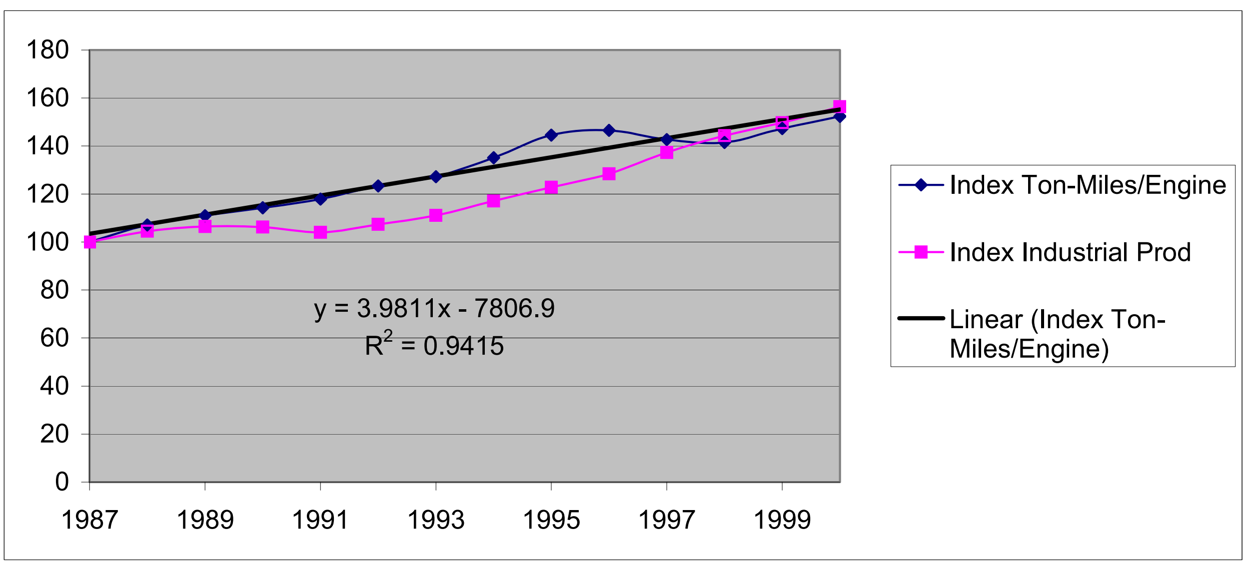
Another surrogate for growth is net ton-miles per engine. Consequently, staff analyzed railroad data from the AAR's Railroad Facts booklet (2001 edition). The booklet contains line-haul railroad statistics including financial status, operation and employment data, and usage profiles. Revenue ton-mile and locomotives in service data from the booklet were used to compute the net ton-miles per engine as shown in Table 5.

Table 5. Revenue Ton-Miles and Ton-Miles/Engine (AAR Railroad Facts 2001 edition)

Year	Locomotive Diesel in Service (US)	Revenue Ton-Miles	Ton-Miles/Engine
1987	19,647	943,747	48.04
1988	19,364	996,182	51.45
1989	19,015	1,013,841	53.32
1990	18,835	1,033,969	54.90
1991	18,344	1,038,875	56.63
1992	18,004	1,066,781	59.25
1993	18,161	1,109,309	61.08
1994	18,496	1,200,701	64.92
1995	18,810	1,305,688	69.41
1996	19,267	1,355,975	70.38
1997	19,682	1,348,926	68.54
1998	20,259	1,376,802	67.96
1999	20,254	1,433,461	70.77
2000	20,026	1,465,960	73.20

As shown in Figure 2, there is a relatively good correlation between net ton-miles per engine growth and industrial production. Because net ton-miles per engine data are compiled by the railroad industry and pertains directly to the railroad segment, staff believes that net ton-miles per engine will better characterize future traffic level changes.

Figure 2. Ton-miles/Engine vs. Industrial Production (index base year = 1987)



The ton-miles/engine data were projected to calculate the future growth rate of traffic level using a linear equation.

Staff also made changes to the "Increased Rail Lube and Aerodynamics" assumption shown in Tables 3 and 4. Rail lubing does not benefit the idling portion of locomotive activity. Since idling contributes 20% of the weighting in the line-haul duty cycle, staff reduced the rail lubing benefit by 20%. Meanwhile, improved dispatching and train control is assumed only to reduce engine idling. Therefore, staff reduced the improved dispatching benefit by 80%.

The benefit of the introduction of new locomotives to the fleet was decreased from the original BAH assumption. BAH assumed 50% penetration of the new engines by 2000. Literature research suggests that the new engines accounted for only about 34% of the fleet in 2000 (www.railwatch.com, http://utahrails.net/all-time/modern-index.php). These new engines are assumed to be 15% cleaner. Therefore, the benefit from new locomotive engines has been reduced to 5% (34% x 15% = 5% reduction).

Tables 6, 7, and 8 present the revised growth factors to be used to project the baseline (1987) locomotive emissions inventory into the future.

Table 6. ARB Revised Growth 1987-2000, ARB's 2003 Almanac Emission Inventory

Train Operation Type	Increased Rail Lube and Aerodynamics	Introduction of New Locos	Population Increase	Changes in Traffic Levels	Cumulative Net Growth in Emissions	Annual Growth
Intermodal	-5.6%	-5.1%	1.9%	50.0%	41.2%	2.69%
Mixed & Bulk	-5.6%	-5.1%	1.9%	50.0%	41.2%	2.69%
Local	-2.4%	0%	0%	-2.0%	-4.4%	-0.35%
Yard	0.0%	0%	0%	-25.0%	-25.0%	-2.19%
Passenger	-5.6%	0%	1.9%	10.0%	6.3%	0.47%

The benefit of new locomotives with cleaner burning engines is accounted for in the control factor from EPA's regulation beginning in 2001, which takes into account introduction of new locomotive engines meeting Tier I and Tier II standards.

Table 7. ARB Revised Growth 2001-2010 (2000 Base Year, ARB's 2003 Almanac Emission Inventory)

Train Operation Type	Increased Rail Lube and Aerodynamics	Improved Dispatching and Train Control	Changes in Traffic Levels	Cumulative Net Growth in Emissions	Annual Growth
Intermodal	-1.6%	-0.6%	22.5%	20.3%	1.87%
Mixed & Bulk	-1.6%	-0.6%	22.5%	20.3%	1.87%
Local	-0.8%	-0.6%	-10.0%	-11.4%	-1.20%
Yard	0.0%	0.0%	-15.0%	-15.0%	-1.61%
Passenger	-1.6%	0.0%	15.0%	13.4%	1.27%

Table 8. ARB Revised Growth 2010-2020 (2010 Base Year, ARB's 2003 Almanac Emission Inventory)

Train Operation Type	Increased Rail Lube and Aerodynamics	Improved Dispatching and Train Control	Changes in Traffic Levels	Cumulative Net Growth	Annual Growth
Intermodal	0.0%	0.0%	18.0%	18.0%	1.67%
Mixed & Bulk	0.0%	0.0%	18.0%	18.0%	1.67%
Local	0.0%	0.0%	0.0%	0.0%	0.00%
Yard	0.0%	0.0%	0.0%	0.0%	0.00%
Passenger	0.0%	0.0%	0.0%	0.0%	0.00%

In Table 8, staff assumes no benefit from aerodynamics and improved train controls. Staff seeks guidance from industry as to their input regarding future benefits.

Table 9. Revised Growth in Emissions (Base Year 1987)

Year	Intermodal	Mixed & Bulk	Local	Yard	Passenger
1987	1.00	1.00	1.00	1.00	1.00
1988	1.03	1.03	1.00	0.98	1.00
1989	1.05	1.05	0.99	0.96	1.01
1990	1.08	1.08	0.99	0.94	1.01
1991	1.11	1.11	0.99	0.92	1.02
1992	1.14	1.14	0.98	0.90	1.02
1993	1.17	1.17	0.98	0.88	1.03
1994	1.20	1.20	0.98	0.86	1.03
1995	1.24	1.24	0.97	0.84	1.04
1996	1.27	1.27	0.97	0.82	1.04
1997	1.30	1.30	0.97	0.80	1.05
1998	1.34	1.34	0.96	0.78	1.05
1999	1.38	1.38	0.96	0.77	1.06
2000	1.41	1.41	0.96	0.75	1.06
2001	1.44	1.44	0.94	0.74	1.08
2002	1.47	1.47	0.93	0.73	1.09
2003	1.49	1.49	0.92	0.71	1.10
2004	1.52	1.52	0.91	0.70	1.12
2005	1.55	1.55	0.90	0.69	1.13
2006	1.58	1.58	0.89	0.68	1.15
2007	1.61	1.61	0.88	0.67	1.16
2008	1.64	1.64	0.87	0.66	1.18
2009	1.67	1.67	0.86	0.65	1.19
2010	1.70	1.70	0.85	0.64	1.21
2011	1.73	1.73	0.85	0.64	1.21
2012	1.76	1.76	0.85	0.64	1.21
2013	1.79	1.79	0.85	0.64	1.21
2014	1.81	1.81	0.85	0.64	1.21
2015	1.85	1.85	0.85	0.64	1.21
2016	1.88	1.88	0.85	0.64	1.21
2017	1.91	1.91	0.85	0.64	1.21
2018	1.94	1.94	0.85	0.64	1.21
2019	1.97	1.97	0.85	0.64	1.21
2020	2.00	2.00	0.85	0.64	1.21

Control Factors for U.S. EPA regulation

In December 1997, the U.S. EPA finalized the locomotive emission standard regulation. The regulatory support document lists the control factors used (http://www.epa.gov/otaq/regs/nonroad/locomotv/frm/locorsd.pdf). Staff modified the control factors to incorporate the existing memorandum of understanding (http://www.arb.ca.gov/msprog/offroad/loco/loco.htm) between the South Coast AQMD and the railroads that operate in the region. Previously, one control factor was applied statewide. In the revised emissions inventory starting in 2010, a lower control factor reflecting the introduction of lower emitting locomotive engines in the SCAB region was applied. Tables 10 and 11 show the revised control factors. Road hauling definition as used by U.S. EPA applies to the line-haul/intermodal, mixed, and local/short haul train type in the emissions inventory.

Table 10. Revised Statewide Control Factors

Year	State Road Hauling HC	State Road Hauling NOx	State Road Hauling PM	State Switcher HC	State Switcher NOx	State Switcher PM	State Passenger HC	State Passenger NOx	State Passenger PM
1999	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2000	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2001	1.00	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2002	1.00	0.88	1.00	1.00	0.98	1.00	1.00	0.98	1.00
2003	1.00	0.82	1.00	1.00	0.97	1.00	1.00	0.96	1.00
2004	1.00	0.75	1.00	1.00	0.95	1.00	1.00	0.94	1.00
2005	0.96	0.68	0.96	0.99	0.93	0.99	0.98	0.92	0.98
2006	0.92	0.62	0.92	0.99	0.91	0.99	0.96	0.90	0.96
2007	0.89	0.59	0.89	0.98	0.89	0.98	0.94	0.83	0.94
2008	0.87	0.57	0.86	0.98	0.87	0.97	0.92	0.76	0.92
2009	0.84	0.55	0.84	0.97	0.85	0.97	0.91	0.69	0.90
2010	0.82	0.54	0.81	0.96	0.83	0.96	0.89	0.62	0.88
2011	0.81	0.53	0.80	0.96	0.81	0.95	0.87	0.57	0.87
2012	0.80	0.53	0.79	0.95	0.79	0.94	0.85	0.56	0.85
2013	0.79	0.52	0.78	0.94	0.77	0.93	0.83	0.54	0.83
2014	0.77	0.51	0.76	0.94	0.75	0.93	0.82	0.53	0.81
2015	0.76	0.50	0.75	0.93	0.73	0.92	0.80	0.52	0.79
2016	0.75	0.50	0.74	0.92	0.71	0.91	0.78	0.51	0.77
2017	0.74	0.49	0.72	0.91	0.70	0.90	0.76	0.50	0.75
2018	0.73	0.48	0.71	0.90	0.69	0.89	0.74	0.49	0.73
2019	0.71	0.48	0.70	0.89	0.68	0.88	0.73	0.48	0.71
2020+	0.70	0.47	0.69	0.89	0.67	0.87	0.71	0.47	0.69

Table 11. Revised SCAB Control Factors

Year	SCAB Road Hauling HC	SCAB Road Hauling NOx	SCAB Road Hauling PM	SCAB Switcher HC	SCAB Switcher NOx	SCAB Switcher PM
1999	1.00	1.00	1.00	1.00	1.00	1.00
2000	1.00	0.99	1.00	1.00	1.00	1.00
2001	1.00	0.95	1.00	1.00	1.00	1.00
2002	1.00	0.88	1.00	1.00	0.98	1.00
2003	1.00	0.82	1.00	1.00	0.97	1.00
2004	1.00	0.75	1.00	1.00	0.95	1.00
2005	0.96	0.68	0.96	0.99	0.93	0.99
2006	0.92	0.62	0.92	0.99	0.91	0.99
2007	0.89	0.59	0.89	0.98	0.89	0.98
2008	0.87	0.57	0.86	0.98	0.87	0.97
2009	0.84	0.55	0.84	0.97	0.85	0.97
2010	0.82	0.36	0.81	0.96	0.36	0.96
2011	0.81	0.36	0.80	0.96	0.36	0.95
2012	0.80	0.36	0.79	0.95	0.36	0.94
2013	0.79	0.36	0.78	0.94	0.36	0.93
2014	0.77	0.36	0.76	0.94	0.36	0.93
2015	0.76	0.36	0.75	0.93	0.36	0.92
2016	0.75	0.36	0.74	0.92	0.36	0.91
2017	0.74	0.36	0.72	0.91	0.36	0.90
2018	0.73	0.36	0.71	0.90	0.36	0.89
2019	0.71	0.36	0.70	0.89	0.36	0.88
2020+	0.70	0.36	0.69	0.89	0.36	0.87

Addition of Class III Locomotive and Industrial/Military Locomotive

The annual hours operated by the class III railroads are shown in Table 12. The results were tabulated from ARB Stationary Source Division's (SSD) survey (http://www.arb.ca.gov/regact/carblohc/carblohc.htm) conducted to support regulation with regards to ARB ultra-clean diesel fuel.

Table 12. Short-Haul and Switcher Annual Hours for Class III Railroads

Air Basin	Operations	Population	Annual Hours Operated
Mountain Counties	SW	2	10214
Mojave Desert	L	10	27440
North Coast	L	3	5700
North Central Coast	L	1	1332
	SW	3	3996
Northeast Plateau	L	5	9892
South Coast	SW	21	75379
South Central Coast	L	5	3200
San Diego	L	4	5000
San Francisco	L	8	31600
	SW	4	5059
San Joaquin Valley	L	29	68780
	SW	19	72248
Sacramento Valley	L	6	11400
Total		120	331240

L = local short-haul, SW = switcher

The short-haul and switcher emission rate are derived from BAH report. The report cites studies from testing done at EPA and Southwest Research Institute.

Table 13. Short-Haul and Switcher Emission Rate

Emission Rate	Short-Haul (g/bhp-hr)	Switcher (g/bhp-hr)
HC	0.38	0.44
CO	1.61	1.45
NOx	12.86	15.82
PM	0.26	0.28
SOx	0.89	0.90
Fuel Rate (lb/hr)	120.00	60.00

Table 14. Statewide Summary of Industrial Locomotives

Air Basin	Number of Locomotives	Avg. HP	Avg. Age
Mojave Desert	9	1,138	56
Others	11	587	54
San Francisco	11	525	54
San Joaquin Valley	38	1,176	54
South Coast	24	1,290	55
TOTALS	93	1,055	55

Table 15. Statewide Summary of Military Locomotives

Air Basin	Number of Locomotives	Avg. HP	Avg. Age
Mojave Desert	7	900	50
Northeast Plateau	2	1,850	50
Sacramento Valley	1	500	50
San Diego	7	835	50
San Francisco	4	1525	47.5
San Joaquin Valley	2	400	50
South Central Coast	1	500	50
TOTALS	24	930	49.6

The data from the survey provides a reasonable depiction of railroad activities in 2003. To forecast and backcast, an assumption was made to keep the data constant and have no growth. More research is needed to quantify the growth projections of smaller, local railroad activities.

Update to Passenger Trains

ARB's survey of intrastate locomotives included passenger agency trains that operated within the state. Staff attempted to reconcile the survey results by calculating the operation schedules posted by the operating agency to obtain hours of operation and mileage information. The results of the survey and calculated operating hours were comparable. Table 16 lists the calculated annual hours operated and miles traveled used to estimate emissions.

Table 16. Passenger Trains Annual Miles and Hours

Air Basin	Annual Miles Operated	Annual Hours Operated
South Coast	3,700,795	92,392
South Central Coast	151,864	4,020
San Diego	914,893	25,278
San Francisco	2,578,862	77,944
San Joaquin Valley	674,824	17,313
Sacramento Valley	635,384	20,058
Total	8,656,621	237,006

The passenger train emission rate is derived from testing done at SWRI on several passenger locomotives.

Table 17. Passenger Train Emission Rate

Emission Rate	Passenger Train (g/bhp-hr)
HC	0.50
CO	0.69
Nox	12.83
PM	0.36
Sox	0.90
Fuel Rate (lb/hr)	455.00

Fuel Correction Factors

<u>Aromatics</u>

Previous studies quantifying the effects of lowering aromatic content are listed in Table 18. These studies tested four-stroke heavy-duty diesel engines (HDD). Although staff would have preferred to analyze data from tests performed on various locomotive engines to determine the effects of lower aromatics, these HDD tests are the best available resources to determine the fuel corrections factors due to lower aromatics.

Table 18. Effect of Lowering Aromatic Volume on PM Emission

STUDY	**Sulfur (ppm)**	**Aromatics (Volume %)**	**PM Reduction (%)**
Chevron (1984)	2,800	31	Baseline
Chevron (1984)	500	31	23.8
Chevron (1984)	500	20	32.2
Chevron (1984)	500	15	36.0
Chevron (1984)	500	10	39.9
CRC-SWRI (1988)	500	31	Baseline
CRC-SWRI (1988)	500	20	9
CRC-SWRI (1988)	500	15	13
CRC-SWRI (1988)	500	10	17

Source : http://www.arb.ca.gov/fuels/diesel/diesel.htm

Using a linear regression of the data from the Table 18, the PM reduction from a change in aromatic content can be described as :

<u>4-Stroke Engine</u>
PM reduction = [(Difference in Aromatic Volume) * 0.785 + 0.05666]/100

For 2-Stroke engines, staff used test data from SWRI's report published in 2000 entitled "Diesel Fuel Effects on Locomotive Exhaust Emissions" to estimate indirectly the potential PM reduction for 2-Stroke engines due to lower aromatics. Table 19 lists the summary of the test results.

Table 19. SWRI 2000 Study Summary Results

Locomotive Engine	Aromatic Changes (Volume %)	PM Difference (g/bhp-hr)	PM % Difference
4 Stroke	28.35 to 21.84	0.080	37.6%
2 Stroke	28.35 to 21.84	0.056	14.1%

Staff assumes that PM emission reduction from 2-Stroke engine will have a factor of 0.38 (14.1%/37.6%) to the 4-Stroke engine PM emission reduction.

Currently, the baseline locomotive emissions inventory assumes an aromatic total volume percent of 31%. Table 21 describes the changes in PM emission due to changes in total volume percent of aromatics.

Table 20. Examples of PM Reductions Due to Changes in Aromatic Total Volume Percent

Aromatic Volume Percent		PM Reduction	PM Reduction	PM Reduction
From	To	2 Stroke	4 Stroke	Composite
31	28	0.9%	2.4%	1.3%
31	19	3.6%	9.5%	5.1%
31	10	6.3%	16.5%	8.9%

*composite is 75% 2 Stroke Engine and 25% 4 Stroke Engine

Table 21,Table 22, and Table 23 show the PM emission reduction for the different type of fuels used in the state.

Table 21. PM Emission Percent Change of Line-Haul Due to Aromatics, Statewide

Calendar Year	CARB Aromatic Volume (%)	EPA Aromatic Volume (%)	Off-road Aromatic Volume (%)	Weighted Aromatic Volume (%)	PM Emission Percent Change
1992	31	31	31	31.00	0.00
1993	10	31	31	31.00	0.00
1994	10	31	31	31.00	0.00
1995	10	31	31	31.00	0.00
1996	10	31	31	31.00	0.00
1997	10	31	31	31.00	0.00
1998-2001	10	31	31	30.18	-0.004
2002-2006	10	31	31	29.05	-0.009
2007+	10	31	31	29.05	-0.009

Table 22. Class I Line Haul Weighted Aromatic Volume Percent by Air Basin

Interstate Locomotive	Air Basin	1993-2001 Weighted Aromatic	2002+ Weighted Aromatic
		Volume Percent	Volume Percent
Class I Line Haul	SCC	31.0	31.0
	MC	31.0	26.6
	MD	30.0	29.8
	NEP	31.0	27.9
	SC	31.0	31.0
	SF	28.6	23.1
	SJV	29.1	29.4
	SS	31.0	31.0
	SV	31.0	27.4

Table 23. PM Emission Reduction from Intrastate Locomotives Due to Aromatics by Air Basin, 1993+

Intrastate Locomotive	Air Basin	CARB Aromatic Volume Percent	EPA Aromatic Volume Percent	Nonroad Aromatic Volume Percent	Weighted Aromatic Volume Percent	PM Emission Reduction Percent
Class I Local/Switcher	SC	10	31	31	29.0	-0.9%
	SJV	10	31	31	25.2	-2.4%
	MD	10	31	31	31.0	0.0%
	BA	10	31	31	13.9	-7.2%
	SD	10	31	31	13.2	-7.5%
	SV	10	31	31	13.2	-7.5%
	SCC	10	31	31	13.2	-7.5%
Class III Local/Switcher	SC	10	31	31	31.0	0.0%
	SJV	10	31	31	18.6	-5.2%
	MD	10	31	31	10.0	-8.8%
	BA	10	31	31	10.0	-8.8%
	SD	10	31	31	10.0	-8.8%
	SV	10	31	31	10.0	-8.8%
	SCC	10	31	31	10.0	-8.8%
	NEP	10	31	31	26.6	-1.9%
	MC	10	31	31	31.0	0.0%
	NC	10	31	31	10.0	-8.8%
	NCC	10	31	31	10.0	-8.8%
Industrial/Military	SC	10	31	31	24.0	-3.0%
	SJV	10	31	31	24.0	-3.0%
	MD	10	31	31	24.0	-3.0%
	BA	10	31	31	24.0	-3.0%
	NEP	10	31	31	24.0	-3.0%
	SD	10	31	31	24.0	-3.0%
	SV	10	31	31	24.0	-3.0%
	SCC	10	31	31	24.0	-3.0%
Passenger	SC	10	31	31	10.8	-8.5%
	SJV	10	31	31	10.0	-8.8%
	BA	10	31	31	10.0	-8.8%
	SD	10	31	31	10.0	-8.8%
	SV	10	31	31	10.0	-8.8%
	SCC	10	31	31	12.1	-8.0%

Source : Fuel Estimate from http://www.arb.ca.gov/regact/carblohc/carblohc.htm

Sulfur

Currently, the baseline locomotive emissions inventory assumes an average fuel sulfur content of 2700 ppm. Industry has provided information on the sulfur content of the fuel that is currently being used by intrastate locomotives. Together with industry data and prior locomotive tests, staff believes a fuel correction factor should be incorporated into the model.

Table 24 shows the test data collected by the ARB, U.S. EPA, and others, where locomotive engines were tested on different fuel sulfur levels.

Table 24. Locomotive Engine Test with Different Sulfur Levels

Locomotive Engine	Fuel Properties Sulfur Content	Percent Change PM	Percent Change NOX	Percent Change CO	Percent Change HC	Source
EMD 12-645E3B	100/3300ppm	-0.29	-0.06	0.17	0.07	Fritz, 1991
GE DASH9-40C	330/3150ppm	-0.43	-0.07	-0.05	-0.18	Fritz (1995, EPA/SWRI)
MK 5000C	330/3150ppm	-0.71	-0.03	-0.03	-0.07	Fritz (1995, EPA/SWRI)
EMD 16-710G3B, SD70MAC	330/3150ppm	-0.38	-0.08	-0.30	-0.01	Fritz (1995, EPA/SWRI)
EMD SD70MAC	50/330ppm	-0.03	-0.04	0.07	0.01	Fritz (ARB/AAR, 2000)
EMD SD70MAC	50/4760ppm	-0.16	-0.06	0.08	0.03	Fritz (ARB/AAR, 2000)
EMD SD70MAC	330/4760ppm	-0.13	-0.03	0.01	0.01	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	50/330ppm	-0.03	-0.03	-0.01	-0.04	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	50/4760ppm	-0.39	-0.07	-0.02	0.02	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	330/4760ppm	-0.38	-0.04	-0.02	0.06	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	50/3190ppm	-0.27	-0.05	-0.03	0.01	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	330/3190ppm	-0.25	-0.02	-0.02	0.04	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	3190/4760ppm	-0.17	-.02	0.00	0.02	Fritz (ARB/AAR, 2000)
Average		-0.28	-0.05	-0.01	0.00	

From the above table, staff concluded that HC and CO emissions are not affected by different sulfur levels in the fuel. From these tests, staff computed the changes in PM emissions associated with changes in sulfur level. Staff corrected the PM emissions to account for the aromatic differences because the test data were not tested at the same aromatic volume percent. Because the locomotive engine testing was performed at various fuel sulfur levels (some at 330 ppm vs. 3190 ppm and some at 50 ppm vs. 3190 ppm), staff cannot assume the average percent change in PM emission is characteristics over the whole range of sulfur levels. From previous studies that staff has analyzed, it is possible to generate estimates of the percent change at various sulfur levels and throttle positions. Locomotive engines have 8 throttle positions plus dynamic braking and idle. During idle, braking, and throttle positions 1 and 2, there are no significant differences in emissions attributable to sulfur level. For the GE 4-

stroke engine, effect of sulfur on PM for throttle positions 3 to 8 can be defined by using the following equations:

Equations to correct for PM for GE (4-Stroke) engines

Notch 8 : PM (g/bhp-hr) = 0.00001308 * (sulfur level,ppm) + 0.0967
Notch 7 : PM (g/bhp-hr) = 0.00001102 * (sulfur level,ppm) + 0.0845
Notch 6 : PM (g/bhp-hr) = 0.00000654 * (sulfur level,ppm) + 0.1037
Notch 5 : PM (g/bhp-hr) = 0.00000548 * (sulfur level,ppm) + 0.1320
Notch 4 : PM (g/bhp-hr) = 0.00000663 * (sulfur level,ppm) + 0.1513
Notch 3 : PM (g/bhp-hr) = 0.00000979 * (sulfur level,ppm) + 0.1565

For the EMD 2-stroke engine, throttle positions 3 to 8 can be defined by using the following equations:

Equations to correct for PM for EMD (2-Stroke) engines

Notch 8 : PM (g/bhp-hr) = 0.0000123 * (sulfur level,ppm) + 0.3563
Notch 7 : PM (g/bhp-hr) = 0.0000096 * (sulfur level,ppm) + 0.2840
Notch 6 : PM (g/bhp-hr) = 0.0000134 * (sulfur level,ppm) + 0.2843
Notch 5 : PM (g/bhp-hr) = 0.0000150 * (sulfur level,ppm) + 0.2572
Notch 4 : PM (g/bhp-hr) = 0.0000125 * (sulfur level,ppm) + 0.2629
Notch 3 : PM (g/bhp-hr) = 0.0000065 * (sulfur level,ppm) + 0.2635

Table 25. Examples of PM Reductions Due to Changes in Sulfur Level

Sulfur Level (ppm)		PM Reduction	PM Reduction	PM Reduction
From	To	2 Stroke	4 Stroke	Composite
3100	1900	4.1%	8.4%	5.2%
3100	1300	6.1%	12.6%	7.7%
1300	330	3.5%	7.9%	4.6%
1300	140	4.2%	9.5%	5.5%
140	15	1.8%	4.0%	2.4%

*composite is 75% 2 Stroke Engine and 25% 4 Stroke Engine

Data provided by industry show that when operating in California, the three main types of diesel fuel used in locomotive engines consists of CARB diesel, EPA On-Highway diesel fuel, and EPA Off-road or High Sulfur diesel fuel. Four-stroke engines and two-stroke engines show different characteristics with respect to sulfur content. From the BAH report, 4-stroke engines make up about 25%, and 2-stroke engines make up about 75% of the locomotive engine fleet. Combining industry data, 4-stroke/2-stroke engine percent change and fleet makeup, Table 26 shows the percent change in PM emissions by year for the line-haul segment of the fleet.

Table 26. PM Emission Percent Change of Line-Haul Due to Sulfur, Statewide

Calendar Year	CARB Sulfur Content	EPA On-Highway Sulfur Content	EPA Off-road Sulfur Content	Weighted Fuel Sulfur Content	4-Stroke Engines PM Percent Change	2-Stroke Engines PM Percent Change	Weighted PM Emission Percent Change
1992	3100	3100	3100	3100	0.03	0.01	0.015
1993	500	330	3100	2919	0.02	0.01	0.009
1994	150	330	3100	2740	0.01	0.00	0.003
1995	140	330	3100	2557	-0.01	0.00	-0.006
1996	140	330	3100	2377	-0.02	-0.01	-0.014
1997	140	330	3100	2196	-0.04	-0.02	-0.022
1998-2001	140	330	3100	1899	-0.06	-0.03	-0.035
2002-2006	140	330	3100	1312	-0.10	-0.05	-0.061
2007+	15	15	330	129	-0.19	-0.09	-0.113

Table 27 and Table 28 provide further details of weighted fuel sulfur level by air basin. Weighted sulfur levels vary significantly from one air basin to another.

Table 27. Class I Line Haul Weighted Fuel Sulfur by Air Basin

Interstate Locomotive	Air Basin	1998 Weighted Sulfur	2002-2006 Weighted Sulfur	2007+ Weighted Sulfur
		ppm	ppm	ppm
Class I Line Haul	SCC	1023	467	31
	MC	2333	1149	113
	MD	2352	1767	180
	NEP	2560	1632	166
	SC	1985	1472	145
	SF	1711	899	88
	SJV	1600	868	78
	SS	2425	1328	129
	SV	2473	1456	147

Table 28. Intrastate Locomotives Weighted Fuel Sulfur by Air Basin

Intrastate Locomotive	Air Basin	1993 Weighted Sulfur	1994-2006 Weighted Sulfur	2007+ Weighted Sulfur
		ppm	ppm	ppm
Class I Local/Switcher	SC	346	312	15
	SJV	377	278	15
	MD	330	330	15
	BA	468	175	15
	SD	475	169	15
	SV	475	169	15
	SCC	475	169	15
Class III Local/Switcher	SC	388	388	21
	SJV	1016	804	80
	MD	500	140	15
	BA	500	140	15
	SD	500	140	15
	SV	500	140	15
	SCC	500	140	15
	NEP	2628	2553	264
	MC	1573	1573	152
	NC	500	140	15
	NCC	500	140	15
Industrial/Military	SC	1340	1220	120
	SJV	1340	1220	120
	MD	1340	1220	120
	BA	1340	1220	120
	NEP	1340	1220	120
	SD	1340	1220	120
	SV	1340	1220	120
	SCC	1340	1220	120
Passenger	SC	493	147	15
	SJV	500	140	15
	BA	500	140	15
	SD	500	140	15
	SV	500	140	15
	SCC	483	159	15

Appendix B,C, and D contains the fuel correction factors for PM, NOx, and SOx emissions by air basin.

Revised Locomotive Emission Inventory

Tables 29-31 shows the revised locomotive emission inventory for calendar years 2000,2010 and 2020.

Table 29. 2000 Statewide Locomotive Emission Inventory, tons/day

TYPE	HC	CO	NOx	PM	SOx
Intermodal/Line-Haul	5.61	18.21	113.03	2.68	6.22
Local/Short-Run	1.01	3.33	22.58	0.41	0.22
Mixed/Bulk	2.13	6.85	48.95	1.09	2.20
Passenger/Amtrak	0.53	1.01	12.21	0.29	0.05
Yard/Switcher	0.55	1.46	10.43	0.20	0.09
Total	9.83	30.86	207.20	4.67	8.78

Table 30. 2010 Statewide Locomotive Emission Inventory, tons/day

TYPE	HC	CO	NOx	PM	SOx
Intermodal/Line-Haul	5.56	21.90	71.35	2.40	0.60
Local/Short-Run	0.77	2.99	12.03	0.30	0.01
Mixed/Bulk	2.11	8.24	29.46	0.99	0.19
Passenger/Amtrak	0.58	1.14	12.29	0.31	0.02
Yard/Switcher	0.47	1.29	6.78	0.17	0.01
Total	9.49	35.56	131.91	4.17	0.83

Table 31. 2020 Statewide Locomotive Emission Inventory, tons/day

TYPE	HC	CO	NOx	PM	SOx
Intermodal/Line-Haul	5.60	25.84	74.33	2.38	0.71
Local/Short-Run	0.67	2.99	11.17	0.26	0.01
Mixed/Bulk	2.13	9.72	31.14	0.98	0.23
Passenger/Amtrak	0.56	1.14	11.72	0.30	0.02
Yard/Switcher	0.44	1.29	6.22	0.16	0.01
Total	9.40	40.98	134.58	4.08	0.98

Appendix A

Methodology to Calculate Locomotive Inventory

Methodology

The methodology and assumptions used for estimating locomotive emissions consists of several steps taken from the Booz-Allen Hamilton's Locomotive Emission Study report (http://www.arb.ca.gov/app/library/libcc.php). First, emission factor data from various engine manufacturers such as EMD and General Electric (GE) must be gathered to calculate average emission factors for locomotives operated by the railroad companies. Second, train operations data, including throttle position profiles and time spent on various types of operations from different railroad companies needs to be estimated. Finally, the locomotive emission inventory can be calculated using train operations data, emission factors, and throttle position profiles.

Step 1 – Average Emission Factors

Engine emission factors are required for the different locomotive engines manufactured by the major locomotive suppliers EMD or GE. Emission factors are obtained from testing done by either the engine manufacturers or by Southwest Research Institute, a consulting company that has performed many tests on locomotive engines. Table A-1 lists the available emission factors.

Table A-1. Available Emission Factors for Different Locomotive Engines

Engine Manufacturer	Engine Model	Locomotive Model
EMD	12-567BC	SW10
EMD	12-645E	SW1500,MP15,GP15-1
EMD	16-567C	GP9
EMD	16-645E	GP38,GP38-2, GP28
EMD	12-645E3B	GP39-2
EMD	12-645E3	GP39-2, SD39
EMD	16-645E3	GP40, SD40, F40PH
EMD	16-645E3B	GP40-2, SD40-2, SDF40-2, F40PH
EMD	16-645F3	GP40X, GP50, SD45
EMD	16-645F3B	SD50
EMD	20-645E3	SD45,SD45-2, F45, FP45
EMD	16-710G3	GP60, SD60, SD60M
GE	127FDL2500	B23-7
GE	127FDL3000	SF30B
GE	167FDL3000	C30-7, SF30C
GE	167FDL4000	B40-8

Source: BAH report, 1992

Next, the locomotive roster from the largest railroad companies operating in the state were obtained. Table A-2 lists the locomotive roster for railroad companies in 1987.

Table A-2. Locomotive Roster 1987

					Type of Service		
Railroad Company	Engine Manufacturer	Engine Model	Horspower Rating	Units	Line Haul	Local	Yard/Switcher
ATSF	EMD	16-567BC	1500	211			X
ATSF	EMD	16-567C	1750	53			X
ATSF	EMD	16-567D2	2000	71		X	X
ATSF	EMD	16-645E	2000	69		X	X
ATSF	EMD	12-645E3	2300	62		X	
ATSF	EMD	12-645E3B	2300	60		X	
ATSF	EMD	16-645E3	2500	231	X	X	
ATSF	EMD	16-645E3	3000	18	X	X	
ATSF	EMD	16-645E3B	3000	203	X	X	
ATSF	EMD	16-645F3	3500	52	X		
ATSF	EMD	16-645F3B	3600	15	X		
ATSF	EMD	20-645E3	3600	243	X		
ATSF	EMD	16-710G3	3800	20	X		
ATSF	GE	GE-12	2350	60		X	
ATSF	GE	GE-12	3000	10	X	X	
ATSF	GE	GE-16	3000	226	X	X	

ATSF	GE	GE-16	3600	43	X		
ATSF	GE	GE-16	3900	3	X		
ATSF	GE	GE-16	4000	20	X		
Union Pacific	EMD	16-645BC	1200	56			X
Union Pacific	EMD	12-567A	1200	12			X
Union Pacific	EMD	12-645E	1500	281			X
Union Pacific	EMD	16-567CE	1500	35			X
Union Pacific	EMD	16-645E	2000	365		X	X
Union Pacific	EMD	12-645E3C	2300	24		X	
Union Pacific	EMD	16-567D3A	2500	16		X	
Union Pacific	EMD	16-645E3	3000	828	X	X	
Union Pacific	EMD	16-645E3B	3000	446	X	X	
Union Pacific	EMD	16-645F3	3500	36	X		
Union Pacific	EMD	16-645F3B	3600	60	X		
Union Pacific	EMD	16-710G3	3800	227	X		
Union Pacific	GE	GE-12	2300	106		X	
Union Pacific	GE	GE-12	3000	57	X	X	
Union Pacific	GE	GE-16	3000	156	X	X	
Union Pacific	GE	GE-16	3750	60	X		
Union Pacific	GE	GE-16	3800	256	X		
Southern Pacific	EMD	12-567C	1200	11			X
Southern Pacific	EMD	12-645E	1500	286			X
Southern Pacific	EMD	16-567BC	1500	37			X
Southern Pacific	EMD	16-567C	1750	326		X	
Southern Pacific	EMD	16-567D2	2000	145		X	
Southern Pacific	EMD	16-645E	2000	84		X	
Southern Pacific	EMD	12-645E3	2300	12		X	
Southern Pacific	EMD	16-645E3	2500	137	X	X	
Southern Pacific	EMD	16-645E3	3000	92	X		
Southern Pacific	EMD	16-645E3B	3000	353	X		
Southern Pacific	EMD	16-645F3	3500	4	X		
Southern Pacific	EMD	20-645E3	3600	425	X		
Southern Pacific	EMD	16-710G3	3800	65	X		
Southern Pacific	GE	GE-12	2300	15		X	
Southern Pacific	GE	GE-12	3000	107	X		
Southern Pacific	GE	GE-16	3600	20	X		
Southern Pacific	GE	GE-16	3900	92	X		

Source : BAH report, 1992

Using the available emission factors and the locomotive rosters, the average emission factors for each class of service can be calculated. Emission factors for models that were not available were assigned an emission factor based on horsepower rating and the number of cylinders from similar engine models.

Step 2 – Throttle Position Profiles and Train Operations Data

The railroad companies provided throttle position profiles. Locomotive engines operate at eight different constant loads and speeds called throttle notches. In addition, several other settings (idle and dynamic brake) are also common. For line haul and local operations, profiles were obtained from Train Performance Calculation (TPC) data and actual event recorder data, which are summarized in the BAH report.

For line haul operations, the data was modified to account for additional idle time between dispatch. Data supplied by Atchison, Topeka and Santa Fe (ATSF) indicates that the turnaround time for line haul locomotives in yards is approximately eight hours.

For local operations, several assumptions were used to develop throttle profiles. First, ten hours was used as an average hours per assignment. Second, the additional average idle time per day per locomotive was assumed to be ten hours.

The switch engine duty cycle is based upon actual tape data supplied by the ATSF railroad company on a switch engine that operated over a 2-day period. Yard engines are assumed to operate 350 days per year, with 2 weeks off for inspections and maintenance.

Train operations data provided by the railroad companies included :

Line Haul	**Local**	**Yard/Switcher**
Train type	Average trailing tons	Number of units assigned
Number of runs per year	Number of runs per year	Number of assignments
Average horsepower	Average horsepower	Average horsepower
Average units	Average units	
Origin/destination	Origin/destination	
Link miles		

Step 3 – Calculate Locomotive Emission Inventory

Emission inventories are calculated on a train-by-train basis using train operations data, average emission factor, and throttle position profiles.

Emission Inventory = Emission factor x average horsepower x time in notch per train x number of runs per year

Appendix B
PM Fuel Correction Factor by Air Basin

Interstate Loc	Air Basin	PM Fuel Correction Factor														
		pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Line H	SCC	1.000	0.991	0.982	0.973	0.964	0.955	0.937	0.931	0.925	0.919	0.913	0.913	0.913	0.913	0.913	0.883
	MC	1.000	0.998	0.996	0.994	0.992	0.990	0.987	0.971	0.955	0.939	0.923	0.923	0.923	0.923	0.923	0.867
	MD	1.000	0.998	0.995	0.993	0.991	0.988	0.984	0.978	0.973	0.967	0.962	0.962	0.962	0.962	0.962	0.884
	NEP	1.000	0.999	0.998	0.998	0.997	0.996	0.995	0.983	0.971	0.959	0.947	0.947	0.947	0.947	0.947	0.875
	SC	1.000	0.996	0.993	0.989	0.986	0.982	0.975	0.970	0.965	0.960	0.955	0.955	0.955	0.955	0.955	0.888
	SF	1.000	0.993	0.987	0.980	0.974	0.967	0.954	0.940	0.926	0.912	0.898	0.898	0.898	0.898	0.898	0.851
	SJV	1.000	0.993	0.986	0.979	0.972	0.965	0.952	0.944	0.937	0.930	0.923	0.923	0.923	0.923	0.923	0.878
	SS	1.000	0.999	0.997	0.996	0.995	0.993	0.991	0.980	0.970	0.959	0.949	0.949	0.949	0.949	0.949	0.887
	SV	1.000	0.993	0.986	0.979	0.972	0.965	0.952	0.948	0.945	0.942	0.939	0.939	0.939	0.939	0.939	0.873

Intrastate Loc	Air Basin	PM Fuel Correction Factor														
		pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Local/	SC	1.000	0.890	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.865
	SJV	1.000	0.863	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.836
	MD	1.000	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.882
	BA	1.000	0.778	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.747
	SD	1.000	0.772	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.741
	SV	1.000	0.772	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.741
	SCC	1.000	0.772	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.741
Class III Loca	SC	1.000	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.882
	SJV	1.000	0.839	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.787
	MD	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	BA	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SD	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SV	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SCC	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	NEP	1.000	0.963	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.858
	MC	1.000	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.888
	NC	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	NCC	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.722
Industrial/Milit	SC	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	SJV	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	MD	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	BA	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	NEP	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	SD	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	SV	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	SCC	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
Passenger	SC	1.000	0.754	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.723
	SJV	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	BA	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SD	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SV	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SCC	1.000	0.764	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.733

Appendix C
NOx Fuel Correction Factor by Air Basin

Interstate Loc	Air Basin	NOx Fuel Correction Factor															
		pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Line H	SCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	NEP	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SF	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SJV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SS	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940

Intrastate Loc	Air Basin	NOx Fuel Correction Factor															
		pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Local/	SC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SJV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	BA	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
Class III Loca	SC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SJV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	BA	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	NEP	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	NC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	NCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
Industrial/Milit	SC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SJV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	BA	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	NEP	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
Passenger	SC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SJV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	BA	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940

Appendix D
SOx Fuel Correction Factor by Air Basin

Interstate Loc	Air Basin	SOx Fuel Correction Factor															
		pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Line H	SCC	1.000	0.896	0.793	0.689	0.586	0.482	0.379	0.327	0.276	0.225	0.173	0.173	0.173	0.173	0.173	0.011
	MC	1.000	0.977	0.955	0.932	0.909	0.887	0.864	0.755	0.645	0.535	0.426	0.426	0.426	0.426	0.426	0.042
	MD	1.000	0.979	0.957	0.936	0.914	0.893	0.871	0.817	0.763	0.709	0.654	0.654	0.654	0.654	0.654	0.067
	NEP	1.000	0.991	0.983	0.974	0.965	0.957	0.948	0.862	0.776	0.690	0.605	0.605	0.605	0.605	0.605	0.062
	SC	1.000	0.956	0.912	0.868	0.823	0.779	0.735	0.688	0.640	0.593	0.545	0.545	0.545	0.545	0.545	0.054
	SF	1.000	0.939	0.878	0.817	0.756	0.695	0.634	0.559	0.483	0.408	0.333	0.333	0.333	0.333	0.333	0.033
	SJV	1.000	0.932	0.864	0.796	0.728	0.660	0.593	0.525	0.457	0.389	0.322	0.322	0.322	0.322	0.322	0.029
	SS	1.000	0.983	0.966	0.949	0.932	0.915	0.898	0.797	0.695	0.594	0.492	0.492	0.492	0.492	0.492	0.048
	SV	1.000	0.986	0.972	0.958	0.944	0.930	0.916	0.822	0.728	0.634	0.539	0.539	0.539	0.539	0.539	0.054

Intrastate Loc	Air Basin	SOx Fuel Correction Factor															
		pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Local/	SC	1.000	0.128	0.127	0.126	0.125	0.124	0.122	0.121	0.120	0.119	0.118	0.117	0.115	0.115	0.115	0.006
	SJV	1.000	0.139	0.136	0.133	0.130	0.126	0.123	0.120	0.116	0.113	0.110	0.106	0.103	0.103	0.103	0.006
	MD	1.000	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.006
	BA	1.000	0.173	0.164	0.154	0.144	0.134	0.124	0.114	0.104	0.095	0.085	0.075	0.065	0.065	0.065	0.006
	SD	1.000	0.176	0.165	0.155	0.145	0.135	0.124	0.114	0.104	0.093	0.083	0.073	0.062	0.062	0.062	0.006
	SV	1.000	0.176	0.165	0.155	0.145	0.135	0.124	0.114	0.104	0.093	0.083	0.073	0.062	0.062	0.062	0.006
	SCC	1.000	0.176	0.165	0.155	0.145	0.135	0.124	0.114	0.104	0.093	0.083	0.073	0.062	0.062	0.062	0.006
Class III Loca	SC	1.000	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.008
	SJV	1.000	0.376	0.369	0.362	0.355	0.348	0.341	0.333	0.326	0.319	0.312	0.305	0.298	0.298	0.298	0.029
	MD	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	BA	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SD	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SV	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SCC	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	NEP	1.000	0.973	0.971	0.968	0.966	0.963	0.961	0.958	0.956	0.953	0.951	0.948	0.946	0.946	0.946	0.098
	MC	1.000	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.056
	NC	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	NCC	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
Industrial/Milit	SC	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	SJV	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	MD	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	BA	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	NEP	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	SD	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	SV	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	SCC	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
Passenger	SC	1.000	0.183	0.171	0.159	0.148	0.136	0.124	0.113	0.101	0.090	0.078	0.066	0.055	0.055	0.055	0.006
	SJV	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	BA	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SD	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SV	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SCC	1.000	0.179	0.168	0.157	0.146	0.135	0.124	0.113	0.103	0.092	0.081	0.070	0.059	0.059	0.059	0.006

APPENDIX B

EMISSION FACTOR DERIVATION AND EMFAC 2007 OUTPUT FOR DIESEL-FUELED YARD TRUCKS

Emission Factors for Diesel-Fueled Yard Trucks
Colton Rail Yard, Bloomington, CA

Running Exhaust Emissions

Equipment	Equipment	Vehicle			Vehicle	Emission Factors (g/mi)[1,2]					
Type	ID/Owner	ID	Make/Model	Year	Class	ROG	CO	NOx	PM10[3]	DPM[3]	SOx
Truck	Engineering	69496	Chevy CK 3500	1998	LDT	0.12	1.13	1.60	0.06	0.06	0.06
Truck	Engineering	69499	Chevy CK 3500	1998	LDT	0.12	1.13	1.60	0.06	0.06	0.06
Truck	Car Dept	1915-73119	Ford F-450	2003	LHDT1	0.33	1.70	6.70	0.11	0.08	0.04
Truck	Engineering	9007E	Ford F-800	1992	MHD	0.94	9.70	18.46	1.25	1.25	0.16
Truck	Engineering	9009E	Ford F-800	1992	MHD	0.94	9.70	18.46	1.25	1.25	0.16
Truck	Engineering	9031E	Ford F-800	1992	MHD	0.94	9.70	18.46	1.25	1.25	0.16
Truck	Engineering	9018E	Ford F-800	1992	MHD	0.94	9.70	18.46	1.25	1.25	0.16
Truck	Car Dept	NA	International	1987	HHD	12.31	41.26	31.86	5.72	5.72	0.22
Truck	Engineering	64274	Ford LT8000	1989	HHD	12.06	40.31	31.60	5.48	5.42	0.24
Truck	Car Dept	1915-9038E	Ford LT9000	1997	HHD	6.92	16.99	31.05	2.34	2.26	0.24
Total											

Idling Exhaust Emissions

Equipment	Equipment	Vehicle			Vehicle	Emission Factors (g/hr)[4]					
Type	ID/Owner	ID	Make/Model	Year	Class	ROG	CO	NOx	PM10[3]	DPM[3]	SOx
Truck	Engineering	69496	Chevy CK 3500	1998	LDT	0.00	0.00	0.00	0.00	0.00	0.00
Truck	Engineering	69499	Chevy CK 3500	1998	LDT	0.00	0.00	0.00	0.00	0.00	0.00
Truck	Car Dept	1915-73119	Ford F-450	2003	LHDT2	3.17	26.30	75.05	0.75	0.75	0.34
Truck	Engineering	9007E	Ford F-800	1992	MHD	3.17	26.30	75.05	1.40	1.40	0.34
Truck	Engineering	9009E	Ford F-800	1992	MHD	3.17	26.30	75.05	1.40	1.40	0.34
Truck	Engineering	9031E	Ford F-800	1992	MHD	3.17	26.30	75.05	1.40	1.40	0.34
Truck	Engineering	9018E	Ford F-800	1992	MHD	3.17	26.30	75.05	1.40	1.40	0.34
Truck	Car Dept	NA	International	1987	HHD	22.84	61.55	82.94	4.28	4.28	0.55
Truck	Engineering	64274	Ford LT8000	1989	HHD	19.45	58.49	85.53	3.43	3.43	0.55
Truck	Car Dept	1915-9038E	Ford LT9000	1997	HHD	12.41	49.53	110.27	1.93	1.93	0.55
Total											

Notes:
1. Running exhaust emissions calculated using the EMFAC2007 model with the BURDEN output option.
2. Running exhaust emission factor calculations assumed an average speed of 15 mph.
3. The PM10 emission factor includes engine exhaust emissions along with brake and tire wear. The DPM emission factor includes engine exhaust emissions only.
4. Idling exhaust emissions factors calculated using the EMFAC2007 model with the EMFAC output option.

Title : Statewide totals Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/08/29 12:52:46
Scen Year: 2005 -- Model year 1998 selected
Season : Annual
Area : Statewide totals Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 59 Los Angeles (SC)
Emissions: Tons Per Day
****

	LDT1-DSL
Vehicles	4219
VMT/1000	153
Trips	27083
Reactive Organic Gas Emissions	
Run Exh	0.02
Idle Exh	0
Start Ex	0

Total Ex	0.02
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	0.02
Carbon Monoxide Emissions	
Run Exh	0.19
Idle Exh	0
Start Ex	0

Total Ex	0.19
Oxides of Nitrogen Emissions	
Run Exh	0.27
Idle Exh	0
Start Ex	0

Total Ex	0.27
Carbon Dioxide Emissions (000)	
Run Exh	0.06
Idle Exh	0
Start Ex	0

Total Ex	0.06
PM10 Emissions	
Run Exh	0.01
Idle Exh	0
Start Ex	0

Total Ex	0.01
TireWear	0
BrakeWr	0

Total	0.01
Lead	0
SOx	0.01
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	5.24

Title : Statewide totals Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/08/29 12:53:28
Scen Year: 2005 -- Model year 1998 selected
Season : Annual
Area : Statewide totals
****
Year: 2005 -- Model Years 1998 to 1998 Inclusive --
Emfac2007 Emission Factors: V2.3 Nov 1 2006 ** WIS Enabled **

State Average State Average

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	LDT1 NCAT	LDT1 CAT	LDT1 DSL	LDT1 ALL
0	0	0	0	0

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	LDT1 NCAT	LDT1 CAT	LDT1 DSL	LDT1 ALL
0	0	0	0	0

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	LDT1 NCAT	LDT1 CAT	LDT1 DSL	LDT1 ALL
0	0	0	0	0

Pollutant Name: Carbon Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	LDT1 NCAT	LDT1 CAT	LDT1 DSL	LDT1 ALL
0	0	0	0	0

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	LDT1 NCAT	LDT1 CAT	LDT1 DSL	LDT1 ALL
0	0	0	0	0

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	LDT1 NCAT	LDT1 CAT	LDT1 DSL	LDT1 ALL
0	0	0	0	0

Title : Statewide totals Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/08/29 12:53:28
Scen Year: 2005 -- Model year 1998 selected
Season : Annual
Area : Statewide totals
****
Year: 2005 -- Model Years 1998 to 1998 Inclusive --
Emfac2007 Emission Factors: V2.3 Nov 1 2006 ** WIS Enabled **

State Average State Average

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	LDT1 NCAT	LDT1 CAT	LDT1 DSL	LDT1 ALL
0	0	0	0	0

Pollutant Name: PM10 - Brake Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	LDT1 NCAT	LDT1 CAT	LDT1 DSL	LDT1 ALL
0	0	0	0	0

Pollutant Name: Gasoline - mi/gal Temperature: 65F Relative Humidity: 60%

Speed MPH	LDT1 NCAT	LDT1 CAT	LDT1 DSL	LDT1 ALL
0	0	0	0	0

Pollutant Name: Diesel - mi/gal Temperature: 65F Relative Humidity: 60%

Speed MPH	LDT1 NCAT	LDT1 CAT	LDT1 DSL	LDT1 ALL
0	0	0	0	0

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/08/29 13:33:54
Scen Year: 2005 -- Model year 2003 selected
Season : Annual
Area : Statewide totals Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 59 Los Angeles (SC)
Emissions: Tons Per Day
****

	LHDT1-DSL
Vehicles	15619
VMT/1000	822
Trips	196467
Reactive Organic Gas Emissions	
Run Exh	0.3
Idle Exh	0
Start Ex	0

Total Ex	0.3
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	0.3
Carbon Monoxide Emissions	
Run Exh	1.54
Idle Exh	0.02
Start Ex	0

Total Ex	1.55
Oxides of Nitrogen Emissions	
Run Exh	6.07
Idle Exh	0.04
Start Ex	0

Total Ex	6.12
Carbon Dioxide Emissions (000)	
Run Exh	0.47
Idle Exh	0
Start Ex	0

Total Ex	0.47
PM10 Emissions	
Run Exh	0.07
Idle Exh	0
Start Ex	0

Total Ex	0.08
TireWear	0.01
BrakeWr	0.01

Total	0.1
Lead	0
SOx	0.04
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	42.56

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/08/29 13:37:39
Scen Year: 2005 -- Model year 2003 selected
Season : Annual
Area : Los Angeles
****
Year: 2005 -- Model Years 2003 to 2003 Inclusive --
Emfac2007 Emission Factors: V2.3 Nov 1 2006 ** WIS Enabled **

County Average Los Angeles

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	23.103	3.173	20.013

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	141.992	26.3	124.054

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	1.561	75.051	12.955

Pollutant Name: Carbon Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	4776.9	4098	4671.638

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0.049	0.341	0.094

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0.753	0.117

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/08/29 13:37:39
Scen Year: 2005 -- Model year 2003 selected
Season : Annual
Area : Los Angeles
****
Year: 2005 -- Model Years 2003 to 2003 Inclusive --
Emfac2007 Emission Factors: V2.3 Nov 1 2006 ** WIS Enabled **

County Average Los Angeles

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0	0

Pollutant Name: PM10 - Brake Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0	0

Pollutant Name: Gasoline - mi/gal Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0	0

Pollutant Name: Diesel - mi/gal Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0	0

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/08/29 11:52:52
Scen Year: 2005 -- Model year 1992 selected
Season : Annual
Area : Los Angeles County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 59 Los Angeles (SC)
Emissions: Tons Per Day
****

	MHDT-DSL
Vehicles	1059
VMT/1000	58
Trips	29682
Reactive Organic Gas Emissions	
Run Exh	0.06
Idle Exh	0
Start Ex	0

Total Ex	0.06
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	0.06
Carbon Monoxide Emissions	
Run Exh	0.62
Idle Exh	0
Start Ex	0

Total Ex	0.62
Oxides of Nitrogen Emissions	
Run Exh	1.18
Idle Exh	0.01
Start Ex	0

Total Ex	1.19
Carbon Dioxide Emissions (000)	
Run Exh	0.1
Idle Exh	0
Start Ex	0

Total Ex	0.1
PM10 Emissions	
Run Exh	0.08
Idle Exh	0
Start Ex	0

Total Ex	0.08
TireWear	0
BrakeWr	0

Total	0.08
Lead	0
SOx	0.01
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	8.66

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/08/29 13:45:18
Scen Year: 2005 -- Model year 1992 selected
Season : Annual
Area : Los Angeles
****
Year: 2005 -- Model Years 1992 to 1992 Inclusive --
Emfac2007 Emission Factors: V2.3 Nov 1 2006 ** WIS Enabled **

County Average Los Angeles

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	MHD NCAT	MHD CAT	MHD DSL	MHD ALL
0	0	23.103	3.173	6.815

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	MHD NCAT	MHD CAT	MHD DSL	MHD ALL
0	0	141.992	26.3	47.438

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	MHD NCAT	MHD CAT	MHD DSL	MHD ALL
0	0	1.561	75.051	61.623

Pollutant Name: Carbon Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	MHD NCAT	MHD CAT	MHD DSL	MHD ALL
0	0	4776.9	4098	4222.044

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	MHD NCAT	MHD CAT	MHD DSL	MHD ALL
0	0	0.049	0.341	0.287

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	MHD NCAT	MHD CAT	MHD DSL	MHD ALL
0	0	0	1.395	1.14

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/08/29 13:45:18
Scen Year: 2005 -- Model year 1992 selected
Season : Annual
Area : Los Angeles
****
Year: 2005 -- Model Years 1992 to 1992 Inclusive --
Emfac2007 Emission Factors: V2.3 Nov 1 2006 ** WIS Enabled **

County Average Los Angeles

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	MHD NCAT	MHD CAT	MHD DSL	MHD ALL
0	0	0	0	0

Pollutant Name: PM10 - Brake Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	MHD NCAT	MHD CAT	MHD DSL	MHD ALL
0	0	0	0	0

Pollutant Name: Gasoline - mi/gal Temperature: 65F Relative Humidity: 60%

Speed MPH	MHD NCAT	MHD CAT	MHD DSL	MHD ALL
0	0	0	0	0

Pollutant Name: Diesel - mi/gal Temperature: 65F Relative Humidity: 60%

Speed MPH	MHD NCAT	MHD CAT	MHD DSL	MHD ALL
0	0	0	0	0

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/08/29 11:47:33
Scen Year: 2005 -- Model year 1987 selected
Season : Annual
Area : Los Angeles County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 5
Emissions: Tons Per Day
****

	HHDT-DSL
Vehicles	816
VMT/1000	84
Trips	4129
Reactive Organic Gas Emissions	
Run Exh	1.14
Idle Exh	0.03
Start Ex	0

Total Ex	1.18
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	1.18
Carbon Monoxide Emissions	
Run Exh	3.82
Idle Exh	0.09
Start Ex	0

Total Ex	3.91
Oxides of Nitrogen Emissions	
Run Exh	2.95
Idle Exh	0.13
Start Ex	0

Total Ex	3.07
Carbon Dioxide Emissions (000)	
Run Exh	0.27
Idle Exh	0.01
Start Ex	0

Total Ex	0.28
PM10 Emissions	
Run Exh	0.53
Idle Exh	0.01
Start Ex	0

Total Ex	0.53
TireWear	0
BrakeWr	0

Total	0.54
Lead	0
SOx	0.02
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	24.86

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/08/29 11:57:55
Scen Year: 2005 -- Model year 1987 selected
Season : Annual
Area : Los Angeles
****
Year: 2005 -- Model Years 1987 to 1987 Inclusive --
Emfac2007 Emission Factors: V2.3 Nov 1 2006 ** WIS Enabled **

County Average Los Angeles

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
	0	0	0 22.835	21.309

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
	0	0	0 61.549	57.434

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
	0	0	0 82.939	77.394

Pollutant Name: Carbon Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
	0	0	0 6617.134	6174.752

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
	0	0	0 0.55	0.513

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
	0	0	0 4.282	3.996

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/08/29 11:57:55
Scen Year: 2005 -- Model year 1987 selected
Season : Annual
Area : Los Angeles
****
Year: 2005 -- Model Years 1987 to 1987 Inclusive --
Emfac2007 Emission Factors: V2.3 Nov 1 2006 ** WIS Enabled **

County Average Los Angeles

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: PM10 - Brake Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: Gasoline - mi/gal Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: Diesel - mi/gal Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/08/29 11:48:28
Scen Year: 2005 -- Model year 1989 selected
Season : Annual
Area : Los Angeles County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 59
Emissions: Tons Per Day
****

	HHDT-DSL
Vehicles	1237
VMT/1000	149
Trips	6260
Reactive Organic Gas Emissions	
Run Exh	1.98
Idle Exh	0.04
Start Ex	0

Total Ex	2.03
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	2.03
Carbon Monoxide Emissions	
Run Exh	6.62
Idle Exh	0.13
Start Ex	0

Total Ex	6.76
Oxides of Nitrogen Emissions	
Run Exh	5.19
Idle Exh	0.2
Start Ex	0

Total Ex	5.39
Carbon Dioxide Emissions (000)	
Run Exh	0.47
Idle Exh	0.02
Start Ex	0

Total Ex	0.49
PM10 Emissions	
Run Exh	0.89
Idle Exh	0.01
Start Ex	0

Total Ex	0.9
TireWear	0.01
BrakeWr	0

Total	0.91
Lead	0
SOx	0.04
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	43.8

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/08/29 11:58:37
Scen Year: 2005 -- Model year 1989 selected
Season : Annual
Area : Los Angeles
****
Year: 2005 -- Model Years 1989 to 1989 Inclusive --
Emfac2007 Emission Factors: V2.3 Nov 1 2006 ** WIS Enabled **

County Average Los Angeles

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
	0	0	0	19.449	18.491

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	58.485	55.602

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	85.533	81.317

Pollutant Name: Carbon Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	6617.134	6290.959

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0.55	0.523

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	3.433	3.264

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/08/29 11:58:37
Scen Year: 2005 -- Model year 1989 selected
Season : Annual
Area : Los Angeles
****
Year: 2005 -- Model Years 1989 to 1989 Inclusive --
Emfac2007 Emission Factors: V2.3 Nov 1 2006 ** WIS Enabled **

County Average Los Angeles

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: PM10 - Brake Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: Gasoline - mi/gal Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: Diesel - mi/gal Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/08/29 11:49:25
Scen Year: 2005 -- Model year 1997 selected
Season : Annual
Area : Los Angeles County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area
Emissions: Tons Per Day
****

	HHDT-DSL
Vehicles	1395
VMT/1000	345
Trips	7058
Reactive Organic Gas Emissions	
Run Exh	2.63
Idle Exh	0.03
Start Ex	0

Total Ex	2.66
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	2.66
Carbon Monoxide Emissions	
Run Exh	6.46
Idle Exh	0.13
Start Ex	0

Total Ex	6.59
Oxides of Nitrogen Emissions	
Run Exh	11.81
Idle Exh	0.29
Start Ex	0

Total Ex	12.1
Carbon Dioxide Emissions (000)	
Run Exh	1.09
Idle Exh	0.02
Start Ex	0

Total Ex	1.11
PM10 Emissions	
Run Exh	0.86
Idle Exh	0
Start Ex	0

Total Ex	0.86
TireWear	0.01
BrakeWr	0.01

Total	0.89
Lead	0
SOx	0.09
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	99.81

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/08/29 11:59:24
Scen Year: 2005 -- Model year 1997 selected
Season : Annual
Area : Los Angeles
****
Year: 2005 -- Model Years 1997 to 1997 Inclusive --
Emfac2007 Emission Factors: V2.3 Nov 1 2006 ** WIS Enabled **

County Average Los Angeles

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
	0	0	0	12.413	11.839

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	49.525	47.237

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	110.267	105.171

Pollutant Name: Carbon Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	6617.135	6311.32

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0.55	0.525

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	1.928	1.839

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2007/08/29 11:59:24
Scen Year: 2005 -- Model year 1997 selected
Season : Annual
Area : Los Angeles
****
Year: 2005 -- Model Years 1997 to 1997 Inclusive --
Emfac2007 Emission Factors: V2.3 Nov 1 2006 ** WIS Enabled **

County Average Los Angeles

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: PM10 - Brake Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: Gasoline - mi/gal Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: Diesel - mi/gal Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

APPENDIX C

EMISSION FACTOR DERIVATION AND EMFAC 2007 OUTPUT FOR HHD DIESEL-FUELED DELIVERY TRUCKS

Emission Factors for HHD Diesel-Fueled Delivery Trucks
Dolores and ICTF Rail Yards, Long Beach, CA

Running Exhaust Emissions

Delivery	2005 Emission Factors (g/mi)[1,2]					
Type	ROG	CO	NOx	PM10[3]	DPM[3]	SOx
Gasoline	6.40	17.23	28.68	2.53	2.47	0.24
Lube Oil	6.40	17.23	28.68	2.53	2.47	0.24
Used Oil	6.40	17.23	28.68	2.53	2.47	0.24
Soap	6.40	17.23	28.68	2.53	2.47	0.24
Sand	6.40	17.23	28.68	2.53	2.47	0.24
Total						

Idling Exhaust Emissions

Delivery	2005 Emission Factors (g/hr)[4]					
Type	ROG	CO	NOx	PM10	DPM	SOx
Gasoline	16.16	52.99	100.38	2.85	2.85	0.55
Lube Oil	16.16	52.99	100.38	2.85	2.85	0.55
Used Oil	16.16	52.99	100.38	2.85	2.85	0.55
Soap	16.16	52.99	100.38	2.85	2.85	0.55
Sand	16.16	52.99	100.38	2.85	2.85	0.55
Total						

Notes:
1. Running exhaust emission factors (g/mi) from EMFAC 2007 using the BURDEN output option. The EMFAC default model year distribution for L.A. County was used.
2. Emission factor calculations assumed an average speed of 15 mph.
3. The PM10 emission factor includes engine exhaust emissions along with brake and tire wear. The DPM emission factor includes engine exhaust emissions only.
4. Idling exhaust emission factors from EMFAC 2007 using the EMFAC output option. The EMFAC default model year distribution for L.A. County was used.

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006 ** WIS Enabled **
Run Date : 2006/12/14 07:57:01
Scen Year: 2005 -- All model years in the range 1965 to 2005 selected
Season : Annual
Area : Los Angeles County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 59 Los Angeles (SC)
Emissions: Tons Per Day
****

	HHDT-DSL
Vehicles	27425
VMT/1000	5538
Trips	138783
Reactive Organic Gas Emissions	
Run Exh	39.07
Idle Exh	0.82
Start Ex	0

Total Ex	39.9
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	39.9
Carbon Monoxide Emissions	
Run Exh	105.2
Idle Exh	2.7
Start Ex	0

Total Ex	107.91
Oxides of Nitrogen Emissions	
Run Exh	175.11
Idle Exh	5.12
Start Ex	0

Total Ex	180.23
Carbon Dioxide Emissions (000)	
Run Exh	17.5
Idle Exh	0.34
Start Ex	0

Total Ex	17.84
PM10 Emissions	
Run Exh	15.05
Idle Exh	0.15
Start Ex	0

Total Ex	15.19
TireWear	0.22
BrakeWr	0.17

Total	15.59
Lead	0
SOx	1.48
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	1605.41

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac2007 V2.3 Nov 1 2006
Run Date : 2006/12/14 08:09:32
Scen Year: 2005 -- All model years in the range 1965 to 2005 selected
Season : Annual
Area : Los Angeles
****
Year: 2005 -- Model Years 1965 to 2005 Inclusive --
Emfac2007 Emission Factors: V2.3 Nov 1 2006

County Average Los Angeles

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	16.163	15.188

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	52.988	49.792

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	100.382	94.327

Pollutant Name: Carbon Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	6617.134	6192.269

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0.55	0.517

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	2.845	2.674

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

APPENDIX D

EMISSION FACTOR DERIVATION AND OFFROAD2007 OUTPUT FOR HEAVY EQUIPMENT

Emission Factors for Diesel Fueled Heavy Equipment
Colton Rail Yard, Bloomington, CA

Equipment Owner	Equipment Type [1]	Equipment Make	Equipment Model	Engine Make	Engine Model	Engine Model Year	Engine Rating (hp)	No of Units	Hours of Operation (hrs/yr)[2,3]	Load Factor[4]	2005 Emission Factor (g/bhp-hr)[5]					
											ROG	CO	NOx	PM10	DPM	SOx
Locomotive Shop	Rail Cleaner	Unknown	Unknown	Detroit	4 cyl	2003	125	1	5	0.68	0.52	2.96	5.32	0.25	0.25	0.06
Car Dept	Rerailer	Cline	Unknown	Unknown	Unknown	1987	183	1	*365*	0.51	1.64	5.52	13.04	0.77	0.77	0.06
Car Dept	Crane	Lorain	LRT-250	Cummins	6BTA	1997	145	1	260	0.43	1.27	3.55	8.35	0.58	0.58	0.06
Car Dept	Forklift	Toyota	6EDU45	Unknown	Unknown	1999	79	1	312	0.30	1.85	4.60	8.36	1.06	1.06	0.06
Total								**4**								

Notes:
1. In addition to the equipment listed above, UPRR also ownes a Rail King Locomotive Mover. This unit did not operate in 2005 and therefore, is not included in the inventory.
2. Hours of operation for the rail cleaner, crane, and forklift estimated by UPRR staff.
3. Hours of operation for the rerailer are an engineering estimate based on disucssion with UPRR staff.
4. Default load factors from OFFROAD2007 model.
5. Emission factors from OFFROAD2007 model.

APPENDIX D
OFFROAD2007 OUTPUT

Cnty	SubR	SCC	HP	TechType	MYr	Population	ROG-Exhaust	CO-Exhaust	NOx-Exhaust	CO2-Exhaust	SO2-Exhaust
San Bernardino		2270002045	175		1997		0.000269232	0.00075251	0.001769009	0.120235	1.17247E-05
San Bernardino		2270003020	120		1999		0.000690862	0.001715249	0.003119413	0.2120184	2.15547E-05
San Bernardino		2270003030	175		2003		0.000431349	0.0024577	0.004416037	0.4716508	4.5993E-05
San Bernardino		2270003040	250		1987		0.000272099	0.000914552	0.00215985	0.09395151	9.16167E-06

APPENDIX D
OFFROAD2007 OUTPUT

PM-Exhaust	Crankcase	FuelCons.	Activity	LF	HPAvg	ROG/ROG	ROG (g/hp-hr)	CO (g/hp-hr)	NOx (g/hp-hr)	SOx (g/hp-hr)	PM (g/hp-hr)
0.000123685			3	0.43	149	1	1.270709383	3.551668213	8.349297277	0.055337766	0.583762999
0.000396337			13.59	0.3	83	1	1.852117299	4.598373373	8.362765802	0.057785602	1.062531159
0.000206176			6.79	0.68	163	1	0.519946268	2.962500544	5.32307117	0.05543972	0.248523504
0.00012771			1.39	0.51	212	1	1.642486503	5.520561912	13.03762887	0.055303118	0.770902738

APPENDIX D
OFFROAD2007 OUTPUT

CY	Season	AvgDays	Code	Equipment	Fuel	MaxHP	Class	C/R	Pre	Hand	Port	County	Air Basin
2005	Annual	Mon-Sun	2270002045	Cranes	D	175	Constructio	U	P	NHH	P	San Bernarc	SC
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial E	U	P	NHH	NP	San Bernarc	SC
2005	Annual	Mon-Sun	2270003030	Sweepers/S	D	175	Industrial E	U	N	NHH	NP	San Bernarc	SC
2005	Annual	Mon-Sun	2270003040	Other Gene	D	250	Industrial E	U	N	NHH	NP	San Bernarc	SC

APPENDIX D
OFFROAD2007 OUTPUT

Air Dist.	MY	Population	Activity	Consumptio	ROG Exhau	CO Exhaust	NOX Exhau	CO2 Exhau	SO2 Exhau	PM Exhaust	N2O Exhau	CH4 Exhaust
SC	1997	0.85	3	11.03	2.69E-04	7.53E-04	1.77E-03	1.20E-01	1.17E-05	1.24E-04	0.00E+00	2.43E-05
SC	1999	2.75	13.59	19.59	6.91E-04	1.72E-03	3.12E-03	2.12E-01	2.16E-05	3.96E-04	0.00E+00	6.23E-05
SC	2003	2.03	6.79	42.98	4.31E-04	2.46E-03	4.42E-03	4.72E-01	4.60E-05	2.06E-04	0.00E+00	3.89E-05
SC	1987	0.35	1.39	8.69	2.72E-04	9.15E-04	2.16E-03	9.40E-02	9.16E-06	1.28E-04	0.00E+00	2.46E-05

APPENDIX E

TANKS OUTPUT AND SPECIATE DATABASE SECTIONS FOR THE GASOLINE STORAGE TANKS

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	Colton # 1189	
City:	Los Angeles C.O.	
State:	California	
Company:	UPRR	
Type of Tank:	Horizontal Tank	
Description:		

Tank Dimensions

Shell Length (ft):		5.00
Diameter (ft):		4.20
Volume (gallons):		500.00
Turnovers:		7.75
Net Throughput(gal/yr):		3,875.00
Is Tank Heated (y/n):	N	
Is Tank Underground (y/n):	N	

Paint Characteristics

Shell Color/Shade:	White/White	
Shell Condition	Good	

Breather Vent Settings

Vacuum Settings (psig):		-0.03
Pressure Settings (psig)		0.03

Meterological Data used in Emissions Calculations: Los Angeles C.O., California (Avg Atmospheric Pressure = 14.67 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

Colton # 1189 - Horizontal Tank
Los Angeles C.O., California

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Gasoline (RVP 13)	All	68.08	62.92	73.24	65.99	8.0605	7.3344	8.8422	62.0000			92.00	Option 4: RVP=13, ASTM Slope=3

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

Colton # 1189 - Horizontal Tank
Los Angeles C.O., California

Annual Emission Calcaulations	
Standing Losses (lb):	193.3005
Vapor Space Volume (cu ft):	44.1224
Vapor Density (lb/cu ft):	0.0882
Vapor Space Expansion Factor:	0.2580
Vented Vapor Saturation Factor:	0.5271
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	44.1224
Tank Diameter (ft):	4.2000
Effective Diameter (ft):	5.1722
Vapor Space Outage (ft):	2.1000
Tank Shell Length (ft):	5.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0882
Vapor Molecular Weight (lb/lb-mole):	62.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	8.0605
Daily Avg. Liquid Surface Temp. (deg. R):	527.7526
Daily Average Ambient Temp. (deg. F):	65.9667
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	525.6567
Tank Paint Solar Absorptance (Shell):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,567.1816
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2580
Daily Vapor Temperature Range (deg. R):	20.6478
Daily Vapor Pressure Range (psia):	1.5079
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	8.0605
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	7.3344
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	8.8422
Daily Avg. Liquid Surface Temp. (deg R):	527.7526
Daily Min. Liquid Surface Temp. (deg R):	522.5906
Daily Max. Liquid Surface Temp. (deg R):	532.9145
Daily Ambient Temp. Range (deg. R):	18.3167
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.5271
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	8.0605
Vapor Space Outage (ft):	2.1000
Working Losses (lb):	46.1078
Vapor Molecular Weight (lb/lb-mole):	62.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	8.0605
Annual Net Throughput (gal/yr.):	3,875.0000

Annual Turnovers:	7.7500
Turnover Factor:	1.0000
Tank Diameter (ft):	4.2000
Working Loss Product Factor:	1.0000
Total Losses (lb):	239.4083

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

Colton # 1189 - Horizontal Tank
Los Angeles C.O., California

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Gasoline (RVP 13)	46.11	193.30	239.41

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification

User Identification:	Colton #1172	
City:	Los Angeles C.O.	
State:	California	
Company:	UPRR	
Type of Tank:	Horizontal Tank	
Description:		

Tank Dimensions

Shell Length (ft):		5.00
Diameter (ft):		4.20
Volume (gallons):		500.00
Turnovers:		0.00
Net Throughput(gal/yr):		500.00
Is Tank Heated (y/n):	N	
Is Tank Underground (y/n):	N	

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition	Good

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig)	0.03

Meterological Data used in Emissions Calculations: Los Angeles C.O., California (Avg Atmospheric Pressure = 14.67 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

Colton #1172 - Horizontal Tank
Los Angeles C.O., California

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Gasoline (RVP 13)	All	68.08	62.92	73.24	65.99	8.0605	7.3344	8.8422	62.0000			92.00	Option 4: RVP=13, ASTM Slope=3

APP-128

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

Colton #1172 - Horizontal Tank
Los Angeles C.O., California

Annual Emission Calcaulations	
Standing Losses (lb):	193.3005
Vapor Space Volume (cu ft):	44.1224
Vapor Density (lb/cu ft):	0.0882
Vapor Space Expansion Factor:	0.2580
Vented Vapor Saturation Factor:	0.5271
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	44.1224
Tank Diameter (ft):	4.2000
Effective Diameter (ft):	5.1722
Vapor Space Outage (ft):	2.1000
Tank Shell Length (ft):	5.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0882
Vapor Molecular Weight (lb/lb-mole):	62.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	8.0605
Daily Avg. Liquid Surface Temp. (deg. R):	527.7526
Daily Average Ambient Temp. (deg. F):	65.9667
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	525.6567
Tank Paint Solar Absorptance (Shell):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,567.1816
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2580
Daily Vapor Temperature Range (deg. R):	20.6478
Daily Vapor Pressure Range (psia):	1.5079
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	8.0605
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	7.3344
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	8.8422
Daily Avg. Liquid Surface Temp. (deg R):	527.7526
Daily Min. Liquid Surface Temp. (deg R):	522.5906
Daily Max. Liquid Surface Temp. (deg R):	532.9145
Daily Ambient Temp. Range (deg. R):	18.3167
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.5271
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	8.0605
Vapor Space Outage (ft):	2.1000
Working Losses (lb):	5.9494
Vapor Molecular Weight (lb/lb-mole):	62.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	8.0605
Annual Net Throughput (gal/yr.):	500.0000

Annual Turnovers:	0.0000
Turnover Factor:	1.0000
Tank Diameter (ft):	4.2000
Working Loss Product Factor:	1.0000
Total Losses (lb):	199.2499

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

Colton #1172 - Horizontal Tank
Los Angeles C.O., California

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Gasoline (RVP 13)	5.95	193.30	199.25

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification		
User Identification:	Colton #1187	
City:	Los Angeles C.O.	
State:	California	
Company:	UPRR	
Type of Tank:	Horizontal Tank	
Description:		
Tank Dimensions		
Shell Length (ft):		5.00
Diameter (ft):		4.20
Volume (gallons):		500.00
Turnovers:		6.88
Net Throughput(gal/yr):		3,440.00
Is Tank Heated (y/n):	N	
Is Tank Underground (y/n):	N	
Paint Characteristics		
Shell Color/Shade:	White/White	
Shell Condition	Good	
Breather Vent Settings		
Vacuum Settings (psig):		-0.03
Pressure Settings (psig)		0.03

Meterological Data used in Emissions Calculations: Los Angeles C.O., California (Avg Atmospheric Pressure = 14.67 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

Colton #1187 - Horizontal Tank
Los Angeles C.O., California

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Gasoline (RVP 13)	All	68.08	62.92	73.24	65.99	8.0605	7.3344	8.8422	62.0000			92.00	Option 4: RVP=13, ASTM Slope=3

APP-133

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

Colton #1187 - Horizontal Tank
Los Angeles C.O., California

Annual Emission Calcaulations	
Standing Losses (lb):	193.3005
Vapor Space Volume (cu ft):	44.1224
Vapor Density (lb/cu ft):	0.0882
Vapor Space Expansion Factor:	0.2580
Vented Vapor Saturation Factor:	0.5271
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	44.1224
Tank Diameter (ft):	4.2000
Effective Diameter (ft):	5.1722
Vapor Space Outage (ft):	2.1000
Tank Shell Length (ft):	5.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0882
Vapor Molecular Weight (lb/lb-mole):	62.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	8.0605
Daily Avg. Liquid Surface Temp. (deg. R):	527.7526
Daily Average Ambient Temp. (deg. F):	65.9667
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	525.6567
Tank Paint Solar Absorptance (Shell):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,567.1816
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2580
Daily Vapor Temperature Range (deg. R):	20.6478
Daily Vapor Pressure Range (psia):	1.5079
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	8.0605
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	7.3344
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	8.8422
Daily Avg. Liquid Surface Temp. (deg R):	527.7526
Daily Min. Liquid Surface Temp. (deg R):	522.5906
Daily Max. Liquid Surface Temp. (deg R):	532.9145
Daily Ambient Temp. Range (deg. R):	18.3167
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.5271
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	8.0605
Vapor Space Outage (ft):	2.1000
Working Losses (lb):	40.9318
Vapor Molecular Weight (lb/lb-mole):	62.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	8.0605
Annual Net Throughput (gal/yr.):	3,440.0000

APP-134

Annual Turnovers:	6.8800
Turnover Factor:	1.0000
Tank Diameter (ft):	4.2000
Working Loss Product Factor:	1.0000
Total Losses (lb):	234.2323

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

Colton #1187 - Horizontal Tank
Los Angeles C.O., California

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Gasoline (RVP 13)	40.93	193.30	234.23

TANKS 4.0.9d
Emissions Report - Detail Format
Tank Indentification and Physical Characteristics

Identification		
User Identification:	Colton #1498	
City:	Los Angeles C.O.	
State:	California	
Company:	UPRR	
Type of Tank:	Horizontal Tank	
Description:		
Tank Dimensions		
Shell Length (ft):		5.00
Diameter (ft):		4.20
Volume (gallons):		500.00
Turnovers:		5.33
Net Throughput(gal/yr):		2,664.00
Is Tank Heated (y/n):	N	
Is Tank Underground (y/n):	N	
Paint Characteristics		
Shell Color/Shade:	White/White	
Shell Condition	Good	
Breather Vent Settings		
Vacuum Settings (psig):		-0.03
Pressure Settings (psig)		0.03

Meterological Data used in Emissions Calculations: Los Angeles C.O., California (Avg Atmospheric Pressure = 14.67 psia)

TANKS 4.0.9d
Emissions Report - Detail Format
Liquid Contents of Storage Tank

Colton #1498 - Horizontal Tank
Los Angeles C.O., California

Mixture/Component	Month	Daily Liquid Surf. Temperature (deg F) Avg.	Min.	Max.	Liquid Bulk Temp (deg F)	Vapor Pressure (psia) Avg.	Min.	Max.	Vapor Mol. Weight.	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Gasoline (RVP 13)	All	68.08	62.92	73.24	65.99	8.0605	7.3344	8.8422	62.0000			92.00	Option 4: RVP=13, ASTM Slope=3

TANKS 4.0.9d
Emissions Report - Detail Format
Detail Calculations (AP-42)

Colton #1498 - Horizontal Tank
Los Angeles C.O., California

Annual Emission Calcaulations	
Standing Losses (lb):	193.3005
Vapor Space Volume (cu ft):	44.1224
Vapor Density (lb/cu ft):	0.0882
Vapor Space Expansion Factor:	0.2580
Vented Vapor Saturation Factor:	0.5271
Tank Vapor Space Volume:	
Vapor Space Volume (cu ft):	44.1224
Tank Diameter (ft):	4.2000
Effective Diameter (ft):	5.1722
Vapor Space Outage (ft):	2.1000
Tank Shell Length (ft):	5.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0882
Vapor Molecular Weight (lb/lb-mole):	62.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	8.0605
Daily Avg. Liquid Surface Temp. (deg. R):	527.7526
Daily Average Ambient Temp. (deg. F):	65.9667
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	525.6567
Tank Paint Solar Absorptance (Shell):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,567.1816
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.2580
Daily Vapor Temperature Range (deg. R):	20.6478
Daily Vapor Pressure Range (psia):	1.5079
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	8.0605
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	7.3344
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	8.8422
Daily Avg. Liquid Surface Temp. (deg R):	527.7526
Daily Min. Liquid Surface Temp. (deg R):	522.5906
Daily Max. Liquid Surface Temp. (deg R):	532.9145
Daily Ambient Temp. Range (deg. R):	18.3167
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.5271
Vapor Pressure at Daily Average Liquid: Surface Temperature (psia):	8.0605
Vapor Space Outage (ft):	2.1000
Working Losses (lb):	31.6983
Vapor Molecular Weight (lb/lb-mole):	62.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	8.0605
Annual Net Throughput (gal/yr.):	2,664.0000

APP-139

Annual Turnovers:	5.3280
Turnover Factor:	1.0000
Tank Diameter (ft):	4.2000
Working Loss Product Factor:	1.0000
Total Losses (lb):	224.9989

TANKS 4.0.9d
Emissions Report - Detail Format
Individual Tank Emission Totals

Emissions Report for: Annual

Colton #1498 - Horizontal Tank
Los Angeles C.O., California

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Gasoline (RVP 13)	31.70	193.30	225.00

TANKS 4.0.9d
Emissions Report - Detail Format
Total Emissions Summaries - All Tanks in Report

Emissions Report for: Annual

Tank Identification				Losses (lbs)
Colton # 1189	UPRR	Horizontal Tank	Los Angeles C.O., California	239.41
Colton #1172	UPRR	Horizontal Tank	Los Angeles C.O., California	199.25
Colton #1187	UPRR	Horizontal Tank	Los Angeles C.O., California	234.23
Colton #1498	UPRR	Horizontal Tank	Los Angeles C.O., California	225.00
Total Emissions for all Tanks:				897.89

Exerpts from CARB's Speciation Profile Database

ORGPROF	SAROAD	ORGFRAC	ORGPROFN	CAS	CHEM_NAME
661	43231	0.01540998	Headspace vapors 1996 SSD etoh 2.0% o (MTBE phaseout)	110543	n-hexane
661	43248	0.01028	Headspace vapors 1996 SSD etoh 2.0% o (MTBE phaseout)	110827	cyclohexane
661	43276	0.01294998	Headspace vapors 1996 SSD etoh 2.0% o (MTBE phaseout)	540841	2,2,4-trimethylpentane
661	45201	0.0036	Headspace vapors 1996 SSD etoh 2.0% o (MTBE phaseout)	71432	benzene
661	45202	0.01702	Headspace vapors 1996 SSD etoh 2.0% o (MTBE phaseout)	108883	toluene
661	45203	0.00118	Headspace vapors 1996 SSD etoh 2.0% o (MTBE phaseout)	100414	ethylbenzene
661	45204	0.00128	Headspace vapors 1996 SSD etoh 2.0% o (MTBE phaseout)	95476	o-xylene
661	45205	0.00343	Headspace vapors 1996 SSD etoh 2.0% o (MTBE phaseout)	108383	m-xylene
661	45206	0.00107	Headspace vapors 1996 SSD etoh 2.0% o (MTBE phaseout)	106423	p-xylene
661	98043	0.00011	Headspace vapors 1996 SSD etoh 2.0% o (MTBE phaseout)	98828	isopropylbenzene (cumene)
661	98132	0.37335999	Headspace vapors 1996 SSD etoh 2.0% o (MTBE phaseout)	78784	isopentane

APPENDIX F

DETAILED EMISSION CALCULATIONS

Summary of Diesel Particulate Matter Emissions
Colton Rail Yard, Bloomington, CA

Source	DPM Emissions (tpy)
Locomotives	16.30
Yard Trucks	0.19
HHD Diesel-Fueled Delivery Trucks	0.00
Heavy Equipment	0.05
Emergency Generator	0.00
Total	**16.54**

Summary of Toxic Air Contaminant Emissions
Colton Rail Yard, Bloomington, CA

CAS	Chemical Name	Non-DPM TAC Emissions (tpy)		
		Gasoline Storage Tanks	WWTP	Total
540841	2,2,4-trimethylpentane	3.61E-03	-	3.61E-03
71432	benzene	1.00E-03	3.88E-01	3.89E-01
	bis(2-ethylhexyl) Phthalate	-	1.91E-02	1.91E-02
	bromomethane	-	6.81E-01	6.81E-01
67663	chloroform	-	4.77E-01	4.77E-01
110827	cyclohexane	2.86E-03	-	2.86E-03
100414	ethylbenzene	3.29E-04	2.31E+00	2.31E+00
78784	isopentane	1.04E-01	-	1.04E-01
98828	isopropylbenzene (cumene)	3.06E-05	-	3.06E-05
	methylene chloride	-	8.17E+00	8.17E+00
108383	m-xylene	9.55E-04	-	9.55E-04
110543	n-hexane	4.29E-03	-	4.29E-03
95476	o-xylene	3.57E-04	-	3.57E-04
106423	p-xylene	2.98E-04	-	2.98E-04
108883	toluene	4.74E-03	2.65E+00	2.66E+00
1330207	xylene (total)	-	4.77E+00	4.77E+00
Total		**1.22E-01**	**1.95E+01**	**1.96E+01**

Summary of Emissions from Locomotives
Colton Rail Yard, Bloomington, CA

Activity	DPM Emissions (tpy)
Through Trains and Power Mov	0.51
Freight Trains	2.45
Local Trains	0.47
Power Moves in Yard	0.14
Hump Operations	4.74
Trim Operations	5.28
Crew Changes	0.07
Service Movements	0.06
Service Idling	2.14
Load Testing	0.44
Total	**16.30**

Summary of Emissions from Diesel-Fueled Yard Trucks
Colton Rail Yard, Bloomington, CA

Running Exhaust Emissions

Equipment	Equipment	Vehicle			Vehicle	Annual VMT	Emission Factors (g/mi)[2]						Emissions (tpy)					
Type	ID/Owner	ID	Make/Model	Year	Class	(miles/yr)[1]	ROG	CO	NOx	PM10	DPM	SOx	ROG	CO	NOx	PM10	DPM	SOx
Truck	Engineering	69496	Chevy CK 3500	1998	LDT	17,060	0.12	1.13	1.60	0.06	0.06	0.06	0.002	0.021	0.030	0.001	0.001	0.001
Truck	Engineering	69499	Chevy CK 3500	1998	LDT	20,042	0.12	1.13	1.60	0.06	0.06	0.06	0.003	0.025	0.035	0.001	0.001	0.001
Truck	Car Dept	1915-73119	Ford F-450	2003	LHDT1	5,250	0.33	1.70	6.70	0.11	0.08	0.04	0.002	0.010	0.039	0.001	0.000	0.000
Truck	Engineering	9007E	Ford F-800	1992	MHD	3,353	0.94	9.70	18.46	1.25	1.25	0.16	0.003	0.036	0.068	0.005	0.005	0.001
Truck	Engineering	9009E	Ford F-800	1992	MHD	3,053	0.94	9.70	18.46	1.25	1.25	0.16	0.003	0.033	0.062	0.004	0.004	0.001
Truck	Engineering	9031E	Ford F-800	1992	MHD	9,929	0.94	9.70	18.46	1.25	1.25	0.16	0.010	0.106	0.202	0.014	0.014	0.002
Truck	Engineering	9018E	Ford F-800	1992	MHD	10,114	0.94	9.70	18.46	1.25	1.25	0.16	0.010	0.108	0.206	0.014	0.014	0.002
Truck	Car Dept	NA	International	1987	HHD	156	12.31	41.26	31.86	5.72	5.72	0.22	0.002	0.007	0.005	0.001	0.001	0.000
Truck	Engineering	64274	Ford LT8000	1989	HHD	18,197	12.06	40.31	31.60	5.48	5.42	0.24	0.242	0.808	0.634	0.110	0.109	0.005
Truck	Car Dept	1915-9038E	Ford LT9000	1997	HHD	16,001	6.92	16.99	31.05	2.34	2.26	0.24	0.122	0.300	0.548	0.041	0.040	0.004
Total													**0.40**	**1.45**	**1.83**	**0.19**	**0.19**	**0.02**

Idling Exhaust Emissions

Equipment	Equipment	Vehicle			Vehicle	Idling [1]		Emission Factors (g/hr)[2]						Emissions (tpy)					
Type	ID/Owner	ID	Make/Model	Year	Class	(min/day)	(hr/yr)	ROG	CO	NOx	PM10	DPM	SOx	ROG	CO	NOx	PM10	DPM	SOx
Truck	Engineering	69496	Chevy CK 3500	1998	LDT	15	91.25	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
Truck	Engineering	69499	Chevy CK 3500	1998	LDT	15	91.25	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000
Truck	Car Dept	1915-73119	Ford F-450	2003	LHDT2	15	91.25	3.17	26.30	75.05	0.75	0.75	0.34	0.000	0.003	0.008	0.000	0.000	0.000
Truck	Engineering	9007E	Ford F-800	1992	MHD	15	91.25	3.17	26.30	75.05	1.40	1.40	0.34	0.000	0.003	0.008	0.000	0.000	0.000
Truck	Engineering	9009E	Ford F-800	1992	MHD	15	91.25	3.17	26.30	75.05	1.40	1.40	0.34	0.000	0.003	0.008	0.000	0.000	0.000
Truck	Engineering	9031E	Ford F-800	1992	MHD	15	91.25	3.17	26.30	75.05	1.40	1.40	0.34	0.000	0.003	0.008	0.000	0.000	0.000
Truck	Engineering	9018E	Ford F-800	1992	MHD	15	91.25	3.17	26.30	75.05	1.40	1.40	0.34	0.000	0.003	0.008	0.000	0.000	0.000
Truck	Car Dept	NA	International	1987	HHD	15	91.25	22.84	61.55	82.94	4.28	4.28	0.55	0.002	0.006	0.008	0.000	0.000	0.000
Truck	Engineering	64274	Ford LT8000	1989	HHD	15	91.25	19.45	58.49	85.53	3.43	3.43	0.55	0.002	0.006	0.009	0.000	0.000	0.000
Truck	Car Dept	1915-9038E	Ford LT9000	1997	HHD	15	91.25	12.41	49.53	110.27	1.93	1.93	0.55	0.001	0.005	0.011	0.000	0.000	0.000
Total														**0.007**	**0.030**	**0.066**	**0.002**	**0.002**	**0.000**

Notes:
1. Annual VMT estimated based on the vehicle age and odometer reading.
2. Running exhaust emissions calculated using the EMFAC2007 model with the BURDEN output option.
3. Running exhaust emission factor calculations assumed an average speed of 15 mph.
4. Idling time (hr/yr) is an engineering estimate based on discussions with UPRR staff.
5. Idling exhaust emissions factors calculated using the EMFAC2007 model with the EMFAC output option.

Summary of Emissions from HHD Diesel-Fueled Delivery Trucks
Dolores and ICTF Rail Yards, Long Beach, CA

Running Exhaust Emissions

Delivery Type	Truck Trips (trips/yr)[1,2]	VMT per Trip (mi/trip)[3]	VMT per Year	2005 Emission Factors (g/mi)[4,5]						2005 Emission Estimates (tons/yr)					
				ROG	CO	NOx	PM10[6]	DPM[6]	SOx	ROG	CO	NOx	PM10	DPM	SOx
Gasoline	2	0.33	0.66	6.40	17.23	28.68	2.53	2.47	0.24	0.00	0.00	0.00	0.00	0.00	0.00
Lube Oil	57	0.58	33.06	6.40	17.23	28.68	2.53	2.47	0.24	0.00	0.00	0.00	0.00	0.00	0.00
Used Oil	24	0.58	13.92	6.40	17.23	28.68	2.53	2.47	0.24	0.00	0.00	0.00	0.00	0.00	0.00
Soap	18	0.71	12.78	6.40	17.23	28.68	2.53	2.47	0.24	0.00	0.00	0.00	0.00	0.00	0.00
Sand	195	0.58	113.10	6.40	17.23	28.68	2.53	2.47	0.24	0.00	0.00	0.00	0.00	0.00	0.00
Total	**296**									**1.22E-03**	**3.30E-03**	**5.49E-03**	**4.84E-04**	**4.72E-04**	**4.64E-05**

Idling Exhaust Emissions

Delivery Type	Number of Truck Trips	Idling		2005 Emission Factors (g/hr)[8]						2005 Emission Estimates (tons/yr)					
		(mins/trip)[7]	(hr/yr)	ROG	CO	NOx	PM10	DPM	SOx	ROG	CO	NOx	PM10	DPM	SOx
Gasoline	2	10	0.33	16.16	52.99	100.38	2.85	2.85	0.55	0.00	0.00	0.00	0.00	0.00	0.00
Lube Oil	57	10	9.50	16.16	52.99	100.38	2.85	2.85	0.55	0.00	0.00	0.00	0.00	0.00	0.00
Used Oil	24	10	4.00	16.16	52.99	100.38	2.85	2.85	0.55	0.00	0.00	0.00	0.00	0.00	0.00
Soap	18	10	3.00	16.16	52.99	100.38	2.85	2.85	0.55	0.00	0.00	0.00	0.00	0.00	0.00
Sand	195	30	97.50	16.16	52.99	100.38	2.85	2.85	0.55	0.00	0.01	0.01	0.00	0.00	0.00
Total	**296**									**2.04E-03**	**6.68E-03**	**1.27E-02**	**3.59E-04**	**3.59E-04**	**6.93E-05**

Notes:
1. Annual truck trips based on annual product deliveries and a tanker truck volume of 8,000 gallons.
2. Annual sand delivery truck trips based on tons of sand used and a truck capacity of 20 tons.
3. VMT per truck trip estimated from Google Earth, for onsite travel only.
4. Running exhaust emission factors (g/mi) from EMFAC 2007 using the BURDEN output option. The EMFAC default model year distribution for L.A. County was used.
5. Emission factor calculations assumed an average speed of 15 mph.
6. The PM10 emission factor includes engine exhaust emissions along with brake and tire wear. The DPM emission factor includes engine exhaust emissions only.
7. Engineering estimate based on personal observation.
8. Idling exhaust emission factors from EMFAC 2007 using the EMFAC output option. The EMFAC default model year distribution for L.A. County was used.

Summary of Emissions from Diesel Fueled Heavy Equipment
Colton Rail Yard, Bloomington, CA

Equipment Owner	Equipment Type [1]	Equipment Make	Equipment Model	Engine Make	Engine Model	Engine Model Year	Engine Rating (hp)	No of Units	Hours of Operation (hrs/yr)[2,3]	Load Factor[4]	2005 Emission Factor (g/bhp-hr)[5]						2005 Emission Estimates (tpy)					
											ROG	CO	NOx	PM10	DPM	SOx	HC	CO	NOx	PM10	DPM	SOx
Locomotive Shop	Rail Cleaner	Unknown	Unknown	Detroit	4 cyl	2003	125	1	5	0.68	0.52	2.96	5.32	0.25	0.25	0.06	0.00	0.00	0.00	0.00	0.00	0.00
Car Dept	Rerailer	Cline	Unknown	Unknown	Unknown	1987	183	1	*365*	0.51	1.64	5.52	13.04	0.77	0.77	0.06	0.06	0.21	0.49	0.03	0.03	0.00
Car Dept	Crane	Lorain	LRT-250	Cummins	6BTA	1997	145	1	260	0.43	1.27	3.55	8.35	0.58	0.58	0.06	0.02	0.06	0.15	0.01	0.01	0.00
Car Dept	Forklift	Toyota	6EDU45	Unknown	Unknown	1999	79	1	312	0.30	1.85	4.60	8.36	1.06	1.06	0.06	0.02	0.04	0.07	0.01	0.01	0.00
Total								**4**									**0.10**	**0.31**	**0.71**	**0.05**	**0.05**	**0.00**

Notes:
1. In addition to the equipment listed above, UPRR also ownes a Rail King Locomotive Mover. This unit did not operate in 2005 and therefore, is not included in the inventory.
2. Hours of operation for the rail cleaner, crane, and forklift estimated by UPRR staff.
3. Hours of operation for the rerailer are an engineering estimate based on disucssion with UPRR staff.
4. Default load factors from OFFROAD2007 model.
5. Emission factors from OFFROAD2007 model.

Summary of Emissions and Equipment Specifications for Storage Tanks
Colton Rail Yard, Bloomington, CA

				Tank Dimensions (ft)					Annual	VOC		
Tank No.	Tank Location	Material Stored	Tank Capacity	Length	Height	Diameter	Shell Color	Shell Condition	Annual Throughput (gal/yr)	VOC Emissions (tpy)	Permitted?	Citation
1149	Service Track	Lube Oil	1,000	12		4	White	Good	18,000	NA	Exempt	Rule 219(m)(4)
1151	Service Track	Lube Oil	15,700	32		9	White	Good	216,000	NA	Exempt	Rule 219(m)(4)
1152	Service Track	Lube Oil	15,700	32		9	White	Good	216,000	NA	Exempt	Rule 219(m)(4)
1153	Service Track	Diesel	15,700	32		9	White	Good	14,550,000	NA	Exempt	Rule 219(m)(4)
1154	Service Track	Diesel	15,700	32		9	White	Good	14,550,000	NA	Exempt	Rule 219(m)(4)
1155	Service Track	Journal Box Oil	7,500	19		8	White	Good	1,500	NA	Exempt	Rule 219(m)(4)
1156	Service Track	Journal Box Oil	7,500	19		8	White	Good	1,500	NA	Exempt	Rule 219(m)(4)
1157	One Spot	Used Oil	400	8		3	White	Good	959	NA	Exempt	Rule 219(m)(4)
1158	WWTP	Stormwater	275,000		16	55	Light Grey	Good	4,318,355	NA	Exempt	Rule 219 (m)
1159	WWTP	Stormwater	275,000		16	55	Light Grey	Good	4,318,355	NA	Exempt	Rule 219 (m)
1160	WWTP	Used Oil	2,000	12		5.5	Light Grey	Good	959	NA	Exempt	Rule 219(m)(4)
1161	WWTP	Sludge	5,000		20	10	Light Grey	Good	NA	NA	Exempt	Rule 219(m)(4)
1168	Locomotive Wash	Used Oil	25,000	39		10.5	White	Good	67,153	NA	Exempt	Rule 219(m)(4)
1169	Locomotive Servicing	Used Oil	25,000	39		10.5	Silver	Good	120,876	NA	Exempt	Rule 219(m)(4)
1172	Locomotive Servicing	Gasoline	500	5		4.2	White	Good	500	0.06	YES	NA
1174	Locomotive Wash	Soap	2,500		12	10	White	Good	140,656	NA	Exempt	Rule 219(m)(6)
1175	Locomotive Wash	Soap Mix Tank	350		5	4	White	Good	NA	NA	Exempt	Rule 219(m)(6)
1176	Locomotive Wash	Soap Mix Tank	350		5	4	White	Good	NA	NA	Exempt	Rule 219(m)(6)
1177	Locomotive Wash	Recycled Water	20,000	24		8	White	Good	NA	NA	Exempt	Rule 219 (m)
1178	Locomotive Wash	Water	10,000	12		8	White	Good	NA	NA	Exempt	Rule 219 (m)
1179	MOW Compound	Used Oil	500	8		4	White	Good	1,919	NA	Exempt	Rule 219(m)(4)
1180	Locomotive Servicing	Radiator Fluid	7,500	20		7	White	Good	NA	NA	Exempt	Rule 219(m)(4)
1187	One Spot	Gasoline	500	5		4.2	White	Good	3,440	0.07	YES	NA
1189	Departure Yard/Trim Tower	Gasoline	500	5		4.2	White	Good	3,875	0.08	YES	NA
1498	One Spot	Gasoline	500	5		4.2	White	Good	2,664	0.07	YES	NA
Total										**0.28**		

Notes:
1. Lube oil and journal box oil throughput based on 2003 Trinity Report. Assumptions confirmed by UPRR staff.
2. Diesel throughput provided by UPRR staff. Diesel fuel is delivered via Kinder Morgan pipeline.
3. Stormwater thoughput is equal to WWTP throughput, equally divided between tanks.
4. Soap throughput provided by UPRR staff
5. Gasoline throughput provided by UPRR staff.
6. Used oil throughput is based on the 2005 facility used oil total (191,867 gallons) and was allocated to tanks based on the assumptions in 2003 Trinity Report. The 2003 tank specific throughput was divided by the total throughput to determine the percent of the total handeled by each tank. This allocation was then applied to the 2005 total throughput.
7. VOC emissions were calculated for tanks that were not exempt from SMAQMD permitting rules only.

Toxic Air Contaminant Emissions from the Gasoline Storage Tank
Colton Rail Yard, Bloomington, CA

Profile[1]	CAS	Chemical Name	Organic Fraction	2005 Emission Estimates (tpy)				
				Tank #1172	Tank #1187	Tank #1189	Tank #1498	Total
661	540841	2,2,4-trimethylpentane	0.0129	7.71E-04	9.52E-04	9.79E-04	9.04E-04	3.61E-03
661	71432	benzene	0.0036	2.14E-04	2.65E-04	2.72E-04	2.51E-04	1.00E-03
661	110827	cyclohexane	0.0103	6.12E-04	7.56E-04	7.77E-04	7.18E-04	2.86E-03
661	100414	ethylbenzene	0.0012	7.03E-05	8.68E-05	8.92E-05	8.24E-05	3.29E-04
661	78784	isopentane	0.3734	2.22E-02	2.75E-02	2.82E-02	2.61E-02	1.04E-01
661	98828	isopropylbenzene (cumene)	0.0001	6.55E-06	8.09E-06	8.32E-06	7.68E-06	3.06E-05
661	108383	m-xylene	0.0034	2.04E-04	2.52E-04	2.59E-04	2.40E-04	9.55E-04
661	110543	n-hexane	0.0154	9.18E-04	1.13E-03	1.16E-03	1.08E-03	4.29E-03
661	95476	o-xylene	0.0013	7.62E-05	9.41E-05	9.68E-05	8.94E-05	3.57E-04
661	106423	p-xylene	0.0011	6.37E-05	7.87E-05	8.09E-05	7.47E-05	2.98E-04
661	108883	toluene	0.0170	1.01E-03	1.25E-03	1.29E-03	1.19E-03	4.74E-03
Total				**2.62E-02**	**3.23E-02**	**3.32E-02**	**3.07E-02**	**1.22E-01**

Notes
1. Organic fraction from ARBs SPECIATE database. Data is from "Headspace vapors 1996 SSD etoh 2.0% (MTBE phaseout)" option.
2. Emissions were calculated for only chemicals that were in both the SPECIATE database and the AB2588 list.

Summary of Emissions from Sand Tower Operations
Colton Rail Yard, Bloomington, CA

Pollutant	2005 Sand Throughput (ton/yr)	Pneumatic Transfer Emission Factor (lb/ton)	Gravity Transfer Emission Factor (lb/ton)	Process Emissions (lb/yr)		
				Pneumatic Transfer	Gravity Transfer	Total
PM10	3885.42	0.00034	0.00099	1.32	3.85	5.17

Notes:
1. Sand throughput provided by Union Pacific
2. Pneumatic transfer emission factor from AP-42, Table 11.12-2, 6/06. Factor for controlled pneumatic cement unloading to elevated storage silo was used. The unit is equipped with a fabric filter.
3. Gravity transfer emission factor from AP-42, Table 11.12-2, 6/06. Factor for sand transfer was used.
4. There are no TAC emissions from this source.

Toxic Air Contaminant Emissions the Wastewater Treatment Plant
Colton Rail Yard, Bloomington, CA

Pollutant	Emission Rate		2005 Emissions	
	(lb/yr)	(g/sec)	(lb/yr)	(tpy)
Benzene	0.22	3.16E-06	3.36E-01	1.68E-04
Bromomethane	0.84	1.21E-05	1.28E+00	6.41E-04
Chloroform	0.43	6.18E-06	6.56E-01	3.28E-04
Ethylbenzene	1.36	1.96E-05	2.08E+00	1.04E-03
Methylene Chloride	7.50	1.08E-04	1.14E+01	5.72E-03
Toluene	3.02	4.34E-05	4.61E+00	2.31E-03
Xylene	5.42	7.80E-05	8.27E+00	4.14E-03
Total	**18.79**	**2.70E-04**	**28.68**	**1.43E-02**

1. Emission rates are from the Air Emissions Inventory and Regulatory Analysis Report for Colton Yard, Trinity Consultants, May 30, 2003.
2. Emission rates are from the July 2002 Permit to Operate Application and are based on a wastewater flow rate of 15,500 gallons per day (5,657,500 gallons per year).
3. Emissions (lb/yr) were calculated multipling the emission rate by the ratio of the 2002 wasterwater flow rate and the 2005 wastewater flow rate.

lb/yr = Emission Rate (lb/yr) x (8,636,710 gal/yr / 5,657,500 gal/yr)

4. The 2005 wastewater flow rate was 8,636,710 gallons, per T.D. Wash.

Summary of Emissions from the Emergency Generator
Colton Rail Yard, Bloomington, CA

Location	Equipment Type	Fuel Type	Rating (hp)	Annual of Operation (hr/yr)	Emission Factors (g/hp-hr)						Emission (tpy)					
					ROG	CO	NOx	PM10	DPM	SOx	ROG	CO	NOx	PM10	DPM	SOx
Bowl Area	Emergency Generator	Diesel	50	20	1.14	3.03	14.06	1.00	1.00	0.93	0.001	0.003	0.016	0.001	0.001	0.001

Notes:
1. CARB's ATCM for Stationary Compression Ignition Engines limits non-emergency operation to 20 hours per year.
2. Emission factors from AP-42, Table 3.3-1, 10/96.

Equipment Specifications for Boilers and Heaters
Colton Rail Yard, Bloomington, CA

Location	Heater Type	Fuel Type	Rating (MMBtu/hr)
Locomotive Wash[1]	Heater	Natural Gas	0.14
Locomotive Wash[1]	Boiler	Natural Gas	1.995
Locomotive Shop[2]	Boiler	Natural Gas	2.5

Notes:
1. These units are exempt from SCAQMD permitting requirements per Rule 219 (b)(2).
2. This unit was installed in 2006, and therefore, did not operate in 2005.

Equipment Specifications for Welders
Colton Rail Yard, Bloomington, CA

Location	Make	Model	Fuel Type	Rating (hp)
Receiving Yard	Lincoln	Ranger 8	Gasoline	16
Receiving Yard	Miller	Blue Star	Gasoline	12.5
Receiving Yard	Miller	Blue Star	Gasoline	13
One Spot	Miller	Blue Star 6000	Gasoline	13
One Spot	Miller	Blue Star 6000	Gasoline	13
One Spot	Miller	Blue Star 6000	Gasoline	13
One Spot	Miller	Blue Star 145	Gasoline	10
One Spot	Miller	Blue Star 145	Gasoline	10
One Spot	Miller	Blue Star	Gasoline	13
One Spot	Miller	Blue Star 180K	Gasoline	13
Departure Yard	Miller	Blue Star	Gasoline	12.5
Departure Yard	Miller	Blue Star	Gasoline	13
Departure Yard	Miller	Blue Star	Gasoline	13
Service Track	Miller	Blue Star	Gasoline	13
Service Track	Miller	Blue Star	Gasoline	13
Service Track	Miller	Unknown	Gasoline	13

Notes:
1. Welding equipment is exempt from SCAQMD permitting requirements per Rule 219(e)(8).
2. IC Engines meet the exempt requirements of SCAQMD Rule 219(b)(1).

Equipment Specifications for Steam Cleaners
Colton Rail Yard, Bloomington, CA

Location	Make	Emission Unit	Fuel Type	Rating (MMBtu/hr or hp)
Locomotive Shop	Hydroblaster	Pump	Electirc	NA
		Heater	Propane	0.360
Wheel Shop	Hydroblaster	Pump	Electirc	NA
		Heater	Propane	0.360

Notes:
1. These units are exempt from SCAQMD permitting requirements per Rule 219(d)(5) and (b)(2).

Specifications for Miscellaneous Combustion Equipment
Colton Rail Yard, Bloomington, CA

Location	Equipment Type	Fuel Type	Rating (hp or MMBtu/hr)
Service Track	Pressure Washer [1]	Propane	0.325
Service Track	Pressure Washer [1]	Propane	0.325
Service Track	Pressure Washer [1]	Propane	0.325
Service Track	Pressure Washer [1]	Propane	0.325
One Spot	Air Compressor [2]	Gasoline	8
One Spot	Air Compressor [2]	Gasoline	11
Bridge Department	Air Compressor [2]	Diesel	42

1. These units are exempt from SCAQMD permitting requirements per Rule 219 (b)(2).
2. These units are exempt from SCAQMD permitting requirements per Rule 219(b)(1).

APPENDIX G

DETAILED RISK SCREENING CALCULATIONS

Summary of Risk Index Values
Colton Rail Yard, Bloomington, CA

Source	Risk Index Value Cancer	% of Total Cancer Risk	Risk Index Value Chronic	% of Total Chronic Risk
Locomotives	4.89E-03	98.54	8.15E+01	56.42
Yard Trucks	5.72E-05	1.15	9.53E-01	0.66
HHD Diesel-Fueled Delivery Trucks	2.49E-07	0.01	4.15E-03	0.00
Heavy Equipment	1.44E-05	0.29	2.41E-01	0.17
WWTP	1.23E-08	0.00	8.06E+00	5.58
Sand Tower	0.00E+00	0.00	0.00E+00	0.00
Gasoline Storage Tanks	4.69E-08	0.00	5.37E+01	37.17
Emergency Generator	3.30E-07	0.01	5.50E-03	0.00
Total	4.96E-03	100.00	1.44E+02	100.00

Notes:
1. There are no TAC emissions from the sand tower or the Diesel fuel storage tanks.

Calculation of Risk Index Values for Diesel-Fueled Sources
Colton Rail Yard, Bloomington, CA

Source	DPM Emissions (tpy)	Unit Risk Factor Cancer	Cancer Risk Index Value	Unit Risk Factor Chronic	Chronic Risk Index Value
Locomotives	16.30	3.00E-04	4.89E-03	5.00E+00	8.15E+01
Yard Trucks	0.19	3.00E-04	5.72E-05	5.00E+00	9.53E-01
HHD Diesel-Fueled Delivery Trucks	0.00	3.00E-04	2.49E-07	5.00E+00	4.15E-03
Heavy Equipment	0.05	3.00E-04	1.44E-05	5.00E+00	2.41E-01
Emergency Generator	0.00	3.00E-04	3.30E-07	5.00E+00	5.50E-03
Total	**16.54**		**4.96E-03**		**8.27E+01**

Notes:
1. Unit risk factor from Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values, April 25, 2005. Cancer inhalation risk used.

Calculation of Risk Index Values for TAC Sources
Colton Rail Yard, Bloomington, CA

		Emissions (tpy)		Unit Risk Factor	Unit Risk Factor	Cancer Risk Index Value		Chronic Risk Index Value	
CAS	Chemical Name	Gasoline Tanks	WWTP	Cancer	Chronic	Gasoline Tank	WWTP	Gasoline Tank	WWTP
540841	2,2,4-trimethylpentane	5.81E-03	-						
71432	Benzene	1.62E-03	1.68E-04	2.90E-05	6.00E+01	4.69E-08	4.87E-09	9.70E-02	1.01E-02
	Bromomethane	-	6.41E-04						
67663	Chloroform	-	3.28E-04	5.30E-06	3.00E+02		1.74E-09		9.85E-02
110827	Cyclohexane	4.62E-03	-						
100414	Ethylbenzene	5.30E-04	1.04E-03		2.00E+03			1.06E+00	2.08E+00
78784	isopentane	1.68E-01	-						
98828	Isopropylbenzene (cumene)	4.94E-05	-						
75092	Methylene Chloride	-	5.72E-03	1.00E-06	4.00E+02		5.72E-09		2.29E+00
108383	m-xylene	1.54E-03	-		7.00E+02			1.08E+00	
110543	n-hexane	6.92E-03	-		7.00E+03			4.84E+01	
95476	o-xylene	5.75E-04	-		7.00E+02			4.02E-01	
106423	p-xylene	4.80E-04	-		7.00E+02			3.36E-01	
108883	Toluene	7.64E-03	2.31E-03		3.00E+02			2.29E+00	6.92E-01
1330207	Xylene (total)	-	4.14E-03		7.00E+02				2.90E+00
Total		**1.97E-01**	**1.4E-02**			**4.69E-08**	**1.23E-08**	**5.37E+01**	**8.06E+00**

APPENDIX H

SOURCE TREATMENT AND ASSUMPTIONS FOR AIR DISPERSION MODELING FOR NON-LOCOMOTIVE SOURCES

Appendix H

Source Treatment and Assumptions for Air Dispersion Modeling for Non-Locomotive Sources

As shown in Figure 2, emissions were allocated spatially throughout the Yard in the areas where each source type operates or is most likely to operate. Emissions from mobile sources, heavy equipment, and moving locomotives were simulated as a series of volume sources along their corresponding travel routes and work areas. Emissions from heavy equipment were first allocated to the areas of the yard where their activity occurs, and were then allocated uniformly to a series of sources within the defined areas.

Emissions from stationary sources, such as fuel tanks, were simulated as a point source corresponding to the actual equipment location within the Yard. Assumptions used spatially to allocate emissions for each source group are shown in the Table below. See Figure 2 for the source locations. See Appendix A-4 for assumptions regarding the spatial allocation of locomotive emissions.

Source Treatment and Assumptions for Air Dispersion Modeling for Non-Locomotive Sources
Colton Rail Yard

Source	Source Treatment	Assumptions for Spatial Allocation of Emissions
Gasoline Storage Tanks	Point	Assumed all emissions occurred at the storage tank location.
WWTP	Point	Assumed all emissions occurred at the storage tank location.
Heavy Equipment (idling and traveling)	Volume	Rail Cleaner – allocated all emissions to the area in and around locomotive shop volume source. Rerailer, Lorain Crane, and Forklift – allocated all emissions to area in and around the One Spot as volume sources.

APPENDIX I

SEASONAL AND DIURNAL ACTIVITY PROFILES

Appendix I

Development of Temporal Activity Profiles for the UPRR Colton Yard

Locomotive activity can vary by time of day and season. For each yard, the number of trains arriving and departing from the yard in each month and each hour of the day was tabulated and used to develop temporal activity profiles for modeling. The number of locomotives released from service facilities in each month was also tabulated. The AERMOD EMISFACT SEASHR option was used to adjust emission rates by season and hour of the day, and the EMISFACT SEASON option was used where only seasonal adjustments were applied. Where hour of day adjustments (but not seasonal) were applied, the EMISFACT HROFDY option was used.

Time of day profiles for train idling activity were developed assuming that departure events involved locomotive idling during the hour of departure and the preceding hour, and that arrival events involved locomotive idling during the hour of arrival only. Thus, the hourly activity fraction for departing trains during hour *i* is given by

$$\frac{\tfrac{1}{2}\cdot\sum_{j=i-1}^{i} ND(j)}{\sum_{j=1}^{24} ND(j)} ,$$

and that for arriving trains during hour *i* is given by

$$\frac{NA(i)}{\sum_{j=1}^{24} NA(j)} ,$$

where *NA(j)* and *ND(j)* are respectively the number of arriving and departing trains in hour *j*. The hourly adjustment factor for idling is then calculated as 24 times the average of the departing and arriving idle time fractions. These factors were applied to both idling on arriving and departing trains.

Similarly, time of day profiles for road power movements in the yard (arrivals, departures, and power moves) were developed without including arrivals in preceding hours and departures in subsequent hours. In this case, the hourly activity adjustment factor for hour *i* is given by

$$\frac{NA(i)+ND(i)}{\sum_{j=1}^{24}(NA(j)+ND(j))} .$$

Seasonal adjustment factors are calculated as the sum of trains arriving and departing in each three month season, divided by the total number of arrivals and departures for the year. The hourly adjustment factors for each season are simply the product of the seasonal adjustment factor and the 24 hourly adjustment factors.

The seasonal profile for train activity at Colton was applied for yard switching operations, but no hourly factors were applied since the hump and trim sets work 24/7. Similarly, a seasonal profile was developed for Service Track and maintenance activities based on monthly Service Track release counts. No hourly factor was applied to either service idling or load testing.

Table I-1 lists the hourly activity factors derived for train movements and train idling at the UPRR Colton Yard. Separate temporal profiles are listed for day and night moving emissions as different volume source parameters are used for day and night. Table I-2 lists the seasonal activity factors for train and yard operations, and service and load test activity.

Table I-1. Hourly Activity Factors for Train Activity at the UPRR Colton Yard

Hour	Train Idling	Train Movements (Daytime)	Train Movements (Nighttime)
1	1.070	0.000	1.138
2	0.871	0.000	0.938
3	0.947	0.000	0.887
4	0.936	0.000	0.950
5	0.913	0.000	0.960
6	0.949	0.000	0.933
7	0.965	0.912	0.000
8	1.101	1.031	0.000
9	1.072	1.039	0.000
10	1.121	1.131	0.000
11	1.047	1.055	0.000
12	0.972	1.009	0.000
13	0.843	0.960	0.000
14	0.717	0.726	0.000
15	0.821	0.752	0.000
16	0.955	0.909	0.000
17	1.017	0.980	0.000
18	1.135	1.092	0.000
19	1.228	0.000	1.282
20	1.116	0.000	1.136
21	1.059	0.000	1.117
22	0.976	0.000	0.992
23	1.028	0.000	0.968
24	1.142	0.000	1.104

Table I-2. Seasonal Activity Factors for the UPRR Colton Yard

Activity Type	Winter	Spring	Summer	Fall
Trains	0.921	1.037	1.027	1.015
Service	0.994	0.956	1.041	1.009

APPENDIX J

SELECTION OF POPULATION FOR THE URBAN OPTION INPUT IN AERMOD AIR DISPERSION MODELING ANALYSIS

Appendix J

Selection of Population for the Urban Option Input in AERMOD Air Dispersion Modeling Analysis

Urban heat islands and the thermal domes generated by them extend over an entire urbanized area[1]. Hot spots within the urban heat island are associated with roads and roofs, which surround each Union Pacific (UP) rail yard in high density. Following guidance cited by the ARB ("*For urban areas adjacent to or near other urban areas, or part of urban corridors, the user should attempt to identify that part of the urban area that will contribute to the urban heat island plume affecting the source.*"), it is the entire metropolitan area that contributes to the urban heat island plume affecting the rail yard. For metropolitan areas containing substantial amounts of open water, the area of water should not be included.

To simulate the effect of the urban heat island on turbulence in the boundary layer, especially at night, when the effect is substantial, AERMOD adjusts the height of the nighttime urban boundary layer for the heat flux emitted into the boundary layer by the urban surface, which is warmer than surrounding rural areas[2,3]. The difference between the urban and rural boundary layer temperatures is proportional to the maximum temperature difference of 12 Celsius degrees observed in a study of several Canadian cities, and directly related to the logarithm of the ratio of the urban population to a reference population of 2,000,000 (i.e., Montreal, the Canadian city with the maximum urban-rural temperature difference)[4].

The adjusted height of the nocturnal urban boundary layer is proportional to the one-fourth power of the ratio of the population of the city of interest to the reference population, based on the observation that the convective boundary layer depth is proportional to the square root of the city size, and city size is roughly proportional to the square root of its population, assuming constant population density[5]. Regardless of wind direction during any specific hour used by AERMOD, it is the entire metropolitan area, minus bodies of water, which moves additional heat flux into the atmosphere and affects its dispersive properties, not just the 400 km^2 area of the air dispersion modeling domain that surrounds the each rail yard, which was chosen purely for modeling convenience.

Continuing to follow the guidance cited by the ARB ("*If this approach results in the identification of clearly defined MSAs, then census data may be used as above to determine the appropriate population for input to AERMOD")*, the population of each Metropolitan Statistical Area, or a smaller area if appropriate, is being used in the modeling run for each rail yard.

[1] USEPA. *Thermally-Sensed Image of Houston,* http://www.epa.gov/heatisland/pilot/houston_thermal.htm, included in Heat Island Effect website, http://www.epa.gov/heatisland/about/index.html, accessed November 8, 2006.
[2] USEPA. *AERMOD: Description of Model Formulation,* Section 5.8 – Adjustments for the Urban Boundary Layer, pages 66-67, EPA-454/R-03-004, September 2004, accessed at http://www.epa.gov/scram001/7thconf/aermod/aermod_mfd.pdf on November 9,
[3] Oke, T.R. *City Size and the Urban Heat Island,* Atmospheric Environment, Volume 7, pp. 769-779, 1973.
[4] Ibid for References 3 and 4.
[5] Ibid.

APPENDIX K

DEMOGRAPHIC DATA

Appendix K

Population Shape Files for UPRR Rail Yards

The accompanying shape files include census boundaries as polygons and the corresponding residential populations from the 2000 U.S. Census. Separate shape files are included at the tract, block group, and block levels. The primary ID for each polygon begins with *ssccctttttt*, where *ss* is the FIPS state code (06 for California), *cc* is the county code, and *tttttt* is the tract code. The primary IDs for block groups have a single additional digit which is the block group number within each tract. Those for blocks have four additional digits identifying the block number. The population for each polygon are included as both the secondary ID and as attribute 1. Polygon coordinates are UTM zone 10 (Oakland and Stockton) or 11 (southern California yards), NAD83, in meters. The files contain entire tracts, block groups, or blocks that are completely contained within a specified area. For all yards except Stockton, the area included extends 10 kilometers beyond the 20 x 20 kilometer modeling domains. For Stockton, this area was extended to 20 kilometers beyond the modeling domain boundaries to avoid excluding some very large blocks.

In merging the population data[1] with the corresponding boundaries[2], it was noted that at all locations, there are defined census areas (primarily blocks, but in some cases block groups and tracts) for which there are no population records listed in the population files. Overlaying these boundaries on georeferenced aerial photos indicates that these are areas that likely have no residential populations (e.g., industrial areas and parks). The defined areas without population data have been excluded from these files. Areas with an identified population of zero have been included. It was also observed that some blocks, block groups and tracts with residential populations cover both residential areas and significant portions of the rail yards themselves. For this reason, any analysis of population exposures based on dispersion modeling should exclude receptors that are within the yard boundaries or within 20 meters of any modeled emission source locations.

To facilitate the exclusion of non-representative receptors, separate shape files have been generated that define the area within 20 meters of the yard boundaries for each yard. These files are also included with the accompanying population files. It should also be noted that the spatial extent of individual polygons can vary widely, even within the same type. For example, single blocks may be as small as 20 meters or as large as 10,000 meters or more in length. To estimate populations contained within specific areas, it may prove most useful to generate populations on a regular grid (e.g., 250 x 250 m cells) rather than attempting to process irregularly shaped polygons.

[1] Population data were extracted from the *Census 2000 Summary File 1* DVD, issued by the U.S. Department of Commerce, September 2001.
[2] Boundaries were extracted from ESRI shapefiles (*.shp) created from the U.S. Census TIGER Line Files downloaded from ESRI (*http://arcdata.esri.com/data/tiger2000/tiger_download.cfm*).