APPENDIX B

Vehicle Costs and Cost Methodology

Appendix B

Vehicle Costs and Cost Methodology

A. Introduction

This Appendix discusses the costs associated with replacing and retrofitting on-road, Class 8 (GVWR > 33,000 lbs), heavy duty diesel vehicles (HDDV) operating at California's ports. The analysis begins with a discussion on the 2005 California Used HDDV market, and the price forecasting model developed to predict used port truck replacement costs when older model year port trucks are being replaced with newer model year vehicles.

The discussion of the used HDDV market is followed by a generalized discussion on cost methodology. Staff then determined truck modernization costs and the cost effectiveness for each of the three strategies. Finally, staff estimated container fees needed to fund each of the three strategies and the cost effectiveness using Carl Moyer methodologies.

B. Analysis of the 2005 California Used HDDV Market

In this section of the Appendix, values of used port trucks are forecasted using a trend line established from sample price data for HDDVs available for sale in California and the neighboring (~ 5 percent of listings) States of Arizona and Nevada. Projected prices are used to determine port truck replacement costs for each of the three strategies.

The marketplace of HDDVs consists of several types of HDDVs. These include, but are not limited to: beverage trucks, car carriers, crane trucks, concrete mixers, dump trucks, flatbed trucks, fire trucks, van trucks, and refuse haulers. However, only specific class 8 HDDVs are capable of hauling containers at ports. These were considered for developing program costs. Other HDDVs which are not typically engaged in the transport of containers were excluded from this analysis.

In selecting sample criteria to develop the vehicle age-price distribution profile, ARB staff surveyed an internet site (TruckPaper.com, 2005) where listings of HDDVs for sale in California and the neighboring states are consolidated. Class 8 HDDVs with GVWR > 33,000 pounds, with or without sleeper cabins, were selected. Of the 130 used and new HDDV qualified listings, 80 (62 percent) were equipped with sleeper cabins, and 50 (38 percent) were not equipped sleeper cabins. Since many of the on-road HDDV operators engaged in the transport of containers at California Ports operate short haul routes, ARB staff determined that including trucks without sleeper cabins in the search criteria was appropriate. Listed prices for vehicles obtained were for tractors only as trailers at California's ports are typically supplied by the terminal. Data from the 2005 California Used HDDV Market Survey is presented in Table 1:

Table 1: Data from the 2005 California Used HDDV Market Survey

MODEL YEAR	MAKE	ENGINE	HP	HDV TYPE	LISTED MILEAGE	LIST PRICE
4/18/2005 Data						
1994	Freightliner	Cummins	370	HDD Conventional, Sleeper		$ 14,900
1995	International	Cummins	280	HDD Conventional	375,938	$ 17,431
1995	Peterbilt	Caterpillar	500	HDD Conventional, Sleeper	898,000	$ 27,950
1996	Freightliner	Cummins	330	HDD Conventional	320,806	$ 20,950
1996	Freightliner	Cummins	330	HDD Conventional, Sleeper	292,036	$ 20,950
1996	Freightliner	Cummins	350	HDD Conventional	296,095	$ 24,450
1996	International	Detroit Diesel	430	HDD Conventional		$ 16,500
1996	International	Detroit Diesel	470	HDD Conventional	771,635	$ 18,500
1996	International	Cummins	370	HDD Conventional	672,108	$ 20,353
1996	Peterbilt	Caterpillar	380	HDD Conventional		$ 35,500
1997	Freightliner	Cummins	370	HDD Conventional, Sleeper	498,725	$ 23,825
1997	Freightliner	Detroit Diesel	400	HDD Conventional	440,000	$ 24,500
1997	Freightliner	Cummins	330	HDD Conventional	449,031	$ 24,575
1997	Freightliner	Cummins	250	HDD Conventional	129,255	
1997	Freightliner	Detroit Diesel	400	HDD Conventional, Sleeper	767,173	
1997	Peterbilt	Cummins	400	HDD Conventional		$ 32,500
1997	Peterbilt	Cummins	435	HDD Conventional, Sleeper		$ 38,500
1997	Peterbilt	Caterpillar	410	HDD Conventional	590,000	
1998	Freightliner	Cummins	330	HDD Conventional, Sleeper	828,169	$ 14,585
1998	Freightliner	Cummins	330	HDD Conventional, Sleeper	93,937	$ 15,500
1998	Freightliner	Cummins	330	HDD Conventional	713,382	$ 19,950
1998	Freightliner	Cummins	370	HDD Conventional		$ 21,500
1998	Freightliner	Cummins	435	HDD Conventional, Sleeper	709,282	$ 27,382
1998	Freightliner	Cummins	330	HDD Conventional	385,827	$ 27,475
1998	Freightliner	Cummins	330	HDD Conventional	279,626	$ 27,475

1998	Freightliner	Cummins	330	HDD Conventional	307,848	$ 27,475
1998	Freightliner	Cummins	370	HDD Conventional, Sleeper	586,114	$ 29,364
1998	Freightliner	Detroit Diesel	400	HDD Conventional	515,000	$ 32,500
1998	Freightliner	Detroit Diesel	400	HDD Conventional	350,000	$ 32,500
1998	Freightliner	Detroit Diesel	430	HDD Conventional	435,000	$ 32,500
1998	International	Cummins	350	HDD Conventional	634,524	$ 21,021
1998	International	Cummins	350	HDD Conventional	575,044	$ 25,223
1998	International	Cummins	280	HDD Conventional	403,634	$ 30,225
1998	Mack	Mack	350	HDD Conventional	358,914	$ 31,725
1998	Peterbilt	Cummins	400	HDD Conventional		$ 39,500
1999	Freightliner	Cummins	370	HDD Conventional	856,385	$ 18,194
1999	Freightliner	Cummins	370	HDD Conventional	781,373	$ 19,353
1999	Freightliner	Cummins	350	HDD Conventional	675,533	$ 20,900
1999	Freightliner	Cummins	350	HDD Conventional	722,844	$ 20,905
1999	Freightliner	Cummins	350	HDD Conventional	705,148	$ 21,557
1999	Freightliner	Cummins	350	HDD Conventional	647,255	$ 23,702
1999	Freightliner	Cummins	350	HDD Conventional	638,567	$ 24,021
1999	Freightliner	Cummins	350	HDD Conventional	678,336	$ 24,195
1999	Freightliner	Cummins	350	HDD Conventional	627,203	$ 24,443
1999	Freightliner	Cummins	370	HDD Conventional, Sleeper	648,187	$ 26,426
1999	Freightliner	Cummins	350	HDD Conventional	571,557	$ 26,471
1999	Freightliner	Cummins	370	HDD Conventional, Sleeper	553,836	$ 27,750
1999	Freightliner	Detroit Diesel	400	HDD Conventional		$ 28,000
1999	Freightliner	Detroit Diesel	360	HDD Conventional		$ 34,500
1999	Freightliner	Detroit Diesel	500	HDD Conventional, Sleeper		$ 37,500
1999	Freightliner	Detroit Diesel	430	HDD Conventional	185,000	$ 41,900
1999	International	Cummins	350	HDD Conventional	462,645	$ 27,769
1999	Kenworth	Cummins	370	HDD Conventional, Sleeper	515,000	$ 29,750

1999	Mack	Mack	310	HDD Conventional	820,141	$	20,875
1999	Peterbilt	Cummins	370	HDD Conventional, Sleeper		$	38,500
1999	Peterbilt	Caterpillar	435	HDD Conventional, Sleeper		$	43,500
1999	Peterbilt	Cummins	370	HDD Conventional, Sleeper	591,000	$	45,500
2000	Freightliner	Cummins	370	HDD Conventional, Sleeper	732,188	$	24,066
2000	Freightliner	Cummins	370	HDD Conventional, Sleeper	780,223	$	24,635
2000	Freightliner	Cummins	435	HDD Conventional, Sleeper	423,192	$	36,950
2000	Kenworth	Cummins	460	HDD Conventional, Sleeper	495,601	$	41,150
2000	Kenworth	Caterpillar	435	HDD Conventional		$	44,500
2000	Peterbilt	Caterpillar	475	HDD Conventional, Sleeper	577,000	$	54,900
2001	Freightliner	Caterpillar	475	HDD Conventional, Sleeper	431,578	$	47,950
2001	Freightliner	Detroit Diesel	470	HDD Conventional, Sleeper	351,227	$	49,950
2001	Freightliner	Detroit Diesel	470	HDD Conventional, Sleeper	351,227	$	49,950
2001	Freightliner	Detroit Diesel	470	HDD Conventional, Sleeper	408,637		
2001	Kenworth	Cummins	460	HDD Conventional, Sleeper		$	43,900
2001	Kenworth	Cummins	500	HDD Conventional, Sleeper	511,000	$	46,500
2001	Peterbilt	Cummins	410	HDD Conventional		$	43,500
2001	Peterbilt	Caterpillar	500	HDD Conventional, Sleeper		$	52,500
2003	Peterbilt	Caterpillar	410	HDD Conventional		$	57,500
2003	Peterbilt	Caterpillar	430	HDD Conventional		$	82,500
2004	Peterbilt	Caterpillar	430	HDD Conventional		$	83,500
2005	International	Caterpillar	430	HDD Conventional, Sleeper		$	79,740
2005	Peterbilt	Caterpillar	475	HDD Conventional, Sleeper	-	$	99,999
7-28-05 DATA							
1994	Freightliner	Detroit Diesel	470			$	9,500
1994	Freightliner	Detroit Diesel	360			$	17,500
1994	Freightliner	Detroit Diesel	360			$	17,500
1994	Freightliner	Detroit Diesel	360			$	17,500

1994	Freightliner	Detroit Diesel	360			$ 17,500
1995	Freightliner	Cummins	435	HDD Conventional, Sleeper		$ 9,500
1995	Freightliner	Cummins	365	HDD Conventional, Sleeper	900,000	$ 11,000
1996	International	Cummins	370	HDD Conventional, Sleeper		$ 9,000
1997	International	Caterpillar	410	HDD Conventional, Sleeper		$ 23,000
1999	Freightliner	Detroit Diesel	430	HDD Conventional, Sleeper	625,000	$ 28,500
2000	Freightliner	Detroit Diesel	430	HDD Conventional, Sleeper	488,369	
2000	Freightliner	Detroit Diesel	500	HDD Conventional, Sleeper		$ 36,500
2000	Freightliner	Detroit Diesel	500	HDD Conventional, Sleeper		$ 36,500
2000	Freightliner	Detroit Diesel	500	HDD Conventional, Sleeper		$ 36,500
2000	Freightliner	Detroit Diesel	430	HDD Conventional, Sleeper	500,000	$ 42,500
2000	Freightliner	Detroit Diesel	430	HDD Conventional, Sleeper	500,000	$ 42,500
2000	Freightliner	Detroit Diesel	430	HDD Conventional, Sleeper	500,000	$ 42,500
2002	Peterbilt	Caterpillar	475	HDD Conventional, Sleeper	528,087	
2004	Volvo	Volvo	465	HDD Conventional, Sleeper	119,000	
8-30-05 Data						
2006	Freightliner	Caterpillar	475	HDD Conventional, Sleeper	-	$ 95,000
2006	Freightliner	Caterpillar	475	HDD Conventional, Sleeper	-	$ 95,000
2006	Freightliner	Caterpillar	475	HDD Conventional, Sleeper	-	$ 95,000
2006	Volvo	Cummins	530	HDD Conventional, Sleeper		$ 119,995
2006	Volvo	Cummins	475	HDD Conventional, Sleeper		$ 109,995
2006	Volvo	Cummins	530	HDD Conventional, Sleeper		$ 106,612
2006	Freightliner	Detroit Diesel	515	HDD Conventional, Sleeper	-	$ 107,000
2006	Freightliner	Caterpillar	475	HDD Conventional, Sleeper	-	$ 95,000
2006	Freightliner	Detroit Diesel	515	HDD Conventional, Sleeper	-	$ 92,500
2006	Volvo	Cummins	530	HDD Conventional, Sleeper		$ 119,995
2006	Volvo	Cummins	475	HDD Conventional, Sleeper		$ 109,995
2006	Volvo	Cummins	530	HDD Conventional, Sleeper		$ 123,995

2005	Peterbilt	Caterpillar	435	HDD Conventional, Sleeper		$ 89,900
2005	Freightliner	Detroit Diesel	500	HDD Conventional, Sleeper		$ 84,900
2005	Kenworth	Caterpillar	475	HDD Conventional, Sleeper		$ 99,500
2004	Peterbilt	Caterpillar	475	HDD Conventional, Sleeper		$ 76,000
2004	Kenworth	Caterpillar	475	HDD Conventional, Sleeper		$ 75,000
2004	Kenworth	Caterpillar	475	HDD Conventional, Sleeper		$ 75,000
2004	Peterbilt	Caterpillar	475	HDD Conventional, Sleeper		$ 89,500
2004	Kenworth	Caterpillar	475	HDD Conventional, Sleeper		$ 75,500
2004	Freightliner	Detroit Diesel	500	HDD Conventional, Sleeper		$ 109,000
2004	Freightliner	Caterpillar	475	HDD Conventional, Sleeper		$ 92,500
2003	Kenworth	Cummins	475	HDD Conventional, Sleeper		$ 83,500
2003	Freightliner	Detroit	500	HDD Conventional, Sleeper		$ 42,000
2003	Freightliner	Detroit	470	HDD Conventional, Sleeper		$ 49,900
2003	Freightliner	Detroit	500	HDD Conventional, Sleeper		$ 62,500
2003	Freightliner	Detroit	500	HDD Conventional, Sleeper		$ 66,000
2003	Kenworth	Cummins	400	HDD Conventional, Sleeper		$ 56,900
2003	Kenworth	Cummins	400	HDD Conventional, Sleeper		$ 58,500
2003	Kenworth	Cummins	450	HDD Conventional, Sleeper		$ 67,000
2003	Peterbilt	Caterpillar	475	HDD Conventional, Sleeper		$ 78,000
2003	Peterbilt	Caterpillar	550	HDD Conventional, Sleeper		$ 87,500
2003	Volvo	Cummins	500	HDD Conventional, Sleeper		$ 89,500
2002	Freightliner	Detroit	470	HDD Conventional, Sleeper		$ 49,999
2002	Freightliner	Detroit	430	HDD Conventional, Sleeper		$ 55,950
Total Number of Sample Points			**130**			

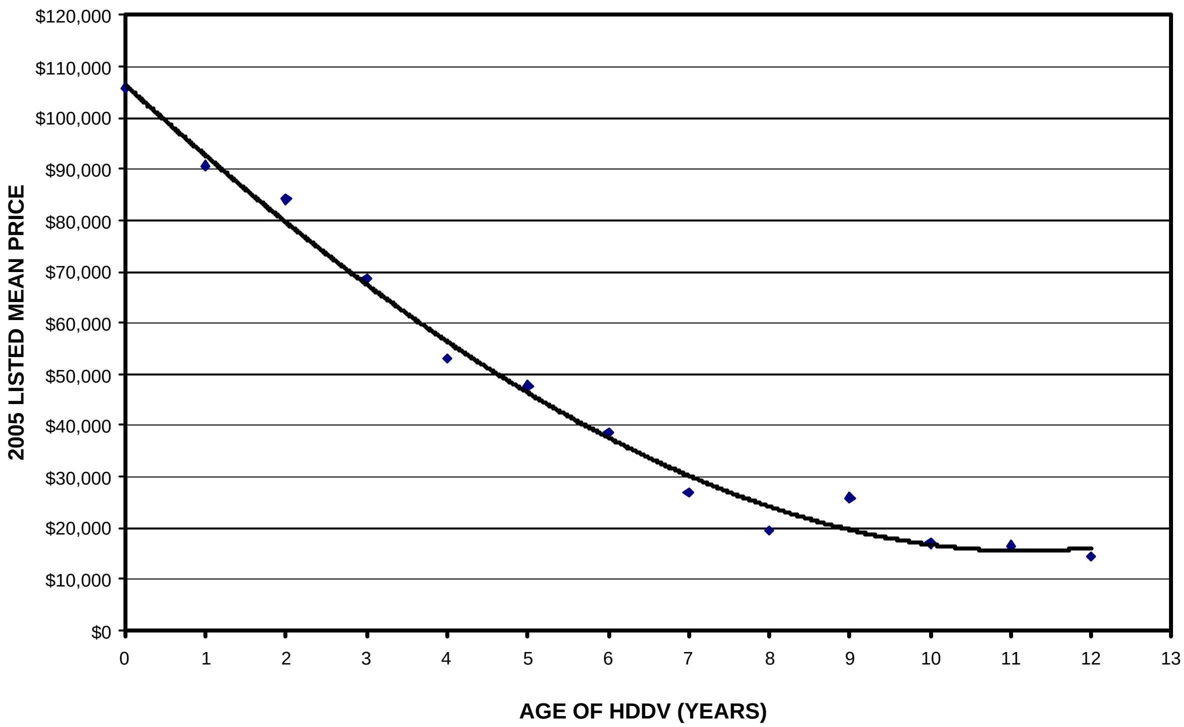
1. 2005 Used HDDV Prices and Forecasts of Prices for Program Years

The above internet survey was used to develop a vehicle age-price distribution profile for the year 2005. ARB staff further assumed that the value of a used port truck established in 2005 will be an average value derived from the survey results. The used

HDDV value may differ depending on unforeseen fluctuations in market demand and prevailing economic conditions.

To determine the HDDV average value, price listings were grouped by model year and a mean price for each model year was developed. ARB staff then used the mean price to develop a trend line for used HDDVs based on the age of the vehicle. Figure 1 below depicts this trend line developed from the survey.

Figure 1: 2005 California Used Truck Price-Age Distribution Profile from Survey



C. Cost Methodology – Common Methodologies and Assumptions for all Three Strategies

Staff determined program strategy costs assuming a capital recovery period of 10 years to correspond with staff's estimation that replacement trucks will be in port service for at least 10 additional years after purchase. The capital recovery analysis used a 5 percent discount rate for consistency with ARB's cold ironing analysis. The individual strategy program costs were developed annually until the end of the capital recovery period and then brought back into present value 2005 dollars using a rate of 7 percent (which includes a cost of money factor of 2 percent). The annual costs during the capital recovery period were then added up for total program costs (present value 2005 dollars). Additionally, annual program costs were combined with estimated annual emission benefits for each phase within each of the three strategies to estimate the cost effectiveness. Lastly, total program costs were combined with estimated port container import volumes through 2015 to estimate container fees needed to fund the modernization of the existing fleet of 12,000 port trucks.

1. Annualized Costs

Annualized Costs = Program Costs x Capital Recovery Factor

The capital recovery factor (CRF) can be derived from the following equation by assuming a discount rate, (i), per period, and the number of compounding periods, (n). The number of compounding periods (n) corresponds to the project life of the strategy:

$$\text{Capital Recovery Factor (CRF)} = \frac{(i) * (1 + i)^n}{(1 + i)^n - 1}$$

Where:
i = 5 percent discount rate
n = 10 year capital recovery period

ARB staff estimated that retrofit and replacement costs of California Port trucks would each have a project life of 10 years, and the prevailing discount rate would be 5 percent. Assuming a 5 percent discount rate (i) scenario, and a 10 year project life (n), the CRF is calculated using the above equation and found to be ~0.1295.

The annualized cost is obtained from the product of the capital recovery factor and the individual strategy cost estimate for its program cost.

2. Present Value

Once the annualized costs are determined, they are then brought back into present value 2005 year costs, as the 2006 calendar year is not yet over. The present value formula is as follows.

$$\text{Present Value (PV)} = \frac{\text{Annual Costs}}{(1 + i)^n}$$

Where:
i = 7 percent discount rate (which includes a 2 percent cost of money factor)
n = Years into the future

3. Cost Effectiveness

The cost effectiveness (CE) measure permits a direct comparison of one strategy with another. Annualized costs and annual emission reductions are used to determine the cost effectiveness of each strategy as show by the following formula.

$$\text{Cost Effectiveness (\$ / Ton)} = \frac{\text{Annualized costs (\$ / Yr)}}{\text{Annual Emission Reductions (Tons / Yr)}}$$

The annualized cost is the amortization (capital recovery) of the individual strategy costs in present value 2005 dollars divided by the annual emissions reduced. All strategies assume a staggered implementation scenario. In years where only a portion of the fleet modernization costs are represented, only the corresponding portion of emission reductions are used to determine the cost effectiveness. This will result in a per-truck cost effectiveness comparison. Also, the cost effectiveness is determined for each pollutant and given in an annual range over the capital recovery period and finally stated as an average of the annual cost effectiveness values.

4. Per-Container Costs

Should funding be needed for port truck modernization efforts, staff analyzed the possible scenario of obtaining funding through an assessment on containers at the ports. One possible approach would levy a fee on all incoming containers bound for port truck transport. Staff obtained data from the "Goods Movement Action Plan: Phase 1"[1] detailing the actual and estimated TEU[2] volumes at the ports of Long Beach (POLB), Los Angeles (POLA) and Oakland in the years 2005, 2010, and 2020. Staff then assumed a linear series between each of the years 2005 - 2010 and 2010 - 2020 to obtain estimated TEU volumes for each year from 2005 – 2020 as shown in Table 2.

[1] Prepared by Business, Transportation and Housing Agency & CAL/EPA
[2] TEU stands for 'Twenty Foot Equivalent Unit'.

Table 2: Estimated and Actual TEU Volumes for Ports of Los Angeles, Long Beach, and Oakland (2005 – 2020) (millions)

Year	OAKLAND	POLA & POLB
2005	2.2	14.5
2006	2.7	15.5
2007	3.1	16.6
2008	3.6	17.6
2009	4.0	18.7
2010	4.5	19.7
2011	4.7	21.3
2012	4.8	22.9
2013	4.9	24.6
2014	5.1	26.2
2015	5.3	27.9
2016	5.4	29.5
2017	5.6	31.1
2018	5.7	32.7
2019	5.9	34.4
2020	6.0	36.0

As this analysis will discus some costs on a per-container basis, staff converted TEUs into containers. This conversion utilized Pacific Maritime Association information detailing the amount and lengths of containers entering each of the three ports in 2004 (Table 3: Highlighted Information).

Table 3: Container and TEU Volumes by Port in 2004

	Container Lengths			Total
	20 foot	**40 foot**	**45 foot**	
POLB	350,014	1,221,366	79,732	1,651,112
POLA	463,230	1,649,877	164,784	2,277,891
Oakland	120,645	334,630	17,754	473,029
Total Containers	933,889	3,205,873	262,270	4,402,032
Container to TEU Conversion Factor	1.00	2.00	2.25	
Total TEUs	933,889	6,411,746	590,108	7,935,743

The TEU-to-container conversion factor was derived from the definition of a TEU being equivalent to a 20 foot container. Thus, a 40 foot container would be equivalent to 2

TEUs and a 45 foot container is the equivalent of 2.25 TEUs. The TEU conversion factor of 0.55 (rounded) is derived by dividing total containers (4,402,032) by total TEUs (7,935,743).

Staff then converted the TEUs in Table 2 into containers. To obtain the total incoming containers transported by truck, staff assumed half the containers are incoming and half outgoing. All of the containers at the port of Oakland and 75 percent of the containers at POLA & POLB are transported by truck[3]. Multiplying the Port of Oakland containers by 0.5 and POLB & POLA containers by 0.5 and 0.75 yields the estimated imported containers transported by truck. Staff then summed the annual imported containers to determine the 2007-2020 total imported containers (Table 4).

Table 4: Estimated Yearly Imported Trucked Containers (millions)

Year	Containers Oakland	Containers POLA, POLB	Trucked Imported Containers
2007	1.7	9.1	4.3
2008	1.9	9.7	4.6
2009	2.2	10.3	4.9
2010	2.5	10.8	5.3
2011	2.6	11.7	5.7
2012	2.6	12.6	6.1
2013	2.7	13.5	6.4
2014	2.8	14.4	6.8
2015	2.9	15.3	7.2
2016	2.9	16.2	7.6
2017	3.1	17.1	7.9
2018	3.1	18.0	8.3
2019	3.2	18.9	8.7
2020	3.3	19.8	9.1
2007-2015 Totals (Rounded)			51
2007-2020 Totals (Rounded)			93

[3] Conversations with port officials

D. Program Costs for the Proposed Strategies

1. Strategy 1

Program costs for strategy 1 consists of costs to modernize trucks entering port service and costs to modernize the existing fleet.

a. Existing Fleet

Strategy 1 requires the existing port fleet of 12,000 trucks to be retrofitted with DPFs for PM reduction. As DPFs can only be retrofitted to 1994+ MY trucks, staff estimates ~ 6,000 trucks will have to be replaced (See Appendix A). Staff will assume the replacement trucks to be 1998+ MY to avoid chip reflash concerns. Staff further assumes 11,800 DPFs will be retrofitted to the existing fleet (See Appendix A). Annual PM and NOx emissions reductions are estimated to be 500 TPY and 480 TPY respectively (See Appendix A). Staff will assume the older pre-1994 MY trucks that are replaced have little intrinsic value due to age and wear and will be destroyed to ensure these trucks do not end up operating (and polluting) in California again. The cost ($16,000) of the 10 year old replacement truck is again derived from the used truck price distribution profile (Figure 1). Also, the replacement truck value will be assumed to be constant over the implementation period as with previous analysis. Tables 5 and 6 show the annual capital recovery of replacement truck costs and DPF retrofits costs, respectively.

Table 5: Strategy 1 – Existing Fleet Truck Replacement Costs
10 Year Capital Recovery Period

Capital Recovery Year	2007	2008	2009	2010	Annual Total	Present Value 2005 dollars
2007	$3,108,109.80				$3,108,109.80	$ 2,904,775.51
2008	$3,108,109.80	$3,108,109.80			$6,216,219.60	$ 5,429,486.94
2009	$3,108,109.80	$3,108,109.80	$3,108,109.80		$9,324,329.40	$ 7,611,430.29
2010	$3,108,109.80	$3,108,109.80	$3,108,109.80	$3,108,109.80	$12,432,439.20	$ 9,484,648.34
2011	$3,108,109.80	$3,108,109.80	$3,108,109.80	$3,108,109.80	$12,432,439.20	$ 8,864,157.32
2012	$3,108,109.80	$3,108,109.80	$3,108,109.80	$3,108,109.80	$12,432,439.20	$ 8,284,259.18
2013	$3,108,109.80	$3,108,109.80	$3,108,109.80	$3,108,109.80	$12,432,439.20	$ 7,742,298.30
2014	$3,108,109.80	$3,108,109.80	$3,108,109.80	$3,108,109.80	$12,432,439.20	$ 7,235,792.80
2015	$3,108,109.80	$3,108,109.80	$3,108,109.80	$3,108,109.80	$12,432,439.20	$ 6,762,423.18
2016	$3,108,109.80	$3,108,109.80	$3,108,109.80	$3,108,109.80	$12,432,439.20	$ 6,320,021.67
2017		$3,108,109.80	$3,108,109.80	$3,108,109.80	$9,324,329.40	$ 4,429,921.73
2018			$3,108,109.80	$3,108,109.80	$6,216,219.60	$ 2,760,075.84
2019				$3,108,109.80	$3,108,109.80	$ 1,289,755.07
Total	$31,081,097.99	$31,081,097.99	$31,081,097.99	$31,081,097.99		$ 79,119,046.18

-Trucks per implementation year = 1,500 (6,000 total trucks / 4 years)

-Trucks costs per implementation year = $24,000,000 (1,500 trucks * $16,000 per truck)
-Annual capital recovery per implementation year = ~$3,108,000 ($24,000,000 *0.1295 capital recovery factor)

Table 6: Strategy 1 – Existing Fleet
DPF, O&M Costs during 10 Year Capital Recovery Period

Capital Recovery Year	2007	2008	2009	2010	O&M Costs	Extended O&M Costs	Annual Total	Present Value 2005 dollars
2007	$3,247,327				$200.00	$590,000.00	$3,837,327.22	$3,586,287.12
2008	$3,247,327	$3,247,327			$210.76	$1,243,484.00	$7,738,138.43	$6,758,789.79
2009	$3,247,327	$3,247,327	$3,247,327		$222.10	$1,965,575.16	$11,707,556.81	$9,556,853.77
2010	$3,247,327	$3,247,327	$3,247,327	$3,247,327	$234.05	$2,761,764.14	$15,751,073.01	$12,016,418.18
2011	$3,247,327	$3,247,327	$3,247,327	$3,247,327	$246.64	$2,910,347.05	$15,899,655.92	$11,336,234.93
2012	$3,247,327	$ 3,247,327	$3,247,327	$3,247,327	$259.91	$3,066,923.72	$16,056,232.59	$10,698,945.73
2013	$3,247,327	$3,247,327	$3,247,327	$3,247,327	$273.89	$3,231,924.21	$16,221,233.08	$10,101,768.72
2014	$3,247,327	$3,247,327	$ 3,247,327	$3,247,327	$288.63	$3,405,801.74	$16,395,110.61	$9,542,103.64
2015	$3,247,327	$3,247,327	$3,247,327	$3,247,327	$304.16	$3,589,033.87	$16,578,342.74	$9,017,520.01
2016	$3,247,327	$3,247,327	$3,247,327	$3,247,327	$320.52	$3,782,123.89	$16,771,432.76	$8,525,745.97
2017		$3,247,327	$3,247,327	$3,247,327	$337.76	$2,989,201.62	$12,731,183.27	$ 6,048,493.46
2018			$3,247,327	$3,247,327	$355.93	$2,100,013.78	$8,594,668.21	$3,816,135.47
2019				$3,247,327	$375.08	$1,106,497.26	$4,353,824.48	$1,806,682.37
Total	$32,473,272.17	$32,473,272.17	$32,473,272.17	$32,473,272.17				$102,811,979.16

-DPFs per implementation year = 2,950 (11,800 total DPFs / 4 years)
-DPF costs per implementation year = ~$25,075,000 (2,950 DPFs * $8,500) Not including O&M
-Annual capital recovery per implementation year (not including O&M) = ~$3,247,000 ($25,075,000 *0.1295 capital recovery factor)
-Year 2007 O&M per-DPF costs of $200 to increase ~5 percent per year

b. Trucks Entering Port Service

All three strategies will require trucks entering port service to meet the same emission standards; therefore staff assumes the costs and benefits will be identical. Trucks entering port service will be required to meet increasingly stringent emission standards during three different time periods: 2007-2011, 2012-2014, and 2015 and later.

i. 2007-2011 Cost Analysis

From program start (2007) until 2011, trucks will be required to meet 2003 emission standards for both NOx and PM. Trucks must be MY 2003+ to meet the NOx emission standard. Since very little information exists detailing the typical age of a port truck when first entering port service, staff will assume the average age of pre-2003 MY trucks entering port service is 10 years. This assumption applies to those trucks that are estimated to be pre-2003 upon entering the fleet. Trucks MY 2003+ will only require a DPF and therefore do not require a differential truck cost analysis. The '10' year old truck' assumption take into account port truck operator economics which typically dictates the purchase of much older, less expensive trucks and the expected availability of such trucks on the used market. Using this generalization, in 2007, the average model year (MY) a truck entering port service would be 1997. By requiring a 2003 MY truck with a DPF, staff reasons that the program costs will result from a difference in costs of a 10 year-old truck to a newer truck plus a DPF. Staff assumes a uniform annual implementation from 2007-2011. Therefore, the 2,400 (see Appendix A) pre-2003 MY trucks entering port service during 2007-2011 results in 480 trucks per year. Because future used truck prices are unknown to a high degree of accuracy, staff assumes that the price differential derived from using Figure 1 data is applicable. Similarly, staff also assumes constant used truck prices through 2011. In reality, future used truck prices could vary from those assumed depending on supply and demand. Staff also assumes the price of DPFs ($8,500[4]) will be constant due to economies of scale and increased production. DPFs also require yearly maintenance. Annual operation and maintenance of DPFs cost ~$200[4]. Since O&M costs are mainly labor costs, staff assumes a 5 percent yearly increase in costs after implementation start year of 2007.

To estimate the average differential cost to the truck owner for purchasing a 'newer' than normal used truck, staff used the mid-year (2009) of the 2007-2011 time period. In 2009, a truck entering port service would normally be 10 years old, but, the strategy will require a 2003 MY truck, which is now only 6 years old. Utilizing Figure 1, the differential cost from a 10 year old truck ($16,000) to a 6 year old truck ($38,000) is $22,000 per truck. Using $22,000 per truck, $8,500 for a DPF, and $200 annual DPF O&M costs, will yield the present value program costs for trucks entering port service 2007-2011. The present value in program costs for 2,400 trucks entering port service is $42 million (rounded) as shown in Table 7.

[4] Ironman Parts and Service, 2005

Table 7: Trucks Entering Port Service 2007-2011
Differential Truck Costs during 10 Year Capital Recovery Period

Capital Recovery Year	2007	2008	2009	2010	I2011	Annual Total	Present Value 2005 dollars
2007	$1,367,568.31					$1,367,568.31	$ 1,278,101.23
2008	$1,367,568.31	$1,367,568.31				$2,735,136.62	$2,388,974.25
2009	$1,367,568.31	$1,367,568.31	$1,367,568.31			$4,102,704.93	$3,349,029.33
2010	$1,367,568.31	$1,367,568.31	$1,367,568.31	$1,367,568.31		$5,470,273.25	$4,173,245.27
2011	$1,367,568.31	$1,367,568.31	$1,367,568.31	$1,367,568.31	$1,367,568.31	$6,837,841.56	$4,875,286.53
2012	$1,367,568.31	$1,367,568.31	$1,367,568.31	$1,367,568.31	$1,367,568.31	$6,837,841.56	$4,556,342.55
2013	$1,367,568.31	$1,367,568.31	$1,367,568.31	$1,367,568.31	$1,367,568.31	$6,837,841.56	$4,258,264.07
2014	$1,367,568.31	$1,367,568.31	$1,367,568.31	$1,367,568.31	$1,367,568.31	$6,837,841.56	$3,979,686.04
2015	$1,367,568.31	$1,367,568.31	$1,367,568.31	$1,367,568.31	$1,367,568.31	$6,837,841.56	$3,719,332.75
2016	$1,367,568.31	$1,367,568.31	$1,367,568.31	$1,367,568.31	$1,367,568.31	$6,837,841.56	$3,476,011.92
2017		$1,367,568.31	$1,367,568.31	$1,367,568.31	$1,367,568.31	$5,470,273.25	$2,598,887.41
2018			$1,367,568.31	$1,367,568.31	$1,367,568.31	$4,102,704.93	$1,821,650.06
2019				$1,367,568.31	$1,367,568.31	$2,735,136.62	$1,134,984.46
2020					$1,367,568.31	$1,367,568.31	$530,366.57
Total	$13,675,683.12	$13,675,683.12	$13,675,683.12	$13,675,683.12	$13,675,683.12		$42,140,162.43

-Trucks per implementation year = 480 (2,400 total trucks / 5 years)
-Trucks costs per implementation year = $10,560,000 (480 trucks * $22,000 per truck)
-Annual capital recovery per implementation year = $1,367,568.31 ($10,560,000 *0.1295 capital recovery factor (rounded)

Similar analysis was used to quantify the cost of retrofitting DPFs. Staff estimates 3,500 DPFs will be required (See Appendix A). Again, staff used a 10 year capital recovery period to generate present value 2005 costs of retrofitting 3,500 DPFs on trucks entering port service to be $30 million (rounded) as shown in Table 8.

Table 8: Trucks Entering Port Service 2007-2011
DPF, O&M Costs during 10 Year Capital Recovery Period

Capital Recovery Year	2007	2008	2009	2010	2011	O&M Costs	Extended O&M Costs	Annual Total	Present Value 2005 dollars
2007	$770,552					$200.00	$140,000.00	$910,552.22	$850,983.38
2008	$770,552	$770,552				$210.76	$295,064.00	$1,836,168.44	$1,603,780.63
2009	$770,552	$770,552	$770,552			$222.10	$466,407.66	$2,778,064.33	$2,267,728.01
2010	$770,552	$770,552	$770,552	$770,552		$234.05	$655,333.86	$3,737,542.75	$2,851,353.47
2011	$770,552	$770,552	$770,552	$770,552	$770,552	$246.64	$863,238.53	$4,715,999.64	$3,362,442.56
2012	$770,552	$770,552	$770,552	$770,552	$770,552	$259.91	$909,680.76	$4,762,441.87	$3,173,416.11
2013	$770,552	$770,552	$770,552	$770,552	$770,552	$273.89	$958,621.59	$4,811,382.69	$2,996,287.33
2014	$770,552	$770,552	$770,552	$770,552	$770,552	$288.63	$1,010,195.43	$4,862,956.54	$2,830,284.98
2015	$770,552	$770,552	$770,552	$770,552	$770,552	$304.16	$1,064,543.94	$4,917,305.05	$2,674,688.14
2016	$770,552	$770,552	$770,552	$770,552	$770,552	$320.52	$1,121,816.41	$4,974,577.51	$2,528,822.96
2017		$770,552	$770,552	$770,552	$770,552	$337.76	$945,736.11	$4,027,944.99	$1,913,647.65
2018			$770,552	$770,552	$770,552	$355.93	$747,462.53	$3,059,119.19	$1,358,285.51
2019				$770,552	$770,552	$375.08	$525,117.34	$2,066,221.79	$857,408.58
2020					$770,552	$395.26	$276,684.33	$1,047,236.55	$434,565.94
2021									
Total	$7,705,522	$7,705,522	$7,705,522	$7,705,522	$7,705,522				$29,703,695.24

-DPFs per implementation year = 700 (3,500 total DPFs / 5 years)
-DPF costs per implementation year = $5,950,000 (700 DPFs * $8,500) Not including O&M
-Annual capital recovery per implementation year (not including O&M) = $770,552 ($5,950,000 *0.1295 capital recovery factor)
-Year 2007 O&M per-truck costs of $200 to increase ~5 percent per year
-Extended O&M costs = O&M costs per DPF * number of truck during capital recovery year.

(e.g. Year 2013 = $273.89 * 3,500 trucks = ~$958,000 and
Year 2018 = $355.93 * 2,100 trucks = ~$747,000)

ii. 2012-2014 Cost Analysis

From 2012-2014, trucks will be required to meet 2007 emission standards. Staff will assume the 2012-2014 costs to truck owners will again comprise of buying 'newer' than normal used trucks. But, because 2007 emission standard trucks will be equipped with a DPF, there will be no additional costs for DPF retrofits.

However, the price of a used 2007 truck could increase over model predictions because of the potential increase in new 2007 MY trucks over 2006 MY trucks. A 2005 staff survey showed that the average price of available, new 2006 MY conventional, class 8, heavy-duty diesel vehicles was ~ $106,000. In 2006, staff further surveyed the California marketplace for new 2007 MY HDV listings, and found the listed price to be ~ $126,000. This price increase between the 2006 MY and 2007 MY price reflects the normal annual price increase for new Model Year vehicles (~3 percent), and the additional cost of compliance with the federal EPA heavy-duty diesel engine PM standards which go into effect for the 2007 Model Year. Specifically, the price increase reflects the inclusion of an active diesel particulate filter integrated with the engine's combustion and air-handling system, a backpressure monitor, a crankcase ventilation system with a coalescing filter, an electronic control module (ECM), and in-cab displays. Staff estimates a 15 - 20 percent price increase for 2007 MY trucks. To compensate for this price increase, staff will increase the used truck price accordingly (20 percent) when the strategy requires the purchase of a 2007 MY or newer truck.

While staff assumes static used truck prices until 2011, it is unreasonable to assume static prices past 2011. For simplicity, staff will assume a 3 percent annual inflation rate for the trucks purchased after 2011. Staff estimates that the 1,300 trucks (see Appendix A) entering port service during 2012-2014 will be required to be 'newer' than they would have normally been. Again taking the mid year of 2013, the difference is between a 10 year old truck and a 6 year old truck (2013 – 2007). Again, a ten year old truck is $16,000 and a 6 year old truck is $38,000 for a difference of $22,000. Growing $22,000 at 3 percent a year past 2011 and increasing it by 20 percent (2007 price adjustment) yields a differential truck price of ~$28,000. Table 9 displays the capital recovery and present value costs for new trucks entering the fleet from 2012-2014.

Table 9: Trucks Entering Port Service 2012-2014
Incremental Truck Costs during 10 Year Capital Recovery Period

Capital Recovery Year	2012	2013	2014	Annual Total	Present Value 2005 dollars
2012	$1,571,322.18			$1,571,322.18	$1,047,038.31
2013	$1,571,322.18	$1,571,322.18		$3,142,644.35	$1,957,080.96
2014	$1,571,322.18	$1,571,322.18	$1,571,322.18	$4,713,966.53	$2,743,571.44
2015	$1,571,322.18	$1,571,322.18	$1,571,322.18	$4,713,966.53	$2,564,085.46
2016	$1,571,322.18	$1,571,322.18	$1,571,322.18	$4,713,966.53	$2,396,341.55
2017	$1,571,322.18	$1,571,322.18	$1,571,322.18	$4,713,966.53	$2,239,571.54
2018	$1,571,322.18	$1,571,322.18	$1,571,322.18	$4,713,966.53	$2,093,057.51
2019	$1,571,322.18	$1,571,322.18	$1,571,322.18	$4,713,966.53	$1,956,128.52
2020	$1,571,322.18	$1,571,322.18	$1,571,322.18	$4,713,966.53	$1,828,157.49
2021	$1,571,322.18	$1,571,322.18	$1,571,322.18	$4,713,966.53	$1,708,558.41
2022		$1,571,322.18	$1,571,322.18	$3,142,644.35	$1,064,522.37
2023			$1,571,322.18	$1,571,322.18	$497,440.36
Total	$15,713,221.76	$15,713,221.76	$15,713,221.76		$22,095,553.92

-Trucks per implementation year = 433.33 (1,300 total trucks / 3 years)
-Trucks costs per implementation year = $12,100,000 (433.33 trucks * $28,000 per truck)
-Annual capital recovery per implementation year = ~$1,570,000 ($12,100,000 *0.1295 capital recovery factor)

iii. 2015-2019 Cost Analysis

From 2015 on, trucks will be required to meet 2010 emission standards. As this will be the continuing standard, staff will analyze costs for 2015-2019 with the knowledge that after 2019 it is expected that 2010 standard trucks would naturally come into service without the strategy (assuming 10 year old used truck). Staff assumes that the 2015-2019 costs to truck owners will again comprise of buying 'newer' than normal used trucks with no additional DPFs. Staff will also assume the 3 percent annual inflation rate for the used truck inflation rate past 2011. Staff estimates the 2,000 trucks entering port service during 2015-2019 will be required to be 'newer' than they would have normally been (see Appendix A). Taking the mid year 2017, the difference between a 10 year old truck and a 7 year old truck (2017 – 2010). A 10 year old truck is $16,000 and a 7 year old truck is $30,000 for a difference of $14,000. Growing $14,000 at 3 percent a year past 2011 yields a differential truck price of ~$17,000. Table 10 displays the capital recovery and present value costs for new trucks entering the fleet from 2015-2019.

Table 10: Trucks Entering Port Service 2015-2019
Incremental Truck Costs during 10 Year Capital Recovery Period

Capital Recovery Year	2015	2016	2017	2018	2019	Annual Total	Present Value 2005 dollars
2015	$880,631.11					$880,631.11	$479,004.98
2016	$880,631.11	$880,631.11				$1,761,262.22	$895,336.40
2017	$880,631.11	$880,631.11	$880,631.11			$2,641,893.33	$1,255,144.49
2018	$880,631.11	$880,631.11	$880,631.11	$880,631.11		$3,522,524.44	$1,564,042.98
2019	$880,631.11	$880,631.11	$880,631.11	$880,631.11	$880,631.11	$4,403,155.55	$1,827,153.01
2020	$880,631.11	$880,631.11	$880,631.11	$880,631.11	$880,631.11	$4,403,155.55	$1,707,619.64
2021	$880,631.11	$880,631.11	$880,631.11	$880,631.11	$880,631.11	$4,403,155.55	$1,595,906.20
2022	$880,631.11	$880,631.11	$880,631.11	$880,631.11	$880,631.11	$4,403,155.55	$1,491,501.12
2023	$880,631.11	$880,631.11	$880,631.11	$880,631.11	$880,631.11	$4,403,155.55	$1,393,926.28
2024	$880,631.11	$880,631.11	$880,631.11	$880,631.11	$880,631.11	$4,403,155.55	$1,302,734.84
2025		$880,631.11	$880,631.11	$880,631.11	$880,631.11	$3,522,524.44	$974,007.36
2026			$880,631.11	$880,631.11	$880,631.11	$2,641,893.33	$682,715.44
2027				$880,631.11	$880,631.11	$1,761,262.22	$425,367.88
2028					$880,631.11	$880,631.11	$198,770.04
Total	$8,806,311.10	$8,806,311.10	$8,806,311.10	$8,806,311.10	$8,806,311.10		$15,793,230.66

-Trucks per implementation year = 400 (2,000 total trucks / 5 years)
-Trucks costs per implementation year = $6,800,000 (400 trucks * $17,000 per truck)
-Annual capital recovery per implementation year = ~$880,000 ($6,800,000 *0.1295 capital recovery factor)
Combining all the implementation time periods into Table 11 yields total program costs of approximately $110 million (2005 dollars) for trucks entering port service. Once again, staff assumes these costs to be identical for all three strategies analyzed later in this appendix.

Table 11: Trucks Entering Port Service 2007-2019
10 Year Capital Recovery Period (rounded)(millions)

Capital Recovery Year	2007 - 2011		2012 - 2014	2015 +	
	TOTAL DPF, INSTALLATION & O&M COSTS	TOTAL INCREMENTAL TRUCK REPLACEMENT COSTS	TOTAL INCREMENTAL TRUCK REPLACEMENT COSTS	TOTAL INCREMENTAL TRUCK REPLACEMENT COSTS*	TRUCKS ENTERING PORT SERVICE COSTS
2007	$0.9	$1.3			$2.2
2008	$1.6	$2.4			$4.0
2009	$2.3	$3.3			$5.6
2010	$2.9	$4.2			$7.1
2011	$3.4	$4.9			$8.3
2012	$3.2	$4.6	$1.0		$8.8
2013	$3.0	$4.3	$2.0		$9.3
2014	$2.8	$4.0	$2.7		$9.5
2015	$2.7	$3.7	$2.6	$0.5	$9.5
2016	$2.5	$3.5	$2.4	$0.9	$9.3
2017	$1.9	$2.6	$2.2	$1.3	$8.0
2018	$1.4	$1.8	$2.1	$1.6	$6.9
2019	$0.9	$1.1	$2.0	$1.8	$5.8
2020	$0.4	$0.5	$1.8	$1.7	$4.4
2021			$1.7	$1.6	$3.3
2022			$1.1	$1.5	$2.6
2023			$0.5	$1.4	$1.9
2024				$1.3	$1.3
2025				$1.0	$1.0
2026				$0.7	$0.7
2027				$0.4	$0.4
2028				$0.2	$0.2
Total	$29.9	$42.2	$22.1	$15.9	$110.1

The costs to modernize the existing fleet and trucks entering port service were combined into Table 12 with resultant total strategy costs of $290 million in present value 2005 dollars (rounded).

Table 12: Strategy 1 – Total Costs During Capital Recovery Period (rounded)(millions)

Capital Recovery Year	TOTAL DPF, INSTALLATION & O&M COSTS	TOTAL TRUCK REPLACEMENT COSTS	TRUCKS ENTERING PORT SERVICE	TOTAL PROGRAM COSTS
2007	$3.6	$2.9	$2.2	$8.7
2008	$6.8	$5.4	$4.0	$16.2
2009	$9.6	$7.6	$5.6	$22.8
2010	$12.0	$9.5	$7.1	$28.6
2011	$11.3	$8.9	$8.3	$28.5
2012	$10.7	$8.3	$8.8	$27.8
2013	$10.1	$7.7	$9.3	$27.1
2014	$9.5	$7.2	$9.5	$26.2
2015	$9.0	$6.8	$9.5	$25.3
2016	$8.5	$6.3	$9.3	$24.1
2017	$6.0	$4.4	$8.0	$18.4
2018	$3.8	$2.8	$6.9	$13.5
2019	$1.8	$1.3	$5.8	$8.9
2020			$4.4	$4.4
2021			$3.3	$3.3
2022			$2.6	$2.6
2023			$1.9	$1.9
2024			$1.3	$1.3
2025			$1.0	$1.0
2026			$0.7	$0.7
2027			$0.4	$0.4
2028			$0.2	$0.2
Total	$102.7	$79.1	$110.1	$291.9

c. Strategy 1 – Cost Effectiveness – Trucks Entering Port Service

As mentioned earlier, the cost effectiveness analysis allows a direct comparison of one strategy with another. In years where only a portion of total annual fleet costs are represented (resulting from staggered implementation), only the corresponding portion of total annual emission reductions are used to determine the cost effectiveness. Staff further bisected annual program costs into those costs primarily responsible for PM reductions and those primarily responsibly for NOx reductions. The cost effectiveness is then presented as a range of annual values over the entire capital recovery period and finally as an average of all annual CE values over the capital recovery period for each pollutant reduced.

i. 2007-2011 - Cost Effectiveness Analysis

Table 13 presents the cost effectiveness determination results for new trucks entering the port fleet during 2007-2011. Staff estimates annual reductions of PM and NOx after full implementation to be 85 TPY and 400 TPY respectively (See Appendix A). One hundred (100) percent of DPF installation and O&M costs are attributed to PM benefits as DPFs are PM reduction technologies. Assuming a 10 year old truck entering port service during 2007-2011 would already be compatible with the installation of a DPF[5], the only additional NOx reductions will be gained by requiring a 2003+ MY truck. Therefore, all differential truck replacement costs will be attributed to NOx reductions.

Table 13: Trucks Entering Port Service 2007-2011
Cost Effectiveness: Annual Range & Annual Average NOx and PM

Capital Recovery Year	Annual $ to PM	Apportioned Annual PM Reductions TPY	Annual PM Cost Effectiveness ($/Ton)	Annual $ to NOx	Apportioned Annual NOx Reductions TPY	Annual NOx Cost Effectiveness ($/Ton)
2007	$850,983.38	17.00	$50,057.85	$1,278,101.23	80	$15,976.27
2008	$1,603,780.63	34.00	$47,170.02	$2,388,974.25	160	$14,931.09
2009	$2,267,728.01	51.00	$44,465.26	$3,349,029.33	240	$13,954.29
2010	$2,851,353.47	68.00	$41,931.67	$4,173,245.27	320	$13,041.39
2011	$3,362,442.56	85.00	$39,558.15	$4,875,286.53	400	$12,188.22
2012	$3,173,416.11	85.00	$37,334.31	$4,556,342.55	400	$11,390.86
2013	$2,996,287.33	85.00	$35,250.44	$4,258,264.07	400	$10,645.66
2014	$2,830,284.98	85.00	$33,297.47	$3,979,686.04	400	$9,949.22
2015	$2,674,688.14	85.00	$31,466.92	$3,719,332.75	400	$9,298.33
2016	$2,528,822.96	85.00	$29,750.86	$3,476,011.92	400	$8,690.03
2017	$1,913,647.65	68.00	$28,141.88	$2,598,887.41	320	$8,121.52
2018	$1,358,285.51	51.00	$26,633.05	$1,821,650.06	240	$7,590.21
2019	$857,408.58	34.00	$25,217.90	$1,134,984.46	160	$7,093.65
2020	$434,565.94	17.00	$25,562.70	$530,366.57	80	$6,629.58
	$29,703,695.24			$42,140,162.43		
Average	$2,121,692.52		$35,417.03	$3,010,011.60		$10,678.59
MIN	$434,565.94		$25,217.90	$530,366.57		$6,629.58
MAX	$3,362,442.56		$50,057.85	$4,875,286.53		$15,976.27

[5] DPFs are ARB verified on 1994 MY and newer trucks

All future cost effectiveness determinations in this appendix (with the exception of those determinations using Carl Moyer methodologies) utilize the same methodologies presented in Table 13. Any differences in staff's assumptions are presented before each summary table.

<u>Sample Calculation - 2009</u>:

In 2009, 60 percent of the 3,500 total trucks expected to enter port service during 2007-2011 will generate the ~$5.6 million annual capital recovery costs (see Tables 7 & 8). Therefore, only 60 percent of the estimated total annual emission reductions after FULL implementation will be used.

85 TPY Total Annual PM Reductions * 0.60 = 51 TPY
400 TPY Total Annual NOx Reductions * 0.60 = 240 TPY

Again, attributing 100 percent of DPF capital recovery costs during 2009 to PM yields a cost effectiveness of ~$44,000 / Ton PM Reduced.

$$\frac{(\$2{,}267{,}728.01 \text{ PM Capital Recovery in 2009})}{(51 \text{ Tons PM Reduced in 2009})} =$$

=~$44,000 per Ton PM Reduced During Capital Recovery Year 2009

Using the same methodology for the NOx capital recovery cost effectiveness in 2009 yields ~$14,000 per ton NOx Reduced. Staff then obtained the minimum, maximum, and average of the annual cost effectiveness determination during the capital recovery years 2007-2020 (Table 13). The rounded results are summarized in Table 14.

Table 14: Trucks Entering Port Service 2007-2011 Summarized Cost Effectiveness: Annual Range & Annual Average NOx and PM (rounded)

Pollutant	Annual Cost Effectiveness Range ($ / Ton)		Average Annual Cost Effectiveness	Annual Pollutant Reductions After Full Implementation (TPY)
	Low	High		
PM	$25,000	$50,000	$35,000	85
NOx	$7,000	$16,000	$11,000	400

ii. 2012-2014 - Cost Effectiveness Analysis

The same methodology was used to determine the annual cost effectiveness during the 2012-2023 (Table 9) capital recovery period for trucks entering port service during 2012-2014. As trucks enter port service during this time, they will be required to operate using 2007 emission standards. No DPF costs are applicable. The only cost is to buy a 'newer' than normal used truck (2007 MY vs. ~10 year old 2003 MY). Since the truck will reduce both NOx and PM emissions, staff estimated half the annual capital recovery costs are attributable to PM reduction and half to NOx reductions. Table 15 provides the summarized annual costs effectiveness determinations for trucks entering port service during 2012-2014 utilizing estimated annual PM and NOx emission reductions of 35 TPY (see Appendix A) and 400 TPY respectively after full implementation.

TABLE 15: Trucks Entering Port Service 2012-2014 Summarized Cost Effectiveness: Annual Range & Annual Average NOx and PM (rounded)

Pollutant	Annual Cost Effectiveness Range ($/Ton)		Average Annual Cost Effectiveness	Annual Pollutant Reductions After Full Implementation (TPY)
	Low	High		
PM	$21,000	$45,000	$32,000	35
NOx	$2,000	$4,000	$3,000	400

iii. 2015-2019 - Cost Effectiveness Analysis

The same methodology was used to determine the annual cost effectiveness during the 2015-2028 (Table 10) capital recovery period for trucks entering port service during 2015-2019. As trucks enter port service during this time, they will be required to operate using 2010 emission standards. No DPF costs are applicable. The only cost is to buy a 'newer' than normal used truck (2010 MY vs. ~10 year old 2007 MY). Because this 'newer' truck will only reduce NOx emissions over the older truck, staff estimated all the annual capital recovery costs are attributable to NOx reductions. Table 16 provides the summarized annual costs effectiveness determinations for trucks entering port service during 2015-2019 utilizing estimated annual NOx emission reductions of 730 TPY (see Appendix A) after full implementation.

Table 16: Trucks Entering Port Service 2015-2019 Summarized Cost Effectiveness: Annual Range & Annual Average NOx (rounded)

Pollutant	Annual Cost Effectiveness Range ($/Ton)		Average Annual Cost Effectiveness	Annual Pollutant Reductions After Full Implementation (TPY)
	Low	High		
NOx	$1,000	$3,000	$2,000	730

d. Strategy 1 – Cost Effectiveness – Existing Fleet

All costs are attributable to PM reductions as there are no NOx reductions. Staff estimates PM of 280 TPY after full implementation (See Appendix A). Table 17 provides the summarized annual costs effectiveness for the existing fleet during the capital recovery period of 2007-2019.

Table 17: Strategy 1 – Summarized Cost Effectiveness: Annual Range and Annual Average during Capital Recovery Period (2007-2019) (rounded)

Pollutant	Annual Cost Effectiveness Range ($/Ton)		Average Annual Cost Effectiveness ($/Ton)	Annual Pollutant Reduced After Full Implementation (TPY)
	Low	High		
PM	$25,000	$52,000	$37,000	500
NOx	$5,000	$12,000	$8,000	480

e. Strategy 1 – Existing Fleet Per-Container Recovery Costs

To estimate the per-container fee to recover the costs of modernizing the existing fleet, staff simply divided total program costs by the number of incoming containers destined for truck transport through 2015 (see Tables 4, 5, and 6 and corresponding analysis). Staff divided the total program costs of ~$180 million by 51 million containers to yield the potential per-container fee to fund modernizing the existing fleet of approximately $4 per container.

2. Program Costs – Strategy 2

Program cost and annual cost effectiveness for strategy 2 was determined using the same methodology as strategy 1. Strategy 2 requires the existing port fleet of 12,000 trucks retrofit with DPFs for PM reduction. Strategy 2 reduces NOx by requiring that all pre-2003 MY trucks be replaced with 2003+ MY trucks. Staff estimates ~ 11,800 trucks will have to be replaced and retrofitted with DPFs (See Appendix A). For this analysis, staff will not factor in potential benefits of the replaced vehicles. Although not quantified here, potentially, truck owners could recoup some costs by selling the newer portion of the replaced fleet (e.g. model year 1998-2002 trucks) and lower the net costs of truck replacement. Staff estimates the cost of a 5 year old[6] replacement truck to be $48,000 (Figure 1). The replacement truck value is assumed to be constant over the implementation period as with previous analysis. The DPF cost analysis in strategy 2 is identical to the DPF cost analysis for strategy 1 and will cost ~$103 million. Table 18 show the annual capital recovery of replacement truck cost and DPF retrofits costs, respectively.

Table 18: Strategy 2 – Existing Fleet Truck Replacement Costs 10 Year Capital Recovery Period

Capital Recovery Year	2007	2008	2009	2010	Annual Total	Present Value 2005 dollars
2007	$18,337,847.82				$18,337,847.82	$17,138,175.53
2008	$18,337,847.82	$18,337,847.82			$36,675,695.63	$32,033,972.95
2009	$18,337,847.82	$18,337,847.82	$18,337,847.82		$55,013,543.45	$44,907,438.71
2010	$18,337,847.82	$18,337,847.82	$18,337,847.82	$18,337,847.82	$73,351,391.26	$55,959,425.19
2011	$18,337,847.82	$18,337,847.82	$18,337,847.82	$18,337,847.82	$73,351,391.26	$52,298,528.21
2012	$18,337,847.82	$18,337,847.82	$18,337,847.82	$18,337,847.82	$73,351,391.26	$48,877,129.17
2013	$18,337,847.82	$18,337,847.82	$18,337,847.82	$18,337,847.82	$73,351,391.26	$45,679,559.97
2014	$18,337,847.82	$18,337,847.82	$18,337,847.82	$18,337,847.82	$73,351,391.26	$42,691,177.55
2015	$18,337,847.82	$18,337,847.82	$18,337,847.82	$18,337,847.82	$73,351,391.26	$39,898,296.77
2016	$18,337,847.82	$18,337,847.82	$18,337,847.82	$18,337,847.82	$73,351,391.26	$37,288,127.82
2017		$18,337,847.82	$18,337,847.82	$18,337,847.82	$55,013,543.45	$26,136,538.19
2018			$18,337,847.82	$18,337,847.82	$36,675,695.63	$16,284,447.47
2019				$18,337,847.82	$18,337,847.82	$7,609,554.89
Total	$183,378,478.15	$183,378,478.15	$183,378,478.15	$183,378,478.15		$466,802,372.45

-Trucks per implementation year = 2,950 (11,800 total trucks / 4 years)
-Trucks costs per implementation year = $141,600,000 (2,950 trucks * $48,000 per truck)
-Annual capital recovery per implementation year = ~$18,300,000 ($141,600,000 *0.1295 capital recovery factor)

[6] A 2003 truck will be 5 years old in 2008 (approximately mid implementation period of 2007 – 2010)

Existing fleet costs and the costs of trucks entering port service (analyzed earlier) were combined into Table 19 for total strategy costs of $680 million (rounded).

Table 19: Strategy 2 – Total Costs during Capital Recovery Period (rounded)(millions)

Capital Recovery Year	TOTAL DPF, INSTALLATION & O&M COSTS	TOTAL TRUCK REPLACEMENT COSTS	TRUCKS ENTERING PORT SERVICE	TOTAL PROGRAM COSTS
2007	$3.6	$17.1	$2.2	$22.9
2008	$6.8	$32.0	$4.0	$42.8
2009	$9.6	$44.9	$5.6	$60.1
2010	$12.0	$56.0	$7.1	$75.1
2011	$11.3	$52.3	$8.3	$71.9
2012	$10.7	$48.9	$8.8	$68.4
2013	$10.1	$45.7	$9.3	$65.1
2014	$9.5	$42.7	$9.5	$61.7
2015	$9.0	$39.9	$9.5	$58.4
2016	$8.5	$37.3	$9.3	$55.1
2017	$6.0	$26.1	$8.0	$40.1
2018	$3.8	$16.3	$6.9	$27.0
2019	$1.8	$7.6	$5.8	$15.2
2020			$4.4	$4.4
2021			$3.3	$3.3
2022			$2.6	$2.6
2023			$1.9	$1.9
2024			$1.3	$1.3
2025			$1.0	$1.0
2026			$0.7	$0.7
2027			$0.4	$0.4
2028			$0.2	$0.2
Total	$102.7	$466.8	$110.1	$679.6

a. Strategy 2 - Cost Effectiveness Analysis – Existing Fleet

Only the existing fleet was analyzed in the cost effectiveness. All DPF costs are attributable to PM reductions. As the increase in replacement truck costs (over strategy 1 truck replacement costs) are strictly for added NOx reductions, staff will attribute all the additional truck replacement costs to NOx reductions. This will result in virtually identical strategy 2 PM cost effectiveness as in strategy 1. Staff estimates PM and NOx emission reduction of 530 TPY and 2,300 TPY, respectively after full implementation (See Appendix A). Table 20 provides the summarized annual costs effectiveness for the existing fleet during the capital recovery period of 2007-2019.

Table 20: Strategy 2: Summarized Cost Effectiveness: Annual Range and Annual Average During Capital Recovery Period (2007-2019) (rounded)

Pollutant	Annual Cost Effectiveness Range ($/Ton)		Average Annual Cost Effectiveness ($/Ton)	Annual Pollutant Reduced After Full Implementation (TPY)
	Low	High		
PM	$23,000	$49,000	$35,000	530
NOx	$11,000	$25,000	$17,000	2,300

b. Strategy 2 – Existing Fleet Per-Container Recovery Costs

Staff divided the total existing fleet program costs of ~$570 million by 51 million containers to yield the potential per-container fee to fund modernizing the existing fleet of approximately $11 per container.

3. Program Costs – Strategy 3

Program cost and annual cost effectiveness for strategy 3 were determined using the same methodology as strategy 1. Strategy 3: Phase1 requires the existing port fleet of 12,000 trucks to be retrofitted with DPFs for PM reduction. As DPFs can only be retrofitted to 1994+ MY trucks, staff estimates ~ 6,000 trucks will have to be replaced (See Appendix A). Again, staff assumes the replacement trucks will be 1998+ MY to avoid chip reflash concerns. Strategy 3: Phase1 will result in increased NOx reductions over strategy 1 by requiring 1998-2002 MY trucks be equipped with NOx reduction technologies as well as DPFs. Staff assumes 1,200 DPFs and 10,500 DPF/NOx combination systems will be retrofitted to the existing fleet (See Appendix A). Annual PM and NOx emission reductions are estimated to be 520 TPY and 2,000 TPY, respectively (See Appendix A). Staff again assumes the older pre-1994 MY trucks that are replaced have little intrinsic value due to age and wear and will be destroyed to ensure these trucks do not end up operating (and polluting) in California again. The cost ($16,000) of the 10 year old replacement truck is again derived from the used truck price distribution profile (Figure 1). Also, the replacement truck value will assumed to be constant over the implementation period as with previous analysis. Tables 21, 22 and 23 show the annual capital recovery of replacement truck, DPF only retrofits, and DPF / NOx combination system retrofits costs, respectively.

Table 21: Strategy 3: Phase 1 – Existing Fleet Truck Replacement Costs
10 Year Capital Recovery Period

Capital Recovery Year	2007	2008	2009	2010	Annual Total	Present Value 2005 dollars
2007	$3,108,109.80				$3,108,109.80	$2,904,775.51
2008	$3,108,109.80	$3,108,109.80			$6,216,219.60	$5,429,486.94
2009	$3,108,109.80	$3,108,109.80	$3,108,109.80		$9,324,329.40	$7,611,430.29
2010	$3,108,109.80	$3,108,109.80	$3,108,109.80	$3,108,109.80	$12,432,439.20	$9,484,648.34
2011	$3,108,109.80	$3,108,109.80	$3,108,109.80	$3,108,109.80	$12,432,439.20	$8,864,157.32
2012	$3,108,109.80	$3,108,109.80	$3,108,109.80	$3,108,109.80	$12,432,439.20	$8,284,259.18
2013	$3,108,109.80	$3,108,109.80	$3,108,109.80	$3,108,109.80	$12,432,439.20	$7,742,298.30
2014	$3,108,109.80	$3,108,109.80	$3,108,109.80	$3,108,109.80	$12,432,439.20	$7,235,792.80
2015	$3,108,109.80	$3,108,109.80	$3,108,109.80	$3,108,109.80	$12,432,439.20	$6,762,423.18
2016	$3,108,109.80	$3,108,109.80	$3,108,109.80	$3,108,109.80	$12,432,439.20	$6,320,021.67
2017		$3,108,109.80	$3,108,109.80	$3,108,109.80	$9,324,329.40	$4,429,921.73
2018			$3,108,109.80	$3,108,109.80	$6,216,219.60	$2,760,075.84
2019				$3,108,109.80	$3,108,109.80	$1,289,755.07
Total	$31,081,097.99	$31,081,097.99	$31,081,097.99	$31,081,097.99		$79,119,046.18

-Trucks per implementation year = 1,500 (6,000 total trucks / 4 years)
-Trucks costs per implementation year = $24,000,000 (1,500 trucks * $16,000 per truck)
-Annual capital recovery per implementation year = ~$3,108,000 ($24,000,000 *0.1295 capital recovery factor)

Table 22: Strategy 3: Phase 1 – Existing Fleet DPF Only, O&M Costs
10 Year Capital Recovery Period

Capital Recovery Year	2007	2008	2009	2010	O&M Costs	Extended O&M Costs	Annual Total	Present Value 2005 dollars
2007	$330,237				$200.00	$60,000.00	$390,236.67	$364,707.16
2008	$330,237	$330,237			$210.76	$126,456.00	$786,929.33	$687,334.56
2009	$330,237	$330,237	$330,237		$222.10	$199,889.00	$1,190,599.00	$971,883.43
2010	$330,237	$330,237	$330,237	$330,237	$234.05	$280,857.37	$1,601,804.03	$1,222,008.63
2011	$330,237	$330,237	$330,237	$330,237	$246.64	$295,967.50	$1,616,914.16	$1,152,837.45
2012	$330,237	$330,237	$330,237	$330,237	$259.91	$311,890.55	$1,632,837.21	$1,088,028.38
2013	$330,237	$330,237	$330,237	$330,237	$273.89	$328,670.26	$1,649,616.92	$1,027,298.51
2014	$330,237	$330,237	$330,237	$330,237	$288.63	$346,352.72	$1,667,299.38	$970,383.42
2015	$330,237	$330,237	$330,237	$330,237	$304.16	$364,986.50	$1,685,933.16	$917,035.93
2016	$330,237	$330,237	$330,237	$330,237	$320.52	$384,622.77	$1,705,569.43	$867,025.01
2017		$330,237	$330,237	$330,237	$337.76	$303,986.61	$1,294,696.60	$615,101.03
2018			$330,237	$330,237	$355.93	$213,560.72	$874,034.06	$388,081.57
2019				$330,237	$375.08	$112,525.14	$442,761.81	$183,730.41
Total	$3,302,366.66	$3,302,366.66	$3,302,366.66	$3,302,366.66				$10,455,455.51

-DPFs per implementation year = 300 (1,200 total DPFs / 4 years)
-DPF costs per implementation year = ~$2,550,000 (300 DPFs * $8,500) Not including O&M
-Annual capital recovery per implementation year (not including O&M) = ~$330,000 ($2,550,000 *0.1295 capital recovery factor)
-Year 2007 O&M per-DPF costs of $200 to increase ~5 percent per year

Table 23: Strategy 3: Phase 1 – Existing Fleet DPF/NOx System, O&M Costs
10 Year Capital Recovery Period

Capital Recovery Year	2007	2008	2009	2010	O&M Costs	Extended O&M Costs	Annual Total	Present Value 2005 dollars
2007	$6,798,990				$200.00	$525,000.00	$7,323,990.19	$6,844,850.64
2008	$6,798,990	$6,798,990			$210.76	$1,106,490.00	$14,704,470.37	$12,843,453.90
2009	$6,798,990	$6,798,990	$6,798,990		$222.10	$1,749,028.74	$22,145,999.30	$18,077,732.21
2010	$6,798,990	$6,798,990	$6,798,990	$6,798,990	$234.05	$2,457,501.99	$29,653,462.73	$22,622,484.74
2011	$6,798,990	$6,798,990	$6,798,990	$6,798,990	$246.64	$2,589,715.59	$29,785,676.34	$21,236,775.57
2012	$6,798,990	$6,798,990	$6,798,990	$6,798,990	$259.91	$2,729,042.29	$29,925,003.03	$19,940,293.07
2013	$6,798,990	$6,798,990	$6,798,990	$6,798,990	$273.89	$2,875,864.77	$30,071,825.51	$18,727,221.57
2014	$6,798,990	$6,798,990	$6,798,990	$6,798,990	$288.63	$3,030,586.29	$30,226,547.03	$17,592,125.57
2015	$6,798,990	$6,798,990	$6,798,990	$6,798,990	$304.16	$3,193,631.83	$30,389,592.58	$16,529,924.83
2016	$6,798,990	$6,798,990	$6,798,990	$6,798,990	$320.52	$3,365,449.23	$30,561,409.97	$15,535,871.12
2017		$6,798,990	$6,798,990	$6,798,990	$337.76	$2,659,882.80	$23,056,853.35	$10,954,144.94
2018			$6,798,990	$6,798,990	$355.93	$1,868,656.33	$15,466,636.70	$6,867,371.66
2019				$6,798,990	$375.08	$984,595.02	$7,783,585.20	$3,229,911.14
Total	$67,989,901.86	$67,989,901.86	$67,989,901.86	$67,989,901.86				$191,002,160.97

-DPF / NOx systems per implementation year = 2,625 (10,500 total DPF- NOx systems / 4 years)
- DPF / NOx systems costs per implementation year = ~$52,500,000 (2,625 DPF / NOx systems * $20,000[7]) Not including O&M
-Annual capital recovery per implementation year (not including O&M) = ~$6,800,000 ($52,500,000 *0.1295 capital recovery factor)
-Year 2007 O&M per-DPF costs of $200 to increase ~5 percent per year

Unlike the first two strategies, strategy 3 has a second phase which further reduces emissions from the port fleet in 2017 and 2019. By 2017, pre-2003 MY trucks would be retired and replaced with trucks meeting 2010 emission standards. The second stage would require the remaining 2003-2009 MY trucks be replaced with trucks meeting 2010 emission standards. Truck owners may be able recoup some of the program costs by selling the older trucks. Staff believes this benefit will be minimal as the trucks will be close to the end of their useful lives. Staff estimates that the stages of phase 2 will be implemented uniformly over a span of two years before each deadline.

By the 2017 deadline, staff estimates 3,900 port trucks will need to be replaced with newer trucks meeting 2010 emission standards reducing NOx emissions by 1,150 TPY after full implementation (see Appendix A). In 2016 (the second year of implementation), a 2010 truck will be 6 years old. The price of a 6 year old truck, from figure 1, is ~$38,000. Again, to estimate future used truck prices beyond 2010, staff grew that figure 3 percent per year until 2016 and increased it by 20 percent (2007 MY

[7] Cleaire Longview system – Diesel Net Report

truck price increase) yielding a cost of ~$54,000 per truck in 2016. The annual capital recovery is shown in Table 24.

Table 24: Strategy 3: Phase 2 Truck Replacement Costs - 2017 Deadline 10 Year Capital Recovery Period

Capital Recovery Year	2015	2016	Annual Total	Present Value 2005 dollars
2015	$13,636,831.74		$13,636,831.74	$7,417,532.93
2016	$13,636,831.74	$13,636,831.74	$27,273,663.49	$13,864,547.53
2017	$13,636,831.74	$13,636,831.74	$27,273,663.49	$12,957,521.05
2018	$13,636,831.74	$13,636,831.74	$27,273,663.49	$12,109,832.76
2019	$13,636,831.74	$13,636,831.74	$27,273,663.49	$11,317,600.71
2020	$13,636,831.74	$13,636,831.74	$27,273,663.49	$10,577,196.93
2021	$13,636,831.74	$13,636,831.74	$27,273,663.49	$9,885,230.77
2022	$13,636,831.74	$13,636,831.74	$27,273,663.49	$9,238,533.43
2023	$13,636,831.74	$13,636,831.74	$27,273,663.49	$8,634,143.39
2024	$13,636,831.74	$13,636,831.74	$27,273,663.49	$8,069,292.89
2025		$13,636,831.74	$13,636,831.74	$3,770,697.61
Total	$136,368,317.44	$136,368,317.44		$107,842,130.01

-Trucks per implementation year = 1,950 (3,900 total trucks / 2 years)
-Trucks costs per implementation year = $105,300,000 (1,950 trucks * $54,000 per truck)
-Annual capital recovery per implementation year = ~$13,600,000 ($105,300,000 *0.1295 capital recovery factor)

By the 2019 deadline, staff estimates 5,300 port trucks will need to be replaced with newer trucks meeting 2010 emission standards reducing NOx emissions by 3,600 TPY after full implementation (see Appendix A). In 2018 (the second year of implementation), a 2010 truck will be 8 years old. The price of an 8 year old truck, from figure 1, is ~$25,000. Again, to estimate future used truck prices beyond 2010, staff grew that figure 3 percent per year until 2018 and increased it by 20 percent (2007 MY truck price increase), yielding a cost of ~38,000 per truck in 2018. The annual capital recovery is shown in Table 25.

Table 25: Strategy 3: Phase 2 Truck Replacement Costs – 2019 Deadline
10 Year Capital Recovery Period

Capital Recovery Year	2017	2018	Annual Total	Present Value 2005 dollars
2015	$13,041,110.70		$13,041,110.70	$6,195,737.75
2016	$13,041,110.70	$13,041,110.70	$26,082,221.40	$11,580,818.22
2017	$13,041,110.70	$13,041,110.70	$26,082,221.40	$10,823,194.60
2018	$13,041,110.70	$13,041,110.70	$26,082,221.40	$10,115,135.14
2019	$13,041,110.70	$13,041,110.70	$26,082,221.40	$9,453,397.33
2020	$13,041,110.70	$13,041,110.70	$26,082,221.40	$8,834,950.77
2021	$13,041,110.70	$13,041,110.70	$26,082,221.40	$8,256,963.34
2022	$13,041,110.70	$13,041,110.70	$26,082,221.40	$7,716,788.17
2023	$13,041,110.70	$13,041,110.70	$26,082,221.40	$7,211,951.56
2024	$13,041,110.70	$13,041,110.70	$26,082,221.40	$6,740,141.64
2025		$13,041,110.70	$13,041,110.70	$3,149,598.90
Total	$126,979,235.75	$126,979,235.75		$90,078,677.44

-Trucks per implementation year = 2,650 (5,300 total trucks / 2 years)
-Trucks costs per implementation year = $100,700,000 (2,650 trucks * $38,000 per truck)
-Annual capital recovery per implementation year = ~$13,000,000 ($100,700,000 *0.1295 capital recovery factor)

Combined strategy 3 costs and the costs of trucks entering port service were combined into Table 26 for total strategy costs of ~$590 million (rounded).

Table 26: Strategy 3 – Total Costs During Capital Recovery Period (rounded)(millions)

Capital Recovery Year	PHASE 1			PHASE 2	TRUCKS ENTERING PORT SERVICE	TOTAL PROGRAM
	DPF, INSTALLATION and O&M	DPF / NOx, INSTALLATION & O&M	TRUCK REPLACEMENT	TRUCK REPLACEMENT		
2007	$0.4	$6.8	$2.9		$2.2	$12.3
2008	$0.7	$12.8	$5.4		$4.0	$22.9
2009	$1.0	$18.1	$7.6		$5.6	$32.3
2010	$1.2	$22.6	$9.5		$7.1	$40.4
2011	$1.2	$21.2	$8.9		$8.3	$39.6
2012	$1.1	$19.9	$8.3		$8.8	$38.1
2013	$1.0	$18.7	$7.7		$9.3	$36.7
2014	$1.0	$17.6	$7.2		$9.5	$35.3
2015	$0.9	$16.5	$6.8	$7.4	$9.5	$41.1
2016	$0.9	$15.5	$6.3	$13.9	$9.3	$45.9
2017	$0.6	$11.0	$4.4	$19.2	$8.0	$43.2
2018	$0.4	$6.9	$2.8	$23.7	$6.9	$40.7
2019	$0.2	$3.2	$1.3	$22.1	$5.8	$32.6
2020				$20.7	$4.4	$25.1
2021				$19.3	$3.3	$22.6
2022				$18.1	$2.6	$20.7
2023				$16.9	$1.9	$18.8
2024				$15.8	$1.3	$17.1
2025				$11.0	$1.0	$12.0
2026				$6.7	$0.7	$7.4
2027				$3.2	$0.4	$3.6
2028					$0.2	$0.2
Total	$10.6	$190.8	$79.1	$197.9	$110.1	$588.5

a. Strategy 3: Phase1 - Cost Effectiveness Analysis – Existing Fleet

All DPF costs are attributable to PM reductions and NOx system costs to NOx reductions. Staff simply split the costs of the $20,000 DPF / NOx systems between two pollutants. As replacement trucks enjoy NOx reductions and are necessary for PM reductions, staff assumes half the truck costs are attributable to PM and half to NOx. Staff estimates PM and NOx emission reductions of 520 TPY and 2,000 TPY respectively after full implementation (See Appendix A). Table 27 provides the summarized annual costs effectiveness for the existing fleet during the capital recovery period of 2007-2019.

Table 27: Strategy 3: Phase 1 Summarized Cost Effectiveness: Annual Range & Annual Average during Capital Recovery Period (rounded)

Pollutant	Annual Cost Effectiveness Range ($/Ton)		Average Annual Cost Effectiveness ($/Ton)	Annual Pollutant Reduced After Full Implementation (TPY)
	Low	High		
PM	$19,000	$40,000	$28,000	520
NOx	$5,000	$10,000	$7,000	2,000

b. Strategy 3: Phase 2 - Cost Effectiveness Analysis

As all the trucks to be retired have maximum PM reduction efficiency, phase 2 costs are solely for NOx reductions. Staff estimates 2017 NOx emission reductions of 1,150 tpy and NOx emission reductions of 3,600 TPY after full implementation (See Appendix A). Table 28 provides the summarized annual costs effectiveness for phase 2.

Table 28: Strategy 3: Phase 2 Summarized Cost Effectiveness: Annual Range & Annual Average during Capital Recovery Period (rounded)

Pollutant	Annual Cost Effectiveness Range ($/Ton)		Average Annual Cost Effectiveness ($/Ton)	Annual Pollutant Reduced After Full Implementation (TPY)
	Low	High		
NOx (2017)	$7,000	$13,000	$9,000	1,150
NOx (2019)	$2,000	$3,000	$3,000	3,600

c. Strategy 3 – Existing Fleet Per-Container Recovery Costs

Staff divided the total existing fleet program costs of ~$280 million by 51 million containers to yield the potential per-container fee to fund modernizing the existing fleet of approximately $5 per container.

E. Cost Effectiveness Using Carl Moyer Methodology

Staff also estimated the cost effectiveness for Strategy 3: Phase 1 using methodology developed for the Carl Moyer program. The Carl Moyer Program is a grant program, implemented as a partnership of ARB and local air districts, which funds incremental costs of cleaner-than-required engines and equipment (See Appendix C). Some Carl Moyer Program cost effectiveness calculation parameters differ from those previously used in this Appendix. Staff's assumptions, which differ from Carl Moyer assumptions, are explained within the previous cost effectiveness methodology discussion. The differences (between the previous analysis and the Carl Moyer based analysis) are listed below along with the reference to the "Carl Moyer Program Guidelines – Approved revision 2005" document.

- Default Project Life: Repowers and retrofits – 5 years (page D-2)
- Capital Recovery Discount Rate – 4 percent (page C-9: Formula C-13)
- Capital Recovery Factor – 0.225 (page B-3: Table 1)
- PM emission reductions are weighted by a factor of 20. (page C-1: Formula C-2)

The total cost for Strategy 3: Phase 1 is presented in Table 29 using Carl Moyer cost effective methodology.

Table 29: Strategy 3, Phase 1 Costs

	DPFs	DPF/NOx	Truck Replacement	Total
Quantity	1,200	10,500	6,000	
Unit Cost	$8,500	$20,000	$16,000	
Annual Unit O&M Costs	$200	$200		
Total	$11,400,000	$220,500,000	$96,000,000	$327,900,000

Where:

-$11,400,000 = (1,200 DPFs) * ($8,500 per DPF) + ($200 Annual O&M cost * 5 years – project life * 1,200 DPFs)
-$220,500,000 = (10,500) * ($20,000) + ($200 * 5 * 10,500)
-$96,000,000 = (6,000) * ($16,000)

The annualized cost (~$73.8 million / year) is simply the product of the total costs ($327,900,000) and the capital recovery factor (.225).

Staff estimated PM and NOx emission reductions after full implementation are 520 tpy and 2,000 tpy respectively. Carl Moyer requires weighting the PM reductions by a factor of 20, which yields an annual combined NOx and weighted PM emission reductions of 12,400 tons year [(520)(20) + (2,000)].

The cost effectiveness is derived by dividing the annualized cost (~$73.8 million / year) by the annual weighted emission reductions (12,400 TPY), which equals ~$5,900 / ton. The same methodology was used to determine the cost effectiveness for modernizing the existing fleet for each of the three strategies as shown in Table 30.

Table 30: Cost Effectiveness of Weighted Surplus Emissions Carl Moyer Method Strategies 1, 2, and 3 – Existing Fleet

	Cost Effectiveness Using Moyer Method ($/Ton)
Strategy 1	$4,500.00
Strategy 2	$11,800.00
Strategy 3	$5,900.00