Land Transport Services

6.1 INTRODUCTION

6.1.1 Industry Description

One of the environmental problems faced by the Philippines today is air pollution which is most evident in urban areas. Rapid industrialization and the growth in vehicular transportation brought about the increase in air pollution at an alarming rate.

The combustion of fuel in motor vehicles produce emissions such as CO, VOC, NOx, hydrocarbon (HC), SOx, PM, lead (Pb) and CO_2.

Pollution such as these may cause harmful effects on the health such as respiratory illness, physical and mental coordination, and lung cancer, to name a few. These pollutants also diminish crop yield and quality, degrade materials, reduce visibility and contribute in the global warming and the destruction of the ozone layer.

6.1.2 Scope and Limitation of the Study

Emissions generated by transport services and from the use of transport equipment as part of the support service of other economic activities are quantified and valued in this study. This is to provide an estimate of the degradation to the environment caused by production activities, particularly the use of motor vehicles.

In addition to the estimation of emissions caused by the transport sector, this study also covered the emissions generated by road transport used by other economic activities as well as that of the household sector and other institutions.

Total vehicular emission that includes exhaust emission, evaporative emission and other air emissions, as shown in Figure 6.1.1, were estimated. Other air emissions are SOx and Pb. Exhaust emissions, on the other hand, consist of PM, CO, NOx, HC and VOC. Evaporative emissions are mainly VOC's emitted from gasoline-fueled vehicles only.

To assist in the evaluation of the absorptive capacity of the atmosphere in the different regions of the country, regional dimension was introduced in the study. A review of the regional data indicates that it is only in the National Capital Region (NCR) that emissions exceeded its absorptive capacity. Hence, the monetary estimate of environmental degradation caused by the transport vehicles was limited to that occurring in NCR. The maintenance cost valuation was used for the monetary estimates. In this study, environmental cost was limited to the cost of inspection and maintenance of vehicle and the cost of emission converter and the cost of lead strap.

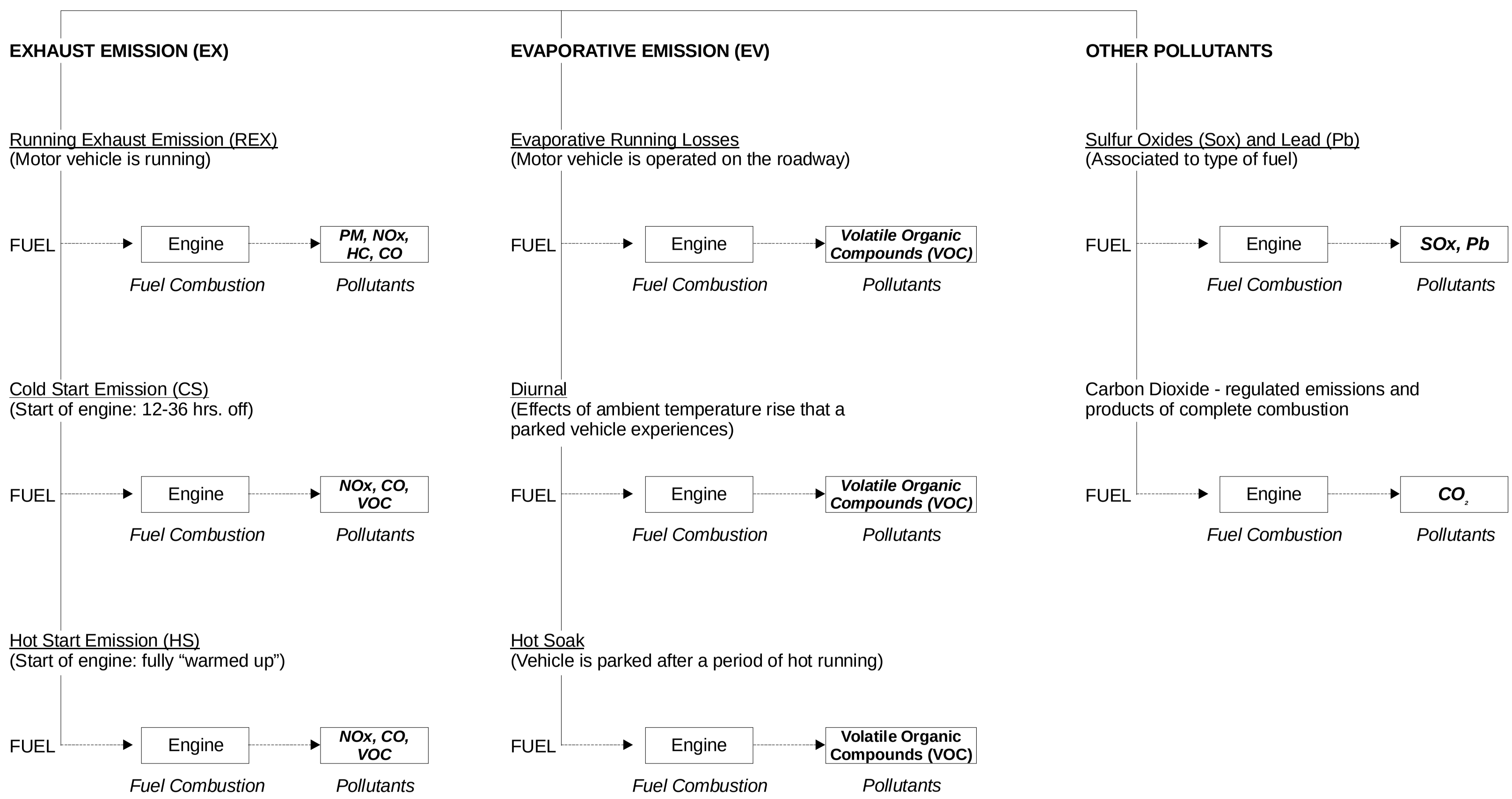


FIGURE 6.1.1 EMISSION PROCESS AND CORRESPONDING POLLUTANTS

6.2 SOURCES AND METHODS

6.2.1 Data Sources

In general, the data used in the study were obtained from related studies conducted by other agencies and institutions and from publications and administrative reports of these agencies. To summarize, the sources of data and other parameters used in the estimation are listed below:

1. Data on emission factors were taken from air pollution studies by the Environmental Management Bureau (EMB), the ADB and the US-EPA.

2. Data on fuel consumption (Appendix Table 6.1.7) were taken from the Energy Regulatory Board (ERB) and from the DOE.

3. Data on motor vehicle registration were obtained from the Land Transportation Office (LTO, Appendix Tables 6.1.5 and 6.1.6).

4. Information on fuel content was derived from the DOE and the Bureau of Product Standards (BPS).

5. Other data requirements were taken from publications and reports of the NSCB, NSO, and ENRAP III study and from transport industry practices shared by various automotive manufacturing companies.

6.2.2 Estimation Methodology

6.2.2.1 Physical Estimation

The same methodology used in the 1990 Air Pollution Emission Inventory for Metro Manila conducted by the EMB was used to estimate total emissions generated by the transport sector throughout the country.

Total vehicular emission was computed as the sum of exhaust emission, evaporative emission and other air emissions. Exhaust emissions include emission during running, hot and cold start, while evaporative emissions are those coming mainly from gasoline-fueled vehicles, comprised of hot soak, diurnal and evaporative running losses (Figure 6.1.1). Table 6.1.1 summarizes the sources of emissions and the corresponding emissions that were estimated in this study.

The emission factors used for the three (3) sources of emissions adopted those used in the EMB report (EMB, 1993). The emission factors for running exhaust emissions were the results of the actual test done by EMB during the 1990 Emission Inventory in Metro Manila (Appendix Table 6.1.1). The rest of the emission factors (e.g. hot start, cold start and evaporative emissions) were based on the standards set by the USEPA. Appendix Table 6.1.2 provides a summary of evaporative emission factors used.

TABLE 6.1.1 TYPE OF EMISSIONS BY SOURCE

SOURCE	EMISSIONS									
Exhaust (EX)										
Running (REX)	PM10	PMex	PMwt	VOC	NOx	HC	CO			
Cold start (CS)				VOC	NOx		CO			
Hot start (HS)				VOC	NOx		CO			
Evaporative (EV)				VOC						
Other emissions								SO_x	Pb	CO_2

- <u>Exhaust Emissions (EX)</u>

The pollutants emitted from this source are PM, CO, NOx, HC and VOC. The formulae for estimating exhaust emission (EX) are as follows:

$$EX = REX + HS + CS \qquad \textit{Eq. 1}$$

$$REX = \sum_{t=1}^{5} \sum_{f=1}^{2} (NV_{tf} \times D_{tf}) \times EF_{tf} \qquad \textit{Eq. 2}$$

$$CS = \sum_{t=1}^{5} \sum_{f=1}^{2} (NV_{tf} \times NT_{tf} \times NO_{tf}) \times EF_{tf} \qquad \textit{Eq. 3}$$

$$HS = \sum_{t=1}^{5} \sum_{f=1}^{2} (NV_{tf} \times NO_{tf}) \times EF_{tf} \qquad \textit{Eq. 4}$$

where:

REX = running exhaust emission
CS = cold start emission
HS = hot start emission
NV_{tf} = number of registered vehicles, by type of vehicle (t) and of type of fuel used, (f)

t = 1, cars
= 2, utility
= 3, trucks
= 4, buses
= 5, mc/tc

f = 1, gasoline
= 2, diesel

D_f = average distance traveled by type of vehicle and of fuel used
EF_{tf} = emission factor by type of vehicle and of fuel used
NT_{tf} = number of trips per vehicle per day by type of vehicle and of fuel used
NO_f = number of days of operations by type of fuel
NO_{fd} = 365 days for diesel-fueled vehicles
NO_{fg} = 240 days for gasoline-fueled vehicles

- Evaporative Emissions (EV)

This source of emission generates mainly VOC's emitted from gasoline-fueled vehicles only. Evaporative emission (EV) was computed using the following formula:

EV = hot soak + diurnal + evaporative running losses *Eq. 5*

The methodology used for estimating hot soak and diurnal emissions was the same as that for hot start emissions (HS) in Eq. 4, differing only in the assumed number of trips per vehicle per day (NT_{tf}) and emission factor (EF_{tf}). Also, the procedure for estimating emissions from evaporative running losses was the same as that for running exhaust emissions (REX) in Eq. 2, except for the emission factor (EF_{tf}). Appendix Table 6.1.3 shows the relevant data used for the estimation of evaporative emissions.

- Other Air Emissions: Sulfur Oxide (SOx) and Lead (Pb)

Other air emissions are also generated due to the quality of fuel used. Sulfur oxide (SOx) emission from motor vehicles depends on the sulfur content of the fuel. SOx emissions were estimated using the following equation:

SOx = SCF x 2 *Eq. 6*

where:

SOx = sulfur oxide emissions
SCF = total sulfur content
= $Q_f \times D_f \times S_f$
Q_f = volume of fuel used
D_f = density of fuel
S_f = factor 2, based on material balance

Lead (Pb) emissions from gasoline-fueled vehicles depends on the volume and lead content of the fuel used and on the assumed percentage of lead that escapes through the tail pipes or exhausts. Lead emissions were estimated as:

$Pb = Q_f \times Pb_f \times L$ *Eq. 7*

where:

Pb_f = lead content of gasoline
L = percent loss through the exhaust, assumed to be 75 percent

- Carbon Dioxide Emissions

Carbon Dioxide (CO_2) emissions caused by complete combustion of fossil fuel were believed to have caused the depletion of the ozone layer. Although this type of emission is not directly harmful to the health of people, its effect on ozone depletion and global warming could be alarming. Carbon dioxide emission was computed using the sectoral approach adopted from the PAGASA ALGAS study.

$CO_2 = (D_f \times NV_f) \times EF_f \times adj_f$ *Eq. 8*

where:

NV_f = number of registered vehicles
Df = average distance traveled

Eff = emission factor for CO_2
Adjustment factor for: Gasoline = 0.5183
Diesel = 0.3690

- Regional Estimates

While this study only required a national aggregate of the physical and monetary estimate, emissions in physical terms at the regional level were also generated. This additional dimension was compiled and used as inputs in deciding the extent of the monetary valuation of emissions generated by the sector. The same parameters and assumptions used in the EMB Inventory in Metro Manila were adopted in the regional estimation, in the absence of any studies conducted in the region.

6.2.2 Monetary Valuation

Monetary valuation of the emissions generated by the transport sector was computed using maintenance cost valuation, which is equal to the cost that would be incurred to minimize if not prevent degradation of the environment by the sector.

The maintenance costs used for this study are the sum of the following: a) the cost of inspection and maintenance (I/M); b) the cost of emission converter; and c) the cost of lead trap. These pollution abatement technologies were found to be the most effective way of reducing emissions by the transport sector.

In valuing the degradation to air caused by the transportation activities, the absorptive capacity of the atmosphere was considered. The evaluation of the absorptive capacity of the different regions was based on the number of vehicles operating in the area, the total land area and its geographic characteristics. Results of the evaluation showed that it is only in the NCR that emissions exceeded the environment's absorptive capacity. This is the reason why monetary valuation of degradation caused by motor vehicle emissions was only estimated for this region (see Appendix Table 6.1.8 and 6.1.9).

- Inspection and Maintenance (I/M)

According to the ADB study (Engineering-Science 1993), the cost of repair and maintenance is negligible. The cost incurred for the proper maintenance of vehicles is being offset by the savings derived from the improved fuel efficiency and greater durability of the vehicle. Hence, only the cost for the inspection was valued.

Inspection Cost = NI x I x NV *Eq. 9*

where:

NI = number of inspection/vehicle/year
I = cost of inspection/vehicle/year at 1993 price:
Light = ₱ 205
Heavy = ₱ 308
NV = number of registered vehicles

The efficiency of I/M was estimated to be about 35 percent for PM and 40 percent for VOC and CO.

- Emission Converter

The use of emission converter addresses the problem of CO, NOx and HC emissions. It effectively eliminates about 90 percent of these emissions. In addition to that, it also reduces about 15 to 50 percent of total PM emissions.

The emission converter used in this study focused on diesel oxidation catalyst, a type of converter for diesel engines. This was considered because of the practicality of installing this type of converter. This does not need to be retrofitted and can be easily installed in diesel engines. No engine modification is needed except for those vehicles that badly need overhaul for greater durability and longer use of the vehicle, optimizing the use of the installed converter.

The use of catalytic converter for gasoline fueled vehicles was excluded in the valuation methodology. This is due to the high cost of retrofitting and engine modification. Further, it would entail too many assumptions on the methodology that can not be supported by the available data.

As such, the cost of emission converter was estimated using the formula:

$$EC = EC_{doc} \times NV_d \qquad \textit{Eq. 10}$$

where:

EC_{doc} = cost of diesel oxidation catalyst emission converter
NV_d = number of registered diesel-fueled vehicles

- Lead Trap

An alternative for catalytic converter for gasoline-fueled vehicles is the lead trap. Lead trap directly controls the lead particulate emissions from gasoline-fueled vehicles. The cost of installing this device is relatively cheaper than the other devices. Conventional mufflers are replaced by mufflers with lead trap device and it reduces at least 90 percent of the total lead emissions in a vehicle. Similar to oxidizing catalysts, there is no need for engine modification and retrofitting in installing this device.

$$\text{Cost of Lead Trap} = CLT \times NV_g \qquad \textit{Eq. 11}$$

Where:

CLT = annual cost of lead trap
NV_g = number of registered gasoline-fueled vehicles

6.2.3 Sectoral Distribution of Emissions in Physical and Monetary Terms

Allocation of the estimates by industry/institutional sector, both for physical and monetary terms, was based on the data on motor vehicle registration by type (i.e., private, for hire, government, diplomatic and tax-exempt) and by the sector's fixed asset value as reported in the CE (Table 6.1.2).

TABLE 6.1.2 ALLOCATION OF MOTOR VEHICLES BY SECTOR/INSTITUTION

Type of Motor Vehicle	Cars	Utility Vehicles	Trucks	Buses	Motor Cycle (MC) / Tricycles (TC)
For Hire	Road Transport Services (PSIC 712) (TCS)				
Government	Government Services (Gov't.)				
Private	Household (HH)	Distributed to other industries (OI) based on stocks of transport equipment (1988 & 1994 CE)			Household (HH)
Diplomatic	Rest of the World (ROW)				
Tax Exempt	Rest of the World (ROW)				

The "for hire" vehicles are classified under the Road Transport Services Sector (PSIC 712), the "government" under the Government Services Sector and "diplomatic" and "tax-exempt" under the Rest of the World sector (Appendix Table 6.1.5 and 6.1.6). Private vehicles, private cars and motorcycles/tricycles (MC/TC) are all assumed to belong to the Households sector, since there is no indicator to segregate from them those belonging to industries other than road transport services sector. For private utility vehicles and other types of vehicles, they were assumed to belong to other industries and further allocated to the different sub-sectors according to their shares of stock of transport equipment as reported in the 1988 and 1994 CE.

6.3 RESULTS

6.3.1 Physical Estimates

6.3.1.1 Airborne Pollutants

For the whole country, among the airborne pollutants caused by transportation sector which are directly harmful to the health of the people, CO registered the highest, followed by HC, NOx, PM, VOC, SOx and Pb (Table 6.1.3). In 1988, CO emission was recorded at 905,679 MT, while that of HC was 165,231 MT. Lead emissions recorded the lowest level at 949 MT. In 1996, CO was still the most significant harmful emission, while Pb emission was almost negligible (Figure 6.1.2).

On the other hand, CO_2, which is not considered a ground level pollutant accounted for a big bulk of the total emissions caused by transportation sector. In 1988, CO_2 was estimated to be about 27 million MT and it went up to 57 million MT in 1996. However, as mentioned in the earlier part of the report, this emission is not directly harmful to the health of people, but its effect on the depletion of the ozone layer and global warming is significant.

TABLE 6.1.3 TOTAL MOTOR VEHICLE EMISSIONS BY TYPE OF FUEL USED, IN METRIC TONS, 1988 AND 1996

FUEL USED	CO	HC	VOC	PB	PM[1]	NOx	SOx	CO_2
1988	***905,679***	***165,231***	***35,094***	***949***	***51,642***	***122,340***	***26,423***	***26,667,129***
Gas	814,255	138,778	34,955	949	17,140	41,386	4,117	3,446,701
Diesel	91,424	26,453	140		34,501	80,954	22,306	23,220,427
1996	***1,833,050***	***380,957***	***77,957***	***297***	***130,886***	***262,839***	***39,802***	***59,014,337***
Gas	1,618,733	319,256	77,580	297	45,979	77,176	8,333	6,360,892
Diesel	214,316	61,701	377		84,906	185,666	31,469	52,653,445

[1] PM = PM10 + PMEX + PMTW

In Figure 6.1.2 there was an increasing trend for the majority of the emissions (e.g., NOx, HC, CO and VOC) except for Pb and SOx for the period between 1988 to 1996. Lead dropped in 1993 due to the introduction of low lead gasoline in the market while the reduction of sulfur content of fuel contributed to the significant drop of SOx in 1996.

By source, the Household and the Other Industries, which cover the sectors of Manufacturing, Electricity, Trade, etc., contributed the biggest share for all emissions for the entire study period. Each sector shared an almost equal amount, except for the household sector, which posted a slightly bigger share. The Transport and Communication Sector (TCS) only ranked third as a source of air pollutant (Figures 6.1.3 and 6.1.4). In 1996, the household sector contributed an average share of about 40 percent of all these emissions, while the other industries contributed 39 percent. TCS accounted for an average of 18 percent for all emissions while the government accounted for 2 percent. The contribution of the rest of the world sector was negligible. Distribution of total emissions by source (sector/institution) largely depends on the allocation of number and type of vehicles by denomination, including the type of fuel used (see Appendix Tables 6.1.5 and 6.1.6).

6.3.2 Monetary Estimates

The value of total vehicular emissions in monetary terms where emissions exceeded the absorptive capacity of the environment, amounted to P 339 million in 1988 and P 1,404 million in 1996 (Appendix Tables 6.1.10 and 6.1.11). These values correspond to the emissions generated in NCR. The NCR was previously identified as the only region in the country where emissions from motor vehicles exceeded the absorptive capacity of the environment (Appendix Tables 6.1.3 and 6.1.4).

The value of degradation to the environment caused by the land transport sector amounted to P 56 million in 1988 and P 306 million in 1996, registering an average annual increase of 25 percent from 1988 to 1994 (Table 6.1.4).

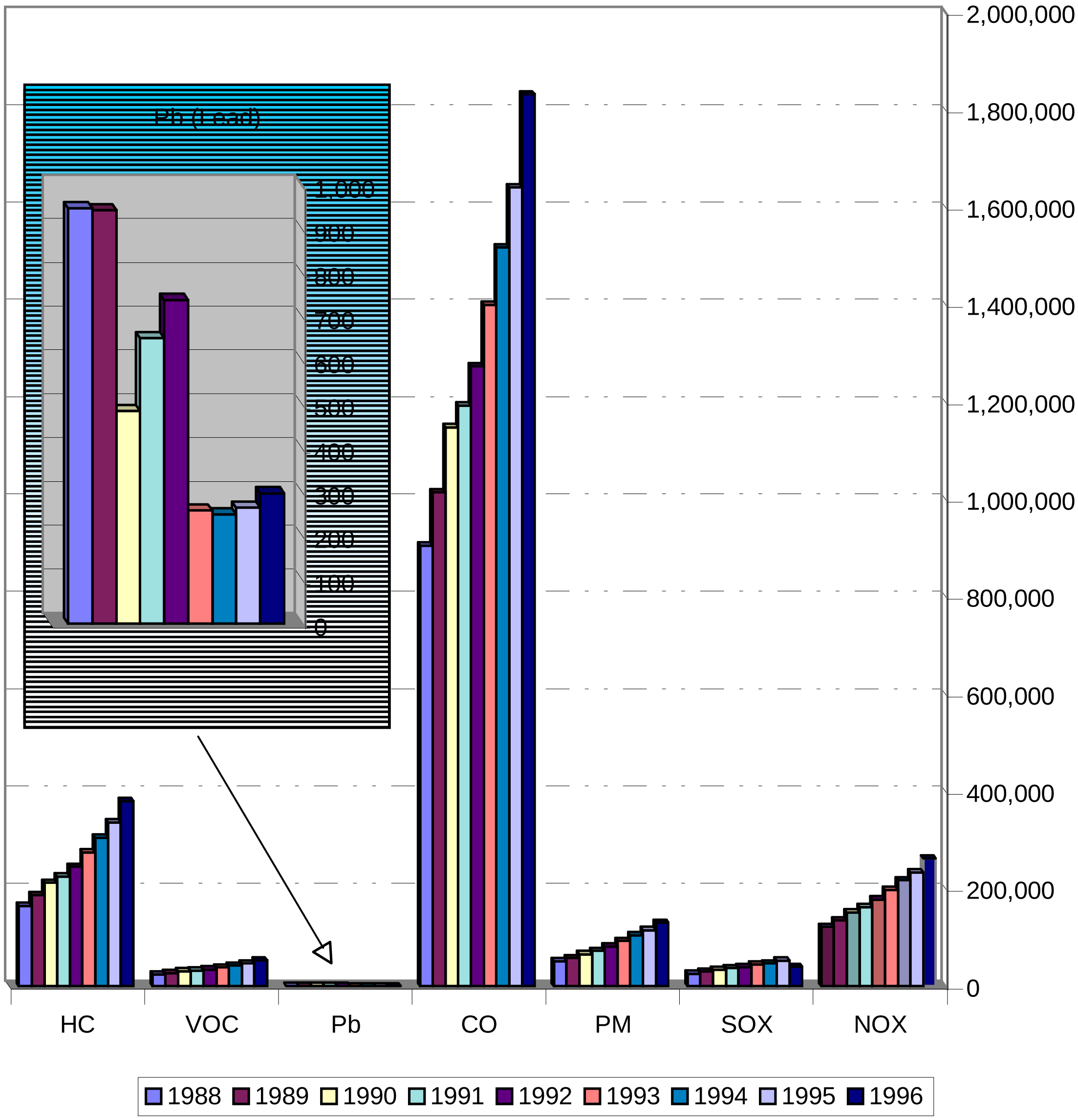


FIGURE 6.1.2 TOTAL MOTOR VEHICLE EMISSIONS, IN METRIC TONS, 1988-1996

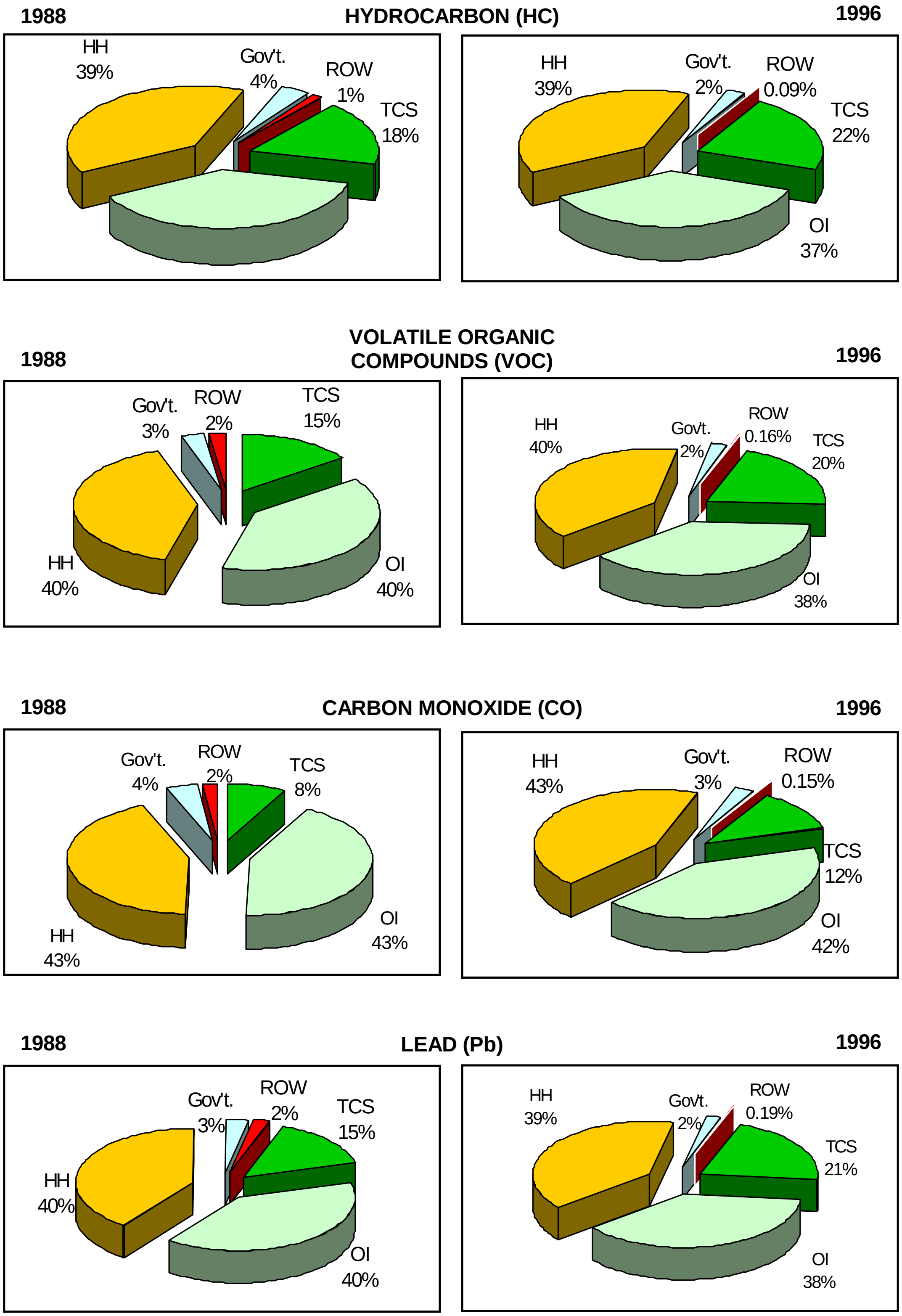
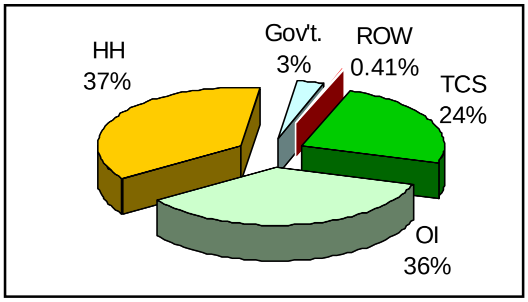
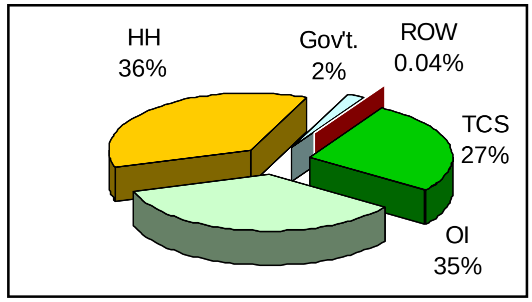


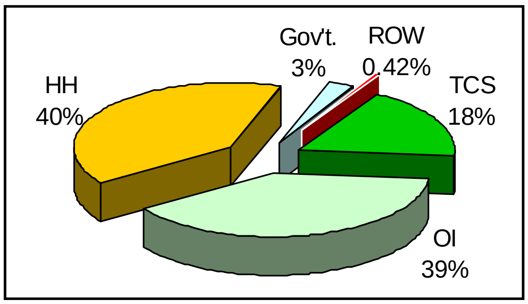
FIGURE 6.1.3 PERCENT SHARE OF HC, VOC, CO AND PB BY SOURCE

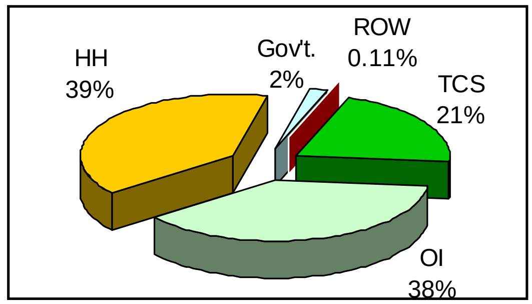
1988 **PARTICULATE MATTER (PM)** **1996**



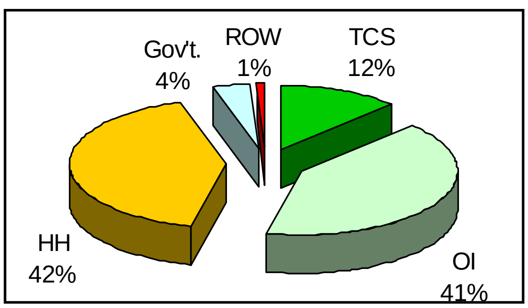


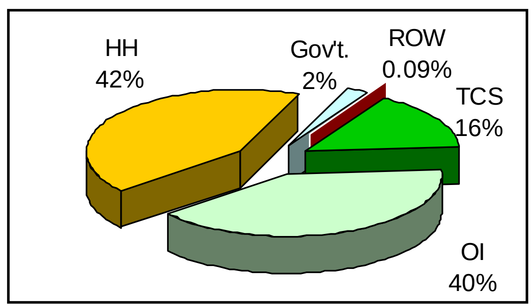
1988 **SULFUR OXIDES (SOx)** **1996**



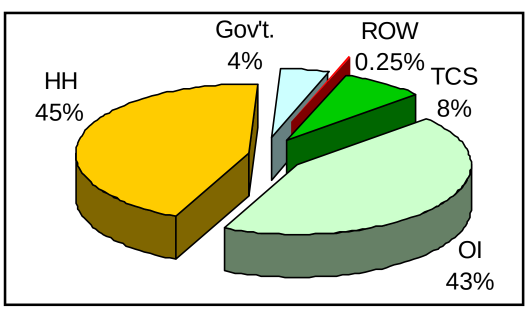


1988 **NITROGEN OXIDE (NOx)** **1996**





1988 **CARBON DIOXIDE (CO_2)** **1996**



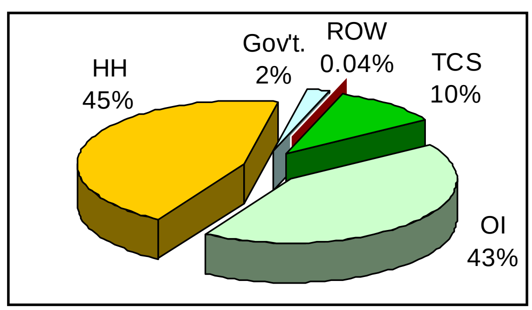


FIGURE 6.1.4 PERCENT SHARE OF PM, SOx, NOx AND CO_2 BY SOURCE

6.3.3 Environmentally Adjusted Net Value Added (EVA)

As a percentage to the net value added of land transport subsector, environmental degradation accounted for less than 0.47 percent, ranging from 0.28 to 0.75 percent from 1988 to 1996. Figure 6.1.5 shows the total cost of degradation to air by the land transport subsector, relative to the NVA of the sector.

TABLE 6.1.4 ENVIRONMENTALLY ADJUSTED NET VALUE ADDED (EVA), IN MILLION PESOS (AT CURRENT PRICES), 1988-1994

Year	GVA [1]	Depreciation [2]	NVA [3] = [1] -[2]	Environmental Degradation [1] [4]	EVA [5] = [3] – [4]
1988	19,215	2,186	17,029	56	16,973
1989	19,679	2,253	17,426	63	17,363
1990	26,239	2,711	23,528	76	23,452
1991	37,824	3,488	34,336	97	34,239
1992	39,097	4,165	34,932	127	34,805
1993	39,984	5,241	34,743	175	34,568
1994	42,070	5,965	36,105	225	35,880
1995	44,184	6,042	38,142	285	37,857
1996	47,542	6,244	41,298	306	40,992

[1] Refer to the Pollution Control Cost of Motor Vehicle Emissions (used by Road Transport sector)

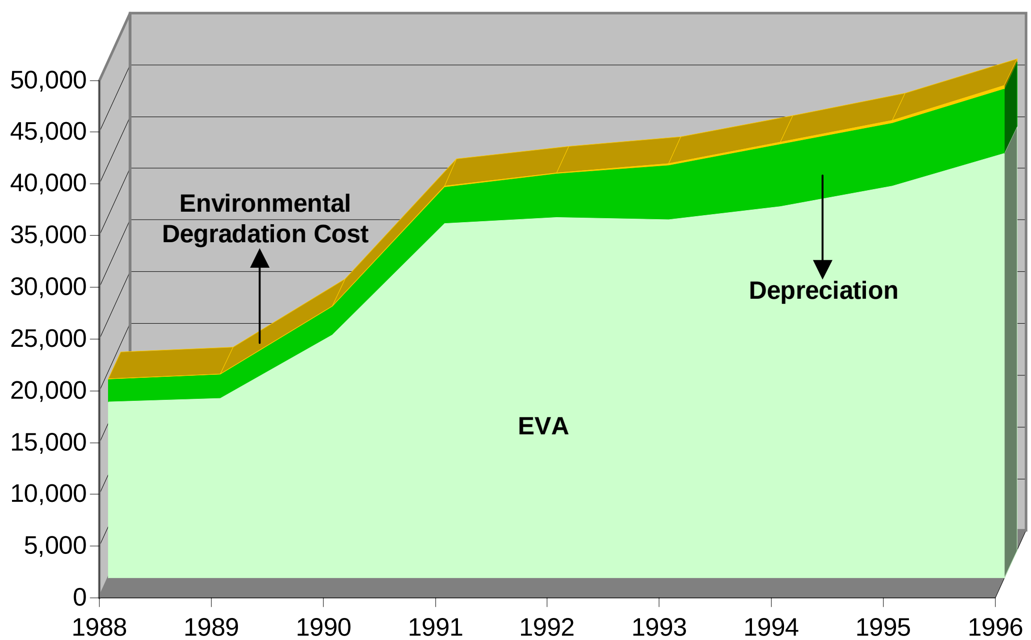


FIGURE 6.1.5 LAND TRANSPORT SECTOR: EVA, DEPRECIATION AND ENVIRONMENTAL DEGRADATION, IN MILLION PESOS (AT CURRENT PRICES), 1988-1996

6.1.4 RECOMMENDATIONS

This study is still preliminary and subject to improvements and refinements. Data support is limited especially on fuel consumption, emission factors, and monetary valuation variables.

The emission factors need to be estimated based on actual conditions in the country since most of the parameters used were borrowed from the USEPA. These were derived based on different traffic conditions and mix of vehicles as compared to the Philippines. In addition, there is a need for further study on the best end of pipe technology for measuring emissions.

Further refinements need to be done on the allocation of emission and its cost to the various sectors and economic activities.

Sub-national study is recommended to improve data support for such activity in the regions as well as to validate the assumptions used in the regional estimates done in the study.

APPENDIX TABLE 6.1.1

RUNNING EXHAUST EMISSIONS IN GRAMS PER TRIP, BY VEHICLE TYPE AND BY TYPE OF FUEL USED

Vehicle & Fuel Type	Cold Start				Hot Start			
	Emission Factors[1]			No. of Trips/day	Emission Factors[1]			No. of Trips/day
	NOx	VOC	CO		NOx	VOC	CO	
Cars								
Gas	4.3	15.82	131.18	2	5.86	10.98	26.12	1
Diesel	0.31	0.72	4.11	1	0.15	0.18	2.19	2
Utility Vehicles								
Gas	4.5	16.47	129.23	1	5.94	10.88	23.80	4
Diesel	1.1	0.83	4.02	1	0.74	0.16	2.68	5
MC/TC								
Gas	0.87	12.48	69.99	1	0.84	4.22	9.83	10
Diesel								

Note:
[1] Source: EMB.1993. 1990 Air Pollution Inventory in Metro Manila
EMISSION = EFf x (NTf x N0f x NVf)
Where:
Eff = emission factor by type of fuel
NTf = number of trips per day by type of fuel
Nof = number of days of operations by type of fuel
= 240 for gasoline-fueled vehicles
= 365 for diesel-fueled vehicles
NVf = number of registered motor vehicles by type of fuel

APPENDIX TABLE 6.1.2

VOLATILE ORGANIC COMPOUNDS (VOC) EMISSIONS, BY VEHICLE TYPE AND BY TYPE OF FUEL USED

Vehicle/ Fuel Type	VOC Emission Factors [1/]			NOT/ DAY	No. of Operations	Distance Traveled (km/vehicle)
	Hot Soak (g/trip)	Diurnal (g/vehicle/day)	Evaporative (g/km)			
Cars						
Gas	10.19	16.7	0.38	1	240	12,000
Diesel						
Utility Vehicles						
Gas	9.39	15.66	0.36	4	240	30,000
Diesel						
Trucks						
Gas	3.79	12.86		2	240	50,000
Diesel						
MC/TC						
Gas	3.92	7.7		10	240	10,000
Diesel						

[1/] Source: EMB.1993. 1990 Air Pollution Inventory in Metro Manila
* differ on the assumed no. of trips per vehicle per day

APPENDIX TABLE 6.1.3

TOTAL MOTOR VEHICLE EMISSIONS, PHILIPPINES, IN METRIC TONS, 1988 - 1996

Year	EMISSIONS (MT)							
	HC	VOC	Pb	CO	PM	SOx	NOx	CO_2
1988	165,231	24,150	949	905,679	51,642	26,423	122,340	26,667,129
1989	187,385	27,301	944	1,015,003	58,364	30,626	135,819	29,403,569
1990	212,897	30,946	485	1,148,751	66,064	34,109	151,887	32,756,181
1991	225,491	32,294	652	1,193,310	72,637	37,749	162,682	35,204,592
1992	245,601	34,776	739	1,274,294	81,769	39,336	178,462	38,308,115
1993	275,524	38,798	258	1,400,358	93,264	45,158	197,886	43,273,078
1994	305,349	42,690	249	1,518,385	104,774	47,378	217,736	47,275,217
1995	337,022	47,198	265	1,641,974	115,844	52,725	234,448	51,904,050
1996	380,957	53,270	297	1,833,050	130,886	39,802	262,839	59,014,337

APPENDIX TABLE 6.1.4

TOTAL MOTOR VEHICLE EMISSIONS, NATIONAL CAPITAL REGION (NCR), IN METRIC TONS, 1988-1996

Year	EMISSIONS (MT)							
	HC	VOC	Pb	CO	PM	SOx	NOx	CO_2
1988	67,259	9,831	386	368,664	21,021	10,756	49,800	10,855,070
1989	76,906	11,205	387	416,573	23,954	12,569	55,742	12,067,674
1990	187,385	27,301	944	1,015,003	58,364	30,626	135,819	29,403,569
1991	94,676	13,559	274	501,030	30,498	15,850	68,305	14,781,202
1992	104,244	14,760	314	540,868	34,707	16,696	75,747	16,259,685
1993	117,054	16,483	110	594,929	39,622	19,185	84,070	18,384,172
1994	126,443	17,678	103	628,754	43,386	19,619	90,163	19,576,365
1995	137,296	19,227	108	668,907	47,192	21,479	95,509	21,144,668
1996	155,194	21,701	121	746,748	53,320	16,215	107,075	24,041,256

APPENDIX TABLE 6.1.5

NUMBER OF REGISTERED MOTOR VEHICLES BY TYPE AND TYPE OF FUEL USED, 1988

Type of Vehicle & Fuel Used	Private	For Hire	Gov't.	Tax Exempt	Diplomat	Total
Total Cars	349,637	6,036	4,941	11,857	4,697	377,168
Gas	340,982	2,867	4,854	11,834	4,561	365,098
Diesel	8,655	3,169	87	23	136	12,070
Utility Vehicles	397,520	55,895	19,038	2,646		475,099
Gas	225,982	5,085	14,926	2,619		248,612
Diesel	171,538	50,810	4,112	27		226,487
Trucks	95,740	5,435	5,241	33		106,449
Gas	12,042	197	1,071	11		13,321
Diesel	83,698	5,238	4,170	22		93,128
Buses	3,269	11,420	390	4		15,083
Gas	492	220	84	1		797
Diesel	2,777	11,200	306	3		14,286
MCs / TCs	149,267	123,418	5,924	2,293		280,902
Gas	147,433	121,576	5,899	2,293		277,201
Diesel	1,834	1,842	25	0		3,701
Taxis		1,056				1,056
Gas		834				834
Diesel		222				222
TOTAL	***995,433***	***203,260***	***35,534***	***16,833***	***4,697***	***1,255,757***
Gas	726,931	130,779	26,834	16,758	4,561	905,863
Diesel	268,502	72,481	8,700	75	136	349,894

APPENDIX TABLE 6.1.6

NUMBER OF REGISTERED MOTOR VEHICLES BY TYPE AND TYPE OF FUEL USED, 1996

Type of Vehicle & Fuel Used	Private	For Hire	Gov't.	Tax Exempt	Diplomat	Total
TOTAL CARS	641,738	12,819	5,473	795	3,273	664,098
Gas	626,794	9,368	5,346	733	2,803	645,044
Diesel	14,944	3,451	127	62	470	19,054
Utility Vehicles	928,159	144,193	28,400	325		1,101,077
Gas	462,503	6,960	17,482	189		487,134
Diesel	465,656	137,233	10,918	136		613,943
Trucks	203,316	11,531	5,464	77		220,388
Gas	10,443	384	708	19		11,554
Diesel	192,873	11,147	4,756	58		208,834
Buses	4,080	25,002	247	1		29,330
Gas	261	321	31	0		613
Diesel	3,819	24,681	216	1		28,717
MCs / TCs	472,492	331,299	17,754	54		821,599
Gas	472,492	331,299	17,754	54		821,599
Diesel	0	0	0	0		0
Taxis		38,480				38,480
Gas		28,634				28,634
Diesel		9,846				9,846
TOTAL	***2,249,785***	***563,324***	***57,338***	***1,252***	***3,273***	***2,874,972***
Gas	1,572,493	376,966	41,321	995	2,803	1,994,578
Diesel	677,292	186,358	16,017	257	470	880,394

APPENDIX TABLE 6.1.7

FUEL CONSUMPTION IN THOUSAND LITERS, BY TYPE OF VEHICLE, BY TYPE OF FUEL, 1988-1996

Vehicle/ Fuel Type	1988	1989	1990	1991	1992	1993	1994	1995	1996
TOTAL	***2,921,307***	***3,401,487***	***3,731,889***	***3,856,863***	***4,448,343***	***5,038,224***	***5,383,479***	***6,123,739***	***6,828,812***
Gas	1,389,660	1,629,750	1,750,749	1,591,113	1,798,449	2,020,155	2,216,842	2,630,541	2,972,375
Premium	979,758	1,167,855	1,277,565	1,165,311	1,327,809	1,513,478	1,681,848	1,761,976	2,023,879
Regular	409,902	461,895	473,184	425,802	470,640	506,677	533,291	590,345	619,820
Unleaded	0	0	0	0	0	0	1,703	278,220	328,675
Diesel	1,531,647	1,771,737	1,981,140	2,265,750	2,649,894	3,018,068	3,166,638	3,493,198	3,856,437
Cars	*612,750*	*700,583*	*740,884*	*670,468*	*759,918*	*843,055*	*893,498*	*1,019,676*	*1,130,526*
Gas	558,947	635,808	663,797	580,447	639,283	703,384	754,159	893,404	1,003,933
Premium	394,077	455,611	484,389	425,112	471,987	526,967	572,157	598,415	683,575
Regular	164,870	180,197	179,408	155,335	167,295	176,416	181,423	200,497	209,347
Unleaded	0	0	0	0	0	0	579	94,491	111,012
Diesel	53,804	64,775	77,086	90,021	120,635	139,671	139,339	126,273	126,592
Utility Vehicles	*1,372,829*	*1,596,863*	*1,779,556*	*1,959,551*	*2,270,329*	*2,591,161*	*2,721,882*	*3,091,498*	*3,415,228*
Gas	381,389	448,150	491,452	449,416	503,200	548,417	580,335	662,913	725,940
Premium	268,892	321,138	358,625	329,147	371,517	410,868	440,282	444,029	494,290
Regular	112,497	127,012	132,827	120,269	131,684	137,549	139,607	148,771	151,378
Unleaded	0	0	0	0	0	0	446	70,113	80,272
Diesel	991,441	1,148,713	1,288,104	1,510,135	1,767,129	2,042,744	2,141,547	2,428,586	2,689,287
Trucks	*430,521*	*485,583*	*527,290*	*576,688*	*631,276*	*716,488*	*731,847*	*819,054*	*931,985*
Gas	22,856	25,699	26,495	20,854	18,983	19,561	20,672	15,224	17,218
Premium	16,114	18,416	19,334	15,273	14,015	14,655	15,683	10,197	11,724
Regular	6,742	7,284	7,161	5,581	4,968	4,906	4,973	3,416	3,590
Unleaded	0	0	0	0	0	0	16	1,610	1,904
Diesel	407,665	459,883	500,795	555,835	612,293	696,927	711,175	803,831	914,767
Buses	*63,759*	*73,898*	*77,869*	*91,079*	*131,607*	*116,296*	*143,299*	*135,433*	*126,704*
Gas	1,223	1,276	1,595	1,176	1,560	934	936	923	914
Premium	862	914	1,164	861	1,152	700	710	619	622
Regular	361	362	431	315	408	234	225	207	190
Unleaded	0	0	0	0	0	0	1	98	101
Diesel	62,537	72,622	76,275	89,903	130,048	115,362	142,362	134,509	125,791
MC / TC	*441,447*	*544,560*	*606,290*	*559,076*	*655,213*	*771,224*	*892,953*	*1,058,077*	*1,224,369*
Gas	425,246	518,816	567,409	539,220	635,424	747,860	860,739	1,058,077	1,224,369
Premium	299,813	371,776	414,053	394,918	469,138	560,288	653,016	708,716	833,669
Regular	125,433	147,040	153,357	144,302	166,285	187,571	207,062	237,453	255,314
Unleaded	0	0	0	0	0	0	661	111,908	135,387
Diesel	16,201	25,744	38,881	19,855	19,789	23,364	32,214	0	0

Source: Energy Regulatory Board (ERB)
Department of Energy (DOE)

APPENDIX TABLE 6.1.8

LAND AREA, POPULATION AND VEHICLE DENSITY BY REGION, 1994

Region	Vehicle Registration			Vehicle Density per Sq. Km	Land Area (Sq. km.)	Vehicle per Pop'n.	Total Population
	New	Renewal	Total				
PHILIPPINES	***316,453***	***2,025,016***	***2,341,469***	***1,595***	***300,075***	***3.41***	***68,624,247***
NCR	144,463	829,087	973,550	1,531	636.0	10.92	8,917,585
CAR	1,015	26,242	27,257	1	18,293.7	2.10	1,297,490
Region I	13,190	94,090	107,280	8	12,840.2	2.71	3,954,447
Region II	8,055	54,242	62,297	2	26,837.3	2.35	2,649,251
Region III	22,986	228,153	251,139	14	18,230.8	3.59	7,002,968
Region IV	43,479	226,834	270,313	6	46,924.4	2.86	9,449,207
Region V	4,903	48,530	53,433	3	17,632.5	1.22	4,391,398
Region VI	13,294	108,565	121,859	6	20,223.2	2.02	6,027,669
Region VII	28,817	137,127	165,944	11	14,951.5	3.21	5,161,992
Region VIII	4,712	32,050	36,762	2	21,431.7	1.07	3,446,240
Region IX	6,527	43,923	50,450	3	18,730.1	1.79	2,814,269
Region X	7,071	57,474	64,545	2	28,327.7	1.61	4,005,557
Region XI	15,458	105,011	120,469	4	31,692.8	2.35	5,127,257
Region XII	2,483	33,688	36,171	2	23,323.2	1.56	2,325,198

APPENDIX TABLE 6.1.9

TOTAL MOTOR VEHICLE EMISSIONS IN METRIC TONS, BY REGION, 1994

AREA	EMISSIONS							
	HC	VOC	Pb	CO	PM	SOx	NOx	CO_2
PHILIPPINES	**305,349**	**42,690**	**249**	**1,518,385**	**104,774**	**47,378**	**217,736**	**47,275,217**
NCR	126,443	17,678	103	628,754	43,386	19,619	90,163	19,576,365
CAR	3,586	501	3	17,830	1,230	556	2,557	555,154
Region I	14,051	1,964	11	69,872	4,821	2,180	10,020	2,175,465
Region II	8,096	1,132	7	40,257	2,778	1,256	5,773	1,253,411
Region III	32,677	4,568	27	162,491	11,212	5,070	23,301	5,059,184
Region IV	35,466	4,958	29	176,361	12,169	5,503	25,290	5,491,025
Region V	7,025	982	6	34,934	2,411	1,090	5,010	1,087,681
Region VI	15,937	2,228	13	79,247	5,468	2,473	11,364	2,467,384
Region VII	21,680	3,031	18	107,805	7,439	3,364	15,459	3,356,528
Region VIII	4,819	674	4	23,965	1,654	748	3,437	746,163
Region IX	6,633	927	5	32,984	2,276	1,029	4,730	1,026,963
Region X	8,457	1,182	7	42,051	2,902	1,312	6,030	1,309,274
Region XI	15,729	2,199	13	78,213	5,397	2,440	11,216	2,435,169
Region XII	4,750	664	4	23,621	1,630	737	3,387	735,451

APPENDIX TABLE 6.1.10

TOTAL COST OF DEGRADATION, IN THOUSAND PESOS, BY SOURCE, 1988-1996

Source	1988	1989	1990	1991	1992	1993	1994	1995	1996
Industries	188,784	213,562	266,044	324,821	430,640	544,584	627,857	783,991	829,682
TCS [1/]	56,408	62,643	76,120	96,754	127,013	175,044	225,392	284,925	306,255
Other Industries	132,376	150,919	189,925	228,067	303,627	369,540	402,465	499,066	523,427
Household	134,591	156,935	196,504	225,478	296,866	363,533	416,875	513,672	544,157
Government	9,586	11,144	13,667	15,010	17,505	20,818	22,507	26,463	28,002
Rest of the World	5,808	5,719	6,383	6,185	3,039	2,154	2,324	2,410	2,210
Total Cost	***338,769***	***387,360***	***482,599***	***571,493***	***748,050***	***931,089***	***1,069,563***	***1,326,536***	***1,404,051***

1/ Degradation cost used to adjust GVA of transport sector

APPENDIX TABLE 6.1.11

TOTAL COST OF DEGRADATION, IN THOUSAND PESOS, BY TYPE OF POLLUTION CONTROL, 1988 - 1996

Pollution Control	1988	1989	1990	1991	1992	1993	1994	1995	1996
Total	***338,769***	***387,360***	***482,599***	***571,493***	***748,050***	***931,089***	***1,069,563***	***1,326,536***	***1,404,051***
Inspection Cost	62,936	83,270	112,542	137,200	174,446	229,338	231,096	306,061	344,056
Cost of Emission Converter	138,958	167,095	200,680	242,007	339,365	423,386	515,133	645,384	686,165
Cost of Lead Strap	136,875	136,995	169,377	192,287	234,239	278,365	323,333	375,091	373,830