CHAPTER 8 BASIC PRINCIPLES FOR PLANNING OF COUNTERMEASURES

8.1 Outline

In the course of this Study, the Team carried out various monitoring, surveys, analyses and forecast, as described in the previous chapters. Based on the findings from those studies, the outstanding issues and significant focal points for planning of countermeasures are summarized in this chapter. These cover air pollution, technical, institutional and financial aspects.

In order to formulate the air pollution control strategies, the basic principles concerning characteristics and goal of the control plan, concept for planning of countermeasures and target pollutants and polluters are established in this chapter.

8.2 Issues and Focal Points for Planning of Countermeasures

Issues and focal points from the entire work output are summarized below in order to comprehend the impending problems and needs to be addressed towards the formulation of anti-air-pollution strategies. The identified issues and focal points are categorized into 4 clearly defined major elements concerning ambient air management in the Jabotabek area: Air pollution condition, technical appropriateness, institutional capacity, and financial constrains.

(1) Air Pollution Aspects

Current air quality

According to the results of air quality monitoring, study of fuel and emissions from stationary and mobile sources, and analysis of air pollution mechanism, characteristics of current air quality are as follows:

1) With regard to ambient air quality, the concentrations of SPM, Non-Methane Hydrocarbon and TSP exceed the Draft National or DKI Jakarta Ambient Air Quality Standards at least in some instances in some stations, but the concentrations of SO_2, NO_2 and CO satisfy the standards in all instances and in all stations.

2) As for stationary sources, electric supply industry is the biggest producer of SOx

and NOx. For PM, cement, iron and steel, and textile are the main contributors. In the case of emission from factories by area, the share of DKI Jakarta is the highest for SOx and NOx. For PM, Bogor's share is the highest in the region.

3) As for mobile sources, more than 50% of CO and NOx are emitted from the passenger car group. SOx and PM emissions are almost equally shared by the passenger car group, bus and truck group with similar values. For HC emission load, passenger car and motorcycle group each occupies around 40%.

4) As for all emission load from stationary and mobile sources, the highest share of SOx emission is from factories and NOx emission from automobiles. For PM, the highest share is from factories.

5) Correlation coefficients of simulated results and actual measurement at monitoring stations are 0.67 for SO_2, 0.92 for NO_2, and 0.94 for CO. So, the simulation model can be used for the present and future predictions for these pollutants. On the other hand, correlation coefficient of SPM simulation is 0.15 and background value is high with 73 ppb, therefore the model should not be used for SPM prediction.

Future trend (2010)

The results of simulation of air quality without countermeasures in 2010 are as follows.

1) Total emission load of air pollutants in 2010 compared with 1995 will be 4.3 times for factories, about 1.4 times for households and 2.0 to 2.3 times for automobiles.

2) As for the ambient air quality in 2010, SO_2 will exceed the standards in the northern part of DKI Jakarta, Tangerang, Cibinong, and Bekasi. NO_2 also will exceed the standards in the central areas of DKI Jakarta and along major roads, but CO will satisfy the standards.

(2) Technical Aspects

1) There is a serious shortage of continuous monitoring stations to monitor the ambient air quality in the whole Jabotabek area. Only part of DKI Jakarta is monitored now.

2) Technical know-how on basic operation of various kinds of monitoring

equipment, check of accuracy and classification of monitoring data is not enough.

3) Due to the lack of technical know-how to grasp working conditions and fluctuations of combustion facilities, assessment of measured data is not so reliable.

4) Technical know-how on analysis of the exhaust gas investigation results is not enough.

5) Larger-scale boiler facilities have significant adverse impacts on ambient air, since they usually use a great deal of MFO containing much sulfur.

6) High dust and NOx concentrations are found in the facilities with diesel generators, even though they use HSD as fuel.

(3) Institutional aspects

1) BAPEDAL has institutional weak points such as lack of working staff, financial and functional capabilities since its establishment in 1990.

2) Air pollution countermeasures are carried out by various agencies such as the Ministry of Health, Ministry of Industry and Trade, Ministry of Mining & Energy, Ministry of Public Works, Ministry of Transportation and so on, but BAPEDAL performance is lacking adjustment and coordination on policies with those agencies.

3) Although KPPL is under the direct control of the Governor of DKI, it is only a local research institute in character, lacking competence in planning and coordinating DKI's environmental policies.

4) All local government agencies are lacking staff, analysis facilities and institutional strength.

5) Factories hardly have exclusive organization on environmental management and carry out environmental countermeasures as an additional work.

(4) Financial Aspects

1) Budget allocation for environmental management is given third priority in the Five-year Development Plan of the Government, i.e. in fact, of lower priority.

2) The Resources & Environmental Division of BAPPEDA (Regional Planning Agency, DKI Jakarta), which is in charge of budgetary planning for resources and environment for the local government, reportedly gives lower priority to environmental management.

3) Financial support from the Government for the AMDAL training courses is too small to train an enough number of environmental experts.

8.3 Basic Principles for Planning of Countermeasures

8.3.1 Characteristics of the Control Plan

The plan integrates countermeasures to manage air quality for the Jakarta metropolitan area, in a well organized and systematic form. It consists of an air-pollution control strategy which shows long-term directions towards the year 2010, and action plans clarifying detailed activities to be implemented by 2000.

8.3.2 Goal of the Control Plan

The plan aims at overall compliance with the draft ambient air-quality standards on a national level, within the Jabotabek area.

8.3.3 Concept for Planning of Countermeasures

The air-pollution control strategy was formulated in order to accomplish the above goal, by taking the following study steps :

1) Establishment of a baseline from the results of air-quality simulation for 2010 without countermeasures,

2) Review and analysis of the on-going "Blue Sky Program" to identify its present situation and back-up necessity, then

3) Evaluation of the proposed countermeasures by means of air-quality simulation for 2010 with such countermeasures.

Individual countermeasures were evaluated only qualitatively, since actual methods for implementation of some measures are subject to governmental policies and/or private-sectors' directions.

Action plans were formulated for countermeasures feasible by 2000 with high urgency, taking due consideration of the present progress of the Blue Sky Program.

8.3.4 Target Pollutants and Polluters

Countermeasures under the plan are targeted for stationary and mobile emission source controls as well as other control measures, and they aim at emission reduction of sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and carbon monoxide (CO).

Only emission load was calculated for suspended particulate matter (SPM) because its simulation model could not be designed due to a severe influence from background concentration. Future quality of hydro-carbon (HC) was also not simulated due to unknown specific sources. But countermeasures related to HC were classified as other control measures since HC quality is largely exceeding the draft standards at present.

CHAPTER 9 SOURCE CONTROL STRATEGY

9.1 Outline

The Team proposed the measures for stationary and mobile emission sources control based on the results of air quality monitoring, emission measurement, simulation of air quality without countermeasures in 2010, and the Blue Sky Program.

Then, the ambient air quality was predicted for 2010 as the targeting year in line with the application of possible countermeasures. Simulation of air quality was carried out by two steps, with existing and planned countermeasures by BAPEDAL (Case 1) as the first step, and together with additional countermeasures (Case 2) as the second step.

Based on the result of simulation, a source control strategy was proposed, showing competent authorities, control items, time of implementation, and cost. Countermeasures with high priority for action plans were selected by the viewpoint of grasping of the most important and basic data in order to manage the air quality effectively.

9.2 Measures for Emission Source Control

9.2.1 Measures Common to Stationary and Mobile Sources Control

(1) Survey on Emission Sources of Hydrocarbon

The air quality monitoring in this Study shows that quality levels at all of the monitoring stations do not comply with the Draft National Ambient Air Quality Standard on hydrocarbon. Due to the lack of data on emission load, it is necessary to carry out a survey on emission of hydrocarbon from stationary and mobile sources in addition to continuous monitoring.

For motor vehicles, one of the main emission sources of hydrocarbon, the Team estimated the total emission in Jabotabek at 97,971 tons in 1995. Most of industrial emission of hydrocarbon comes from evaporation loss sources, which include various sources such as laundry, surface coating, storage of organic liquids, transportation and marketing of petroleum liquids. Besides, the emitted hydrocarbon is various in kind.

Hydrocarbon is one of the major air pollutants, and nitrogen oxides and non-methane hydrocarbon generate photochemical smog under solar energy. Photochemical smog is very harmful to health and vegetation. For this reason, the Team proposes to conduct a survey on hydrocarbon emission sources which are air pollutant violating the air quality standard. The scope of work should include the following items:

a) Inventory of emission sources,
b) Identification of potential control measures for major sources,
c) Assessment of the costs, emission reductions and cost-effectiveness of alternative control measures,
d) Recommendation of a feasible and cost-effective emission control strategy, and
e) Preparation of specifications and TOR to implement the strategy

(2) Strengthening of Ambient Air Monitoring System

According to the result of simulation of air quality without countermeasures in 2010, high SO_2 concentrations are predicted in Tangerang, Cibinong, and Bekasi, which do not have any monitoring station, in addition to the northern part of DKI Jakarta. New monitoring stations should be established in those areas for the implementation of proper measures and confirmation of effect. Also, additional monitoring stations should be established besides the 6 continuous monitoring stations in DKI Jakarta.

The purpose of monitoring stations is to collect the necessary basic information for the implementation of proper measures to keep the local air always clean. Hence, each monitoring station must undertake the following four functions :

a) Provision of adequate data to evaluate the state of ambient air quality in comparison with the air quality standards,
b) Capability of rapid collection and delivery of the necessary information so that emergency action can be taken rapidly to prevent air pollution,
c) Capability of comprehending the general trend of air pollution over the entire area (Background concentration data are essential for this purpose), and
d) Provision of useful data to evaluate land utilization plans in urban areas, public transportation construction plans, and new air pollution control measures.

Each monitoring station must be able to grasp the level of air pollution and the pattern of its changes over the entire area it covers. Its covering range must be determined in the light of meteorological conditions, topographical features, and the distribution of pollution sources in that area.

In the continuous monitoring of air quality, it is necessary to maintain the measuring instruments in the best condition. The functions of continuous monitoring will be lost if the measurement is interrupted frequently. Therefore periodic inspection and overhaul are very important for continuous monitoring.

Periodic inspection aims at the maintenance of the precision of automatic measuring instruments. Inspection should be carried out comprehensively on the performance of assemblies to find any deterioration and to restore the expected function. Performance of measuring instruments gradually decline with time despite the periodic inspection. When continued performance of the instrument is found to be difficult in the periodic inspection, overhauling has to be carried out. That is, the instrument is disassembled and performance of each part is inspected, and changed if necessary. Then, a test running should be made for a certain period of time to insure the function and accuracy of all parts. To prevent measurement interruption and to tackle with an emergency, it is desired to reserve spares of instruments and their parts.

In order to maintain a certain level of accuracy, the inspection and maintenance should be carried out in accordance with the guideline prepared by the Team.

9.2.2 Measures for Stationary Emission Source Control

According to the result of simulation of air quality without countermeasures in 2010, SO_2 concentrations are very high in the northern part of DKI Jakarta, Tangerang, Cibinong, and Bekasi. NO_2 concentrations also are high in the central area of DKI Jakarta. So, it is necessary to implement the measures for stationary emission source control.

(1) Strengthening of Regulations on Emission Gas

The Decree of State Minister (KEP-13/MENLH/3/1995) "Emission Standards for Stationary Emission Sources" regulates emissions from 4 prime industries (iron & steel, pulp & paper, cement, and coal-fired steam power plants) and all other industries. The standards are effective in 2 target years of 1995 and 2000 as shown in Table 5.4.3. According to the result of emission gas measurement of 36 facilities in 31 factories, the emission standards for stationary emission sources were exceeded in 3 facilities for SO_2 and 1 facility for NOx out of 7 facilities in pulp &

paper industry as shown in Table 9.2.1. Also 2 facilities for TSP and 4 facilities for SO_2 out of 26 facilities in all other industries exceeded the emission standards, with a maximum exceeding rate as high as 2.1 times. It is necessary to introduce penalty and fine on entrepreneurs who violate regulations on emission gas.

Table 9.2.1 Ratios of Surveyed Facilities Exceeding National Emission Standards

Industries	TSP	SO_2	NOx
Iron and Steel Industry	0/1 (0/1)	-	-
Pulp and Paper Industry	0/7 (1/7)	3/7 (3/7)	1/7 (1/7)
Cement Industry	0/2 (1/2)	0/2 (0/2)	0/2 (0/2)
All Other Industries	2/26 (3/26)	4/26 (7/26)	0/26 (0/26)
Total	2/36 (5/36)	7/35 (10/35)	1/35 (1/35)

Notes: 1) Numerators show the numbers of exceeding facilities, while denominators mean the total numbers of the surveyed facilities.
2) Figures in brackets are those is as compared to the effective standards as of 2000.
3) Data are based only on one-spot measurements.

In order to strengthen the regulations on the emission gas from factories, an inspection system should be established by local governments. During this Study, emission measurement was carried out by co-operating with EMC engineers trained by the stationed JICA experts and the Team members. As a result, their measurement techniques were improved. Inspection and monitoring of the emission gas from factories under the law and decree are a duty of the local government. The inspection system should be strengthened by making full use of trained technicians.

Also, there are many small and medium scale industries scattered throughout the urban areas of Jabotabek and located in industrial parks. A source inventory of 91 factories was made by questionnaire survey in this Study. In order to carry out inspection and monitoring, a stationary source inventory is needed to cover all industries, utilizing the inventory guideline provided by the Team.

(2) Introduction of Total Emission Control

According to the result of simulation of air quality without countermeasures in 2010, SO_2 concentrations around the cement factories, power plants and industrial areas are very high. Emission control is applicable to areas where factories and businesses are concentrated, and thus it is difficult to maintain the level required by the Draft National Ambient Air Quality Standard by applying only the emission standard applicable to unit facilities. Such areas are designated by the Government as areas to which the standard for total emission control should be applied. The local governor of such a designated area should apply the total emission control standard to the designated factories whose scales are larger than a certain standard, and the fuel use control standard to factories other than designated factories.

The local governments should consider to enter into pollution control agreements with local enterprises, with which they would have jurisdiction primarily to prevent environmental pollution. Since such agreements are not legal actions, the violator of the agreement cannot be penalized, but if each agreement would be considered in the environmental management system (ISO 14000), the parties related to such agreements are not supposed to violate the provisions of the agreement. Consequently, such an agreement is recognized virtually as a law.

Increase in such pollution control agreements can be attributed to the following reasons:

a) The pollution control agreement will force the local government to precise and effectively enforce pollution control measures suited to geographical and social conditions of the locality.

b) It is not possible for the enterprise eager to construct its facilities in a desired location, to conduct its activity without obtaining the agreement of the local people.

In Japan, the City of Yokohama became the first local government to enter into a pollution control agreement with a local electric power company in 1964. In 1986, the number of agreements concluded between local governments and enterprises amounted to 22,593, and that between resident groups and enterprises was 3,630.

(3) Introduction of Management System for Emission Control

Owners and operators of many industries are ignorant of their legal and social obligations to control pollution and have little or no knowledge of the technical mechanisms required to reduce the effect of their activities on the environment. In order to meet the emission standards for stationary sources in each industry, managers with technical knowledge on air pollution control measures would be more effective in doing the daily inspection and monitoring. As for the selection of managers, employment of certificate holders under the AMDAL system should be considered.

The "Pollution Control Manager" system is rather unique and has been successfully implemented in Japan. Briefly speaking, it aims at coordinating and ensuring effectiveness of environmental control jobs in specified factories under the provisions of the "Law Concerning the Improvement of Pollution Prevention Systems in Specific Factories" enacted in 1971. Specified factories which are required to station air pollution control managers are the following :

a) All the factories that have facilities which deal with the hazardous substances designated by law.
b) Other factories that discharge more than 10,000 m^3/hour of gas.

The pollution control manager must have expertise necessary for pollution control, and be able to manage the collective control works for pollution prevention. Such manager's jobs are :

a) inspection of raw material, fuels, and control equipment and their maintenance,
b) measurement and reporting of pollutant concentration,
c) inspection of measuring devices, and
d) all necessary efforts for reduction/prevention of pollutants in factory premises through routine as well as emergency works.

(4) Introduction of Combustion Control System

Automatic combustion control has become popular with the increasing use of liquid fuels. Appropriate design of the heating system is now an important factor, leaving less room for combustion control. Its aim is only to make operation of the heating system efficient, in a narrow sense. Yet combustion control in a wider sense, including the use of proper fuel and regular maintenance of the entire heating system and control equipment used, is still important.

Further, improvement of combustion equipment and techniques as well as fuel reform would significantly reduce NOx. The great majority of NOx comes from the combustion of fossil fuels (called "fuel NOx"), and most is in the form of NO at the time of occurrence. Another part of NOx results from the reaction of nitrogen in the air at a high temperature, and it is therefore called "thermal NOx". The volume of NOx can be reduced to half or so by the combustion modification (CM) method as shown in Table 9.2.2.

Table 9.2.2 NOx Concentration in Combustion Gas

(Unit : ppm)

	Gas N=0%	Oil N=0.1 - 0.5%	Coal N=1 -3%
Without CM	200 - 300	300 - 500	500 - 1000
With CM	50 - 100	80 - 200	200 - 400

Source: Industrial Pollution Control - General Review and Practice in Japan

In order to promote combustion control, government support for installing control equipment in new or existing combustion facilities is effective. Also, guidance and training on combustion management should be provided to personnel running combustion facilities in factories.

(5) Fuel Reform

According to the result of simulation of air quality with countermeasures in 2010, the concentration of SO_2 do not meet the Draft National Ambient Air Quality Standard around the industrial areas.

The concentration of SO_2 in the exhaust gas is in direct proportion to the sulfur content in the fuel. Therefore a direct effect of strengthening of regulations on emission gas and introduction of total emission control can be expected by promoting the conversion of fuel use from petroleum fuel to natural gas. Also, for the air pollution control in Jabotabek, utilization of coal should not be allowed because of its high sulfur content.

Another method of reducing SOx is to decrease sulfur content in fuel by strengthening regulatory standards. In the case of heavy oil, hydrodesulfurization process has been developed. Since sulfur in heavy oil is combined chemically with carbon, this is allowed to react with hydrogen gas at a temperature of about 400°C and a pressure of 150 atmospheres using catalyst, and is then released in the form of hydrogen sulfide.

(6) Stack Gas Control

Installation of stack gas desulfurization, stack gas denigration and dust separation systems in combustion facilities is effective for stack gas control in high concentration areas predicted by simulation. The methods to remove air pollutants may be divided into the dry and wet processes. In the wet process, water or suitable aqueous solutions are used to trap particulates or to absorb hazardous gases. In the dry process, exhaust gases are treated in the dry state without using water. Removal of SO_2 can be usually carried out more effectively by using a wet process. On the other hand, as NOx cannot be removed sufficiently by wet processes, a dry process is principally employed.

9.2.3 Measures for Mobile Emission Source Control

According to the result of ambient air pollution measurement in this Study, the Thamrin and KPPL stations along the main roads show high concentrations of SO_2, NO_2 and CO, and also a high concentration of SPM next to the Pulo Gadung station. This means that they are under the influence of the automobiles running through the main roads. Also, according to the result of simulation of air quality without countermeasures in 2010, SO_2 and NO_2 concentrations along major roads are high due to the increased traffic volume estimated as more than twice that in 1995. So, it is needed to implement the measures for mobile emission source control.

As for traffic flow control and traffic volume control, improvement of the road network and introduction of a new transportation system (subway) have been planned and executed, and those measures have been considered in the simulation of air quality without countermeasures in 2010. So, they are not included here (see Appendix 6.5).

(1) Introduction of New Regulations on Vehicle Emission Gas

Emission standards for vehicles emission gas are regulated by Decree KEP-35/MENLH/10/1993 that stimulates the permissible limits of CO, HC and Black Smoke as polluted matters emitted from vehicles. The standards are applied for both new and presently used cars. Inspection of emission gas from new cars is conducted in the Motor Vehicle and Testing Center of the Department of Communication. As part of a series of certificate inspections for new cars, the tests are conducted at idling condition.

New regulations are needed with stricter standards which would require the installation of emission gas control equipment such as catalytic converters introduced in Japan and Europe. BAPEDAL considers to apply UN-ECE standards as shown in Table 9.2.3 (Latest automobile emission standards in Japan are shown in Appendix 6.2) under the Blue Sky Program. The standards would be established for each car type, and their measurement is carried out using the chassis dynamometer under actual vehicle driving patterns.

Table 9.2.3 Latest Emission Levels in ECE Regulation No.83 Revision 1

Fuel	Category of vehicle	Reference mass Rm(kg)	CO L1(g/km)	HC+NOx L2(g/km)	PM L3(g/km)
Gasoline	M (*1)	All	3.16 (2.72)	1.13 (0.97)	- -
	N1 (*2)	Rm≦1,250	3.16 (2.72)	1.13 (0.97)	- -
		1,250<Rm≦1,700	6.0 (5.17)	1.6 (1.4)	- -
		1,700<Rm	8.0 (6.9)	2.0 (1.7)	- -
Diesel	M *1)	All	3.16 (2.72)	1.13 (0.97)	0.18 (0.14)
	N1 *2)	Rm≦1,250	3.16 (2.72)	1.13 (0.97)	0.18 (0.14)
		1,250<Rm≦1,700	6.0 (5.17)	1.6 (1.4)	0.22 (0.19)
		1,700<Rm	8.0 (6.9)	2.0 (1.7)	0.29 (0.25)

Notes : *1) Except:
- vehicles designed to carry more than six occupants including the driver;
- vehicles whose maximum mass exceeds 2,500 kg.

*2) And those category M vehicles which are specified in note *1).

*3) Values are maximum permissible limits with average value in brackets.

(2) Strengthening of Vehicles' Inspection and Maintenance Program

Half-yearly inspection and maintenance are compulsory for all commercial vehicles, but they are not satisfactory due to the lack of inspection facilities such as vehicle gas meter for CO and HC, and diesel smoke meter for black smoke.

According to the result of emission gas tests on present used cars in this Study, CO and HC exceed the standards in 50.0% and 34.5% cases respectively out of 142 gasoline vehicles, and Black Smoke exceed the standards in 23.0% out of 135 diesel vehicles. Especially, Small/Medium Buses show high excess rates of 64.0% for HC and 34.8% for Black Smoke, one of reasons for people to complain about air pollution. So, measures such as reinforced inspection for emission gas concentration, penalization of vehicles in poor repair condition and increase of inspection units are needed.

A vehicle inspection campaign by DKI Jakarta was started in 1996 for the purpose of checking their conformity to the standards. In this campaign, vehicles exceeding the emission quality standards are punished by putting a red sticker besides an obligation to repair the emission within three days, which is related with the registration renewal. Meanwhile, vehicles not exceeding emission quality standards are given a green sticker and receive a reward.

Although safety check for automobiles in DKI Jakarta is conducted for commercial vehicles in three public inspection units, another three new private inspection units are planned due to the shortage of inspection units, and one of them has already been established. DKI Jakarta plans to conduct an inspection including emission gas test for the private cars once a year starting from 1998.

(3) Promotion of Unleaded Gasoline Usage

Extension of the use of unleaded gasoline is needed not only for the benefit of health, but also due to the introduction of new regulations including the installation of catalytic converters which is damaged by using leaded gasoline. PERTAMINA started to sell Super TT (unleaded gasoline) in August 1995. The sold quantity of the Super TT was only 1,890 kl per year due to its higher price (Rp. 1,000/l, revised to Rp.975/l in Dec. 1996) than that of Premium (Rp.700/l) and Premix (Rp.870/l, revised to Rp. 925/l in Dec. 1996). Besides, only 6 refueling stations sell the Super TT. In the period of transition from leaded gasoline to unleaded gasoline in Japan, the transition was conducted smoothly by a policy, that is regular gasoline (as Premium in Indonesia) was converted into unleaded at first, and high-octane gasoline (as Premix in Indonesia) was kept leaded for a while with high price. In order to promote the utilization of leaded gasoline, price control as economic incentive such as higher taxation on leaded gasoline, and increase of number of filling stations should be further considered.

PERTAMINA plans to increase unleaded gasoline production to 5,000 kl for supporting the Blue Sky program. PERTAMINA also plans to reduce the lead content of premium grade (Premix) gasoline to 0.15 g/l from the current 0.45 g/l. The Government has set 1999 as the deadline for the phasing out of leaded gasoline.

Since virtually all gasoline fueled vehicles in Jabotabek can operate satisfactorily on unleaded gasoline, there is no need to maintain supplies of leaded gasoline and, therefore, no need to install additional tanks or pumps in filling stations for unleaded gasoline. A straightforward conversion to a 'unleaded' gasoline supply would be feasible. The introduction of unleaded gasoline is an essential prerequisite for the introduction of appropriate controls of motor vehicle exhaust emission.

(4) Acceleration of Vehicle Turnover Rate

If new regulations on vehicle emission gas are introduced, their effect is limited due to the continued use of old and polluting vehicles. It is necessary to establish measures to accelerate the turnover rate of current vehicle fleet, such as new taxation system which gives old car higher tax rate than that of new car as an incentive not to keep old car.

(5) Promotion of Low-pollution Vehicles

In order to reduce polluted matters emitted from the vehicles, low emission gas vehicles, low-pollution vehicles should be promoted more extensively. It is necessary to introduce and promote CNG, LPG and electric vehicles in public transportation system, and government support is required for introduction of low-pollution vehicles.

Vehicles utilizing the compressed natural gas (CNG) and liquefied petroleum gas (LPG) are low-polluters and their use can reduce PM, Black Smoke, NOx and SOx compared with diesel vehicles. Promoting CNG vehicles is being planned as a scheme in the Blue Sky Program under the commission consisting of the Ministry of Mine & Energy, the Ministry of Communication, the Ministry of Finance, PERTAMINA and GAIKINDO. 1,960 CNG vehicles were introduced as bus and taxi until 1993. Most of the existing CNG vehicles have converters to use both gasoline and CNG. The Heavy tank required for the CNG vehicle should be improved. CNG fuel facilities need to be installed, in addition to the existing 15 gas stations (2 of them under construction) in Jabotabek.

Liquefied petroleum gas is extensively used in taxi fleets overseas (314,000 LPG vehicles in Japan, 1993). LPG requires more different processing than CNG and its overall energy efficiency is therefore slightly reduced. However, the simpler vehicle technology, lighter storage cylinders and more rapid filling make it a more convenient fuel for general transport use. LPG-fueled engines are now readily available at a marginal extra cost and the existing petrol vehicles can be easily converted to LPG-fueled vehicles. To support the LPG bus and taxi fleet, LPG fuel facilities need to be installed to add to the existing 11 gas stations in Jakarta.

(6) Utilization of low-sulfur fuel

According to the result of simulation of air quality without countermeasure in 2010, high SO_2 concentration is predicted along major roads. Also, average sulfur content of diesel fuel (Solar) for motor vehicles is high at about 0.4% according to the result of fuel analysis in this Study. Strengthening of regulatory standards on sulfur content in diesel fuel is effective for the reduction of SO_2 emission load in the same way as the control of diesel fuel vehicle. Also low sulfur diesel fuel (less than 0.2% sulfur content) is a prerequisite for catalytic converter technology for diesel vehicles.

9.3 Air Quality with Countermeasures in 2010

9.3.1 Air Quality with Existing and Planned Countermeasures by BAPEDAL (Case 1)

(1) Estimate of Emissions from Factories

BAPEDAL enforced air pollutant emission regulation against stationary sources in 1995 (Section 5.4). It has two target years of 1995 and 2000. To evaluate the emission regulation, the amount of emission reduction from factories in 2000 and 2010 was estimated. To estimate the effect of the regulation the following three assumptions were made.

(1) No new facility will be introduced before 2000.
(2) Old (existing) facilities will continue to work in 2010.
(3) Emissions from unsurveyed sources (factories) will not change regardless of the regulation.

With the above assumptions, relations between production and emission regulation in 2000 and 2010 are summarized in Table 9.3.1.

Table 9.3.1 Production and Emission Regulation in 2000 and 2010

Facility type	Production			Regulation type
	1995	2000	2010	
Old	1.00	1.60	1.60	1995
New			2.72	2000

Facilities subject to emission reduction by the emission regulation include boiler, electric furnace, melting furnace (glass) and absorption facility (sulfuric acid) as shown in Table 9.3.2. Procedure for calculating emission reduction of each facility is given in Appendix 6.1.1.

Table 9.3.2 Facilities Subject to Emission Reduction by Emission Regulation

Industry	Boiler		Electric furnace iron scrap	Melting furnace glass	Absorption facility sulfuric acid
	utility	general			
Drinks		SOx			
Textile		SOx			
Pulp and paper		SOx			
Chemical		SOx			SOx
Cosmetics		SOx			
Glass and ceramics				SOx	
Iron and Steel			PM		
Assembling		SOx			
Electric supply	SOx				

The effects of emission regulation in 2000 and 2010 are shown in Tables 9.3.3 and 9.3.4 respectively. In 2000, 30% of the total SOx emission and 11% of the total PM emission will be reduced by the emission regulation. In 2010, 36% of the total SOx emission and 11% of PM emission will be reduced. However, there is no reduction in NOx both in 2000 and 2010. The annual total emission with the emission regulation is 48,000 tons of SOx, 59,000 tons of NOx, 20,000 tons of PM in 2000, and 117,000 tons of SOx, 159,000 tons of NOx, 49,000 tons of PM in 2010. Yearly changes of emissions of SOx, NOx, and PM are shown in Figures 9.3.1 to 9.3.3.

Basic source data on factories necessary for air dispersion simulation are shown in Appendix 6.1.2.

Table 9.3.3 Emission Reduction from Factories by Emission Regulation (2000)

Pollutant	Industry	No regulation (ton/year)	Regulation (ton/year)	Reduction (ton/year)	Reduction rate (%)
SOx	Electricity supply	24,153	10,834	13,319	55.1
	Cement	10,206	10,206	0	0.0
	Other	33,955	27,138	6,817	20.1
	Total	68,314	48,178	20,136	29.5
NOx	Electricity supply	32,141	32,141	0	0.0
	Cement	9,185	9,185	0	0.0
	Other	17,606	17,606	0	0.0
	Total	58,932	58,932	0	0.0
PM	Electricity supply	1,215	1,215	0	0.0
	Cement	3,215	3,215	0	0.0
	Other	17,299	15,025	2,274	13.1
	Total	21,729	19,455	2,274	10.5

Table 9.3.4 Emission Reduction from Factories by Emission Regulation (2010)

Pollutant	Industry	No regulation (ton/year)	Regulation (ton/year)	Reduction (ton/year)	Reduction rate (%)
SOx	Electricity supply	65,214	20,656	44,558	68.3
	Cement	27,557	27,557	0	0.0
	Other	91,679	69,101	22,578	24.6
	Total	184,450	117,314	67,136	36.4
NOx	Electricity supply	86,781	86,781	0	0.0
	Cement	24,799	24,799	0	0.0
	Other	47,537	47,537	0	0.0
	Total	159,117	159,117	0	0.0
PM	Electricity supply	3,281	3,281	0	0.0
	Cement	8,680	8,680	0	0.0
	Other	46,708	40,291	6,417	13.7
	Total	58,669	52,252	6,417	10.9

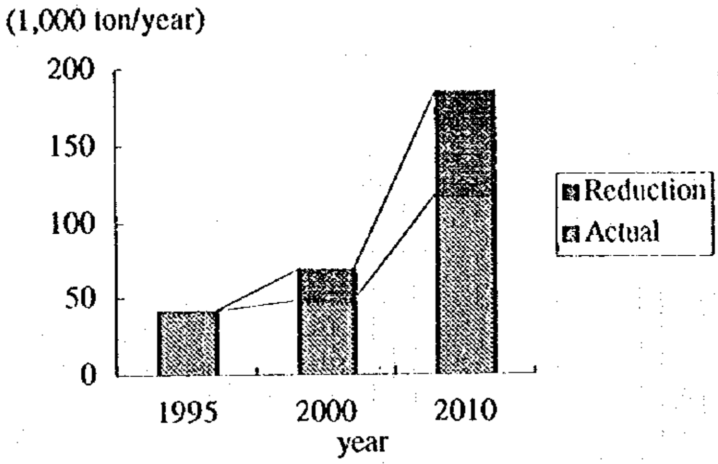


Figure 9.3.1 Yearly Change of SOx Emission

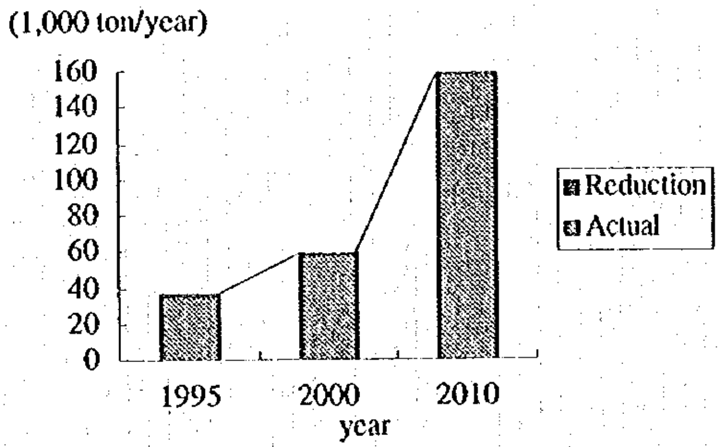


Figure 9.3.2 Yearly Change of NOx Emission

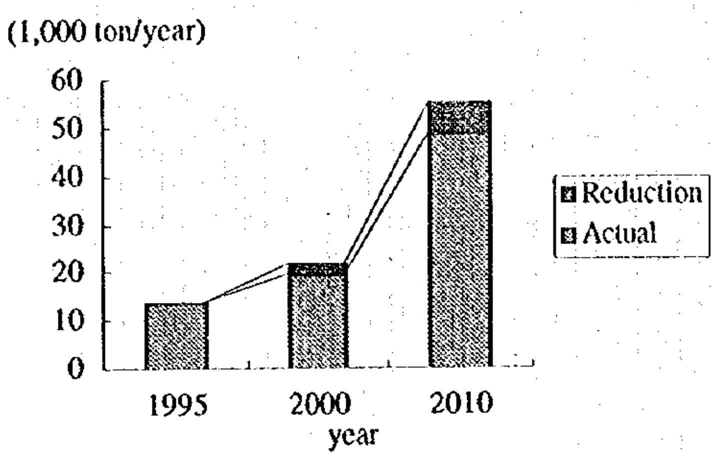


Figure 9.3.3 Yearly Change of PM Emission

(2) Estimate of Emission from Automobiles

1) Mobile Emission Source Control

(a) Estimate Procedure

BAPEDAL will apply ECE83/01 Standards according to the Blue Sky Program, and contents of the standards are shown in Table 9.2.3.

To estimate the emission factors under mobile source control, the following conditions should be considered.

- Starting date of mobile source control
- Target type of running vehicle
- Vehicle ratio of existing vehicle and new vehicle at 2010
- Characteristics of emission factors by traveling speed

The mobile emission standard is assumed to start from January 1st, 2001, and running vehicle types targeted by the standard to be Passenger Car, Taxi, Van, and Small Truck based on vehicle weight. The vehicle ratios in 2010 are estimated on yearly trend of registration number as shown in Table 9.3.5.

Table 9.3.5 Trend of Registration Number of Passenger Cars

Year	1989	1990	1991	1992	1993
Number	434,659	485,844	534,210	572,149	617,565

Source: State Police of Indonesia

By regression analysis, registration number increase per annum was estimated at 45,212 and the registration total was assumed to increase until 2010 without scraping. Finally, the ratio of new vehicle under source control was estimated at 30.4% at the middle of 2010.

The limit values of ECE83/01 are defined with ECE+EUDC test driving cycle, and the average speed of the driving cycles is more than 60km/h. Then, the limit values are kept at 60 to 80 km/h speed rank in our emission factor table, and the characteristics of emission factors are maintained in each speed rank.

(b) Estimate of Emission Factor Changes

Comparisons of the existing emission factors and the future emission factors under regulation are compiled in Table 9.3.6.

The emission factors of new (regulated) vehicles are around 20% to 50% compared with existing vehicles. However, the averaged emission factors of new and existing vehicles in 2010 decrease not so much because around 70% of existing vehicles remain on the roads.

Table 9.3.6 Emission Factor Changes by Regulation

(Unit : g/km/vehicle)

CO	60 to 80 km/h			15 to 25 km/h		
	Existing	New	2010	Existing	New	2010
Passenger Car	8.87	3.16	7.13	18.71	6.67	15.05
Taxi	6.20	3.16	5.28	13.07	6.66	11.12
Van	13.58	3.16	10.41	19.98	4.65	15.32
Small Truck	12.23	7.00	10.64	17.98	10.29	15.64
HC	60 to 80 km/h			15 to 25 km/h		
	Existing	New	2010	Existing	New	2010
Passenger Car	1.32	0.32	1.01	2.44	0.59	1.88
Taxi	0.94	0.29	0.74	1.73	0.53	1.37
Van	1.40	0.27	1.06	2.44	0.48	1.84
Small Truck	1.28	0.43	1.02	2.22	0.74	1.77
NOx	60 to 80 km/h			15 to 25 km/h		
	Existing	New	2010	Existing	New	2010
Passenger Car	3.39	0.81	2.61	2.24	0.54	1.72
Taxi	2.72	0.84	2.15	2.00	0.62	1.58
Van	4.40	0.86	3.32	2.95	0.57	2.23
Small Truck	4.09	1.37	3.26	2.83	0.95	2.40

2) Introduction of Low Emission Vehicles

(a) Estimate Procedure

The low emission vehicles assumed were LPG vehicle for taxi and CNG vehicle for bus, and it was estimated that all taxies and 50% of buses (excluding Microbus) are converted to low emission vehicles in the year 2010.

Emission factors for LPG taxi were obtained from the report "Estimation of Vehicle Exhaust Gas Emission in Tokyo Metropolitan Area" (Ref. 247). The report provided the emission factors by speed ranks and only some modification was conducted because the speed ranks were different from that of this Study.

Emission factors for bus were estimated in another report "To Spread CNG Vehicle" (Ref. 240). Some assumptions were necessary for estimating CNG bus emission. The data in the report are shown in Table 9.3.7.

Table 9.3.7 Examples of Emission Factors of CNG Vehicles

Pollutant	Vehicle Type	Emission Factor	Driving Cycle
CO	Small Truck	0.13 g/km	G10+15 Cycle
HC	Small Truck	0.06 g/km	G10+15 Cycle
NOx	Bus	2.22 g/kWh	G13 Cycle

Source: To Spread CNG Vehicle

CO and HC emission factors for bus were corrected based on difference of vehicle weights.

E.F.(Bus) = E.F.(Small Truck) × V.W. (Bus) / V.W. (Small Truck)

where, E.F.: Emission Factor, V.W.: Vehicle Weight

NOx emission for heavy duty diesel vehicle is said to be reduced to 26% of uncontrolled vehicle by future regulation on JEA (Japan Environment Agency) report, and the regulation value is 4.5 g/kWh. Then, CNG bus NOx emission would be reduced to 13% of uncontrolled bus.

0.26 × 2.22 (g/kWh) / 4.5 (g/kWh) = 0.13

The procedure for speed dependency is the same as the ones for LPG vehicle, and the average speed of G10+15 driving cycle is around 23 km/h. SOx emission factor is set at '0' and PM emission factor is set at the minimum value (0.01 g/km).

(b) Estimate of Emission Factor Change

Comparisons of the existing emission factors and the future emission factors by introduction of low emission vehicles are compiled in Table 9.3.8.

Table 9.3.8 Emission Factor Changes with Low Emission Vehicles

(Unit : g/km/vehicle)

CO	60 to 80 km/h			15 to 25 km/h		
	Existing	LPG/CNG	2010	Existing	LPG/CNG	2010
Taxi	6.20	0.55	0.55	13.07	1.03	1.03
Bus	9.26	0.55	4.91	18.65	1.10	9.88
HC	60 to 80 km/h			15 to 25 km/h		
	Existing	LPG/CNG	2010	Existing	LPG/CNG	2010
Taxi	0.94	0.03	0.03	1.73	0.10	0.10
Bus	1.84	0.23	1.04	4.08	0.51	2.30
NOx	60 to 80 km/h			15 to 25 km/h		
	Existing	LPG/CNG	2010	Existing	LPG/CNG	2010
Taxi	2.72	0.48	0.48	2.00	0.51	0.51
Bus	10.30	1.34	5.82	11.73	1.52	6.63
SOx	60 to 80 km/h			15 to 25 km/h		
	Existing	LPG/CNG	2010	Existing	LPG/CNG	2010
Taxi	0.15	0.00	0.00	0.21	0.00	0.00
Bus	1.54	0.00	0.77	2.09	0.00	1.05
PM	60 to 80 km/h			15 to 25 km/h		
	Existing	LPG/CNG	2010	Existing	LPG/CNG	2010
Taxi	0.22	0.01	0.01	0.22	0.01	0.01
Bus	1.40	0.01	0.71	1.40	0.01	0.71

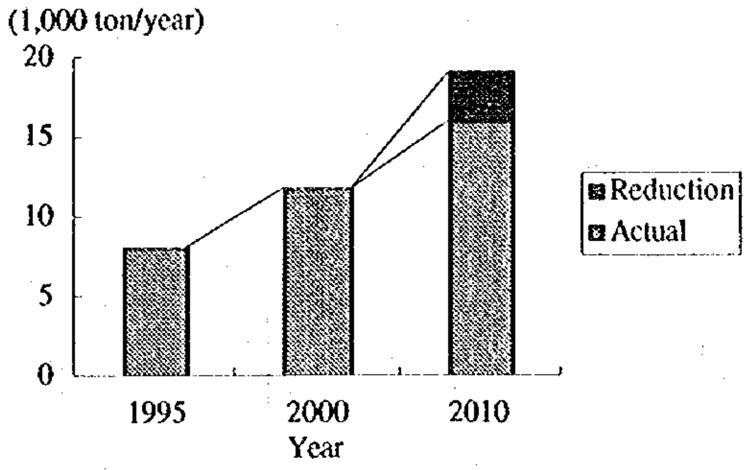
3) Air Pollution Emissions from Automobiles with Countermeasures

Air pollution emissions from automobiles with countermeasures were estimated as shown in Table 9.3.9. Future pollutant emission loads could be reduced from 10 to 20% by the countermeasures. Changes of pollutant emissions are also shown in Figure 9.3.4.

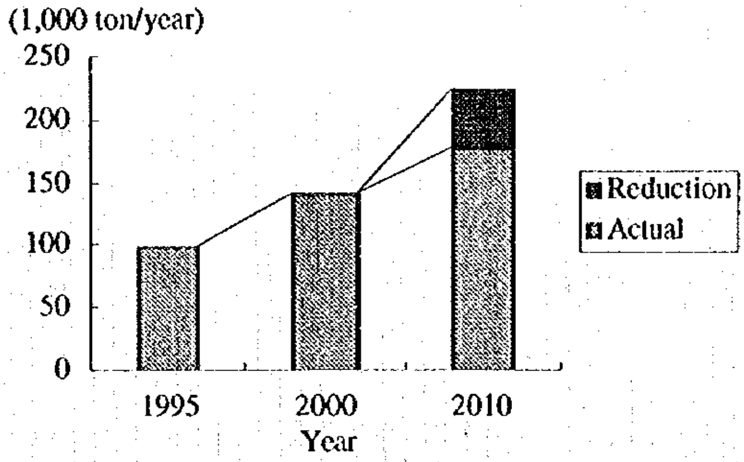
Table 9.3.9 Comparison of Air Pollution Emissions

(Unit : ton/year)

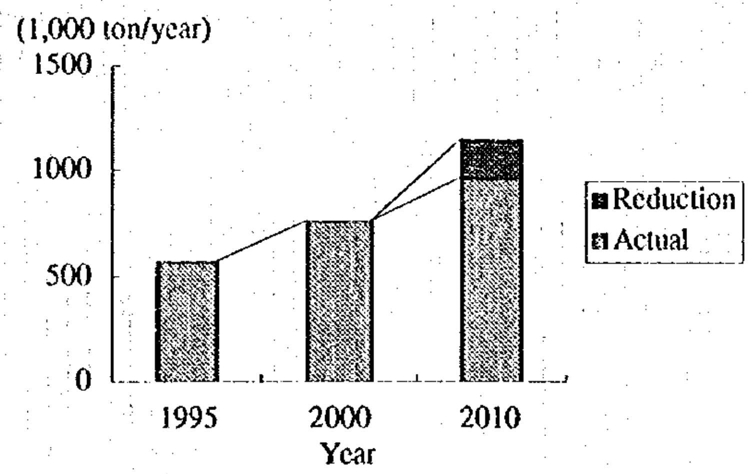
	CO	HC	NOx	SOx	PM
Year 1995	564,292.0	97,970.6	98,738.3	8,142.3	9,563.0
Year 2010	1,154,492.8	196,879.5	223,913.0	18,991.5	21,964.3
With Control	964,535.8	168,103.5	178,135.1	16,041.2	19,368.7
Reduction	189,957.0	28,776.0	45,777.9	2,950.3	2,595.6
(%)	16.5	14.6	20.4	15.5	11.8



Yearly Change of SOx Emission

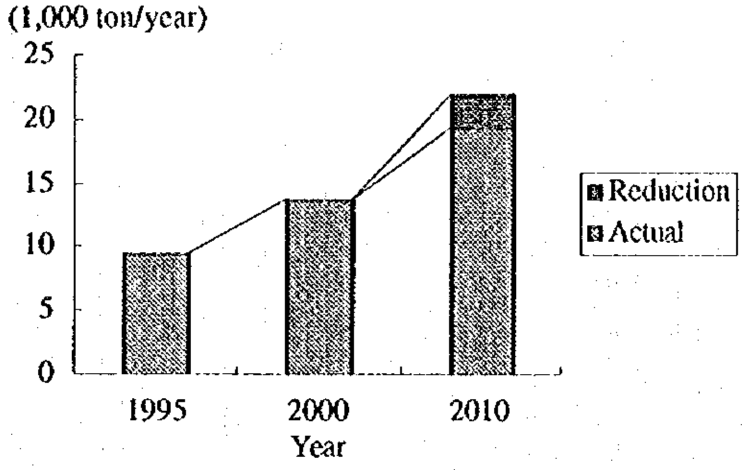


Yearly Change of NOx Emission

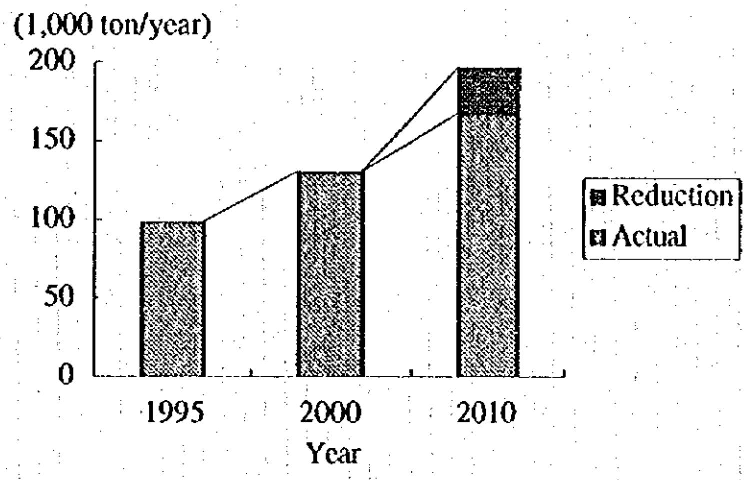


Yearly Change of CO Emission

Figure 9.3.4 Changes of Pollutant Emissions with Countermeasures (1/2)



Yearly Change of PM Emission



Yearly Change of HC Emission

Figure 9.3.4 Changes of Pollutant Emissions with Countermeasures (2/2)

(3) Simulation of Air Quality (Case 1)

SO_2, NO_2 and CO concentration maps are shown in Figures 9.3.5 to 9.3.7, and NOx and SPM maps are included in Appendix 6.4.

SO_2 concentrations decrease with the planned countermeasures. Number of grids with high SO_2 concentrations exceeding the standards decreases from 441 to 107, but more than one hundreds of grids remain exceeding the standards.

The contributions from the factories are reduced by regulation and severe concentrations (two times higher than the standards) are extinguished. However, the reductions by the regulation are not enough to satisfy the standards. Because the regulations define concentration of pollutant from the factories and never define total amount of SO_x, some factories could emit much amount of SO_x even under the regulations.

SO_x emission is reduced by the introduction of LEVs, but no limit for SO_x in the planned regulation. More reduction of SO_x from automobiles is necessary to satisfy the standards beside heavy traffic road and low sulfur diesel oil is the preferable option.

NO_2 concentrations decrease with the planned countermeasures and number of grids with high NO_2 concentrations exceeding the standards decrease from 47 to 16. However, the countermeasures are not sufficient to solve the NO_2 problem perfectly at heavy traffic roads. The main reasons is insufficient exchange from existing vehicle to new (regulated) vehicle. The effect of the regulation is weak in the cause of the low exchange rate. The automobiles are main polluters for NO_2, and reduction of NO_x from the automobiles may be inevitable and sufficient.

CO concentrations are below the standard even without the planned countermeasures and reduced by the regulation.

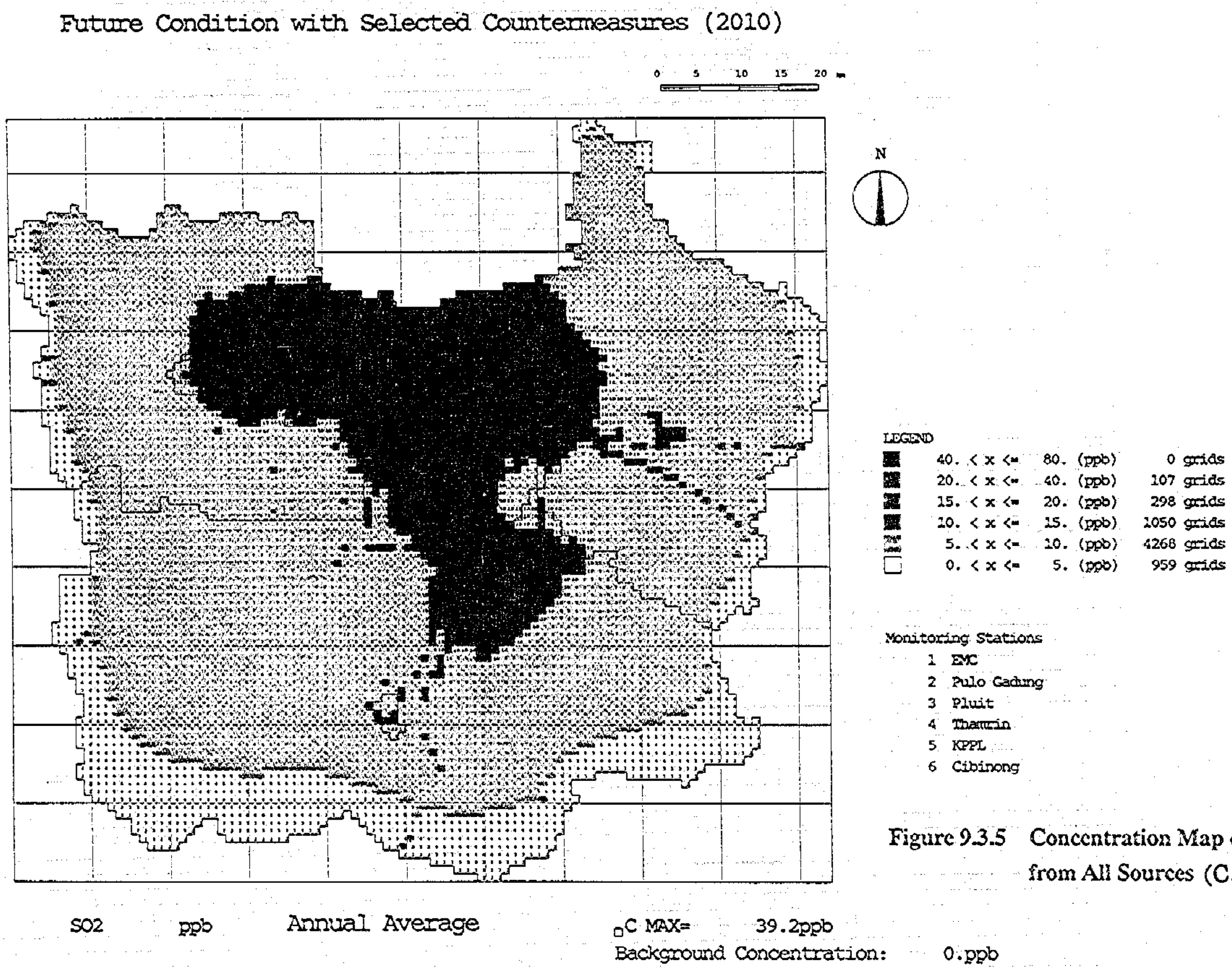
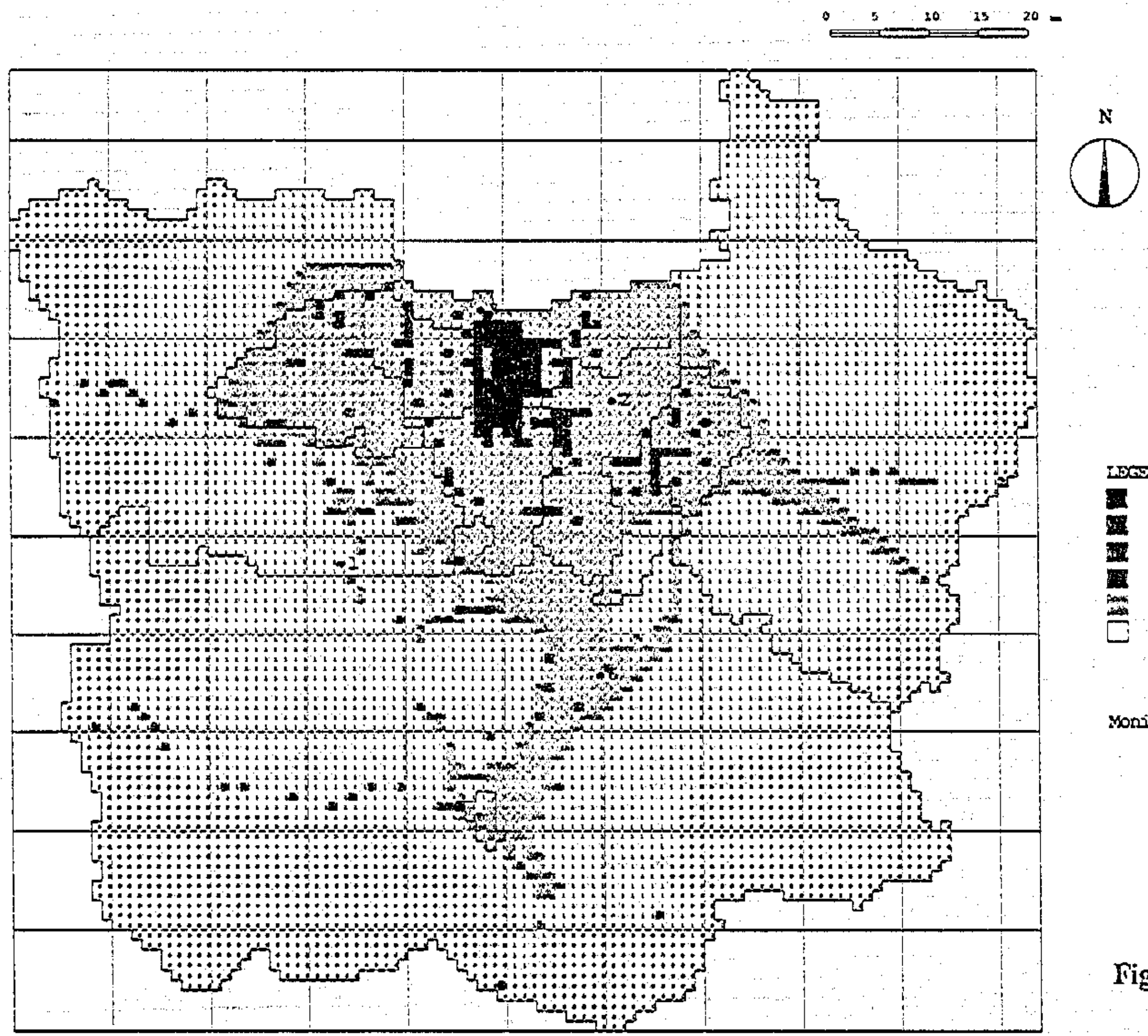


Figure 9.3.5 Concentration Map of SO_2 from All Sources (Case 1)

Future Condition with Selected Countermeasures (2010)



LEGEND

100. < x <= 200. (ppb)	1 grids
50. < x <= 100. (ppb)	15 grids
40. < x <= 50. (ppb)	38 grids
30. < x <= 40. (ppb)	120 grids
10. < x <= 30. (ppb)	1419 grids
0. < x <= 10. (ppb)	5089 grids

Monitoring Stations

1 EMC
2 Pulo Gadung
3 Pluit
4 Thamrin
5 KPPL
6 Cibinong

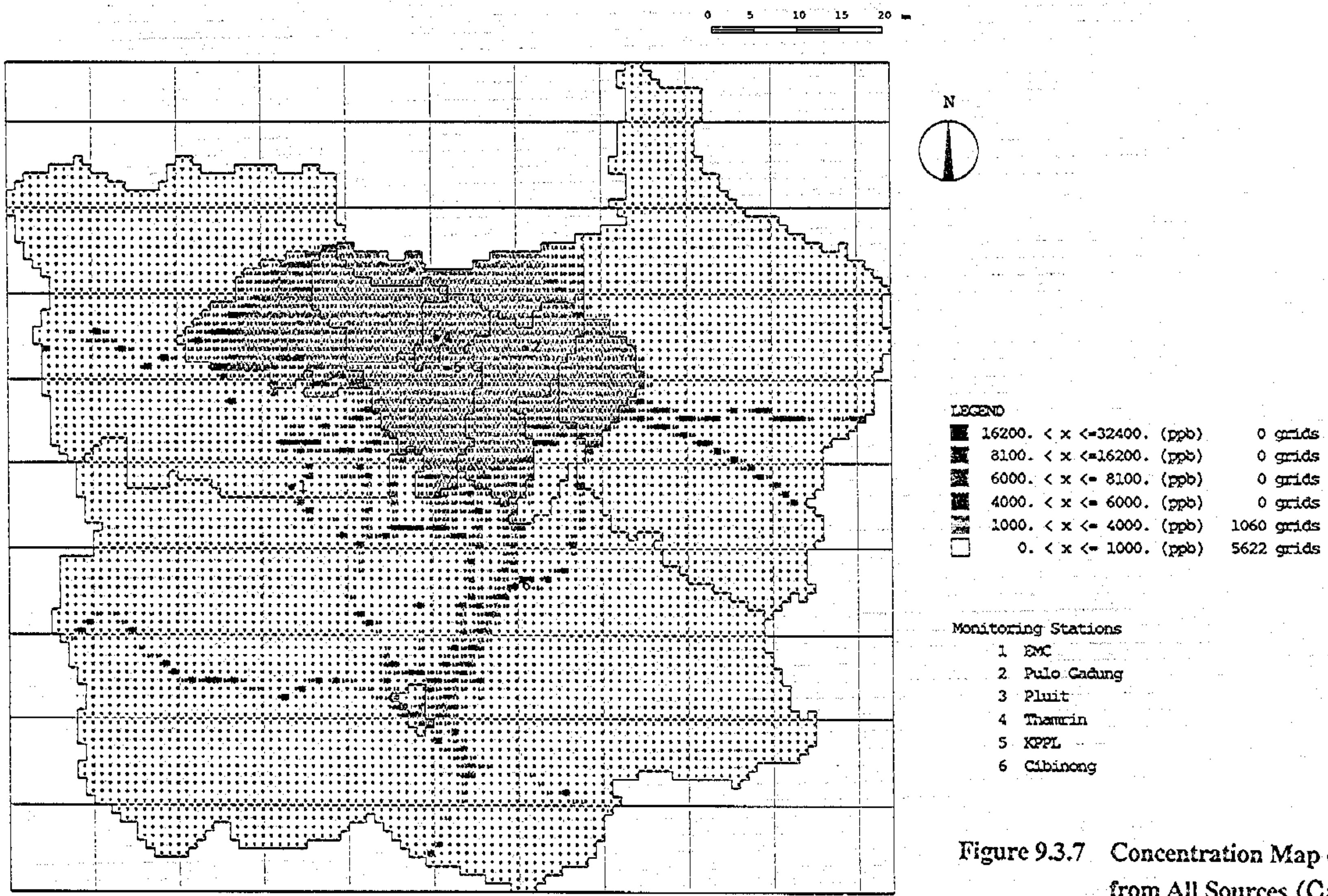
Figure 9.3.6 Concentration Map of NO_2 from All Sources (Case 1)

NO2 10ppb Annual Average

C MAX= 115.7ppb

Background Concentration: 0.ppb

Future Condition with Selected Countermeasures (2010)



CO 100ppb Annual Average

C MAX= 3604.8ppb

Background Concentration: 860.ppb

Figure 9.3.7 Concentration Map of CO from All Sources (Case 1)

9.3.2 Air Quality with Additional Countermeasures (Case 2)

In this Section countermeasures necessary to satisfy the proposed air quality standards for SO_2 and NO_2 for the whole Jabotabek area are examined.

(1) Additional Measures against Factories

SO_2 concentrations, mainly affected by the factories, in the following three regions exceed the proposed air quality standard (Figure 9.3.5).

(1) Cibinong area in Bogor
(2) East area in Tangerang
(3) Bekasi near DKI Jakarta

The Team evaluated the following additional measures.

(1) Regional total SOx reduction by fuel change and introduction of desulfurization
(2) Installing high stack

Measures to be taken in each region are summarized in Table 9.3.10.

Table 9.3.10 Target Factories and Measures by Region

Target Area	Target factory	Measures taken	Purpose
Cibinong area in Bogor	Cement	Desulfurization of exhaust gas	old : 50% reduction of SOx new : 80% reduction of SOx
		High stack	dispersion in wide area
	Pulp and paper	(Emission regulation)	SOx reduction
		High stack	dispersion in wide area
East area in Tangerang	6 factories	(Emission regulation)	SOx reduction
		Desulfurization of HSD (Solar) (*1)	HSD with 0.1% sulfur
		Fuel change	from IDO to HSD
Bekasi area	Assembling	(Emission regulation)	SOx reduction
		High stack	dispersion in wide area

Note: Measures in brackets are existing measures by BAPEDAL
(*1) desulfurization of Solar is a common measure among factories and automobile.

Total SOx emission is reduced to 94,562 tons/year by implementing the additional measures and about 51% reduction of SOx is achieved as shown in Table 9.3.11.

Table 9.3.11 SOx Emission Change by Implementing Control Measures (2010)

(Unit : ton/year)

Countermeasures	No measure	Emission regulation	Additional measures
SOx emission	184,450	117,314	94,562
Ratio	1.0	0.64	0.51

(2) Additional Countermeasures against Automobiles and Ships

Even if the planned countermeasures by BAPEDAL are implemented, there remain some points with high concentrations of SO_2 and NO_2 caused by mobile sources, which exceed the standards.

The causes of the exceeding are the following:

NO_2;

- Some exceeding concentrations along major roads due to heavy traffic

SO_2;

- Some exceeding concentrations along major roads with heavy traffic
- 2 points affected by SOx emission from ships at Tanjung Priok

Then, the Team evaluated the following additional measures:

NO_2;

- Accelerating change to new vehicles (100% changed to regulated vehicles)

SO_2;

- Reduction of sulfur content in diesel from around 0.4% to 0.1%
- Reduction of sulfur contents for ships from around 0.6% to 0.4%

As a result of these additional countermeasures, NOx and SOx emissions from automobiles will be reduced to 51% and 26% respectively compared with no countermeasures case in 2010 (Table 9.3.12). SOx emissions from ships will be reduced with the ratio of sulfur contents (0.4 / 0.6), and the sulfur content reduction will be necessary only in the port area.

Table 9.3.12 Emission Change from Automobiles by Additional Countermeasures

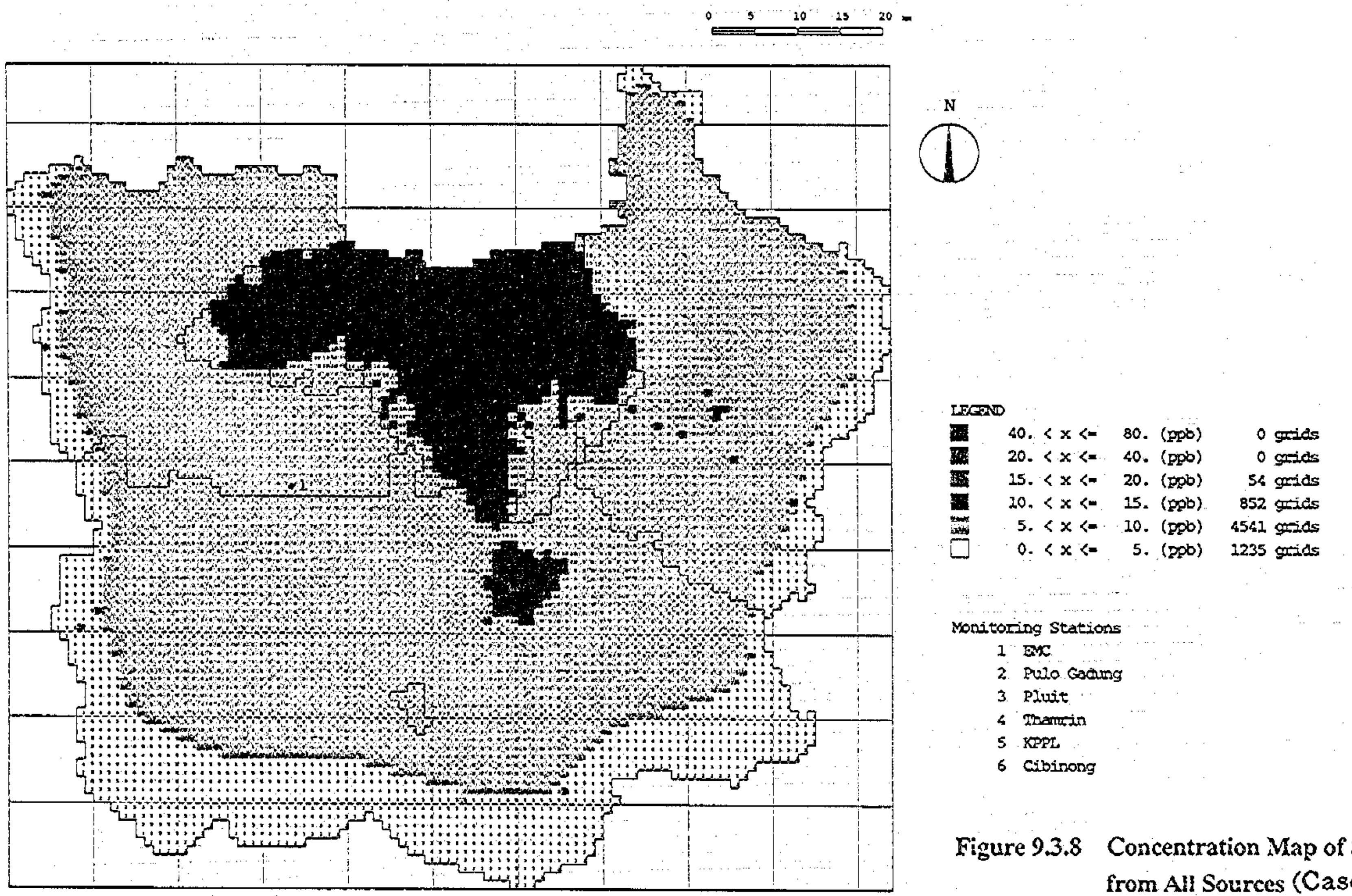
(Unit : ton/year)

Countermeasures	No measure	Planned measures	Additional measures
NOx emission	223,913	178,135	113,865
Ratio	1.0	0.80	0.51
SOx emission	18,992	16,041	4,927
Ratio	1.0	0.84	0.26

(3) Simulation of Air Quality

SO_2 and NO_2 concentration maps are shown in Figures 9.3.8 and 9.3.9. As a result of application of full countermeasures, the standards will be satisfied in the whole Jabotabek area. In a sense, the full countermeasures are considered ideal. A detailed feasibility study will be necessary for implementation of each countermeasure, and detailed specifications like reduction rate, sulfur content, etc. could be changed in the future.

Future Condition with Full Countermeasures (2010)

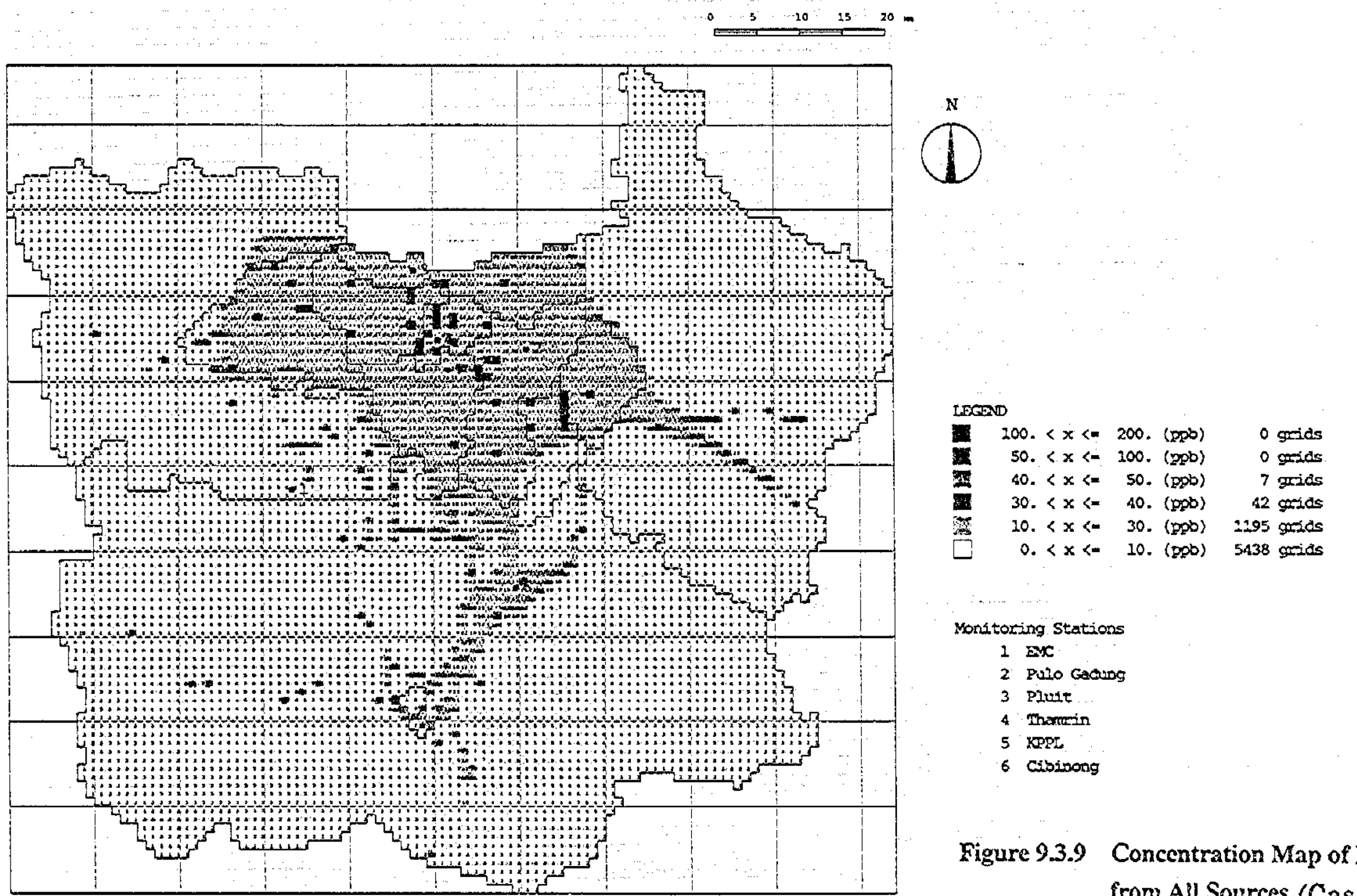


SO2 ppb Annual Average

C MAX= 19.5ppb
Background Concentration: 0.ppb

Figure 9.3.8 Concentration Map of SO_2 from All Sources (Case 2)

Future Condition with Full Countermeasures (2010)



NO2 ppb Annual Average C MAX= 48.4ppb

Background Concentration: 0.ppb

Figure 9.3.9 Concentration Map of NO_2 from All Sources (Case 2)

9.3.3 Social Benefits Accrued from the Proposed Countermeasures

Based on the population and simulation data mentioned in the previous chapters and sections, an economic evaluation was carried out based on the benefits accrued from people's health improvement, which would be expected from the implementation of the strategic measures against air pollution in the Study area. For estimating the benefits in terms of air pollution-related health, the following steps were taken :

(1) 1st Step

It is to develop or refer to the estimated changes in the probability of a given health effect associated with a change in ambient air quality (as represented by the equation below), i.e. the slope of a dose-response function (Table 9.3.13).

$$dHi = bi \times POPi \times dA$$

where dHi = change in population risk of health effect i

bi = slope from dose-response curve

POPi = population at risk of health effect i

dA = change in air pollution under consideration

(2) 2nd Step

It involves multiplying the above slope by the affected population. For certain pollution-related health effects this may include the entire exposed population, for other effects there may be particularly sensitive groups such as children, asthmatics, or individuals with pre-existing chronic respiratory disease.

(3) 3rd Step

It involves the change in air quality under consideration. It was postulated that the relevant pollutant concentrations change from the existing levels to the proposed Indonesian standards.

(4) 4th Step

The economic value (Vi) of the health impacts was developed based on tentative assumptions about the willingness-to-pay to reduce mortality and estimated cost of illness (Table 9.3.14). So, the change in total social value (dT) of the health effects due to the change in air pollution under consideration is the summation of all effects and can be represented by :

$$dT = \Sigma\ Vi \times dHi$$

Table 9.3.13 Estimated Increment in Annual Health Effects associated with Unit Change in Pollutants based on Dose-Response Functions

Pollutants (Units) Health Damage/year	PM10 (10μg/m³)	SO_2 (10μg/m³)	O_3 (pphm)	Lead (1.0μg/m³)	NO_2 (pphm)
Premature Mortality (% change)	0.96	0.48			
Premature Mortality/100,000	6.72				
RHA/100,000	12.0		7.70		
ERV/100,000	235.4				
RAD/person (adults)	0.575				
LRI/child (17 year old and below)	0.016				
Asthma Symptoms/asthmatic	0.326		0.68		
Respiratory Symptoms/person	1.83		0.55		
Chronic Bronchitis/100,000	61.2				
MRAD/person			0.34		
Respiratory Symptoms/1,000 children		0.18			
Respiratory Symptoms/adults		0.10			0.10
Eye Irritations/person			0.266		
Hypertension /100,000 adult males				7,260	
Coronary Disease/100,000 adult males				34.0	
Premature Mortality/100,000 adult males				35.0	
IQ Decrement / 100,000 children				97,500	

Source : Estimating the Health Effects of Air Pollutants : A Method with an Application to Jakarta (Ref. 178)

Notes : RHA = Respiratory hospital admissions, ERV = Emergency room visits,
RAD = Restricted activity days, LRI = Lower respiratory illness,
MRAD = Minor restricted activity days, and pphm = parts per hundred million

Table 9.3.14 Unit Value of Health Damage by Air Pollution in Jakarta

Health Damage	Unit Value (US$/year)
Avoidable Mortality (cases)	75,000
Restricted Activity Days	3.1
Outpatient Visits	16
Hospital Admissions	260
Respiratory Symptom Days (children)	5.6
Asthma Attacks	2.5
Respiratory Symptom Days (adults)	0.4
Hypertension (cases)	5.5
Myocardial Infarction (cases)	1,230
IQ Loss in Children (points)	115

Source : Indonesia Environmental and Development : Challenge for the Future (Ref. 182)
Note : Figures in this table are constant values as of 1990.

In estimating the social benefits accrued from the countermeasures, the following assumptions were set out :

(1) Population in each mesh used in the simulation work is equal within a same district.

(2) Adult ratios in DKI Jakarta and the other area in 2010 are 67% and 60% respectively, according to the data in "Jakarta in Figures 1994" (Ref.62) and "Indonesia Demographic & Health Survey 1994" (Ref. 179).

(3) Crude mortality ratio in the Study area is 0.79% in 2010, based on Ref. 179.

Benefits of reduction of only SO_2 and NO_2 emissions were estimated because they were the simulated parameters with reliable scientific dose-response coefficients as shown in Table 9.3.13. The estimated annual benefits in 2010 are summarized in Table 9.3.15 together with the standard compliance ratios and the beneficiary population for every district in the Study area.

Net annual benefits between with-measures and without-measures conditions in 2010 are US$ 26,000 (Rp. 60 million) for NO_2 reduction and US$ 24.6 million (Rp. 57 billion) for SO_2 reduction, in the Case 2 where these pollutant concentrations clear their standards within the whole Study area. These social benefits as of 2010 are 1.5 times and 1.1 times those in the Case 1 where only some selected measures are implemented, for NO_2 and SO_2 respectively.

In addition to health effects related to NO_2 and SO_2 which were subject to the current benefit calculation, there are benefits from other ambient pollutant reductions and from the impacts on other environmental receptors of air pollution that are less known but important. Those include soil productivity, ground-water contamination, aquatic ecosystems, materials damage and amenity loss. On the other hand, annual benefits before 2010 were not also included due to a lack of more detailed yearly data. Therefore, the benefit figures for both the Case 1 and 2 in Table 9.3.15 can be regarded as a minimum level of social benefits accrued from the proposed countermeasures.

Table 9.3.15 Annual Social Benefits Accrued in 2010 from the Reduction of NO_2 and SO_2

District		Standard Compliance Ratio (%) [1]						Total Population in 2010	Beneficiary Population (1,000)				Economic Benefit (US$ 1,000) [2]			
		Without Measures		Case 1		Case 2			Case 1		Case 2		Case 1		Case 2	
		NO_2	SO_2	NO_2	SO_2	NO_2	SO_2	('000)	NO_2	SO_2	NO_2	SO_2	NO_2	SO_2	NO_2	SO_2
Jakarta	Barat	95	21	97	89	100	100	2,842.6	56.9	1,933.0	142.1	2,245.7	5.2	7,327.4	10.8	7,967.8
	Pusat	78	12	92	74	100	100	978.5	137.0	606.7	215.3	861.1	5.3	3,079.1	6.1	3,423.0
	Utara	99	31	100	89	100	100	2,010.0	20.1	1,165.8	20.1	1,386.9	0.2	5,448.5	0.2	5,774.3
	Selatan	95	79	99	93	100	100	2,419.3	96.7	338.7	121.0	508.1	2.2	1,127.0	2.4	1,435.2
	Timur	97	78	98	97	100	100	3,088.5	30.9	586.8	92.7	679.5	2.5	1,371.6	3.3	1,518.8
	Sub total/Average	92.8	44.2	97.2	88.4	100	100	11,338.9	341.6	4,631.0	591.1	5,681.2	15.4	18,353.6	22.8	20,119.1
Bogor	Kota	93	100	100	100	100	100	380.6	26.6	0.0	26.6	0.0	0.1	0.0	0.1	0.0
	Kabu	100	99	100	99	100	100	6,589.4	0.0	0.0	0.0	65.9	0.0	146.1	0.0	275.9
	Sub total / Average	96.5	99.5	100	99.5	100	100	6,970.0	26.6	0.0	26.6	65.9	0.1	146.1	0.1	275.9
Tangerang	Kota	99	67	100	91	100	100	1,979.1	19.8	475.0	19.8	653.1	0.4	2,097.9	0.7	2,434.6
	Kabu	100	100	100	100	100	100	4,034.4	0.0	0.0	0.0	0.0	0.3	35.1	0.6	35.1
	Sub total / Average	99.5	83.5	100	95.5	100	100	6,013.5	19.8	475.0	19.8	653.1	0.7	2,133.0	1.3	2,469.7
Bekashi	Central	96	77	99	92	100	100	1,563.3	46.9	234.5	62.5	359.6	1.0	1,179.0	1.6	1,631.1
	Other	100	99	100	100	100	100	2,870.7	0.0	27.7	0.0	27.7	0.1	52.4	0.2	91.8
	Sub total/Average	98	88	99.5	96	100	100	4,434.0	46.9	262.2	62.5	387.3	1.1	1,231.4	1.8	1,722.9
Jabotabek	Total/Average	96	72	99	93	100	100	28,756.4	434.9	5,368.1	700.1	6,787.4	17.3	21,864.1	26.0	24,587.6

Notes : All the figures are estimated ones for the target year 2010.
1) Standard Compliance Ratio = [No. of meshes complying with the standards in a district] ÷ [Total No. of meshes of the district]
2) Benefits were calculated based on constant values as of 1990.

9.4 Proposed Strategy and Its Components

9.4.1 Countermeasures with High Priority

The final goal of the proposed strategy and countermeasures is to comply the draft ambient air quality standards by 2010 within the Jabotabek region.

In order to accomplish this goal, it was clarified through the air-quality simulation works that all the proposed countermeasures for stationary, mobile and the both emission sources should be implemented.

Those countermeasures should be implemented organically and effectively. So the following characteristics of individual countermeasures were analyzed to prioritize the countermeasures:

1) Existing organizations like agencies, institutes, etc. concerned with preparation and implementation of the countermeasures,

2) Existing legislations and programs covering activities proposed under each countermeasures,

3) Institutional systems or legislations necessary to implement the control measures,

4) Estimated annual cost on average for preparing and implementing the countermeasures, and

5) Proposed years to commence the preparatory and implementation stages of the countermeasures

In order to put priority for implementation on the proposed countermeasures, the two(2) aspects, i.e. "institutional / legislative necessity" and "commencement year for preparation" of each countermeasures, were taken into consideration. The more institutional / legislative-capacity building or the earlier commencement for preparation is required, the higher priority the countermeasures has. Countermeasures already going on were regarded as with low priority, since they have been anyway commenced by certain organizations in duty. Figure 9.4.1 shows priority position of each countermeasures, largely divided into three(3) groups; "high priority", "medium priority" and "low priority".

Table 9.4.1 summarizes various characteristics and priority of each control measures. Table 9.4.2 summarizes preparation and implementation schedule of control measures.

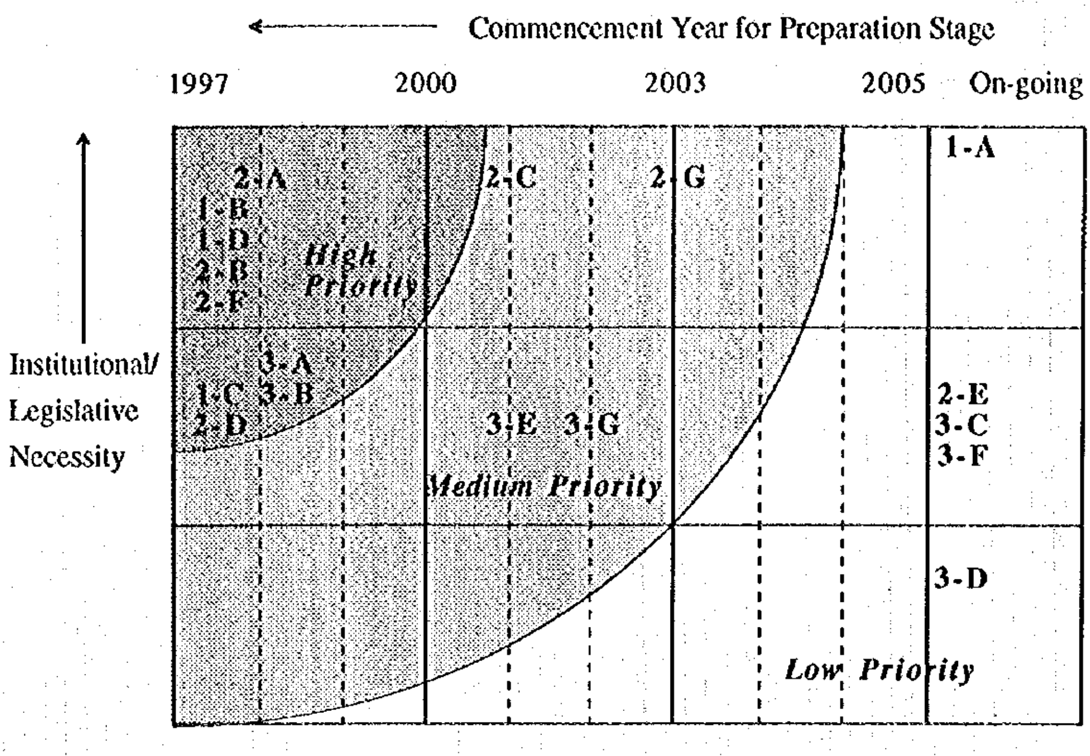


Figure 9.4.1 Priority of Countermeasures

Strategic plan of proposed control measures are described in detail in next section 9.4.2.

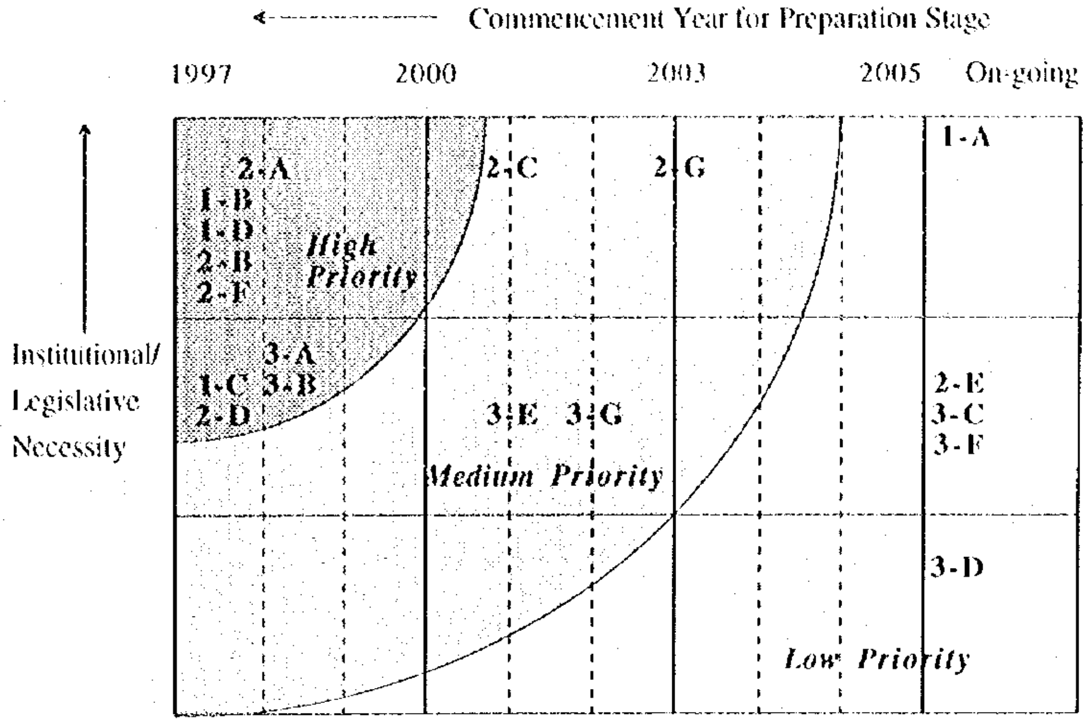
Countermeasures by priority are as follows :

<u>High-Priority Group</u>

1-B. Reduction of Hydrocarbon Emissions
1-C. Reduction of Particulate Matter in Ambient Air
1-D. Strengthening of Ambient Air Monitoring System
2-A. Stationary Source Inventory
2-B. Enforcement of Emission Standards Decree
2-D. Emission Management System
2-F. Fuel Conversion
3-A. Preparation of Mobile Source Inventory in Jabotabek
3-B. Introduction of New Regulations for Vehicle Emission Gas

<u>Medium-Priority Group</u>

2-C. Total Emission Reduction Plan
2-G. Direct Stack Gas Control
3-E. Acceleration of Turn-over Rate of Aged Vehicles
3-G. Suppression of Diesel Use in Vehicles



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1-C. Reduction of Particulate Matter in Ambient Air
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2-A. Stationary Source Inventory
2-B. Enforcement of Emission Standards Decree
2-D. Emission Management System
2-F. Fuel Conversion
3-A. Preparation of Mobile Source Inventory in Jabotabek
3-B. Introduction of New Regulations for Vehicle Emission Gas

<u>Medium-Priority Group</u>

2-C. Total Emission Reduction Plan
2-G. Direct Stack Gas Control
3-E. Acceleration of Turn-over Rate of Aged Vehicles
3-G. Suppression of Diesel Use in Vehicles

Table 9.4.1 Results of Evaluation of Countermeasures

Control Measures		Institutions & Legislations					Commencement Year		Average Annual Cost from1997 to 2000 (million Rp.)	Priority
		Existing Bodies for Preparation	Existing Bodies for Implementation	Existing Legislations and Programs	Reinforcement of staff in charge	Enactment	Preparation	Implementation		
(1) Common to Stationary & Mobile Sources	1-A. Monitoring of Hydrocarbon Concentration in Ambient Air	BAPEDAL	BAPEDAL, L-BLH	• Industrial Act • AMDAL	BAPEDAL and L-BLH	Air Pollution Control Law	—	already commenced	—	Low
	1-B Reduction of Hydrocarbon Emissions	BAPEDAL	BAPEDAL, L-BLH	• Industrial Act • AMDAL	BAPEDAL and L-BLH	Air Pollution Control Law	1997	1998	2,370	High
	1-C. Reduction of Particulate Matter in Ambient Air	MOH, BAPEDAL	L-BLH	• Waste Act • Revised Environment Act	L-BLH	—	1997	1997	1,060	High
	1-D. Strengthening of Ambient Air Monitoring System	BAPEDAL	BAPEDAL, L-BLH, BLK, BMG, L-PU	• Revised Environment Act	L-BLH, BPPI and L-PU	Air Pollution Control Law	1997	1999	150 (17,310)	High
(2) Stationary Sources	2-A. Preparation of Stationary Source Inventory	BAPEDAL	BAPEDAL, L-BLH	• Industrial Act • AMDAL	BAPEDAL and L-BLH	Air Pollution Control Law	1998	2001	70 (1,420)	High
	2-B. Enforcement of Emission Standards Decree	BAPEDAL	BAPEDAL, L-BLH, BPPI	• Industrial Act • Blue Sky Program • Emission Gas Standard, • Revised Environment Act	L-BLH	Air Pollution Control Law	1997	2002	40	High
	2-C. Total Emission Reduction Plan	BAPEDAL, L-BLH	L-BLH	• Industrial Act, • Revised Environment Act	BAPEDAL and L-BLH	Air Pollution Control Law	2001	2006	No cost up to 2000	Medium
	2-D. Emission Management System	BAPEDAL, PERIND	BAPEDAL, PERIND	• AMDAL • Industrial Act • Blue Sky Program	—	Pollution Control Manager System	1997	2002	—	High
	2-E. Combustion Control System	BAPEDAL, BAKOREN	BPPI, L-BLH, PELAKSANA, Indonesia Bank	• Industrial Act • Environmental Soft Loan Program	BAPEDAL, BPPI and L-BLH	Energy Saving Act	—	already commenced	—	Low
	2-F. Fuel Conversion	TAM, BAPEDAL	L-BLH, BPPI, PERTAMINA	—	L-BLH and BPPI	Air Pollution Control Law	1997	2006	— (136,000)	High
	2-G. Direct Stack Gas Control	BAPEDAL	BAPEDAL, PELAKSANA, Indonesia Bank	• Soft Loan Program	BAPEDAL	Air Pollution Control Law	2003	2006	No cost up to 2002	Medium
(3) Mobile Sources	3-A. Preparation of Mobile Source Inventory in Jabotabek	BAPEDAL	BAPEDAL	—	BAPEDAL	—	1998	2000	30 (10,210)	High
	3-B. Introduction of New Regulations for Vehicle Emission Gas	BAPEDAL	HUB	• Industrial Act • Blue Sky Program	—	Road Transport & Motor Vehicle Law	1998	2001	700 (11,300)	High
	3-C. Strengthening of Vehicle Inspection Program	HUB, BAPEDAL	DLLAJK, L-BLH	• Road Traffic Law • Blue Sky Program • Automobile Exhaust Standard	DLLAJK and L-BLH	—	—	already commenced	—	Low
	3-D. Promotion of Unleaded Gasoline Usage	BAPENAS, BAPEDAL, HUB	BAPEDAL, PERTAMINA	• Blue Sky Program	—	—	—	already commenced	500 (350,000)	Low
	3-E. Acceleration of Turn-over Rate of Aged Vehicles	BAPENAS, BAPEDAL	DLLAJK, L-BLH	• Road Traffic Law	DLLAJK and L-BLH	—	2001	2006	No cost up to 2000	Medium
	3-F. Promotion of Low-pollution Vehicles	BAPEDAL	DLLAJK, L-BLH, BAPEDAL, PELAKSANA Indonesia Bank	• Blue Sky Program • Soft Loan Program	BAPEDAL	—	—	already commenced	—	Low
	3-G. Suppression of Diesel Use in Vehicles	BAPEDAL	PERTAMINA	—	—	Air Pollution Control Law	1998	2006	No cost up to 2001	Medium

Notes: 1) Prioritization is only among the countermeasures proposed here by the JICA Study Team in addition to the on-going projects. (But all these proposed countermeasures should be implemented to reach the 2010 goals.) Therefore, remaining potential countermeasures are not subject to the prioritization here.
2) Average annual cost shows wage including PR cost. ( ) shows equipment/facilities initial investment cost and foreign consultant fee.