4) Shops around LRT stairs

At all LRT stations, food stall and copying service are operating under the LRT stairs. They occupy the space not only under the stair but also in the outer area depriving space for passengers and pedestrians.

5) Loading and unloading activities of jeepneys

Jeepneys are more convenient for passengers because they stop at any point along the route to pick up or unload passengers. From the viewpoint of efficient traffic operation, disorderly behaviour of jeepney is a main factor that reduces the capacity. The problem is often observed at the exit side of intersection and in front of LRT station. In the former case, vehicles queuing inside the intersection block the flow on the crossing street. In the latter case, jeepney even waits on the busy street until they get enough passengers. They pay little attention to the impact that they give on the traffic flow.

9.9 Proposed Improvement Plan

Improvement plans have been prepared for the bottleneck and problematic intersection/area along the route. In addition, rehabilitation of street lighting facility, application of pavement markings and removal of shops around LRT stairs are proposed for the entire route. Measures that can be implemented under the existing condition are selected and proposed here. Further study is necessary for some measures, as there are other projects or plans such as LRT Line 2 or EDSA LRT at these locations, which create additional demand or change in the pattern of vehicular and pedestrian movements.

As mentioned above, congestion is created by the fact that there are many pedestrians along the route, particularly near LRT stations, while sidewalk is narrow and often occupied by street vendors. Even if frontage parking is removed, the sidewalk is not wide enough to accommodate a large number of pedestrians. Pedestrian deck is proposed at three locations, Monument, EDSA and Baclaran to provide more space to pedestrians. The deck connects LRT station with the nearest intersection with an elevated pedestrian pass.

Baclaran area forms a large terminal. Service road of Roxas Blvd., Redemptorist and Quirino Avenue make up a jeepney route in clockwise direction. Jeepneys load and unload passengers while travelling slowly along Redemptorist, where jeepneys, pedestrian and on-street vendors are creating a chaotic situation filled with polluted air exhausted by smoke belching jeepneys. Buses plying Manila – Cavite route load and unload passengers at roadside in front of Baclaran Church taking up effectively two lanes from the four-road in each direction. As a result, long queue is created along Roxas Blvd. Particularly, queue in southbound direction is severe reaching beyond Gil Puyat fly-over. To alleviate the problem, a bus/jeepney terminal is proposed on a site adjoining the Roxas Blvd. across Baclaran Church. For the northbound bus traffic, exclusive bus lane is proposed. New Jeepney route diverting them from Redemptorist to a new jeepney route is also proposed.

In the area between Aurora Blvd. and C. M. Recto, a grid road network is formed. The roads in north-south direction have reasonably good pavement. But the street parallel to Rizal Avenue is under-utilized, due probably poor connectivity. Improvement of railroad crossing, opening of new railroad crossing at Blumentritt, and new median opening with a signal at C. M. Recto are proposed to encourage the use of the roads parallel to Rizal Avenue.

LRT runs along Arroceros at the back of Manila City Hall and Mehan Garden. P. Burgos is located on the other side of Hall and Garden, and facing Intramuros, the old fort constructed by Spanish when they first established a settlement in Manila. Another park is located at moat, which no longer has water. The location is situated at a focal point in Manila's road network. Large number of jeepneys also run on P. Burgos and jeepney terminals with waiting shed is provided. Considering symbolic nature of the location, provision of guide signs on a gantry and rehabilitation and beautification of pedestrian underpass are proposed at this location.

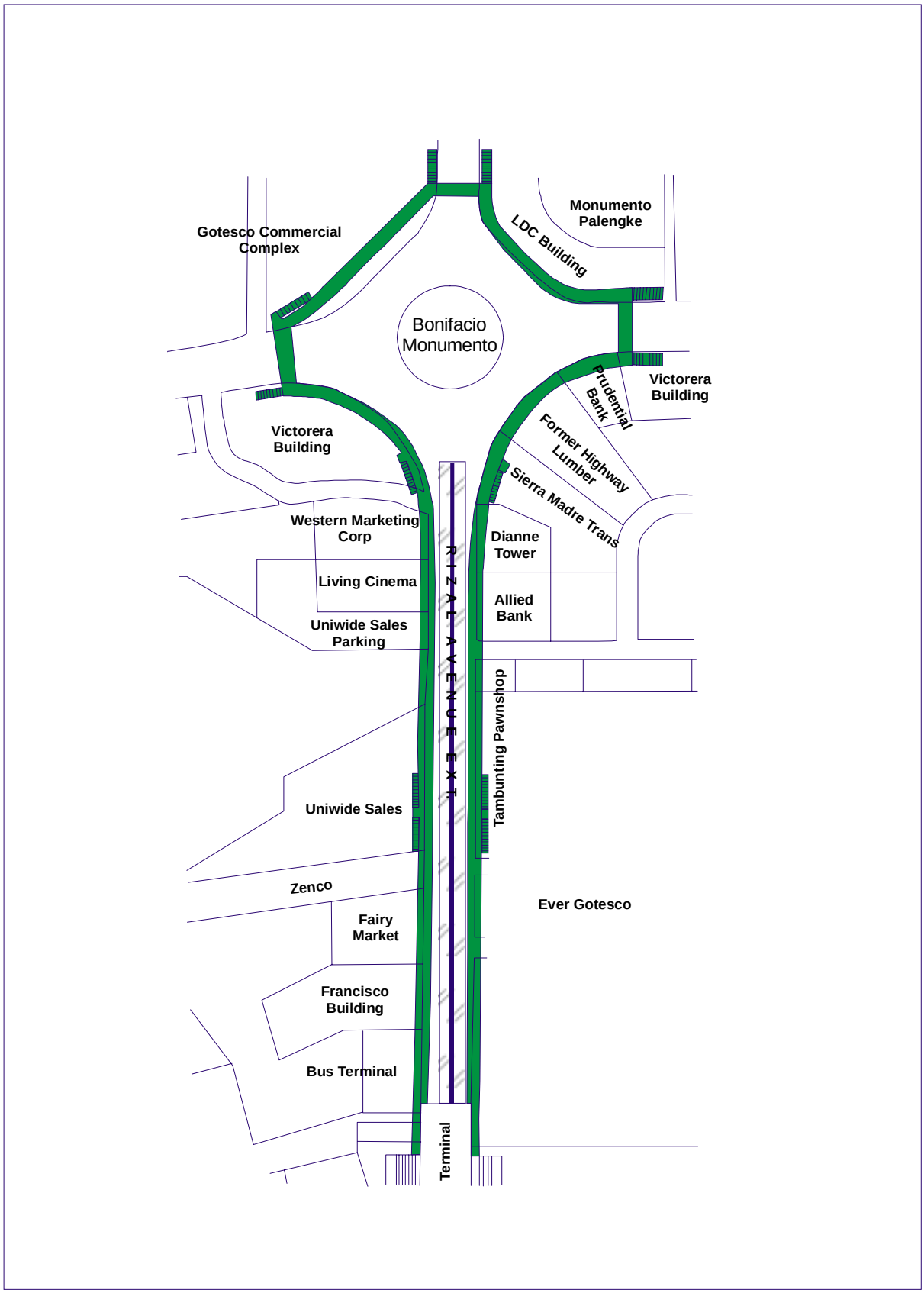
9.9.1 Monumento

There is a large volume of pedestrian flow between LRT station and Monumento intersection. The existing sidewalk is narrow and already crowded with pedestrians, sidewalk vendors, parked vehicles, ad signs, utility poles, etc. In fact, pedestrians and waiting passengers occupy the outmost lane. Another problem is that the space at LRT station is too small to accommodate waiting passengers. The situation is expected to worsen when the LRT capacity expansion program is completed. The capacity of train will become 1.5 times as three units form a train instead of existing two-unit system, while the area of station, particularly stairs, corridors and space in front of station, remains same.

The proposed pedestrian deck directly connects LRT station with Monumento intersection, around which several bus and jeepney terminals are located. It also provides space for waiting passengers.

The biggest obstacle of constructing the proposed pedestrian deck is the utility poles along the sidewalk. Roof and canopy extruding over sidewalk must also be demolished.

Figure 17
Proposed Pedestrian Deck from LRT Station – Monumento Intersection



9.9.2 Blumentritt

Blumentritt intersection is congested as roads in north-south direction is cut by PNR line except Rizal Avenue and Mapua, which is located some 120 meter on the west side, so that traffic concentrate there. The proposed measures shown in Figure 18 are intended to divert the traffic on Rizal Avenue to the two neighbouring streets.

Mapua is under-utilized in spite of the good pavement. One of the reasons is the poor condition of railroad crossing with PNR line. Vehicles are forced to slow down to a crawling speed. If the surface condition is improved, the street is expected to carry more traffic relieving heavy congestion along Rizal Avenue to some extent.

On the east side of Rizal Avenue runs Oroquieta in parallel to Rizal Avenue. It is cut by PNR and south and north sections of Oroquieta is not connected each other. If two sections are connected, jeepney route that is causing congestion at Blumentritt can be diverted to here. No PNR facility stands on the proposed opening. But barangay office located on both sides of PNR line must be removed. A section of Oroquieta south of PNR is not paved and currently used as parking. Pavement work is required there. On the north side, street market occupies along Blumentritt and Oroquieta. The market along Oroquieta must also be removed.

There is almost no space for pedestrian at the railroad crossing at Blumentritt. Sidewalk is narrow and blocked by vendors. People walk on the carriageway disturbing vehicular traffic. New pedestrian railroad crossings are proposed on both sides of the existing railroad crossing. The crossing will be several meters away from carriageway and pass the back of the columns for LRT stations.

9.9.3 C. M. Recto

At the intersection of Rizal Ave. – C. M. Recto, jeepney stops after crossing the intersection at all exits. Jeepneys loading and unloading passengers stack up during green signal blocking the vehicles behind. The signal there is most of the time operated manually and traffic enforcer extends green signal until intersection is cleared. The situation is worst at the north-east corner for northbound traffic along Rizal Avenue, as the road becomes narrow there. Oroquieta is a street about 60 meter on the east side parallel to Rizal Avenue. The street is currently under-utilized as only right turn from C. M. Recto is allowed.

The proposed measure opens up the median along C. M. Recto at Oroqueta and divert some of the northbound traffic to it. In order to implement the measure, a signal, which operates in close coordination with the signal at C. M. Recto – Rizal Ave. must be installed. These two signals must have the phase sequence shown in Figure 19. No manual operation of signal is allowed including the signal at C. M. Recto – Mapua after the measures is implemented. To supplement the signal operation, traffic enforce must be assigned at C. M. Recto – Oroquieta intersection to prevent blocking of intersection by westbound traffic.

The west end station of LRT Line 2 will be constructed on C. M. Recto near Rizal Avenue. There is a plan to develop Old Manila City Jail. Further study is necessary to coordinate with these projects.

Figure 18
Proposed Improvements along PNR Corridor (Blumentritt)

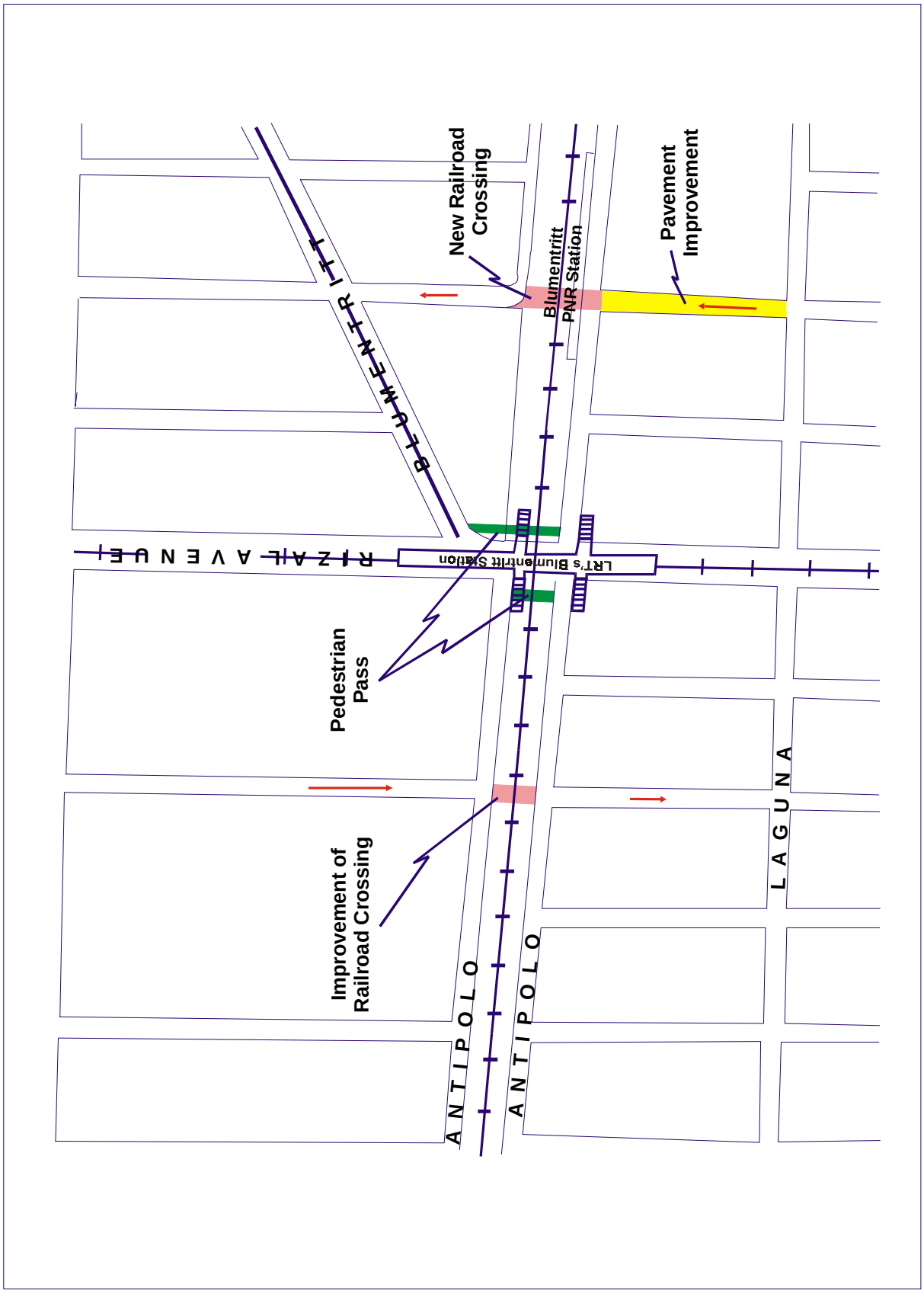
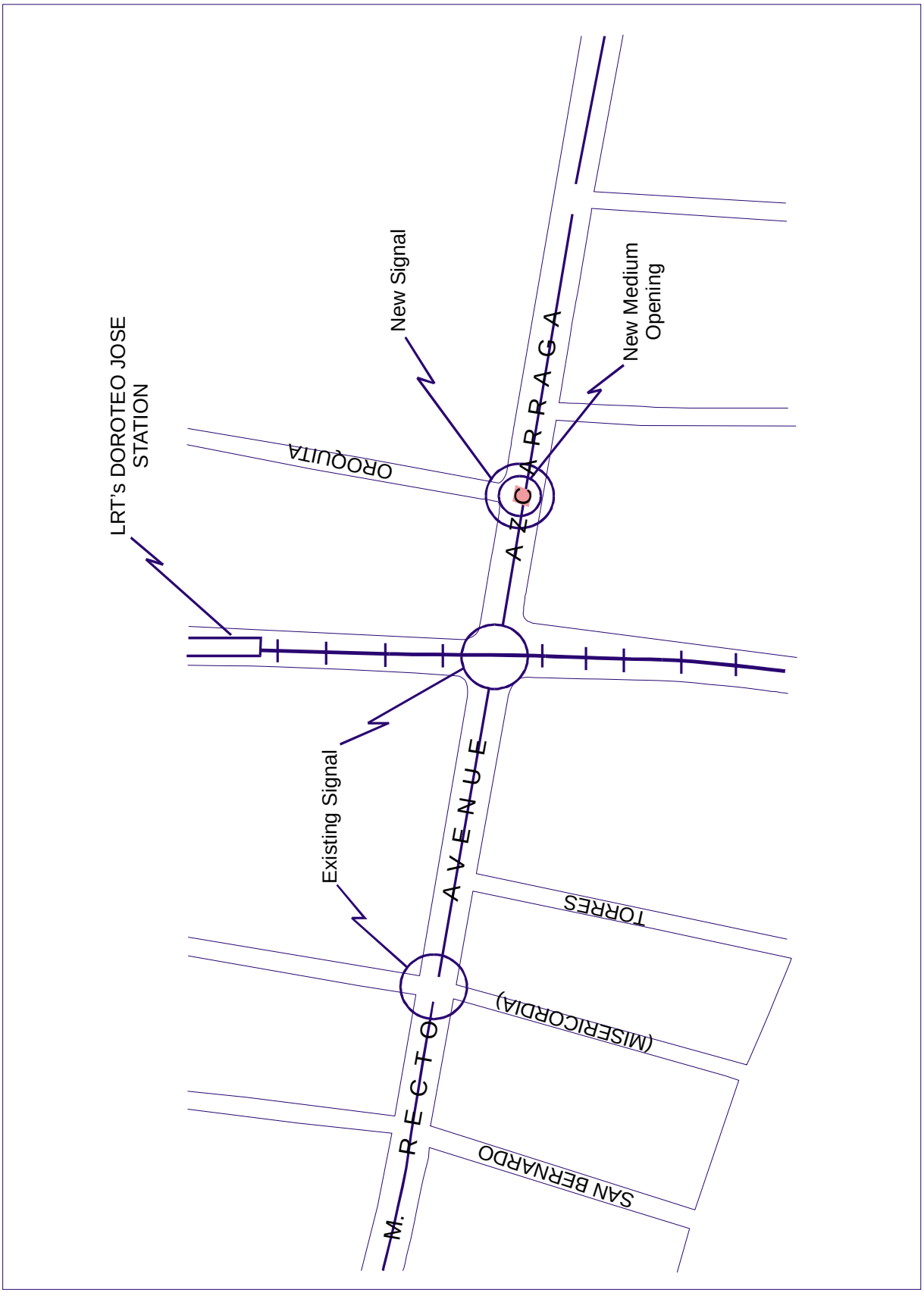


Figure 19
Proposed Improvements along Oroqueta and Azcaraga



9.9.4 Central Station (P. Burgos)

P. Burgos in front of Manila City Hall and Mehan Garden is located at a focal point in Metro Manila's road network. Traffic flow there will be a showcase for other locations. In order to foster orderly traffic flow, guide sign showing lane assignment and destination is proposed. A guide sign for northbound traffic is located in front of Freedom Park traversing seven lanes. It shows the lane assignment going toward Quezon Bridge, McArthur Bridge and Jones Bridge. Another guide sign for southbound traffic will be installed on the opposite side of P. Burgos at the same location, where the southbound has five lanes. It shows the lane assignment going toward Taft Avenue and Roxas Blvd.

There are three underpasses under P. Burgos. Underpasses are wide and well designed but no maintenance seems to be undertaken. Rehabilitation of these underground passes is proposed to improve the amenity for users. The work will include general cleaning, painting, fixing of lighting facility, dredging of drainage, etc.

9.9.5 EDSA

A large volume of pedestrian movement exists between EDSA station and Taft – EDSA intersection. Definitely the number will increase substantially when the ongoing EDSA LRT is completed and a new station will be constructed in the area. The connection of LRT Line 1 and EDSA LRT is an important issue. Movement of pedestrians and passengers must be carefully studied. Considering the role the location will play after the completion of EDSA LRT, facilities for vehicles, public transport and pedestrians that allow efficient and safe movement of these components must be designed and constructed in an integrated manner. At this moment, however, the design of EDSA LRT station is not yet finalised. Regardless of the location of EDSA LRT station, pedestrian deck is necessary to connect the intersection directly to the existing EDSA station. The proposed pedestrian deck is shown in Figure 21.

Figure 20
Proposed Improvement along P. Burgos

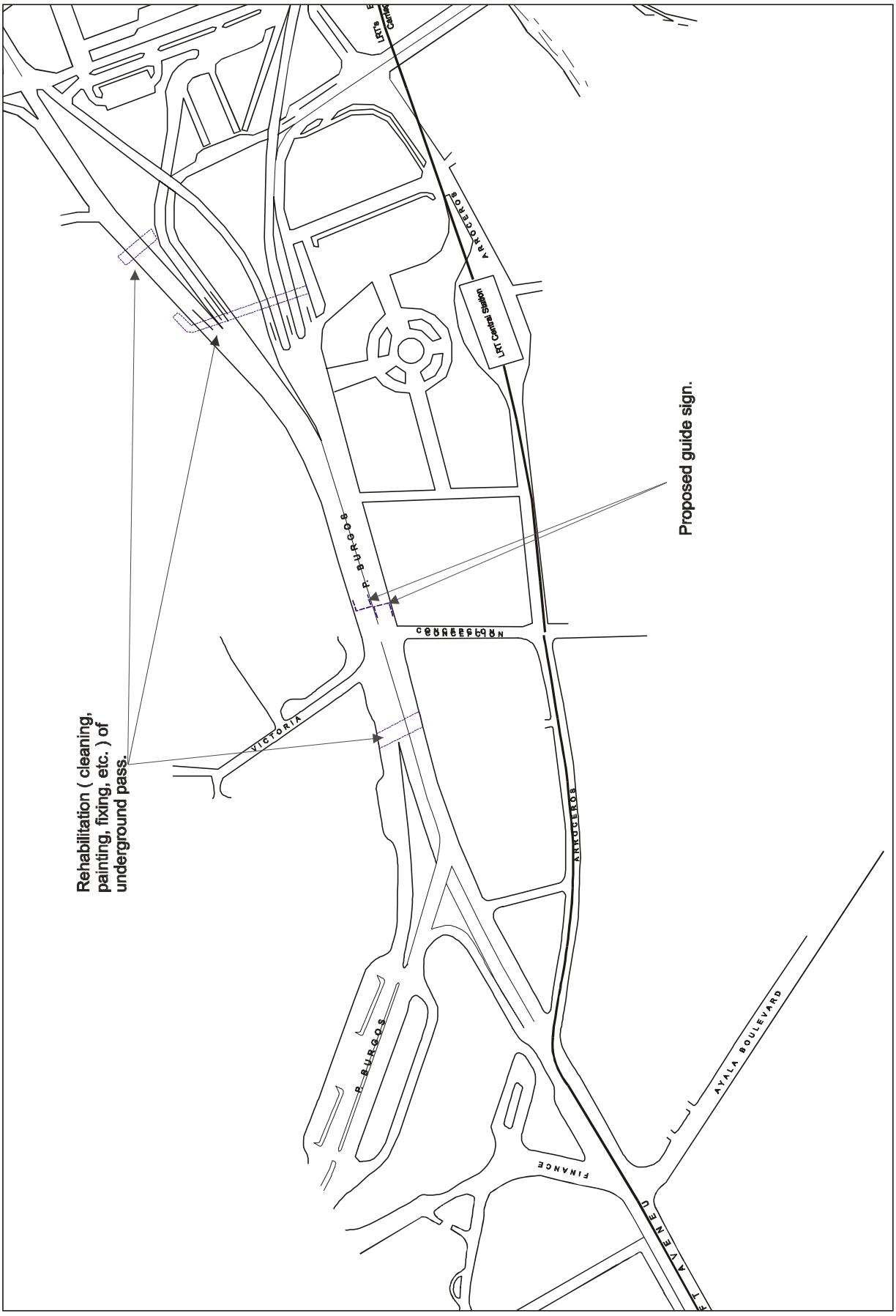
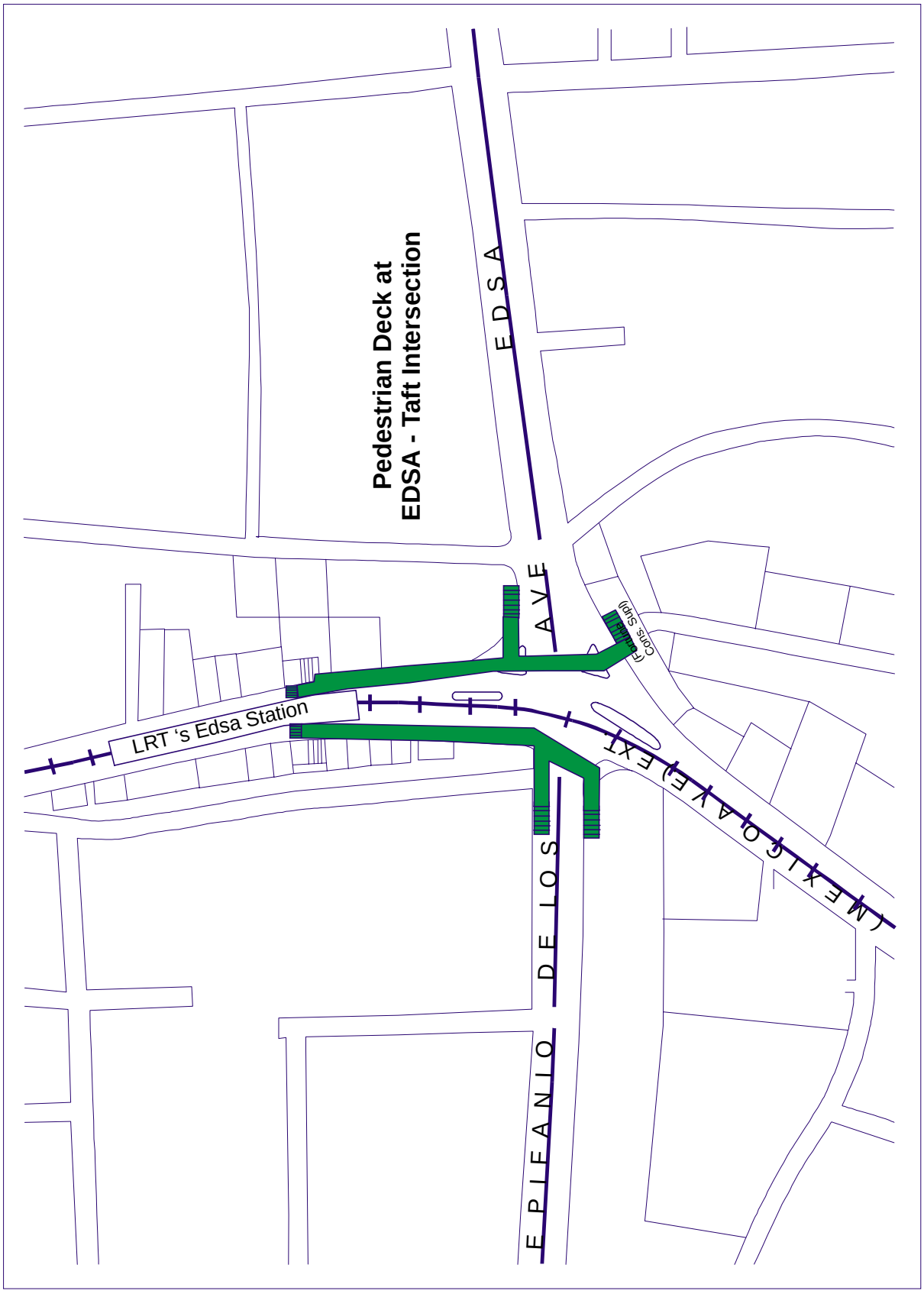


Figure 21
Pedestrian Decks at ESDA – Taft Intersection



9.9.6 Baclaran

At the south end of the LRT, a large number of pedestrian were moving around Baclaran station, in jeepney terminals at Redemptorist, and bus terminals in Roxas Blvd. Currently huge congestion is created everyday along Roxas Blvd. and to a lesser extent on Redemptorist due to the inefficient operation of traffic in the area. The proposed measures are intended to segregate vehicle flow and pedestrian movement.

The proposed measures are:

- Pedestrian deck connecting Baclaran Station and Redemptorist
- Pedestrian mall along Redemptorist
- Pedestrian overpass across Roxas Blvd.
- Bus/jeepney terminal on the reclaimed land

Pedestrian deck

Mexico Road is not wide enough to accommodate both pedestrians and vehicles. The large volume of pedestrian made the location a good place of business and street vendors have flourished. A pedestrian deck is proposed to segregate pedestrian movement from vehicle flow. It connects Baclaran station with Redemptorist, which is proposed to become a pedestrian mall.

Pedestrian mall

Redemptorist will be converted to a pedestrian mall and entry of vehicles will be prohibited except emergency vehicle. Facilities such as plants and trees, benches, comfort rooms, trash bins, street lighting will be provided. Street vendors will be allowed to do business at the designated locations.

Pedestrian overpass across Roxas Blvd.

To provide safe path for pedestrians who need to cross Roxas Blvd., a pedestrian overpass will be constructed. The overpass is connected to the proposed bus/jeepney terminal so that pedestrians can access to bus and jeepney without crossing vehicle path.

Bus jeepney terminal

A bus and jeepney terminal is proposed on the west side of Roxas Blvd. at Redemptorist and exclusive bus lane will be created on the service road of Roxas Blvd. The layout of the site and conceptual design of bus terminal is shown in Figures 22 and 23, respectively. The terminal is intended to alleviate the congestion at Roxas Blvd. – Redemptorist, which is mainly caused by loading and unloading of buses, and to accommodate jeepneys re-routed from Redemptorist.

All southbound buses that is to load or unload passengers are required to enter the terminal. No stopping of bus is allowed on Roxas Blvd. in the area. Likewise, the

northbound buses that want to stop at Redemptorist are required to take exclusive bus lane.

Jeepneys plying Redemptorist (Baclaran – Sucat, Baclaran – Alabang, Baclaran – Zapote, etc.) are required to turn left at Roxas – Redemptorist into the proposed bus jeepney terminal. They are allowed to unload at the jeepney lane in front of Baclaran Church but not allowed to load passengers. Passengers are required to board at the terminal. The existing intersection layout must be modified and the signal is rehabilitated. Minor modification of jeepney routes is required as shown in Figures 24 and 25.

9.9.7 Other Measures

In addition to the measures proposed to the specific locations, the following measures are highly recommended for implementation:

1) Street lighting

   Lighting facilities are provided under LRT structure throughout the route. The lighting system is not operating at all sections except the section between D. Jose and Carriedo. It is not known whether the facilities are in working condition but switch is not turned on, or the facilities are aleady defective. In both cases, rehabilitation of the facilities and modification of the system from manual switching to automatic switching are recommended.

2) Pavement Marking

   Pavement Marking is at poor condition for the entire stretch of the road under LRT Line 1. Reflective studs are recently installed. But stud works if used together with markings. Re-application of pavement markings, which include lane line, stop line, directional arrow, pedestrian crossing, zebra, etc., is recommended.

3) Removal of Shops around LRT Stairs

   Shops selling foodstuff or offering copying service are established under the LRT stairs without exception. According to LRTA, these shops have an annual contract with a subsidiary company of LRTA and pay rent for the space. They are one of the causes of congestion at LRT station, as they take up the narrow space around LRT stairs making it narrower. It is recommended not to renew the contract when it expires and recover the space for passengers and pedestrians.

Figure 22
Proposes Pedestrian Deck Connecting Baclaran LRT Station to Redemporist

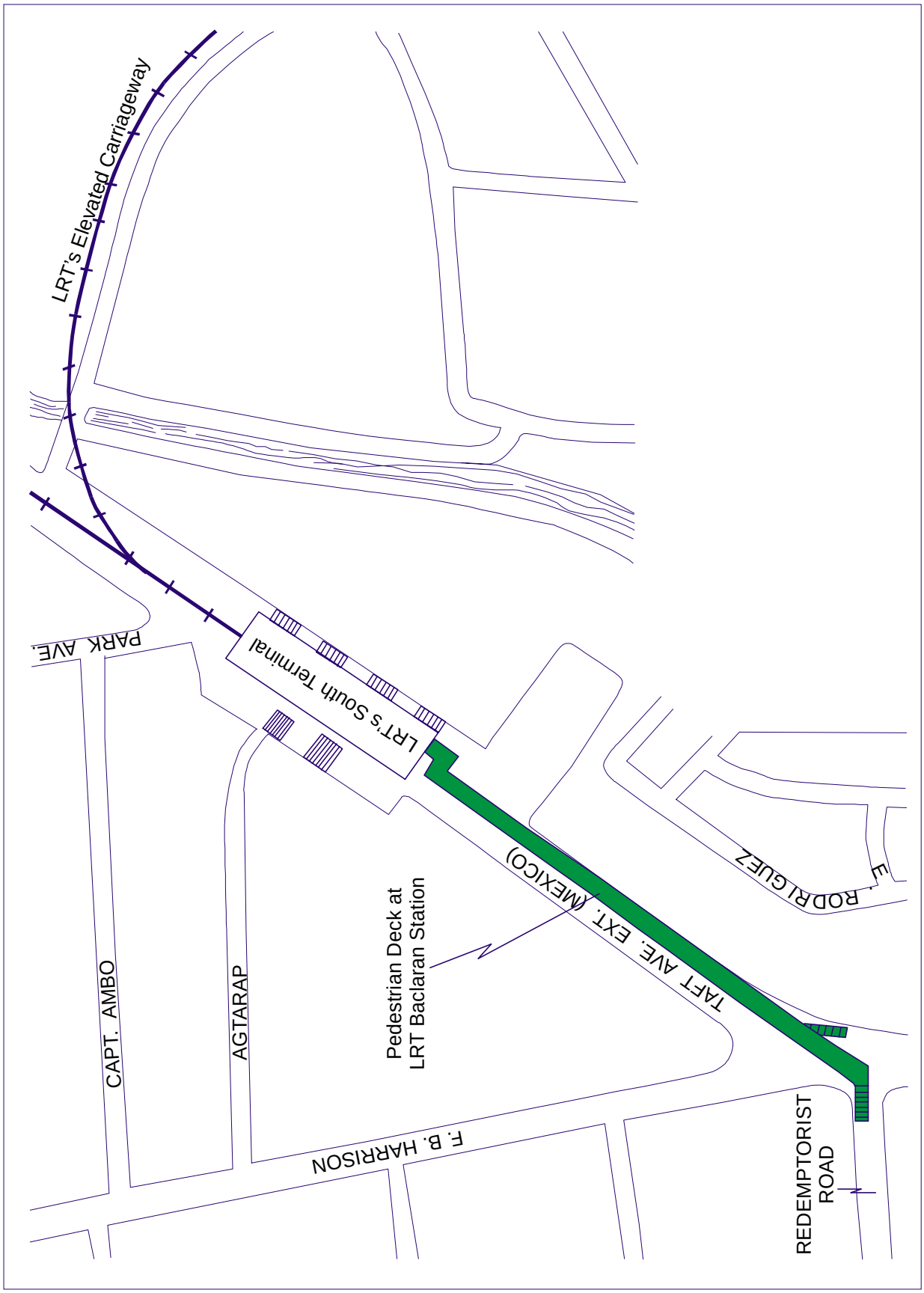


Figure 23
Proposed Bus/Jeepney Terminal

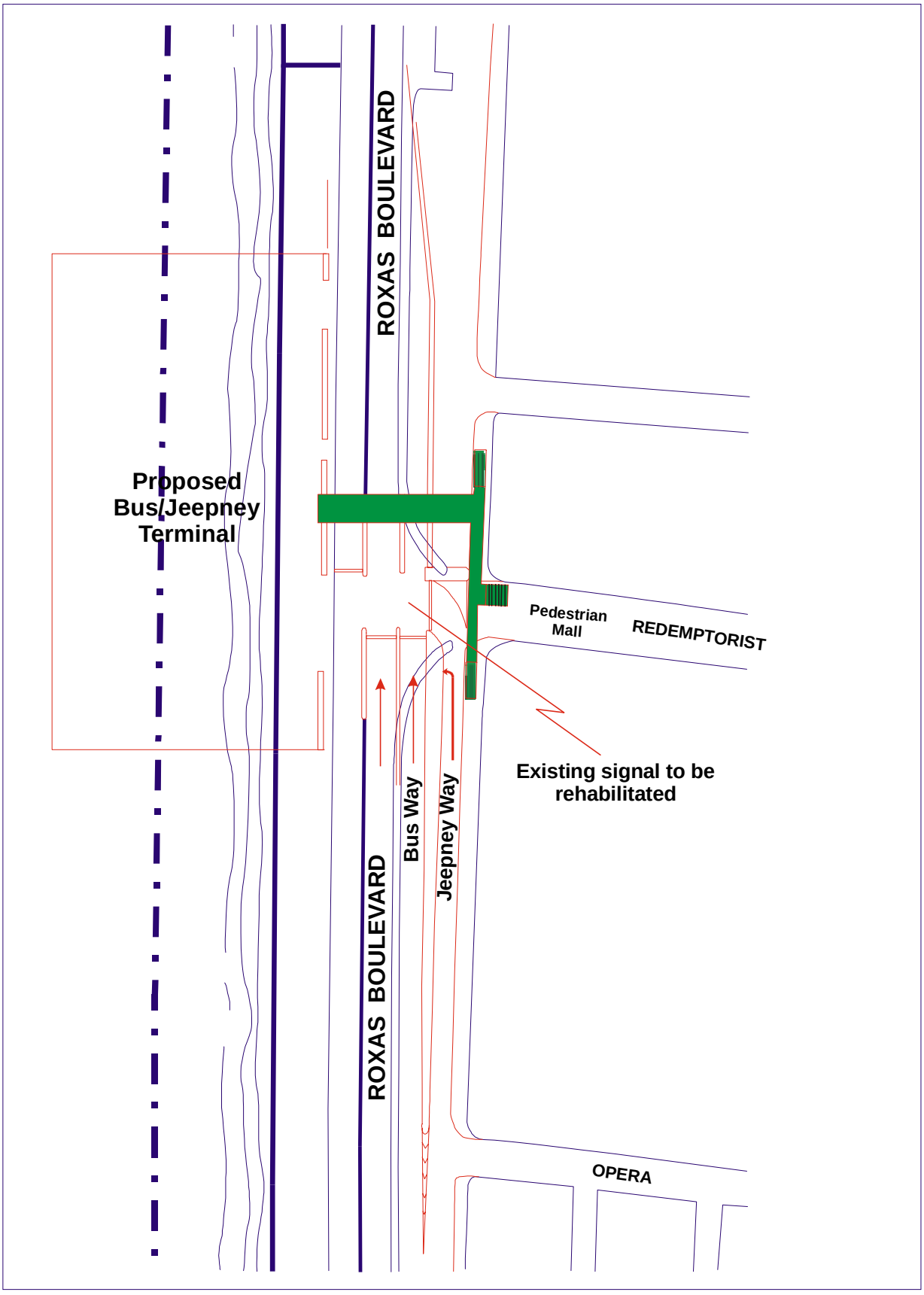


Figure 24
Existing Jeepney Routes

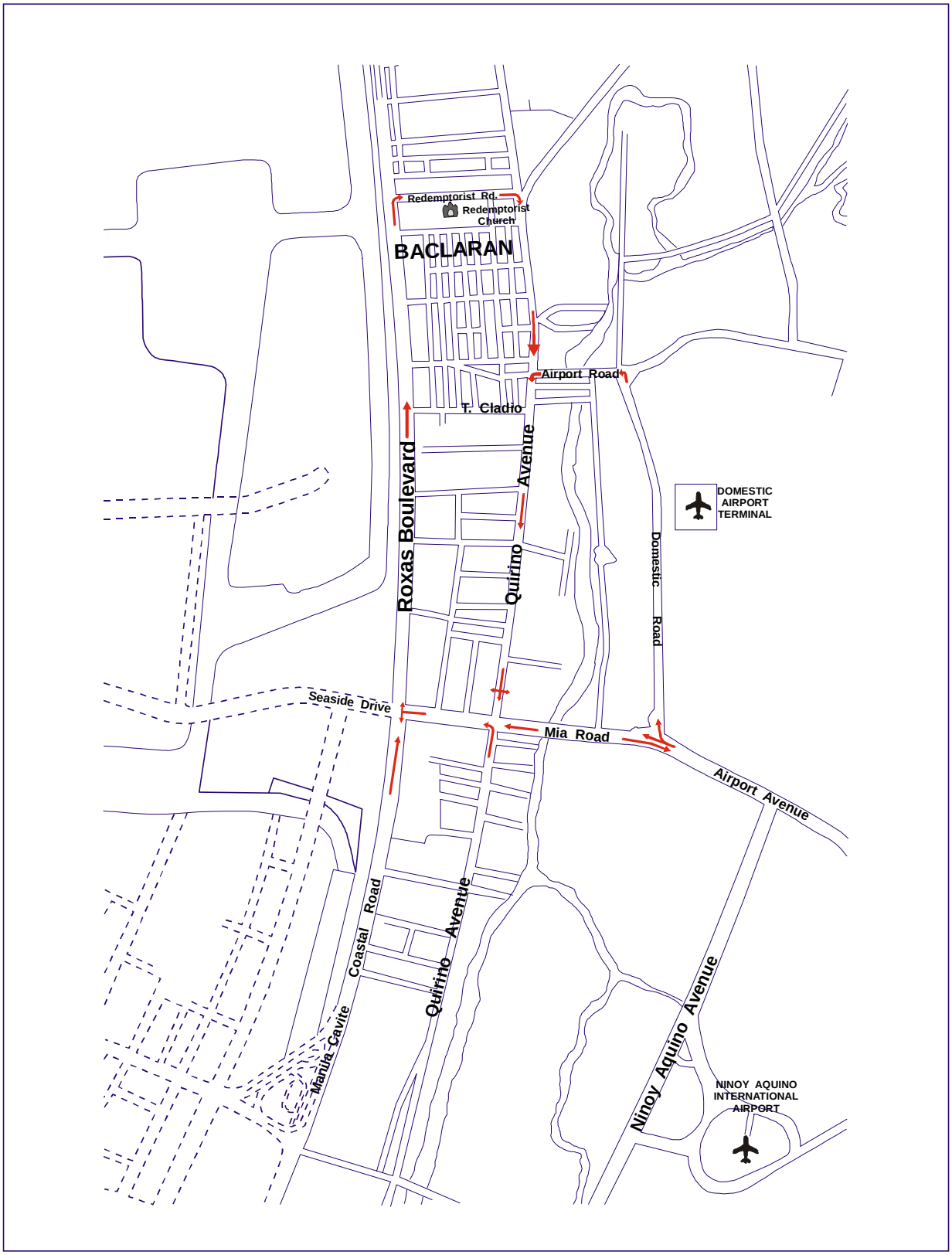
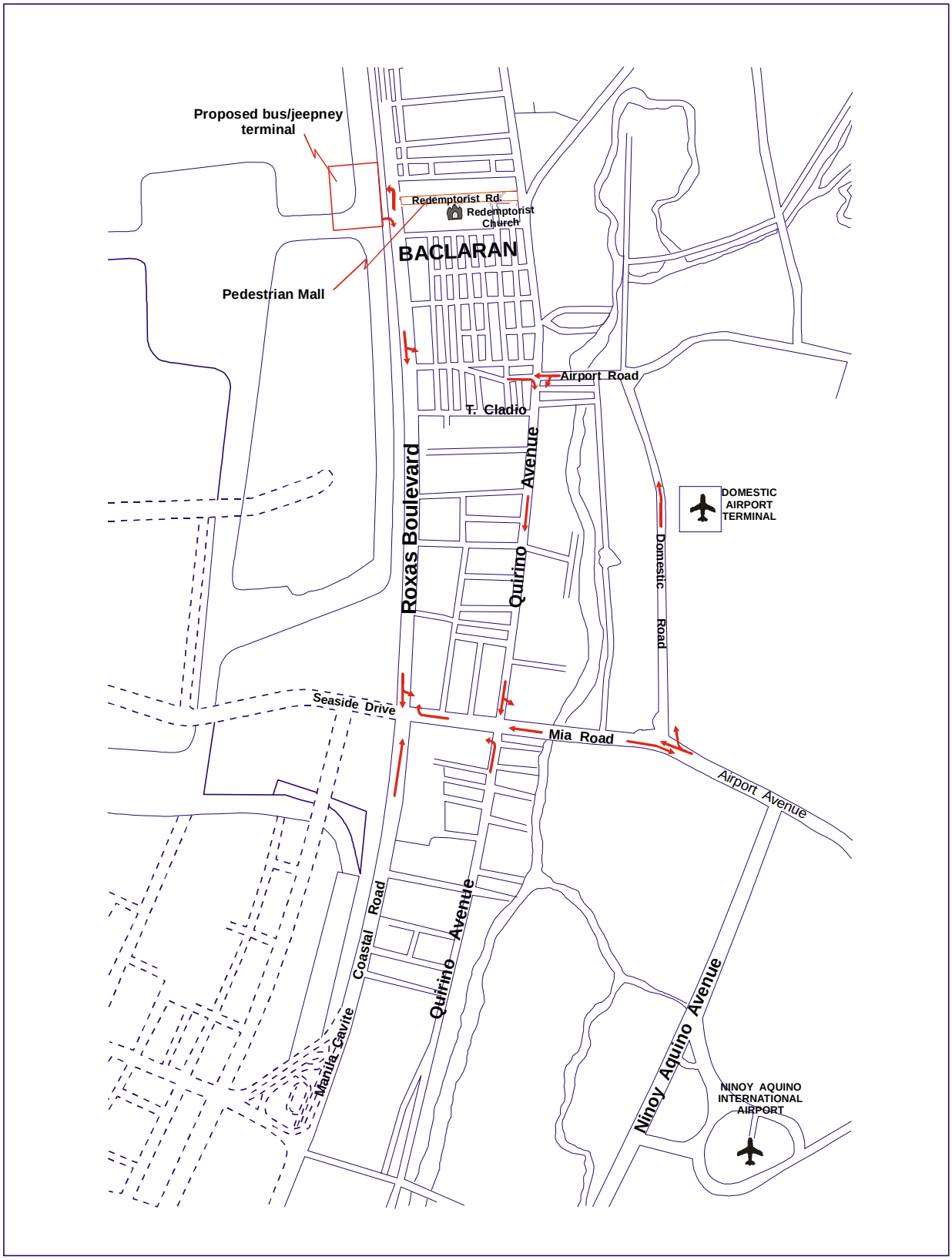


Figure 25
Proposed Jeepney Routes



APPENDIX II

TECHNICAL NOTES/MATERIALS
MMURTRIP RECOMMENDATION SUMMARY

10. MMURTRIP RECOMMENDATIONS

Table 1
LRT Line 2 Corridor

	Project	Signal improv't	New signal	Pave't Marking	Sidewalk improv't	Ped'n overpass	Ped'n barrier	Road improv't	Bollard	Street light	New road	Road widening	ROW	Note
1.1	Recto station	O		O	O		O	O	O	O				
1.2	Legarda station	O	O	O	O		O		O					4/
1.3	Nagtahan-Araneta	O		O	O		O			O				
1.4	Araneta-Cubao	O	O	O	O		O	O	O					
1.5	Cubao-Katipunan	O		O	O		O							

Table 2
EDSA Corridor

	Project	Signal improv't	New signal	Pave't Marking	Sidewalk improv't	Ped'n overpass	Ped'n barrier	Road improv't	Bollard	Street light	New road	Road widening	ROW	Note
2.1	North Ave.	O		O	O	O	O							
2.2	Quezon Ave.	O		O	O		O							
2.3	East Ave.-Santolan	O	O	O	O	O	O	O	O	O				
2.4	White Plain		O			O								
2.5	Ortigas-Shaw	O		O	O		O	O		O				
2.6	Shaw-Guadalupe				O		O	O	O					
2.7	Guadalupe-Gil Puyat	O		O	O		O	O		O				
2.8	Gil Puyat-Magallanes	O		O	O					O				
2.9	Magallanes-Taft	O	O	O	O	O	O	O		O				
2.10	Taft-Roxas	O		O						O				

Table 3
Southern Corridor

	Project	Signal improv't	New signal	Pave't Marking	Sidewalk improv't	Ped'n overpass	Ped'n barrier	Road improv't	Bollard	Street light	New road	Road widening	ROW	Note
3.1	Nichols IC	Interim scheme being implemented												
3.2	Bicutan IC	O	O	O	O		O				O			5/
3.3	Sucat IC	O		O	O		O				O			5/
3.4	Alabang IC	O	O	O	O		O			O				6/

Table 4
MARIPAS Area

	Project	Signal improv't	New signal	Pave't Marking	Sidewalk improv't	Ped'n overpass	Ped'n barrier	Road improv't	Bollard	Street light	New road	Road widening	ROW	Note
4.1	Katipunan-Maj. Dizon	O		O	O		O			O				
4.2	Marikina Road Network	New road network, widening of Marcos Bridge, intersection improvement at C5-Boni Serrano												
4.3	Evangelista-Sumulong	O	O	O	O	O	O					O		
4.4	Sumulong-C6		O				O					O		
4.5	Ortigas (C5-Mangahan)	O	O	O	O		O	O						
4.6	Ortigas (Mangahan-Tikling	O	O	O	O			O						
4.7	Radial Road II	New road and bridge, widening and improvement of existing road, intersection imimprovement												
4.8	Radial Road III	New road and bridge, widening of existing road, intersection improvement												

Table 5
Secondary Roads

	Project	Signal improv't	New signal	Pave't Marking	Sidewalk improv't	Ped'n overpass	Ped'n barrier	Road improv't	Bollard	Street light	New road	Road widening	ROW	Note
5.1	DMMA Ext.		O	O						O	O		O	
5.2	Central Ave.	O	O	O	O						O	O	O	
5.3	Tandang Sora	O	O	O	O	O		O				O	O	
5.4	New Balara-Marikina Road	O	O	O	O			O			O		O	
5.5	Quirino Highway	O	O	O	O			O						7/
5.6	Del Monte	O	O	O	O			O				O	O	7/
5.7	Roosevelt Ave.	O	O	O				O					O	
5.8	Banawe Ave.	O	O	O				O						7/
5.9	North Ave.	O	O	O	O		O	O					O	
5.10	Antonio Arnaiz	O	O	O				O						7/
5.11	SSH West Service Road				O			O						
5.12	SSH East Service Road				O			O						
5.13	A. Santos/Alabang-Zapote	New jeepney route, open of subdivision road to private vehicles												
5.14	Pedro Gil	O	O	O				O						7/
5.15	Aurora Blvd.	O		O	O			O						
5.16	Tayuman	O		O	O			O						
5.17	Moriones	O	O	O	O			O				O	O	7/
5.18	10th Avenue	O		O	O			O						7/
5.19	D. Romualdez/S. Marcerino	O		O				O						8/
5.20	Gil Puyat	O		O				O						
5.21	C. M. Recto	O	O	O	O			O				O	O	
5.22	Legarda	O		O				O						
5.23	Pasong Tamo	O	O	O				O						
5.24	Quezon Blvd.	O		O				O						9/
5.25	De La Fuente/ V.G. Cruz	O		O	O			O						7/
5.26	Fajardo/Loyola	O		O				O						7/

Notes:
1/ Road improvement includes re-concreting, asphalt overlay, new/improvement of drainage facilities, and improvement of alignment
2/ Sidewalk improvement includes cleaning of sidewalk, provision of sidewalk, and removal of sidewalk vendors.
3/ Pedestrian barrier includes pedestrian barrier on sidewalk, pedestrian barrier on medium and service road barrier
4/ Pedestrian walk path
5/ Geometric improvement as per TEC plan
6/ Bridge widening
7/ Removal of on-street parking
8/ Banning of truck parking
9/ Removal of sidewalk vendors

APPENDIX II

TECHNICAL NOTES/MATERIALS
VEHICLE OPERATING COST ESTIMATION FOR URBAN CONDITION

11. VEHILCE OPERATING COST ESTIMATION FOR URBAN CONDITIONS

DPWH Model

The main source of vehicle operating cost estimates for the Philippines appears to be an annual series produced by DPWH. Details of the methodology are not readily available, but it appears to follow that developed by Peder Nielson in 1982 mission and documented in the 8 volume Highway Planning Manual (HPM) and 1991 review and update[1].

The representative vehicles (and their individual weight in each of the 15 vehicle types analyzed) may change from year to year, but there does not seem to have been any update of other assumptions (e.g. vehicle occupancy, journey purpose proportions etc.). Further, it is not explicit in model the output which of the 15 categories the emerging vehicle types, such as the Tamara, go into.

The DPWH model generates cost per vehicle km. and vehicle hour free flow running on open (inter-urban) road, defined as:

1) reasonably good paved surface as found on the new paved asphalt concrete surfaces financed by local funds;
2) at least 6.0 m of carriageway width, with shoulde disths of 2 x 2.0 m or more;
3) gradients below 1%;
4) design speeds no less than 70 kph for cars and 60 kph for trucks;
5) minimum roadside friction and traffic volumes with no effect on driver behavior (free flow conditions); and
6) average Philippine driver behavior.

(HPM, Volume 4, Introduction)

Costs are then published for 8 roads types, ranging from "good
"very bad gravel", but detailed costs are probably generated for good metalled and factored ("dl" factors) for other road types. Assumptions (detailed in appendices to the 1982 report) are made on the free flow speed for each vehicle type on each road type, e.g. 30 km/hr for bus/truck on very bad gravel. Costs are thus only estimated for one speed for each vehicle type and road type.

The DPWH costs are thus for use in inter-urban and rural road assessments, and have a number of disadvantages for evaluation of projects in urban areas, including:

- inability to estimate costs for different speeds;
- inability to estimate costs for different road types; and
- unrealistically high assumed speeds (for urban conditions) on the better road types; and
- unrealistic assumptions on traffic conditions (item 5).

[1] Coordinating Consultancy Services for the Organization, Planning, Coordination and Review of the Feasibility Studies on the Improvement of Major Road Sections and the Arterial Road Program, Renadet S.A. and others for DPWH, 1997

In an attempt to overcome these deficiencies, a vehicle operating cost model originally developed by the (Pakistan) National Transport Research Center (NTRC) in Islamabad has been adapted. Vehicle speed, road roughness, road curvature and road rise and fall can all be varied within a reasonable range to generate cost estimates under a much wider range of operating conditions than is possible with the existing (published) Philippine methodology.

The NTRC model also contains formulate which adjust annual vehicle km. and vehicle life according to the average speed.

Work to date has concentrated on calibrating the NTRC model to Philippine conditions, making adjustments where necessary. There will be problems with transferring any model between countries, and the NTRC mode, while based on authoritative studies[2] has itself been adapted to Pakistan conditions. It has therefore been necessary to identify and remove, where possible, the "Pakistan" elements of the model before inserting any necessary "Philippines" features.

The capabilities of the NTRC model have been expanded to include features of the DPWH model, including:

- split of depreciation into distance and time elements;
- assignment of some costs on a per-km. basis, others on per-hour (NTRC) methodology assigned all costs per km.);
- ability to shadow price labor cost and value of travel time; and
- incorporation of an internal sub-model to generate values time for vehicle types.

While the NTRC model generates costs for 9 vehicle types, it only uses accurate consumption data for three types:

- saloon car;
- heavy 2-axle truck; and
- big bus.

A fourth vehicle type, a mini-bus derived from a Ford Transit 1.5 ton van which is particularly common in Pakistan, has been added, with all other costs estimated by factoring the costs for these base vehicle types.

Calibration has been by adopting DPWH assumptions on speed, road type and vehicle use and comparing the resource consumption output of the tow models (resource valuation is a separate issued) for these base vehicle types. Judgement has then been used in selection of the factors to generate costs for the other vehicle types common in the Philippines.

Results are good/acceptable if it is assumed that the HPM "good" road has a roughness factor of 25000, as shown in Table 1.

[2] Detailed in a technical note on the first adaptation of the NTRC model, for a 1995 toll-road study in Pakistan, which will be forwarded from London.

Table 1
Comparison of Model Results

Vehicle	Resource	DPWH	New Model output
Car	fuel / 1000 km	110	105
	oil / 1000 km	1	1.18
	tire life	40,000	48,000
	parts (as % of new vehicle) / 100 km	14.7%	10.9%
	maintenance labor (hours) per 1000 km	3.53	3.79
Jeepney	fuel / 1000 km	90	102
	oil / 1000 km	1	1.2
	tire life	40,000	43,500
	parts (as % of new vehicle) / 100 km	17.0%	17.2%
	maintenance labor (hours) per 1000 km	3.33	3.80
Big Bus	fuel / 1000 km	240	254
	oil / 1000 km	3	3.5
	tire life	60,000	51,500
	parts (as % of new vehicle) / 100 km	12.5%	18.0%
	maintenance labor (hours) per 1000 km	3.75%	4.07
Truck	fuel / 1000 km	270	230
	oil / 1000 km	3.25	3.87
	tire life	55,000	51,500
	parts (as % of new vehicle) / 100 km	14.0%	18.3%
	maintenance labor (hours) per 1000 km	5.50	5.26

The resource assumptions of the two models are thus reasonably similar and, in calculating overall vehicle operating cost, the differences tend to balance out – for truck, for example, the new model will generate higher costs per km than DPWH model for oil, tires and spare parts, but lower costs for fuel and maintenance labor.

It is not considered to be worth spending more time investigating both models until they match exactly. Benefits for evaluations depend more on differences between the with and without project scenarios than they do on the absolute level of costs. The main feature of the new model is thus its ability to generate differential costs for small changes in operating conditions, and the speed-consumption relationships in the model are well founded.

MMU Model

If the strength of the new Metr0-Manila Urban (MMU) model is this ability to generate reasonably accurate costs under a range of road and speed conditions, its weaknesses are that input consumption is well founded for only three of the nine vehicle types an are based on studies carried out in the early 1960s. The technical note discusses this and concludes that, for a variety of reasons, these relationships may still be valid today[3]

If therefore makes poor estimation of m/c costs (but there are few of in Manila at present) and has no basis whatsoever for forecasting tricycle costs, the MMUTIS surveys are the best data available. "UV" is a catch-all for private jeepney, puck-up, "van" etc., and necessarily incorporates light goods vehicles (as they are not included anywhere else) while excluding crew costs on current input values. Type 5 is captioned "HOV/taxi", but no cost data relating to Tamaraw have yet been entered. Costs output for this vehicle type should be treated with

[3] Many of the relationships in the DPWH model seem to be equally out of date.

caution. Bus is bit (11-12 m) bus. The output table present a composite value for medium / heavy goods vehicle – costs for the heavier vehicles are factored up from heavy 2-axle, but both NTRC and DPWH methodologies seem to make similar assumptions on this, vehicle proportions are selected by the user.

The MMU model does not, therefore, produce definitive cost estimates but by virtue of its greater flexibility, produces better estimates for congested urban conditions than are currently available for the Philippines.

Vehicle operating cost in Peso per 1,000 km for diferent speeds
ECONOMIC COSTS

Speed (kmh)	Vehicle	Distance related cost / 1000 km					Time related cost / hour	Time related cost / 1000 km	Value of time / hour	Value of time / 1000 km	Total / 1000 km Road Typ v good
	Road Type	v good	good	fair	poor	v poor					
	Roughnes	1500	2500	3500	5500	7500					
	Rise/Fall	10	10	20	20	30					
	Curvature	100	100	200	300	400					
10	m/c	489	548	644	835	1,026	1.36	136	13.24	1,324	1,949
	car (priv)	2,337	2,618	3,294	4,550	5,855	23.86	2,386	51.36	5,136	9,859
	UV (priv)	2,370	2,675	3,067	693	4,398	19.49	1,949	36.53	3,653	7,973
	jeepney	2,080	2,509	3,047	3,924	4,900	38.09	3,809	58.36	5,836	11,725
	HOV/taxi	1,199	1,552	1,910	2,627	4,248	41.66	4,166	42.78	4,278	9,643
	bus	6,032	7,190	8,510	10,824	13,297	70.81	7,081	218.45	21,845	34,959
	MGV/HGV	8,883	10,043	11,380	13,593	16,182	76	7,598	0.00	0	16,481
20	m/c	455	525	641	872	1,104	1.37	68	13.24	662	1,185
	car (priv)	2,159	2,442	3,123	4,390	5,705	26.95	1,348	51.36	2,568	6,075
	UV (priv)	2,191	2,498	2,895	3,529	4,244	22.69	1,135	36.53	1,827	5,152
	jeepney	1,912	2,343	2,887	3,775	4,762	40.70	2,035	58.36	2,918	6,864
	HOV/taxi	1,136	1,491	1,854	2,580	4,119	45.73	2,286	42.78	2,139	5,561
	bus	5,558	6,716	8,037	10,351	12,825	80.95	4,048	218.45	10,923	20,528
	MGV/HGV	7,435	8,596	9,933	12,147	14,736	84.21	4,210	0.00	0	11,645
30	m/c	435	519	659	937	1,216	1.25	42	13.24	441	918
	car (priv)	2,028	2,315	3,002	4,280	5,607	26.48	883	51.36	1,712	4,623
	UV (priv)	2,049	2,360	2,764	3,412	4,140	22.58	753	36.53	1,218	4,019
	jeepney	1,783	2,219	2,771	3,676	4,681	41.45	1,381	58.36	1,945	5,109
	HOV/taxi	1,083	1,443	1,813	2,553	4,040	47.35	1,570	42.78	1,426	4,079
	bus	5,251	6,415	7,754	10,078	12,563	85.99	2,829	218.45	7,282	15,362
	MGV/HGV	6,366	7,535	8,904	11,133	13,737	84.79	2,855	0.00	0	9,222
40	m/c	430	530	696	1,028	1,420	1.12	28	13.24	331	789
	car (priv)	1,944	2,234	2,928	4,220	5,575	25.18	629	51.36	1,284	3,858
	UV (priv)	1,942	2,258	2,671	3,338	4,108	21.59	540	36.53	913	3,395
	jeepney	1,693	2,135	2,699	3,627	4,684	41.45	1,036	58.36	1,459	4,188
	HOV/taxi	1,040	10,406	1,785	2,543	4,032	47.35	1,184	42.78	1,069	3,293
	bus	5,109	6,283	7,632	9,977	12,552	85.99	2,150	218.45	5,461	12,720
	MGV/HGV	5,674	6,858	8,235	10,494	13,225	84.79	2,120	0.00	0	7,793
50	m/c	456	593	872	1,497	2,451	1.01	20	13.24	265	741
	car (priv)	1,909	2,209	2,931	4,296	5,804	23.72	474	51.36	1,027	3,411
	UV (priv)	1,876	2,206	2,664	3,447	4,446	20.39	408	36.53	731	3,015
	jeepney	1,649	2,109	2,728	3,801	5,142	41.17	823	58.36	1,167	3,640
	HOV/taxi	1,011	1,394	1,816	2,690	4,392	47.12	942	42.78	856	2,809
	bus	5,277	6,485	7,990	10,618	13,720	85.78	1,716	218.45	4,369	11,362
	MGV/HGV	5,567	6,798	8,394	11,052	14,528	83.10	1,662	0.00	0	7,229
60	m/c	492	664	1,049	2,029	3,678	0.92	15	13.24	221	728
	car (priv)	1,917	2,226	2,974	4,446	6,125	22.31	372	51.36	856	3,145
	UV (priv)	1,842	2,186	2,686	3,621	4,904	19.20	320	36.53	609	2,771
	jeepney	1,641	2,118	2,790	4,052	5,476	40.76	679	58.36	973	3,293
	HOV/taxi	989	1,388	1,853	2,871	4,873	46.66	778	42.78	713	2,480
	bus	5,595	6,839	8,512	11,588	15,449	84.93	1,415	218.45	3,641	10,652
	MGV/HGV	5,814	7,094	8,929	12,205	16,731	81.18	1,353	0.00	0	7,167

Vehicle operating cost in Peso per 1,000 km for diferent speeds
ECONOMIC COSTS

Speed (kmh)	Vehicle	Distance related cost / 1000 km					Time related cost / hour	Time related cost / 1000 km	Value of time / hour	Value of time / 1000 km	Total / 1000 km Road Typ v good
	Road Type	v good	good	fair	poor	v poor					
	Roughnes	1500	2500	3500	5500	7500					
	Rise/Fall	10	10	20	20	30					
	Curvature	100	100	200	300	400					
70	m/c	546	760	1,364	2,950	5,391	0.84	12	13.24	189	747
	car (priv)	1,980	2,299	3,108	4,741	6,641	21.01	300	51.36	734	3,014
	UV (priv)	1,842	2,203	2,806	3,996	5,628	18.09	258	36.53	522	2,622
	jeepney	1,672	2,171	2,971	4,549	6,678	40.31	576	58.36	834	3,082
	HOV/taxi	977	1,396	1,952	3,223	5,622	46.11	659	42.78	611	2,246
	bus	5,595	7,428	9,612	13,525	18,361	83.76	1,197	218.45	3,121	10,453
	MGV/HGV	5,814	7,873	10,418	14,847	20,669	79.25	1,132	0.00	0	7,654
80	m/c	631	908	1,781	4,375	8,657	0.77	10	13.24	165	806
	car (priv)	2,089	2,423	3,307	5,225	7,606	19.83	248	51.36	642	2,978
	UV (priv)	1,885	2,273	2,998	4,654	7,072	17.07	213	36.53	457	2,555
	jeepney	1,755	2,287	3,239	5,396	8,502	39.86	498	58.36	729	2,983
	HOV/taxi	977	1,428	2,100	3,803	7,091	45.53	569	42.78	535	2,081
	bus	7,053	8,422	11,268	16,837	-	82.46	1,031	218.45	2,731	10,814
	MGV/HGV	7,909	9,370	12,840	19,575	-	77.42	968	0.00	0	8,876
90	m/c	769	1,157	2,769	8,360	-	0.72	8	13.24	147	924
	car (priv)	2,252	2,615	3,712	6,442	436,475	18.77	209	51.36	571	3,032
	UV (priv)	1,979	2,415	3,463	6,467	-	16.15	179	36.53	406	2,564
	jeepney	1,898	2,490	3,843	7,676	-	39.42	438	58.36	648	2,985
	HOV/taxi	999	1,507	2,497	5,499	-	44.94	499	42.78	475	1,974
	bus	8,617	10,123	15,042	-	-	81.12	901	218.45	2,427	11,945
	MGV/HGV	10,375	12,032	18,446	-	-	75.71	841	0.00	0	11,216
100	m/c	1,021	1,634	5,710	-	-	0.67	7	13.24	132	1,160
	car (priv)	2,498	2,917	4,781	342,041	-	17.80	178	51.36	514	3,189
	UV (priv)	2,151	686	4,872	-	-	15.31	153	36.53	365	2,669
	jeepney	2,137	2,851	5,620	-	-	39.01	390	58.36	584	3,110
	HOV/taxi	1,064	1,688	3,752	587,204	-	44.38	444	42.78	428	1,936
	bus	11,572	13,364	-	-	-	79.79	798	218.45	2,185	14,555
	MGV/HGV	14,990	17,051	-	-	-	74.14	741	0.00	0	15,731

APPENDIX II

TECHNICAL NOTES/MATERIALS
ECONOMIC EVALUATION

12. ECONOMIC EVALUATION OF MTDP PROJECTS

1. Master Plan - All Projects

	Cash Flow			Discounted Cash Flow (15%)		
Year	Cost	Benefit	B-C	Cost	Benefit	B-C
1999	0	0	0	0	0	0
2000	10,413	0	(10,413)	9,055	0	(9,055)
2001	11,951	0	(11,951)	9,036	0	(9,036)
2002	22,590	0	(22,590)	14,853	0	(14,853)
2003	44,731	0	(44,731)	25,575	0	(25,575)
2004	105,922	0	(105,922)	52,662	0	(52,662)
2005	22,481	99,489	77,008	9,719	43,012	33,293
2006	23,605	130,459	106,854	8,874	49,044	40,171
2007	24,785	161,430	136,645	8,102	52,772	44,669
2008	26,024	192,400	166,376	7,398	54,692	47,294
2009	27,325	223,371	196,045	6,754	55,214	48,459
2010	28,692	254,341	225,650	6,167	54,669	48,502
2011	30,126	285,312	255,186	5,631	53,327	47,696
2012	31,633	316,282	284,650	5,141	51,405	46,264
2013	33,214	347,253	314,039	4,694	49,077	44,383
2014	34,875	378,223	343,349	4,286	46,482	42,196
2015	0	409,194	409,194	0	43,728	43,728
2016	0	440,164	440,164	0	40,903	40,903
2017	0	471,135	471,135	0	38,070	38,070
2018	0	502,105	502,105	0	35,281	35,281
2019	0	533,076	533,076	0	32,571	32,571
2020	0	564,047	564,047	0	29,968	29,968
2021	0	595,017	595,017	0	27,490	27,490
2022	0	625,988	625,988	0	25,149	25,149
2023	0	656,958	656,958	0	22,950	22,950
2024	(148,356)	0	148,356	(4,507)	0	4,507

IRR= 46.37 %
B/C= 4.65
NPV= 632,361

2. Master Plan - Railway Projects

	Cash Flow			Discounted Cash Flow (15%)		
Year	Cost	Benefit	B-C	Cost	Benefit	B-C
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	4,980	0	(4,980)	3,274	0	(3,274)
2003	18,054	0	(18,054)	10,323	0	(10,323)
2004	67,052	0	(67,052)	33,337	0	(33,337)
2005	5,507	27,668	22,162	2,381	11,962	9,581
2006	5,782	35,800	30,018	2,174	13,459	11,285
2007	6,071	43,932	37,861	1,985	14,362	12,377
2008	6,375	52,064	45,690	1,812	14,800	12,988
2009	6,693	60,196	53,503	1,655	14,880	13,225
2010	7,028	68,328	61,300	1,511	14,687	13,176
2011	7,380	76,460	69,081	1,379	14,291	12,912
2012	7,749	84,592	76,844	1,259	13,749	12,489
2013	8,136	92,724	84,588	1,150	13,105	11,955
2014	8,543	100,856	92,313	1,050	12,395	11,345
2015	0	108,988	108,988	0	11,647	11,647
2016	0	117,120	117,120	0	10,884	10,884
2017	0	125,252	125,252	0	10,121	10,121
2018	0	133,384	133,384	0	9,372	9,372
2019	0	141,516	141,516	0	8,647	8,647
2020	0	149,648	149,648	0	7,951	7,951
2021	0	157,779	157,779	0	7,290	7,290
2022	0	165,911	165,911	0	6,665	6,665
2023	0	174,043	174,043	0	6,080	6,080
2024	(27,280)	0	27,280	(829)	0	829

IRR= 40.56 %
B/C= 3.46
NPV= 153,883

3. Master Plan - Expressway Projects

	Cash Flow			Discounted Cash Flow (15%)		
Year	Cost	Benefit	B-C	Cost	Benefit	B-C
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	14,700	0	(14,700)	9,665	0	(9,665)
2003	14,700	0	(14,700)	8,405	0	(8,405)
2004	14,700	0	(14,700)	7,308	0	(7,308)
2005	4,733	37,025	32,292	2,046	16,007	13,961
2006	4,969	38,987	34,018	1,868	14,657	12,789
2007	5,218	40,950	35,732	1,706	13,387	11,681
2008	5,478	42,912	37,434	1,557	12,198	10,641
2009	5,752	44,875	39,122	1,422	11,092	9,670
2010	6,040	46,837	40,797	1,298	10,067	8,769
2011	6,342	48,799	42,458	1,185	9,121	7,936
2012	6,659	50,762	44,103	1,082	8,250	7,168
2013	6,992	52,724	45,732	988	7,451	6,463
2014	7,342	54,687	47,345	902	6,721	5,818
2015	0	56,649	56,649	0	6,054	6,054
2016	0	58,612	58,612	0	5,447	5,447
2017	0	60,574	60,574	0	4,895	4,895
2018	0	62,536	62,536	0	4,394	4,394
2019	0	64,499	64,499	0	3,941	3,941
2020	0	66,461	66,461	0	3,531	3,531
2021	0	68,424	68,424	0	3,161	3,161
2022	0	70,386	70,386	0	2,828	2,828
2023	0	72,349	72,349	0	2,527	2,527
2024	(34,394)	0	34,394	(1,045)	0	1,045

IRR= 50.84 %
B/C= 3.8
NPV= 107,340

4. Master Plan - Primary Road Projects

	Cash Flow			Discounted Cash Flow (15%)		
Year	Cost	Benefit	B-C	Cost	Benefit	B-C
1999	0	0	0	0	0	0
2000	11,647	0	(11,647)	10,128	0	(10,128)
2001	4,552	0	(4,552)	3,442	0	(3,442)
2002	3,757	0	(3,757)	2,470	0	(2,470)
2003	3,757	0	(3,757)	2,148	0	(2,148)
2004	3,757	0	(3,757)	1,868	0	(1,868)
2005	13,251	15,982	2,731	5,729	6,909	1,181
2006	13,913	34,949	21,036	5,230	13,139	7,908
2007	14,609	53,917	39,308	4,776	17,626	12,850
2008	15,339	72,884	57,545	4,360	20,718	16,358
2009	16,106	91,852	75,746	3,981	22,704	18,723
2010	16,911	110,819	93,908	3,635	23,820	20,185
2011	17,757	129,787	112,030	3,319	24,258	20,939
2012	18,645	148,754	130,110	3,030	24,177	21,146
2013	19,577	167,722	148,145	2,767	23,704	20,937
2014	20,556	186,690	166,134	2,526	22,943	20,417
2015	0	205,657	205,657	0	21,978	21,978
2016	0	224,625	224,625	0	20,873	20,873
2017	0	243,592	243,592	0	19,684	19,684
2018	0	262,560	262,560	0	18,449	18,449
2019	0	281,527	281,527	0	17,201	17,201
2020	0	300,495	300,495	0	15,966	15,966
2021	0	319,462	319,462	0	14,759	14,759
2022	0	338,430	338,430	0	13,596	13,596
2023	0	357,397	357,397	0	12,485	12,485
2024	(85,074)	0	85,074	(2,584)	0	2,584

IRR= 47.47 %
B/C= 6.25
NPV= 298,165

5. Master Plan - Secondary Road Projects

	Cash Flow			Discounted Cash Flow (15%)		
Year	Cost	Benefit	B-C	Cost	Benefit	B-C
1999	0	0	0	0	0	0
2000	6,939	0	(6,939)	6,034	0	(6,034)
2001	8,376	0	(8,376)	6,333	0	(6,333)
2002	3,216	0	(3,216)	2,114	0	(2,114)
2003	3,139	0	(3,139)	1,795	0	(1,795)
2004	3,139	0	(3,139)	1,561	0	(1,561)
2005	3,083	7,603	4,520	1,333	3,287	1,954
2006	3,237	10,569	7,332	1,217	3,973	2,756
2007	3,399	13,535	10,136	1,111	4,425	3,313
2008	3,569	16,501	12,932	1,015	4,691	3,676
2009	3,748	19,467	15,720	926	4,812	3,886
2010	3,935	22,433	18,498	846	4,822	3,976
2011	4,132	25,399	21,267	772	4,747	3,975
2012	4,338	28,365	24,027	705	4,610	3,905
2013	4,555	31,331	26,776	644	4,428	3,784
2014	4,783	34,297	29,514	588	4,215	3,627
2015	0	37,263	37,263	0	3,982	3,982
2016	0	40,229	40,229	0	3,738	3,738
2017	0	43,195	43,195	0	3,490	3,490
2018	0	46,161	46,161	0	3,244	3,244
2019	0	49,127	49,127	0	3,002	3,002
2020	0	52,093	52,093	0	2,768	2,768
2021	0	55,059	55,059	0	2,544	2,544
2022	0	58,025	58,025	0	2,331	2,331
2023	0	60,991	60,991	0	2,131	2,131
2024	(29,031)	0	29,031	(882)	0	882

IRR= 28.66 %
B/C= 2.73
NPV= 45,127

6. MTDP - All Projects

	Cash Flow			Discounted Cash Flow (15%)		
Year	Cost	Benefit	B-C	Cost	Benefit	B-C
1999	0	0	0	0	0	0
2000	18,586	0	(18,586)	16,162	0	(16,162)
2001	16,094	0	(16,094)	12,169	0	(12,169)
2002	30,413	0	(30,413)	19,997	0	(19,997)
2003	52,677	0	(52,677)	30,118	0	(30,118)
2004	114,224	0	(114,224)	56,790	0	(56,790)
2005	0	99,489	99,489	0	43,012	43,012
2006	0	100,036	100,036	0	37,607	37,607
2007	0	100,584	100,584	0	32,881	32,881
2008	0	101,132	101,132	0	28,748	28,748
2009	0	101,679	101,679	0	25,134	25,134
2010	0	102,227	102,227	0	21,973	21,973
2011	0	102,775	102,775	0	19,209	19,209
2012	0	103,322	103,322	0	16,793	16,793
2013	0	103,870	103,870	0	14,680	14,680
2014	0	104,418	104,418	0	12,832	12,832
2015	0	104,965	104,965	0	11,217	11,217
2016	0	105,513	105,513	0	9,805	9,805
2017	0	106,061	106,061	0	8,570	8,570
2018	0	106,608	106,608	0	7,491	7,491
2019	0	107,156	107,156	0	6,547	6,547
2020	0	107,704	107,704	0	5,722	5,722
2021	0	108,251	108,251	0	5,001	5,001
2022	0	108,799	108,799	0	4,371	4,371
2023	0	109,347	109,347	0	3,820	3,820
2024	(51,346)	0	51,346	(1,560)	0	1,560

IRR= 30.89 %
B/C= 2.36
NPV= 181,737

7. MTDP - Northern Package (Road)

	Cash Flow			Discounted Cash Flow (15%)		
Year	Cost	Benefit	B-C	Cost	Benefit	B-C
1999	0	0	0	0	0	0
2000	4,236	0	(4,236)	3,684	0	(3,684)
2001	2,050	0	(2,050)	1,550	0	(1,550)
2002	2,050	0	(2,050)	1,348	0	(1,348)
2003	1,973	0	(1,973)	1,128	0	(1,128)
2004	1,973	0	(1,973)	981	0	(981)
2005	0	610	610	0	264	264
2006	0	2,439	2,439	0	917	917
2007	0	4,267	4,267	0	1,395	1,395
2008	0	6,095	6,095	0	1,733	1,733
2009	0	7,924	7,924	0	1,959	1,959
2010	0	9,752	9,752	0	2,096	2,096
2011	0	11,580	11,580	0	2,164	2,164
2012	0	13,409	13,409	0	2,179	2,179
2013	0	15,237	15,237	0	2,153	2,153
2014	0	17,065	17,065	0	2,097	2,097
2015	0	18,894	18,894	0	2,019	2,019
2016	0	20,722	20,722	0	1,926	1,926
2017	0	22,551	22,551	0	1,822	1,822
2018	0	24,379	24,379	0	1,713	1,713
2019	0	26,207	26,207	0	1,601	1,601
2020	0	28,036	28,036	0	1,490	1,490
2021	0	29,864	29,864	0	1,380	1,380
2022	0	31,692	31,692	0	1,273	1,273
2023	0	33,521	33,521	0	1,171	1,171
2024	(3,410)	0	3,410	(104)	0	104

IRR= 28.31 %
B/C= 3.65
NPV= 22,765

8. MTDP - Southern Package (Road)

	Cash Flow			Discounted Cash Flow (15%)		
Year	Cost	Benefit	B-C	Cost	Benefit	B-C
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	8,612	0	(8,612)	6,512	0	(6,512)
2002	2,657	0	(2,657)	1,747	0	(1,747)
2003	2,856	0	(2,856)	1,633	0	(1,633)
2004	2,856	0	(2,856)	1,420	0	(1,420)
2005	0	22,551	22,551	0	9,749	9,749
2006	0	22,941	22,941	0	8,624	8,624
2007	0	23,330	23,330	0	7,627	7,627
2008	0	23,720	23,720	0	6,743	6,743
2009	0	24,109	24,109	0	5,959	5,959
2010	0	24,499	24,499	0	5,266	5,266
2011	0	24,888	24,888	0	4,652	4,652
2012	0	25,278	25,278	0	4,108	4,108
2013	0	25,667	25,667	0	3,628	3,628
2014	0	26,057	26,057	0	3,202	3,202
2015	0	26,447	26,447	0	2,826	2,826
2016	0	26,836	26,836	0	2,494	2,494
2017	0	27,226	27,226	0	2,200	2,200
2018	0	27,615	27,615	0	1,940	1,940
2019	0	28,005	28,005	0	1,711	1,711
2020	0	28,394	28,394	0	1,509	1,509
2021	0	28,784	28,784	0	1,330	1,330
2022	0	29,173	29,173	0	1,172	1,172
2023	0	29,563	29,563	0	1,033	1,033
2024	(7,968)	0	7,968	(242)	0	242

IRR= 52.76 %
B/C= 6.84
NPV= 64,703

9. MTDP - Central Package (Road)

	Cash Flow			Discounted Cash Flow (15%)		
Year	Cost	Benefit	B-C	Cost	Benefit	B-C
1999	0	0	0	0	0	0
2000	4,284	0	(4,284)	3,725	0	(3,725)
2001	1,362	0	(1,362)	1,030	0	(1,030)
2002	1,362	0	(1,362)	896	0	(896)
2003	1,362	0	(1,362)	779	0	(779)
2004	1,362	0	(1,362)	677	0	(677)
2005	0	1,483	1,483	0	641	641
2006	0	1,889	1,889	0	710	710
2007	0	2,295	2,295	0	750	750
2008	0	2,700	2,700	0	768	768
2009	0	3,106	3,106	0	768	768
2010	0	3,512	3,512	0	755	755
2011	0	3,918	3,918	0	732	732
2012	0	4,324	4,324	0	703	703
2013	0	4,730	4,730	0	669	669
2014	0	5,136	5,136	0	631	631
2015	0	5,542	5,542	0	592	592
2016	0	5,948	5,948	0	553	553
2017	0	6,354	6,354	0	513	513
2018	0	6,759	6,759	0	475	475
2019	0	7,165	7,165	0	438	438
2020	0	7,571	7,571	0	402	402
2021	0	7,977	7,977	0	369	369
2022	0	8,383	8,383	0	337	337
2023	0	8,789	8,789	0	307	307
2024	(4,177)	0	4,177	(127)	0	127

IRR= 19.8 %
B/C= 1.59
NPV= 4,133

10. MTDP - Eastern Package (Road)

	Cash Flow			Discounted Cash Flow (15%)		
Year	Cost	Benefit	B-C	Cost	Benefit	B-C
1999	0	0	0	0	0	0
2000	608	0	(608)	529	0	(529)
2001	430	0	(430)	325	0	(325)
2002	430	0	(430)	283	0	(283)
2003	430	0	(430)	246	0	(246)
2004	430	0	(430)	214	0	(214)
2005	0	556	556	0	240	240
2006	0	768	768	0	289	289
2007	0	980	980	0	320	320
2008	0	1,192	1,192	0	339	339
2009	0	1,403	1,403	0	347	347
2010	0	1,615	1,615	0	347	347
2011	0	1,827	1,827	0	342	342
2012	0	2,039	2,039	0	331	331
2013	0	2,251	2,251	0	318	318
2014	0	2,463	2,463	0	303	303
2015	0	2,674	2,674	0	286	286
2016	0	2,886	2,886	0	268	268
2017	0	3,098	3,098	0	250	250
2018	0	3,310	3,310	0	233	233
2019	0	3,522	3,522	0	215	215
2020	0	3,734	3,734	0	198	198
2021	0	3,946	3,946	0	182	182
2022	0	4,157	4,157	0	167	167
2023	0	4,369	4,369	0	153	153
2024	(717)	0	717	(22)	0	22

IRR= 28.97
B/C= 3.26
NPV= 3,554

11. MTDP - Skyway Stage II&III

	Cash Flow			Discounted Cash Flow (15%)		
Year	Cost	Benefit	B-C	Cost	Benefit	B-C
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	11,177	0	(11,177)	7,349	0	(7,349)
2003	11,177	0	(11,177)	6,391	0	(6,391)
2004	11,177	0	(11,177)	5,557	0	(5,557)
2005	0	31,970	31,970	0	13,821	13,821
2006	0	34,405	34,405	0	12,934	12,934
2007	0	36,839	36,839	0	12,043	12,043
2008	0	39,274	39,274	0	11,164	11,164
2009	0	41,709	41,709	0	10,310	10,310
2010	0	44,144	44,144	0	9,489	9,489
2011	0	46,579	46,579	0	8,706	8,706
2012	0	49,014	49,014	0	7,966	7,966
2013	0	51,449	51,449	0	7,271	7,271
2014	0	53,884	53,884	0	6,622	6,622
2015	0	56,319	56,319	0	6,019	6,019
2016	0	58,754	58,754	0	5,460	5,460
2017	0	61,189	61,189	0	4,944	4,944
2018	0	63,624	63,624	0	4,471	4,471
2019	0	66,059	66,059	0	4,036	4,036
2020	0	68,494	68,494	0	3,639	3,639
2021	0	70,929	70,929	0	3,277	3,277
2022	0	73,364	73,364	0	2,947	2,947
2023	0	75,799	75,799	0	2,648	2,648
2024	(8,048)	0	8,048	(245)	0	245

IRR= 61.52 %
B/C= 7.23
NPV= 118,715

12. MTDP - Port Access (R10/C3)

	Cash Flow			Discounted Cash Flow (15%)		
Year	Cost	Benefit	B-C	Cost	Benefit	B-C
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	3,523	0	(3,523)	2,316	0	(2,316)
2003	3,523	0	(3,523)	2,014	0	(2,014)
2004	3,523	0	(3,523)	1,751	0	(1,751)
2005	0	2,474	2,474	0	1,070	1,070
2006	0	3,045	3,045	0	1,145	1,145
2007	0	3,616	3,616	0	1,182	1,182
2008	0	4,188	4,188	0	1,190	1,190
2009	0	4,759	4,759	0	1,176	1,176
2010	0	5,330	5,330	0	1,146	1,146
2011	0	5,901	5,901	0	1,103	1,103
2012	0	6,472	6,472	0	1,052	1,052
2013	0	7,044	7,044	0	995	995
2014	0	7,615	7,615	0	936	936
2015	0	8,186	8,186	0	875	875
2016	0	8,757	8,757	0	814	814
2017	0	9,328	9,328	0	754	754
2018	0	9,900	9,900	0	696	696
2019	0	10,471	10,471	0	640	640
2020	0	11,042	11,042	0	587	587
2021	0	11,613	11,613	0	537	537
2022	0	12,184	12,184	0	490	490
2023	0	12,756	12,756	0	446	446
2024	(2,536)	0	2,536	(77)	0	77

IRR= 30.27 %
B/C= 2.80
NPV= 10,827

13. MTDP - C-5 North Section

	Cash Flow			Discounted Cash Flow (15%)		
Year	Cost	Benefit	B-C	Cost	Benefit	B-C
1999	0	0	0	0	0	0
2000	9,458	0	(9,458)	8,224	0	(8,224)
2001	972	0	(972)	735	0	(735)
2002	972	0	(972)	639	0	(639)
2003	972	0	(972)	556	0	(556)
2004	972	0	(972)	483	0	(483)
2005	0	5,744	5,744	0	2,484	2,484
2006	0	7,083	7,083	0	2,663	2,663
2007	0	8,421	8,421	0	2,753	2,753
2008	0	9,759	9,759	0	2,774	2,774
2009	0	11,097	11,097	0	2,743	2,743
2010	0	12,435	12,435	0	2,673	2,673
2011	0	13,773	13,773	0	2,574	2,574
2012	0	15,111	15,111	0	2,456	2,456
2013	0	16,449	16,449	0	2,325	2,325
2014	0	17,787	17,787	0	2,186	2,186
2015	0	19,125	19,125	0	2,044	2,044
2016	0	20,463	20,463	0	1,902	1,902
2017	0	21,801	21,801	0	1,762	1,762
2018	0	23,140	23,140	0	1,626	1,626
2019	0	24,478	24,478	0	1,496	1,496
2020	0	25,816	25,816	0	1,372	1,372
2021	0	27,154	27,154	0	1,255	1,255
2022	0	28,492	28,492	0	1,145	1,145
2023	0	29,830	29,830	0	1,042	1,042
2024	(6,819)	0	6,819	(207)	0	207

IRR= 30.09 %
B/C= 3.77
NPV= 28,841

14. MTDP - MRT2 Extension (Santolan - Masinag)

	Cash Flow			Discounted Cash Flow (15%)		
Year	Cost	Benefit	B-C	Cost	Benefit	B-C
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	2,274	0	(2,274)	1,300	0	(1,300)
2004	5,113	0	(5,113)	2,542	0	(2,542)
2005	0	514	514	0	222	222
2006	0	741	741	0	279	279
2007	0	968	968	0	317	317
2008	0	1,196	1,196	0	340	340
2009	0	1,423	1,423	0	352	352
2010	0	1,651	1,651	0	355	355
2011	0	1,878	1,878	0	351	351
2012	0	2,106	2,106	0	342	342
2013	0	2,333	2,333	0	330	330
2014	0	2,561	2,561	0	315	315
2015	0	2,788	2,788	0	298	298
2016	0	3,015	3,015	0	280	280
2017	0	3,243	3,243	0	262	262
2018	0	3,470	3,470	0	244	244
2019	0	3,698	3,698	0	226	226
2020	0	3,925	3,925	0	209	209
2021	0	4,153	4,153	0	192	192
2022	0	4,380	4,380	0	176	176
2023	0	4,608	4,608	0	161	161
2024	(1,092)	0	1,092	(33)	0	33

IRR= 19.09 %
B/C= 1.38
NPV= 1,439

15. MTDP - MRT3 Extension (North Ave. - Caloocan)

	Cash Flow			Discounted Cash Flow (15%)		
Year	Cost	Benefit	B-C	Cost	Benefit	B-C
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	3,641	0	(3,641)	2,082	0	(2,082)
2004	9,371	0	(9,371)	4,659	0	(4,659)
2005	0	646	646	0	279	279
2006	0	923	923	0	347	347
2007	0	1,200	1,200	0	392	392
2008	0	1,477	1,477	0	420	420
2009	0	1,754	1,754	0	433	433
2010	0	2,030	2,030	0	436	436
2011	0	2,307	2,307	0	431	431
2012	0	2,584	2,584	0	420	420
2013	0	2,861	2,861	0	404	404
2014	0	3,138	3,138	0	386	386
2015	0	3,415	3,415	0	365	365
2016	0	3,692	3,692	0	343	343
2017	0	3,969	3,969	0	321	321
2018	0	4,245	4,245	0	298	298
2019	0	4,522	4,522	0	276	276
2020	0	4,799	4,799	0	255	255
2021	0	5,076	5,076	0	235	235
2022	0	5,353	5,353	0	215	215
2023	0	5,630	5,630	0	197	197
2024	(1,748)	0	1,748	(53)	0	53

IRR= 14.57 %
B/C= 0.96
NPV= (234)

16. MTDP - MRT4 Phase I

	Cash Flow			Discounted Cash Flow (15%)		
Year	Cost	Benefit	B-C	Cost	Benefit	B-C
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	7,520	0	(7,520)	4,300	0	(4,300)
2004	21,653	0	(21,653)	10,766	0	(10,766)
2005	0	6,744	6,744	0	2,916	2,916
2006	0	7,560	7,560	0	2,842	2,842
2007	0	8,376	8,376	0	2,738	2,738
2008	0	9,192	9,192	0	2,613	2,613
2009	0	10,007	10,007	0	2,474	2,474
2010	0	10,823	10,823	0	2,326	2,326
2011	0	11,639	11,639	0	2,175	2,175
2012	0	12,455	12,455	0	2,024	2,024
2013	0	13,270	13,270	0	1,876	1,876
2014	0	14,086	14,086	0	1,731	1,731
2015	0	14,902	14,902	0	1,593	1,593
2016	0	15,718	15,718	0	1,461	1,461
2017	0	16,533	16,533	0	1,336	1,336
2018	0	17,349	17,349	0	1,219	1,219
2019	0	18,165	18,165	0	1,110	1,110
2020	0	18,981	18,981	0	1,008	1,008
2021	0	19,796	19,796	0	915	915
2022	0	20,612	20,612	0	828	828
2023	0	21,428	21,428	0	749	749
2024	(3,610)	0	3,610	(110)	0	110

IRR= 29.67 %
B/C= 2.27
NPV= 18,977

17. MTDP - North Rail (Meycauayan - Caloocan)

	Cash Flow			Discounted Cash Flow (15%)		
Year	Cost	Benefit	B-C	Cost	Benefit	B-C
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	3,862	0	(3,862)	2,540	0	(2,540)
2003	3,862	0	(3,862)	2,208	0	(2,208)
2004	16,623	0	(16,623)	8,265	0	(8,265)
2005	0	2,016	2,016	0	871	871
2006	0	2,948	2,948	0	1,108	1,108
2007	0	3,879	3,879	0	1,268	1,268
2008	0	4,811	4,811	0	1,368	1,368
2009	0	5,743	5,743	0	1,420	1,420
2010	0	6,675	6,675	0	1,435	1,435
2011	0	7,607	7,607	0	1,422	1,422
2012	0	8,539	8,539	0	1,388	1,388
2013	0	9,471	9,471	0	1,339	1,339
2014	0	10,403	10,403	0	1,278	1,278
2015	0	11,335	11,335	0	1,211	1,211
2016	0	12,267	12,267	0	1,140	1,140
2017	0	13,199	13,199	0	1,067	1,067
2018	0	14,131	14,131	0	993	993
2019	0	15,062	15,062	0	920	920
2020	0	15,994	15,994	0	850	850
2021	0	16,926	16,926	0	782	782
2022	0	17,858	17,858	0	717	717
2023	0	18,790	18,790	0	656	656
2024	(2,781)	0	2,781	(85)	0	85

IRR= 21.40 %
B/C= 1.64
NPV= 8,305

18. MTDP - MCX/PNR Improvement (Caloocan - Alabang)

	Cash Flow			Discounted Cash Flow (15%)		
Year	Cost	Benefit	B-C	Cost	Benefit	B-C
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	0	0	0	0	0	0
2003	12,348	0	(12,348)	7,060	0	(7,060)
2004	39,528	0	(39,528)	19,653	0	(19,653)
2005	0	8,902	8,902	0	3,849	3,849
2006	0	10,809	10,809	0	4,064	4,064
2007	0	12,717	12,717	0	4,157	4,157
2008	0	14,624	14,624	0	4,157	4,157
2009	0	16,532	16,532	0	4,086	4,086
2010	0	18,439	18,439	0	3,963	3,963
2011	0	20,346	20,346	0	3,803	3,803
2012	0	22,254	22,254	0	3,617	3,617
2013	0	24,161	24,161	0	3,415	3,415
2014	0	26,069	26,069	0	3,204	3,204
2015	0	27,976	27,976	0	2,990	2,990
2016	0	29,884	29,884	0	2,777	2,777
2017	0	31,791	31,791	0	2,569	2,569
2018	0	33,698	33,698	0	2,368	2,368
2019	0	35,606	35,606	0	2,176	2,176
2020	0	37,513	37,513	0	1,993	1,993
2021	0	39,421	39,421	0	1,821	1,821
2022	0	41,328	41,328	0	1,660	1,660
2023	0	43,236	43,236	0	1,510	1,510
2024	(5,927)	0	5,927	(180)	0	180

IRR= 27.68
B/C= 2.19
NPV= 31,646

19. MTDP - MRT6 (Baclaran - Imus)

	Cash Flow			Discounted Cash Flow (15%)		
Year	Cost	Benefit	B-C	Cost	Benefit	B-C
1999	0	0	0	0	0	0
2000	0	0	0	0	0	0
2001	0	0	0	0	0	0
2002	4,980	0	(4,980)	3,274	0	(3,274)
2003	4,980	0	(4,980)	2,847	0	(2,847)
2004	19,020	0	(19,020)	9,456	0	(9,456)
2005	0	3,661	3,661	0	1,583	1,583
2006	0	4,765	4,765	0	1,791	1,791
2007	0	5,870	5,870	0	1,919	1,919
2008	0	6,974	6,974	0	1,982	1,982
2009	0	8,078	8,078	0	1,997	1,997
2010	0	9,183	9,183	0	1,974	1,974
2011	0	10,287	10,287	0	1,923	1,923
2012	0	11,392	11,392	0	1,851	1,851
2013	0	12,496	12,496	0	1,766	1,766
2014	0	13,600	13,600	0	1,671	1,671
2015	0	14,705	14,705	0	1,571	1,571
2016	0	15,809	15,809	0	1,469	1,469
2017	0	16,914	16,914	0	1,367	1,367
2018	0	18,018	18,018	0	1,266	1,266
2019	0	19,122	19,122	0	1,168	1,168
2020	0	20,227	20,227	0	1,075	1,075
2021	0	21,331	21,331	0	986	986
2022	0	22,436	22,436	0	901	901
2023	0	23,540	23,540	0	822	822
2024	(3,586)	0	3,586	(109)	0	109
IRR=	0.24					
B/C=	1.88					
NPV=	13,614					

Sensitibity Test

1. Master Plan - All Projects

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	46.4	47.6	48.9	51.7	54.9	56.7	58.7
1.15	45.2	46.4	47.6	50.4	53.6	55.4	57.3
1.10	44.0	45.1	46.4	49.1	52.2	54.0	55.9
1.00	41.4	42.6	43.8	46.4	49.4	51.1	52.9
0.90	38.8	39.8	41.0	43.5	46.4	48.0	49.8
0.85	37.3	38.4	39.5	42.0	44.8	46.4	48.1
0.80	35.9	36.9	38.0	40.4	43.1	44.7	46.4

2. Master Plan - Railway Projects

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	40.6	41.8	43.2	46.3	49.9	52.0	54.3
1.15	39.3	40.6	41.9	44.9	48.4	50.4	52.7
1.10	38.1	39.3	40.6	43.5	46.9	48.9	51.0
1.00	35.5	36.6	37.8	40.6	43.8	45.6	47.7
0.90	32.8	33.9	35.0	37.6	40.6	42.3	44.2
0.85	31.5	32.5	33.6	36.0	38.9	40.6	42.4
0.80	30.1	31.0	32.1	34.4	37.2	38.8	40.6

3. Master Plan - Expressway Projects

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	50.8	52.5	54.2	58.1	62.6	65.1	67.8
1.15	49.2	50.8	52.6	56.3	60.7	63.2	65.9
1.10	47.6	49.2	50.8	54.6	58.9	61.3	63.9
1.00	44.2	45.7	47.3	50.8	55.0	57.3	59.8
0.90	40.7	42.1	43.6	46.9	50.8	53.0	55.5
0.85	38.8	40.2	41.6	44.9	48.7	50.8	53.2
0.80	36.9	38.2	39.7	42.8	46.5	48.6	50.8

4. Master Plan - Primary Road Projects

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	47.5	48.4	49.4	51.5	53.8	55.1	56.5
1.15	46.6	47.5	48.4	50.5	52.8	54.1	55.5
1.10	45.6	46.5	47.5	49.5	51.9	53.1	54.5
1.00	43.6	44.5	45.5	47.5	49.8	51.0	52.4
0.90	41.5	42.3	43.3	45.2	47.5	48.7	50.0
0.85	40.3	41.2	42.1	44.1	46.3	47.5	48.8
0.80	39.1	40.0	40.9	42.8	45.0	46.2	47.5

5. Master Plan - Secondary Road Projects

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	28.7	29.3	30.0	31.6	33.4	34.4	35.4
1.15	28.0	28.7	29.4	30.9	32.7	33.6	34.7
1.10	27.3	28.0	28.7	30.2	31.9	32.9	33.9
1.00	25.9	26.5	27.2	28.7	30.3	31.3	32.3
0.90	24.3	24.9	25.6	27.0	28.7	29.6	30.5
0.85	23.5	24.1	24.8	26.2	27.8	28.7	29.6
0.80	22.6	23.2	23.9	25.3	26.8	27.7	28.7

6. MTDP - All Projects

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	30.9	31.9	32.9	35.2	37.9	39.4	41.1
1.15	29.9	30.9	31.9	34.2	36.8	38.3	39.9
1.10	28.9	29.9	30.9	33.1	35.7	37.1	38.7
1.00	26.9	27.8	28.8	30.9	33.4	34.7	36.3
0.90	24.8	25.6	26.5	28.5	30.9	32.2	33.7
0.85	23.7	24.5	25.4	27.3	29.6	30.9	32.3
0.80	22.5	23.3	24.2	26.1	28.3	29.5	30.9

7. MTDP - Northern Package (Road)

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	28.3	28.8	29.4	30.5	31.9	32.6	33.4
1.15	27.8	28.3	28.9	30.0	31.3	32.1	32.9
1.10	27.3	27.8	28.3	29.5	30.8	31.5	32.3
1.00	26.2	26.7	27.2	28.3	29.6	30.3	31.1
0.90	25.0	25.5	26.0	27.1	28.3	29.0	29.7
0.85	24.4	24.8	25.3	26.4	27.6	28.3	29.0
0.80	23.7	24.2	24.7	25.7	26.9	27.6	28.3

8. MTDP - Southern Package (Road)

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	52.8	54.0	55.2	58.0	61.2	63.0	65.0
1.15	51.6	52.8	54.0	56.8	59.9	61.7	63.6
1.10	50.4	51.5	52.8	55.5	58.6	60.3	62.2
1.00	47.8	48.9	50.1	52.8	55.8	57.5	59.3
0.90	45.1	46.2	47.3	49.9	52.8	54.4	56.1
0.85	43.7	44.7	45.9	48.3	51.2	52.8	54.5
0.80	42.2	43.2	44.3	46.8	49.5	51.1	52.8

9. MTDP - Central Package (Road)

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	19.8	20.3	20.8	21.9	23.2	23.9	24.6
1.15	19.3	19.8	20.3	21.4	22.6	23.3	24.1
1.10	18.9	19.3	19.8	20.9	22.1	22.8	23.5
1.00	17.8	18.3	18.8	19.8	21.0	21.7	22.4
0.90	16.8	17.2	17.7	18.7	19.8	20.4	21.1
0.85	16.2	16.6	17.1	18.1	19.2	19.8	20.5
0.80	15.6	16.0	16.4	17.4	18.5	19.1	19.8

10. MTDP - Eastern Package (Road)

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	29.0	29.6	30.2	31.6	33.2	34.1	35.1
1.15	28.4	29.0	29.6	31.0	32.6	33.5	34.4
1.10	27.7	28.3	29.0	30.3	31.9	32.8	33.7
1.00	26.5	27.0	27.6	29.0	30.5	31.3	32.2
0.90	25.1	25.6	26.2	27.5	29.0	29.8	30.7
0.85	24.3	24.9	25.5	26.7	28.2	29.0	29.8
0.80	23.6	24.1	24.7	25.9	27.3	28.1	29.0

11. MTDP - Skyway Stage II&III

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	61.5	63.2	64.9	68.8	73.4	75.9	78.7
1.15	59.9	61.5	63.2	67.1	71.5	74.0	76.7
1.10	58.3	59.8	61.5	65.3	69.6	72.1	74.7
1.00	54.9	56.4	58.0	61.5	65.7	68.0	70.6
0.90	51.3	52.7	54.2	57.6	61.5	63.7	66.2
0.85	49.4	50.8	52.3	55.5	59.4	61.5	63.9
0.80	47.5	48.8	50.3	53.4	57.1	59.2	61.5

12. MTDP - Port Access(R10/C3)

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	30.3	31.1	31.9	33.9	36.1	37.3	38.7
1.15	29.5	30.3	31.1	33.0	35.2	36.4	37.8
1.10	28.7	29.5	30.3	32.1	34.2	35.4	36.8
1.00	27.0	27.7	28.5	30.3	32.3	33.5	34.7
0.90	25.2	25.9	26.7	28.3	30.3	31.4	32.6
0.85	24.3	25.0	25.7	27.3	29.2	30.3	31.4
0.80	23.4	24.0	24.7	26.3	28.1	29.2	30.3

13. MTDP - C-5 North Section

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	30.1	30.7	31.3	32.7	34.2	35.1	36.1
1.15	29.5	30.1	30.7	32.1	33.6	34.5	35.4
1.10	28.9	29.5	30.1	31.4	33.0	33.8	34.7
1.00	27.6	28.2	28.8	30.1	31.6	32.4	33.3
0.90	26.3	26.8	27.4	28.7	30.1	30.9	31.8
0.85	25.6	26.1	26.7	27.9	29.3	30.1	30.9
0.80	24.8	25.3	25.9	27.1	28.5	29.3	30.1

14. MTDP - MRT2 Extension(Santolan - Masinag)

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	19.1	19.7	20.3	21.7	23.3	24.2	25.2
1.15	18.5	19.1	19.7	21.1	22.6	23.5	24.5
1.10	17.9	18.5	19.1	20.4	22.0	22.8	23.8
1.00	16.7	17.2	17.8	19.1	20.6	21.4	22.3
0.90	15.4	15.9	16.5	17.7	19.1	19.9	20.8
0.85	14.7	15.2	15.8	17.0	18.3	19.1	19.9
0.80	14.0	14.5	15.0	16.2	17.5	18.3	19.1

15. MTDP - MRT3 Extension(North Ave. - Caloocan)

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	14.6	15.1	15.6	16.8	18.2	19.0	19.8
1.15	14.1	14.6	15.1	16.3	17.6	18.4	19.2
1.10	13.6	14.1	14.6	15.7	17.1	17.8	18.6
1.00	12.5	13.0	13.5	14.6	15.9	16.6	17.3
0.90	11.4	11.8	12.3	13.4	14.6	15.3	16.0
0.85	10.8	11.2	11.7	12.7	13.9	14.6	15.3
0.80	10.2	10.6	11.0	12.1	13.2	13.9	14.6

16. MTDP - MRT4 Phase I

<Cost>

<Revenue>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	29.7	30.7	31.8	34.2	37.1	38.7	40.6
1.15	28.7	29.7	30.7	33.1	35.9	37.5	39.3
1.10	27.7	28.7	29.7	32.0	34.7	36.2	38.0
1.00	25.7	26.6	27.5	29.7	32.2	33.7	35.3
0.90	23.6	24.5	25.3	27.3	29.7	31.0	32.5
0.85	22.6	23.4	24.2	26.1	28.4	29.7	31.1
0.80	21.5	22.2	23.1	24.9	27.1	28.3	29.7

17. MTDP - North Rail(Meycauayan - Caloocan)

<Cost>

<Revenue>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	21.4	22.0	22.7	24.1	25.8	26.7	27.8
1.15	20.8	21.4	22.0	23.5	25.1	26.0	27.0
1.10	20.2	20.8	21.4	22.8	24.4	25.3	26.3
1.00	18.9	19.5	20.1	21.4	22.9	23.8	24.8
0.90	17.5	18.1	18.7	19.9	21.4	22.2	23.1
0.85	16.8	17.4	17.9	19.2	20.6	21.4	22.3
0.80	16.1	16.6	17.1	18.4	19.8	20.5	21.4

18. MTDP - MCX/PNR Improvement(Caloocan - Alabang)

<Cost>

<Revenue>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	27.7	28.6	29.5	31.6	34.0	35.5	37.0
1.15	26.8	27.7	28.6	30.6	33.0	34.4	35.9
1.10	26.0	26.8	27.7	29.7	32.0	33.3	34.8
1.00	24.2	25.0	25.8	27.7	29.9	31.1	32.5
0.90	22.4	23.1	23.9	25.6	27.7	28.9	30.1
0.85	21.4	22.1	22.9	24.6	26.6	27.7	28.9
0.80	20.5	21.1	21.9	23.5	25.4	26.5	27.7

19. MTDP - MRT6 (Baclaran - Imus)

<Cost>

<Revenue>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	23.8	24.5	25.2	26.9	28.8	29.9	31.0
1.15	23.1	23.8	24.5	26.1	28.0	29.1	30.2
1.10	22.4	23.1	23.8	25.4	27.2	28.2	29.4
1.00	21.0	21.6	22.3	23.8	25.5	26.5	27.6
0.90	19.5	20.1	20.7	22.1	23.8	24.7	25.7
0.85	18.7	19.3	19.9	21.3	22.9	23.8	24.8
0.80	17.9	18.4	19.0	20.4	22.0	22.8	23.8

APPENDIX II

TECHNICAL NOTES/MATERIALS
FINANCIAL EVALUATION OF MTDP PROJECTS

13. FINANCIAL EVALUATION OF MTDP PROJECTS

1. Skyway Stage II&III

(PhP Million)

	Cost					
	Capital Investment	O&M	Total	Fare Revenue	Net Income	Discounted
1999						
2000						
2001						
2002	6,708		6,708		-6,708	-4,411
2003	6,708		6,708		-6,708	-3,835
2004	6,708		6,708		-6,708	-3,335
2005		201	201	2,122	1,921	830
2006		201	201	2,282	2,081	782
2007		201	201	2,443	2,242	733
2008		201	201	2,603	2,402	683
2009		201	201	2,763	2,562	633
2010		201	201	2,924	2,723	585
2011		201	201	3,084	2,883	539
2012		201	201	3,244	3,043	495
2013		201	201	3,404	3,203	453
2014		201	201	3,565	3,364	413
2015		201	201	3,725	3,524	377
2016		201	201	3,885	3,684	342
2017		201	201	4,046	3,845	311
2018		201	201	4,206	4,005	281
2019		201	201	4,366	4,165	254
2020		201	201	4,527	4,326	230
2021		201	201	4,687	4,486	207
2022		201	201	4,847	4,646	187
2023		201	201	5,007	4,806	168
2024	-4,025	201	-3,824	5,168	8,992	273
	FIRR=	11.7%				Discounted
	B/C=	0.77				at 15% p.a.
	NPV=	(2,805)				

2. Port Access(R10/C3)

(PhP Million)

	Cost					
	Capital Investment	O&M	Total	Fare Revenue	Net Income	Discounted
1999						
2000						
2001						
2002	4,244		4,244		-4,244	-2,790
2003	4,244		4,244		-4,244	-2,427
2004	4,244		4,244		-4,244	-2,110
2005		127	127	713	586	253
2006		127	127	743	616	231
2007		127	127	774	647	211
2008		127	127	804	677	192
2009		127	127	834	707	175
2010		127	127	864	737	158
2011		127	127	894	767	143
2012		127	127	925	798	130
2013		127	127	955	828	117
2014		127	127	985	858	105
2015		127	127	1,015	888	95
2016		127	127	1,045	918	85
2017		127	127	1,076	949	77
2018		127	127	1,106	979	69
2019		127	127	1,136	1,009	62
2020		127	127	1,166	1,039	55
2021		127	127	1,196	1,069	49
2022		127	127	1,227	1,100	44
2023		127	127	1,257	1,130	39
2024	-2,547	127	-2,420	1,287	3,707	113
	FIRR=	3.5%				Discounted
	B/C=	33.6%				at 15% p.a.
	NPV=	(5,119)				

3. Financial Evaluation of MRT2 Extension(Santolan - Masinag)

(PhP Million)

	Cost					Fare	Net	Discounted
	Capital Investment							
	Construction	E&M	Total	O&M	Total	revenue	Income	at15%p.a
1999								
2000								
2001								
2002								
2003								
2004	5,480	3,640	9,120		9,120		(9,120)	-4,534
2005				121	121	920	799	345
2006				128	128	967	839	315
2007				135	135	1,013	878	287
2008				141	141	1,060	919	261
2009				148	148	1,106	958	237
2010				154	154	1,153	999	215
2011				161	161	1,199	1,038	194
2012				168	168	1,246	1,078	175
2013				174	174	1,292	1,118	158
2014				181	181	1,339	1,158	142
2015				187	187	1,385	1,198	128
2016				194	194	1,432	1,238	115
2017				201	201	1,478	1,277	103
2018				207	207	1,525	1,318	93
2019				214	214	1,571	1,357	83
2020				220	220	1,618	1,398	74
2021				227	227	1,664	1,437	66
2022				234	234	1,711	1,477	59
2023				240	240	1,757	1,517	53
2024	(1,315)		(1,315)	247	(1,068)	1,804	2,872	87

FIRR= 10.1%
B/C= 0.73
NPV= -1,342

4. Financial Evaluation of MRT3 Extension(North Rail - Caloocan)

(PhP Million)

	Cost					Fare	Net	Discounted
	Capital Investment							
	Construction	E&M	Total	O&M	Total	revenue	Income	at15%p.a
1999			0		0	0	0	0
2000			0		0	0	0	0
2001			0		0	0	0	0
2002			0		0	0	0	0
2003	3,800		3,800		3,800	0	-3,800	-2,173
2004	3,800	7,346	11,146		11,146	0	-11,146	-5,542
2005			0	238	238	1,068	830	359
2006			0	253	253	1,123	870	327
2007			0	268	268	1,177	909	297
2008			0	283	283	1,232	949	270
2009			0	298	298	1,286	988	244
2010			0	313	313	1,341	1,028	221
2011			0	328	328	1,396	1,068	200
2012			0	343	343	1,450	1,107	180
2013			0	358	358	1,505	1,147	162
2014			0	373	373	1,559	1,186	146
2015			0	388	388	1,614	1,226	131
2016			0	403	403	1,669	1,266	118
2017			0	418	418	1,723	1,305	105
2018			0	433	433	1,778	1,345	95
2019			0	448	448	1,832	1,384	85
2020			0	463	463	1,887	1,424	76
2021			0	478	478	1,942	1,464	68
2022			0	493	493	1,996	1,503	60
2023			0	508	508	2,051	1,543	54
2024	-1,520		-1,520	523	-997	2,105	3,102	94

5. Financial Evaluation of MRT4 Phase I

(PhP Million)

	Cost					Fare	Net	Discounted
	Capital Investment							
	Construction	E&M	Total	O&M	Total	revenue	Income	at15%p.a
1999			0		0	0	0	0
2000			0		0	0	0	0
2001			0		0	0	0	0
2002			0		0	0	0	0
2003	9,060		9,060		9,060	0	-9,060	-5,180
2004	9,060	18,120	27,180		27,180	0	-27,180	-13,513
2005			0	525	525	3,492	2,967	1,283
2006			0	556	556	3,699	3,143	1,181
2007			0	586	586	3,905	3,319	1,085
2008			0	617	617	4,112	3,495	994
2009			0	648	648	4,319	3,671	907
2010			0	679	679	4,526	3,847	827
2011			0	709	709	4,732	4,023	752
2012			0	740	740	4,939	4,199	682
2013			0	771	771	5,146	4,375	618
2014			0	802	802	5,352	4,550	559
2015			0	832	832	5,559	4,727	505
2016			0	863	863	5,766	4,903	456
2017			0	894	894	5,972	5,078	410
2018			0	925	925	6,179	5,254	369
2019			0	955	955	6,386	5,431	332
2020			0	986	986	6,593	5,607	298
2021			0	1,017	1,017	6,799	5,782	267
2022			0	1,047	1,047	7,006	5,959	239
2023			0	1,078	1,078	7,213	6,135	214
2024	-3,624		-3,624	1,109	-2,515	7,419	9,934	302

FIRR= 9.5%
B/C= 0.69
NPV= -6,412

6. Financial Evaluation of North Rail(Meycauayan - Caloocan)

(PhP Million)

	Cost					Fare	Net	Discounted
	Capital Investment							
	Construction	E&M	Total	O&M	Total	revenue	Income	at15%p.a
1999			0		0	0	0	0
2000			0		0	0	0	0
2001			0		0	0	0	0
2002	4,653		4,653		4,653	0	-4,653	-3,059
2003	4,653		4,653		4,653	0	-4,653	-2,660
2004	4,654	16,360	21,014		21,014	0	-21,014	-10,448
2005			0	226	226	1,796	1,570	679
2006			0	248	248	1,965	1,717	645
2007			0	270	270	2,134	1,864	609
2008			0	292	292	2,303	2,011	572
2009			0	314	314	2,472	2,158	533
2010			0	336	336	2,640	2,304	495
2011			0	358	358	2,809	2,451	458
2012			0	380	380	2,978	2,598	422
2013			0	402	402	3,147	2,745	388
2014			0	425	425	3,316	2,891	355
2015			0	463	463	4,000	3,537	378
2016			0	506	506	4,169	3,663	340
2017			0	548	548	4,338	3,790	306
2018			0	591	591	4,506	3,915	275
2019			0	634	634	4,675	4,041	247
2020			0	677	677	4,844	4,167	221
2021			0	720	720	5,013	4,293	198
2022			0	763	763	5,182	4,419	178
2023			0	806	806	5,351	4,545	159
2024	-2,792		-2,792	849	-1,943	5,520	7,463	227

FIRR= 6.7%
B/C= 0.51
NPV= -8,481

7. Financial Evaluation of MCX/PNR Improvement (Caloocan - Alabang)

(PhP Million)

	Cost					Fare	Net	Discounted
	Capital Investment							
	Construction	E&M	Total	O&M	Total	revenue	Income	at15%p.a
1999			0		0	0	0	0
2000			0		0	0	0	0
2001			0		0	0	0	0
2002			0		0	0	0	0
2003	14,877		14,877		14,877	0	-14,877	-8,506
2004	14,877	34,847	49,724		49,724	0	-49,724	-24,721
2005			0	1,447	1,447	10,791	9,344	4,039
2006			0	1,517	1,517	11,254	9,737	3,660
2007			0	1,587	1,587	11,717	10,130	3,311
2008			0	1,657	1,657	12,181	10,524	2,992
2009			0	1,727	1,727	12,644	10,917	2,699
2010			0	1,797	1,797	13,107	11,310	2,431
2011			0	1,867	1,867	13,570	11,703	2,187
2012			0	1,936	1,936	14,033	12,097	1,966
2013			0	2,006	2,006	14,497	12,491	1,765
2014			0	2,076	2,076	14,960	12,884	1,583
2015			0	2,146	2,146	15,423	13,277	1,419
2016			0	2,216	2,216	15,886	13,670	1,270
2017			0	2,286	2,286	16,349	14,063	1,136
2018			0	2,355	2,355	16,813	14,458	1,016
2019			0	2,425	2,425	17,276	14,851	907
2020			0	2,495	2,495	17,739	15,244	810
2021			0	2,565	2,565	18,202	15,637	722
2022			0	2,635	2,635	18,665	16,030	644
2023			0	2,705	2,705	19,129	16,424	574
2024	-5,951		-5,951	2,775	-3,176	19,592	22,768	692

FIRR= 16.2%
B/C= 1.07
NPV= 2,598

8. Financial Evaluation of MRT6(Baclaran - Imus)

(PhP Million)

	Cost					Fare	Net	Discounted
	Capital Investment							
	Construction	E&M	Total	O&M	Total	revenue	Income	at15%p.a
1999			0		0	0	0	0
2000			0		0	0	0	0
2001			0		0	0	0	0
2002			0		0	0	0	0
2003	9,000		9,000		9,000	0	-9,000	-5,146
2004	9,000	18,000	27,000		27,000	0	-27,000	-13,424
2005			0	349	349	2,874	2,525	1,091
2006			0	389	389	3,189	2,800	1,053
2007			0	429	429	3,505	3,076	1,006
2008			0	468	468	3,820	3,352	953
2009			0	508	508	4,135	3,627	897
2010			0	547	547	4,451	3,904	839
2011			0	587	587	4,766	4,179	781
2012			0	627	627	5,081	4,454	724
2013			0	666	666	5,396	4,730	668
2014			0	706	706	5,712	5,006	615
2015			0	746	746	6,027	5,281	564
2016			0	785	785	6,342	5,557	516
2017			0	825	825	6,658	5,833	471
2018			0	864	864	6,973	6,109	429
2019			0	904	904	7,288	6,384	390
2020			0	944	944	7,604	6,660	354
2021			0	983	983	7,919	6,936	320
2022			0	1,023	1,023	8,234	7,211	290
2023			0	1,063	1,063	8,549	7,486	262
2024	-3,600		-3,600	1,102	-2,498	8,865	11,363	345

FIRR= 10.1%
B/C= 0.70
NPV= -6,001

Sensitibity Test

1. Skyway Stage II&III

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	11.7	12.2	12.7	13.9	15.3	16.1	17.0
1.15	11.2	11.7	12.2	13.4	14.8	15.5	16.4
1.10	10.7	11.1	11.7	12.8	14.2	14.9	15.7
1.00	9.6	10.1	10.6	11.7	12.9	13.7	14.5
0.90	8.5	8.9	9.4	10.4	11.7	12.4	13.1
0.85	7.9	8.3	8.8	9.8	11.0	11.7	12.4
0.80	7.3	7.7	8.1	9.1	10.3	11.0	11.7

2. Port Access(R10/C3)

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	38.7	39.9	41.1	43.7	46.7	48.4	50.1
1.15	37.5	38.7	39.9	42.6	45.5	47.1	48.9
1.10	36.3	37.5	38.7	41.3	44.3	45.9	47.6
1.00	33.8	34.9	36.1	38.7	41.6	43.2	44.9
0.90	31.0	32.1	33.3	35.8	38.7	40.3	41.9
0.85	29.4	30.6	31.8	34.3	37.1	38.7	40.4
0.80	27.8	29.0	30.2	32.7	35.5	37.1	38.7

3. MRT2 Extension (Santolan - Masinag)

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	10.1	10.7	11.4	12.8	14.6	15.5	16.6
1.15	9.5	10.1	10.8	12.2	13.9	14.8	15.9
1.10	8.9	9.5	10.1	11.5	13.1	14.1	15.1
1.00	7.7	8.2	8.8	10.1	11.7	12.5	13.5
0.90	6.3	6.9	7.4	8.7	10.1	10.9	11.9
0.85	5.6	6.1	6.7	7.9	9.3	10.1	11.0
0.80	4.9	5.4	5.9	7.1	8.5	9.3	10.1

4. MRT3 Extension (North Ave. - Caloocan)

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	4.8	5.3	5.9	7.1	8.5	9.3	10.2
1.15	4.3	4.8	5.3	6.6	7.9	8.7	9.6
1.10	3.7	4.3	4.8	6.0	7.4	8.1	8.9
1.00	2.6	3.1	3.6	4.8	6.1	6.9	7.7
0.90	1.4	1.9	2.4	3.5	4.8	5.5	6.3
0.85	0.7	1.2	1.7	2.8	4.1	4.8	5.5
0.80	0.1	0.5	1.0	2.1	3.4	4.1	4.8

5. MRT4 Phase I

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	9.5	10.1	10.7	12.1	13.7	14.6	15.6
1.15	8.9	9.5	10.1	11.4	13.0	13.9	14.9
1.10	8.3	8.9	9.5	10.8	12.3	13.2	14.2
1.00	7.1	7.6	8.2	9.5	11.0	11.8	12.7
0.90	5.8	6.3	6.9	8.1	9.5	10.3	11.1
0.85	5.1	5.6	6.1	7.3	8.7	9.5	10.3
0.80	4.4	4.9	5.4	6.6	7.9	8.7	9.5

6. North Rail(Meycauayan - Caloocan)

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	6.7	7.1	7.6	8.7	9.9	10.6	11.4
1.15	6.2	6.7	7.1	8.2	9.4	10.1	10.8
1.10	5.7	6.2	6.7	7.7	8.9	9.6	10.3
1.00	4.7	5.2	5.6	6.7	7.8	8.5	9.2
0.90	3.7	4.1	4.6	5.5	6.7	7.3	8.0
0.85	3.1	3.5	4.0	4.9	6.0	6.7	7.3
0.80	2.5	2.9	3.4	4.3	5.4	6.0	6.7

7. MCX/PNR Improvement (Caloocan - Alabang)

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	16.2	17.0	17.8	19.8	22.0	23.3	24.8
1.15	15.4	16.2	17.0	18.9	21.1	22.4	23.8
1.10	14.6	15.4	16.2	18.0	20.2	21.4	22.7
1.00	13.0	13.7	14.5	16.2	18.2	19.4	20.6
0.90	11.3	11.9	12.7	14.3	16.2	17.3	18.5
0.85	10.4	11.0	11.7	13.3	15.1	16.2	17.3
0.80	9.4	10.1	10.8	12.3	14.1	15.1	16.2

8. MRT6 (Baclaran - Imus)

<Revenue> \ <Cost>	1.20	1.15	1.10	1.00	0.90	0.85	0.80
1.20	10.1	10.7	11.3	12.6	14.0	14.9	15.8
1.15	9.6	10.1	10.7	12.0	13.4	14.3	15.2
1.10	9.0	9.6	10.1	11.4	12.8	13.6	14.5
1.00	7.9	8.4	8.9	10.1	11.5	12.3	13.1
0.90	6.6	7.1	7.7	8.8	10.1	10.9	11.7
0.85	6.0	6.5	7.0	8.1	9.4	10.1	10.9
0.80	5.3	5.8	6.3	7.4	8.7	9.4	10.1

APPENDIX II

TECHNICAL NOTES/MATERIALS
AIR POLLUTION PROJECTION

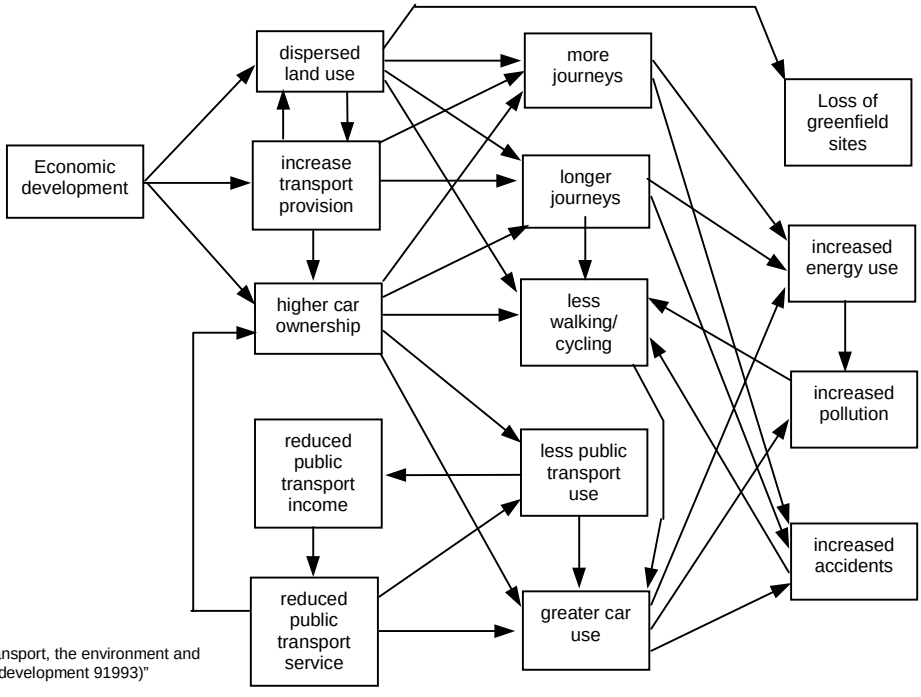
14. AIR POLLUTION PROJECTION

As transport brings unquestionable benefits so does it cause an indispensable side effect such as environmental degradation. This chapter examines the interaction between transport and environment which contribute to unsustainability in urban travel. And because of the side effect of transport, transport policies were considered in many countries. Recently prototypical example of transport policy was introduced in some countries. However, proposed measures for air quality improvement in Metro Manila will be taken into account. Based on these backgrounds, an environmental analysis for Metro Manila was carried out. Transport policy for sustainable environment development was roughly recommended.

Interaction between transport and environment

Above all, it is greatly important to understand interaction between transport and environment because transport policy starts form it. As Figure 1 indicates, a lot of factors are to a considerable extent interrelated. In general, environmental impact is determined largely by vehicles themselves and the way they are used. In the latter's case it is important how to cope with rapidly increasing travel demand, i.e. more journeys, longer journeys and greater car use. The travel demand has been increasing at a rapid rate annually. Comparison of the 1980 and 1996 person trip surveys in Metro Manila indicates that over the 16-year period, the number of trip increased by 63.6%. Also, rough estimation shows that total vehicle travel in the year 2015, in veh-km, will increase by around 170% in the case of "Do-Nothing". These are encouraged by a number of factors, including the trend of lower density development; construction of larger, more remote, schools, shopping centers and hospitals, provision of transport at less than the marginal cost, and discouragement of shorter journeys. As a result, conditions for walking and cycling are worsened and the level of public service is reduced. More journeys, longer journeys and greater car use adversely impacted on the environment and a radically different concept on how to deal with those factors is being taken in many other countries.

Figure 1
Interaction between Transport and Environment
in a Sustainable Development



Source: "Transport, the environment and sustainable development 91993)"

Policy Responses

As environmental quality has worsened day by day, a new approach or concept has been proposed. In the past, demand forecasts have been made for traffic and networks, have been defined to meet that demand. It has now been realized that it may not be socially efficient or desirable or possible to meet unrestricted demand. So, TDM (Transport Demand Management) measures have become key concerns of transport planners. In particular, the integrated package approach, including supply-side and demand-side or institutionalized measures has been thought to be greatly effective to reduce travel demand and improve environment. As a result, the policy goal is attained. An example of integrated package approach, as shown in Table 1, includes financing factor, , demand-side factor, fare level factor and supply-side factor. It should be stressed that pricing-related measure and measures for improving non-motorized transport, like walking and cycling, are considered important tools to improvement of air quality.

Table 1
An Example of Integrated Package Approach

Strategy	Do Minimum	C1	C2	C3	C4	C5	C6
Access by car	**-----**	+++	-	--	--	++	--
Access by bus/rail	----	+++	+++	-++	-	+++	--
Environmental Quality	**-----**	+	--	-	---	+	---
Local economic quality	----	----	-	----	--	---	---
Fuel consumption	-16%	-2%	-7%	0	-10%	-1%	-12%
Causality	-7%	-8%	-1%	-7%	-2%	-7%	-3%
Benefits (£m NPV)	N/A	-410	-300	-330	-180	-310	-110
Finance (£m PVF)	N/A	-260	-270	-100	-160	-10	0
Capital cost (£m 1990)	N/A	530	520	530	540	5830	340

Key < Worse

----- ---- --- -- - || - -- --- ---- -----

NPV: Net Present Value as measure of economic efficiency relative to Do Maximum

THE SIX COMBINED STRATEGIES

Strategy	C1	C2	C3	C4	C5	C6
Finance	High	High	Medium	Medium	Low	Low
Infrastructure	NS EW WR	NS EW WR	NS EW WR	NS WR	NS EW WR	NS WR
Capacity Reduction (%)[1]	10%	10%	25%	10%	25%	10%
Fares level (%)[2]	-50%	0	-25%	0	-10%	-25%
Road pricing	Yes	No	Yes	No	Yes	No

Notes
1. High : £200m - £300m PVF"
   Medium : £100m - £200m PVF"
   Low : Zero financial outlay
   NS : North-South Light Rapid Transit:
   EW : East-West Light Rapid Transit:
   WR : Western Radial
2. Percentage reduction in city center road capacity.
3. Percentage change from level anticipated in 2010.
   Inclusion or otherwise of a change of £1.50 to enter or leave the city center throughout the day

As a general guideline for improving air quality, measures as Table 2 can be takenm into account. In Metro Manila , measures which seem to be appropriate for reducing air pollution were proposed by foreign research group. The measures are categorized as traffic, power, fuel combustion other than in power plants, non-combustion sources, construction and refuse burning and ones in traffic are summarized as follows:

1) Enhancing effectiveness of the anti-smoke belching program;
2) Improving diesel fuel quality;
3) Implementation of a scheme for inspection and maintenance;
4) Fuel switches (diesel to gasoline) in the transportation sector induced by price-shifts;
5) Adoption of clean vehicle emission standards; and
6) Other measures;

Source: URBAIR (1995)

These measures were evaluated from the viewpoint of benefit/cost analysis and its result showed that those measures could bring a great of benefit. However, the measures taken above are related to technical factors and no transport-related measures were evaluated. From the viewpoint of transport, its impact on air pollution is herein analyzed and discussed.

Table 2
General Guideline for Improving Air Pollution

1. Technical Fixes 1: Pollutant Reduction and Energy Efficiency	
Pollution reduction technology	– oxidation catalysts three-way catalysts catalytic trap oxidisers
Improving energy efficiencies	– engine changes (e.g. lean burn) weight reduction aerodynamics other technological modifications (e.g. transmission changes, rolling resistance)
Technical fixes 2: Alternative Fuels and Power Sources	
Diesel Electricity Hydrogen Alternative power sources (e.g. power, gas from power stations, renewable sources) Gas (e.g. liquefied natural gas, liquefied petroleum gas) Methanol and ethanol	
2. The Role of the Driver	
Lower average engine size: the vehicle purchase decision The vehicle replacement decision Increasing car occupancies Better driving Better maintenance	
3. Transport Planning Policies	
Intermodal shift Road traffic management	– Improving traffic flow reducing excessive speeds discouraging car traffic
Land-use planning Other policies	– public information campaigns encouraging telecommuting
4. Transport Planning Policies	

Source: Road pricing
Fuel pricing and taxation policies
Company car tax policies
Vehicle pricing and taxation

Environmental Analysis in Metro Manila

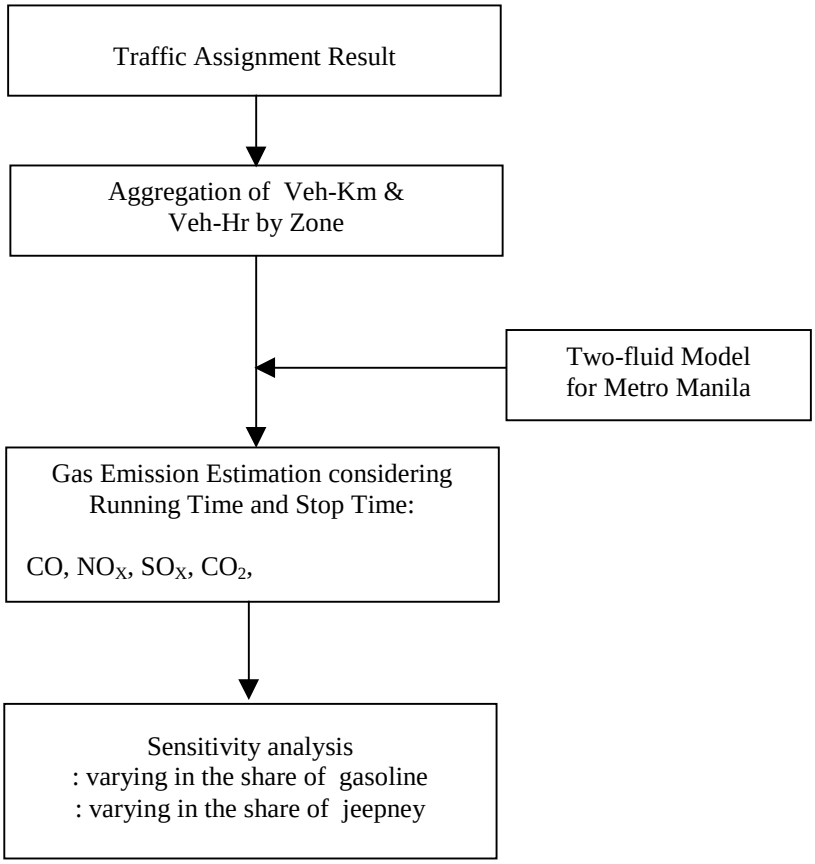
Environmental analysis model was developed in order to examine the impact of transport on air pollution. In addition, some scenarios were evaluated based on this model.

Methodology: air pollution is affected by many factors and composes of a very complex function. Its general form can be expressed as:

Air pollutant emission = f (travel distance, travel speed, idling, emission factors, wind speed, wind direction)

However it must be noted that it is very difficult to put so many factors into air pollution model, especially macro analysis model. In general, traditional traffic assignment model uses travel distance, travel speed and emission factor as exogenous factors to conduct emission estimation. However, the methodology presented in this paper will include idling factor and estimate air pollutant emission.

Figure 2
Methodology for Environment Analysis



Methodology for environment analysis is shown if Figure 2. Firstly, travel distances (veh-km) and average speed (km/h) are aggregated by each zone based on traffic assignment results for "Do-Nothing", "Master Plan" and Do-Max". air pollutants emissions, as mentioned earlier, are estimated based on travelling distance and average speed. However, we have to be attention that air pollutant emissions are affected by travelling patterns in while vehicles is not only moving but also stopped. In order to do reasonable emission estimation, we have to consider air pollutant emissions in while vehicle is not only moving but also stopped. Problems is that traffic assignment result estimated from STRADA doesn't give any information on vehicle stop time. That's why we incorporate two fluid model, we can estimate emission unit in while vehicle is stopped (i.e. idling) as well as emission unit in while vehicle is moving. After then, each air pollutant emissions (CO, NO_X, SO_X, and PM) are estimated by zone. Finally, sensitivity analysis by varying in the share of gasoline and diesel and the share of bus and jeepney was carried out.

Two-Fluid Model: Two –fluid model deals with a simple relation between two traffic variables, namely the travel time per unit distance (reciprocal of speed) and the stop time per unit distance. Likewise the traffic in a non-highway urban street network may be considered to consist of two traffic fluids – one composed of moving vehicles an the other of vehicles that are stopped as a consequence of congestion, traffic control devices, obstruction resulting from construction, accidents, etc., but not cars stopped in the parked condition.

In the two fluid model ideas are followed by assuming that the average speed of the moving cars, ν_r depends on the fraction of the cars that are moving, f_r in the following form:

$$\nu_r = \nu f_r^{-1} = \nu_m (1 - f_r)^n$$

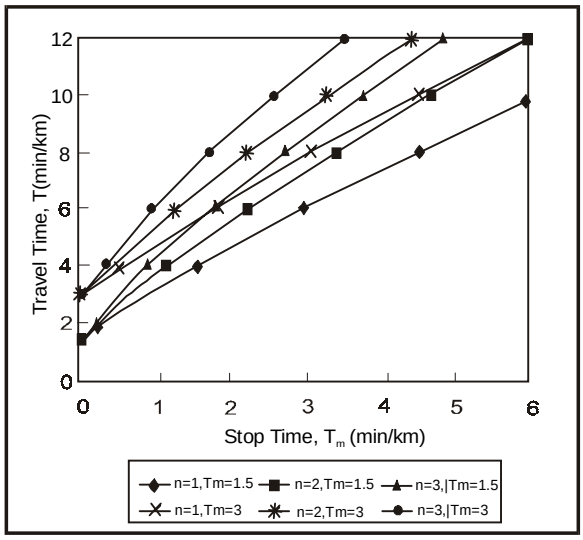
Where ν_m is the average maximum running speed in the network, ν is the average speed of the traffic, and n is a parameter. Note that

$f_r + f_s = 1$
$\nu_m = 1/T_m$
$\nu_r = 1/T_r$
$\nu = 1/T$

where f_s and f_r are the fraction of the vehicles stopped and moving, respectively: T_m is a parameter representing the average minimum trip time per unit distance: T_r is the running time per unit distance: and T is the trip time per unit distance. If, in addition, the stop time per unit distance is denoted by T_s, it follows that:

$T = T_s + T_r$

Figure 3
Travel Time Versus Stop Time Relation



In the two-fluid model it is also assumed that the fraction of time stopped for the with vehicle circulating in a network, $(T_s/T)_1$, is equal to the average fraction of the population of vehicles stopped in the system, $\langle f_s \rangle_p$, over the same time period, namely,

$\langle f_s \rangle_p = (T_s/T)_1$

These assumptions lead to the two-fluid model relation between the trip time, T, and the running time, T_r, namely:

$$T_r = T_m^{\frac{1}{n+1}} T^{\frac{n}{n+1}}$$

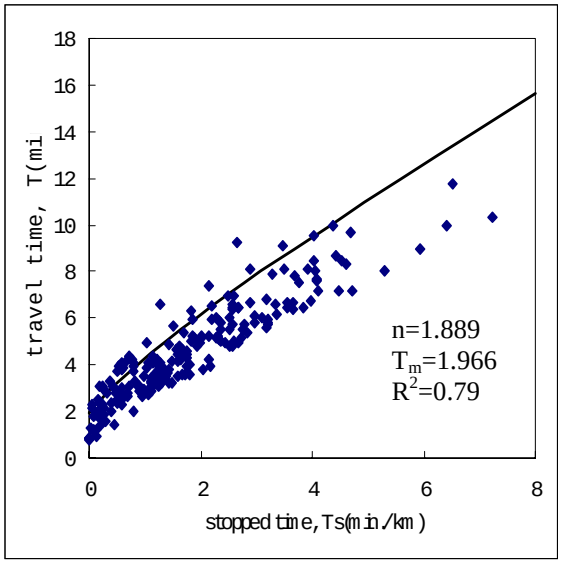
Yielding the final result:

$$T_s = T - T_m^{\frac{1}{n+1}} T^{\frac{n}{n+1}}$$

The two-fluid model represented by equation yields a curvilinear relation between T and T_s as shown in Figure 3 for T_m values of 1,2 and 3.

A traffic system with smaller values of parameters T_m and n offers a better time per unit distance or the reciprocal of the average maximum speed that can be achieve in a network under the lightest traffic conditions. Therefore, the larger T_m implies a less efficient network geometry and control system.

Figure 4
Two-fluid Model for Metro Manila



Two-fluid model in Metro Manila, as shown in Figure 4, was estimated using speed survey data (refer to Appendix A) collected in MMUTIS speed survey in 1997. As a result, two-fluid model in Metro Manila has significantly high values of T_m = 1.966 (min/km) and n = 1889. As mentioned earlier, it must be noted that a city which appears to have less traffic control and geometric features has higher values of T_m and n. Therefore, it seems that Metro Manila with significantly high values of T_m and n has less traffic control and geometric features. Actually, it is thought that Metro Manila has higher values of T_m and n because it has bad traffic control, long-cycled traffic signals and so on.

Table 3
Comparison of Two-fluid Model with Other Cities

Downtown Network	Two-Fluid Model Parameter		
	T_m (min./km)	n	R^2
London, 1984	1.26	1.66	0.86
Lubbock, 1984	1.33	0.82	0.70
San Antonio, 1984	1.24	1.33	0.81
Albuquerque	1.20	1.62	0.70
Roanoke	1.19	1.60	0.79
Tehran, Iran	1.57	1.45	0.74
Matamoros, Mexico	1.85	2.10	0.88
Brussels	0.78	2.67	0.92
Austin	1.11	1.65	0.78
Dallas	1.22	1.48	0.80
Houston	1.68	0.80	0.63
Milwaukee	0.98	1.41	0.81
Melbourne	1.08	1.41	0.95
Sydney	1.15	1.68	0.88
Metro Manila	1.97	1.89	0.79

Note: two-fluid models except Metro Manila were cited from “traffic engineering and control, 1985”

Table 3 shows the comparison of two-fluid model with ones for other cities. Two-fluid model in Metro Manila has significantly high values of T_m and n compared to other cities. From this comparison, it is manifest that Metro Manila has less efficient network geometry and control system.

Aggregation of Travel Distance & Average Speed: Travel distance (veh-km) and average speed (km/h) were aggregated by zone (refer to Appendix B). Table 4 shows the summary of changes in travel distance and average speed. It must be noted that, in the case of "Do-Nothing" without any projects, travel distance greatly increased, especially in private vehicle, and average speed greatly decreased. On the other hand, travel distance in public vehicle for both "Master Plan" and "Do-Max" decreased up to about 40%. It seems to be because MRT systems was incorporated into "Master Plan" and "Do-Max" and users of public transport converted to MRT. This, as already known well, means that railways system such as MRT, subway, etc. contributes to shorter travel journey and the environmental improvement. However, the increase of travel distance in private vehicle is still high even for both "Master Paln" and "Do- Max".

One problem of traffic assignment results estimated from STRADA is that average speeds in CBD area such as Manila and Makati City were estimated highly (refer to Appendix B), even though actual speeds are significant low. It seems that traffic assignment results estimated from STRADA can't consider factors such as delay time at signal intersection and do on.

Based on travel distance and average speed, air pollutant emissions are estimated as a next step.

Table 4
Change in Travel Distance & Ave. Speed

	Present (1996)		Do-Nothing (2015)		Master Plan (2015)		Do-Max (2015)	
	Public	Private	Public	Private	Public	Private	Public	Private
Veh-km ('000)	9,827	24,434	15,017 (+52.3)	76,319 (+212.3)	6,480 (-34.1)	43,290 (+77.2)	4,925 (49.9)	39,764 (+62.7)
Ave. Speed	28.9	30.6	13.5 (-53.3)	13.1 (-57.2)	19.4 (-37.3)	19.2 (-37.3)	19.2 (-33.6)	20.1 (-34.3)

Note: parenthesis refers to % changes which report present situation

Emission Estimation: In the emission estimation, a basic requirement is the air pollutant emission parameter varying travel by speed and mode type. As the emission parameter for emission estimation couldn't be obtained, it was built from MMUTIS environmental survey. The air pollutant emission parameters are followed as Table 5-8. All the air pollutants taken in this paper are related to local or regional factors. It is noted that global factors such as CO2 were not taken in this paper because of the constraint of data set.

The emission parameters are different by mode types, i.e. car, jeepney and bus. Here, it is a problem how to reflect the emission parameters of jeepney and bus upon the emission estimation for public transport because jeepney and bus aren't separated in traffic assignment results. So, the share of the present travel distance for jeepney and bus was used to divide the travel distance by public transport into travel distances by jeepney and bus, Table 9 shows the share of the present travel distance for jeepney and bus obtained from MMUTIS person trip survey.

Table 5
CO Emission Parameter

		Idling	-10km/h	10km/h~20km/h	20km/h~
Gasoline	Car	0.0858	27.57	23.50	18.70
	Jeepney	0.0781	47.58	52.20	41.14
Diesel	Car	0.0095	7.85	6.54	5.94
	Jeepney	0.0124	8.02	6.80	6.20
	Bus	0.0214	8.12	7.11	6.50
Unit		g/min.	g/km	g/km	g/km

Note: air pollution emission parameter was built from MMUTIS air pollution survey.

Table 6
NO_X Emission Parameter

		Idling	-10km/h	10km/h~20km/h	20km/h~
Gasoline	Car	1.51	2.75	2.76	2.78
	Jeepney	1.55	4.70	3.59	3.53
Diesel	Car	6.84	5.65	4.28	3.89
	Jeepney	9.35	8.95	7.66	7.01
	Bus	12.6	11.24	10.59	9.22
Unit		g/min.	g/km	G/km	g/km

Note: air pollution emission parameter was built from MMUTIS air pollution survey.

Table 7
SO_X Emission Parameter

		Idling	-10km/h	10km/h~20km/h	20km/h~
Gasoline	Car	0.018	0.013	0.011	0.011
	Jeepney	0.02	0.015	0.011	0.010
Diesel	Car	0.09	0.140	0.080	0.070
	Jeepney	0.18	0.180	0.121	0.110
	Bus	0.22	0.200	0.150	0.100
Unit		g/min.	g/km	G/km	g/km

Note: air pollution emission parameter was built from MMUTIS air pollution survey.

Table 8
PM Emission Parameter

		Idling	-10km/h	10km/h~20km/h	20km/h~
Gasoline	Car	0.10	0.07	0.05	0.05
	Jeepney	0.10	0.07	0.06	0.05
Diesel	Car	0.90	1.20	0.07	0.07
	Jeepney	1.50	1.80	0.90	0.81
	Bus	1.50	2.30	1.50	0.80
Unit		g/min.	g/km	G/km	g/km

Note: air pollution emission parameter was built from MMUTIS air pollution survey.

Table 9
The Share of the Present Travel Distance by Jeepney and Bus

	Vehicle trips ('000)	Ave. Trip Length (km)	Veh-km ('000)	Share of veh-km (%)
Bus	57	13.0	741	31.5
Jeepney	460	3.5	1,610	68.5

In addition, it is necessary to consider the share of gasoline and diesel of mode type because emission parameters are different by engine type. Table 10 shows the share of gasoline and diesel of mode type and emission estimation was conducted by assuming that their share would not change even in the future, 2015.

Table 10
The Share of Gasoline & Diesel of Mode Type

	Car	Jeepney	Bus
Gasoline	95.3%	54.6%	6.7%
Diesel	4.7%	45.4%	93.3%

Source: MMUTIS Survey

Air pollutants can be estimated as follows:

Air pollutants = travel distance (veh-km)* emission factor at running speed (g/veh-km)
+ total stop time (min)* emission factor at stop time (g/min)

The air pollutants were estimated based on this equation (refer to Figure 4-7 and Appendix C). Table 11 shows the emission estimation results. Some founding can be taken from the emission estimation results. Firstly, areas with MRT system have comparatively low increases in air pollutant emission. Secondly, there are significant increases in air pollutant emission even in "Master Plan" and "Do-Max" and it seems that this is mainly caused by the travel distance increase of private transport. In order to preserve the present situation or improve the air pollution quality, the reduction of private transport volume is required. This will be discussed in details later.

Table 11
Emission Estimation Results

	Present (1996)	Do-Nothing (2015)	Master Plan (2015)	Do-max (2015)
CO	841.5	2372.1 (+181.9)	1286.1 (+52.8)	1161.6 (+38.0)
NO_X	145.7	613.7 (+321.2)	232.2 (+59.4)	201.4 (+38.2)
SO_X	1.3	6.9 (+430.7)	2.2 (+69.2)	1.9 (+46.1)
PM	9.5	49.0 (+415.8)	15.5 (+63.1)	13.1 (+37.9)

Note: parentheses refer to % increases with regard o present situation. Unit: ton/day

Sensitivity Analysis: Sensitivity analysis was done in order to investigate how changes in the mode and engine type will affect air pollutant emissions. Scenario 1 and 2 indicate the change in the share of gasoline and diesel, and Scenario 3 and 4 indicate the change in the share of bus and jeepney.

Table 12
Changes in the Share of Gasoline and Diesel

	Jeepney Gasoline	Jeepney Diesel
Present	54.6%	45.4%
Scenario 1	75.0%	25.0%
Scenario 2	100.0%	0.0%

Table 13
Changes in the Share of Bus and Jeepney

	Jeepney Gasoline	Jeepney Diesel
Present	3.15%	68.5%
Scenario 3	50.0%	50.0%
Scenario 4	75.0%	25.0%

Sensitivity analysis was conducted based on these four scenarios. Results, as referred to Table 14, show that, as the share of gasoline vehicle increases, CO emission increases and the remainder decreases, and as the bus share increases, CO emission decreases and the remainder increases. However, increase of CO emission, generally speaking, is very small and it seems that more gasoline vehicle and less bus share have good impact on the air pollution.

Table 14
Sensitivity Analysis Results

	Master Plan	Scenario 1	Scenario 2	Scenario 3	Scenario 4
CO	1,286.1	1,319.4 (+2.6)	1,360.3 (+5.7)	1,262.4 (-1.8)	1,230.4 (-4.3)
NO_X	232.2	225.4 (-2.9)	217.0 (-6.5)	242.1 (+4.3)	255.3 (+9.9)
SO_X	2.23	2.06 (-7.6)	1.86 (-16.6)	2.37 (+6.3)	2.54 (+13.9)
PM	15.5	14.1 (-9.0)	12.4 (-20.0)	16.6 (+7.1)	18.1 (+16.8)

Note: parentheses refer to % increases with regard o present situation. Unit: ton/day

Recommendation for Sustainable Environment Development

Analysis results showed that, compared to “Do-Nothing”, “Master Plan” and Do-Max” brought much reduction in air pollutant emission. However, it must be noted that the increase of air pollutant emission even in “Master Plan” and “Do-Max” is very significant and it will increase by around 30-50% as compared to the present situation. It could be found with ease that this is caused by intractable private vehicle increase. This means that only supply-side transport measures may not solve transport problems such as traffic congestion and the environmental concern s with which Metro Manila is facing now. From now on, as explained earlier, integrated package approach should be considered and evaluated in Metro Manila. In MMTUIS, pricing related measures such as heavier vehicle tax, heavier fuel tax, road pricing and cordon pricing were also taken and their effect were evaluated. Among those measures, EDSA cordon pricing was taken as an experimental case in order to investigate its effect on air pollutant reduction. As a result, air pollutants in the case of Master Plan with EDSA cordon pricing were reduced up to about 6% with regards to “Master Plan”. It seems that air pollutant reduction would be very significant in the case with heavier vehicle tax. Integrated package approach in Metro Manila will contribute to traffic congestion reduction and air quality improvement.

Figure 4
CO Emissions

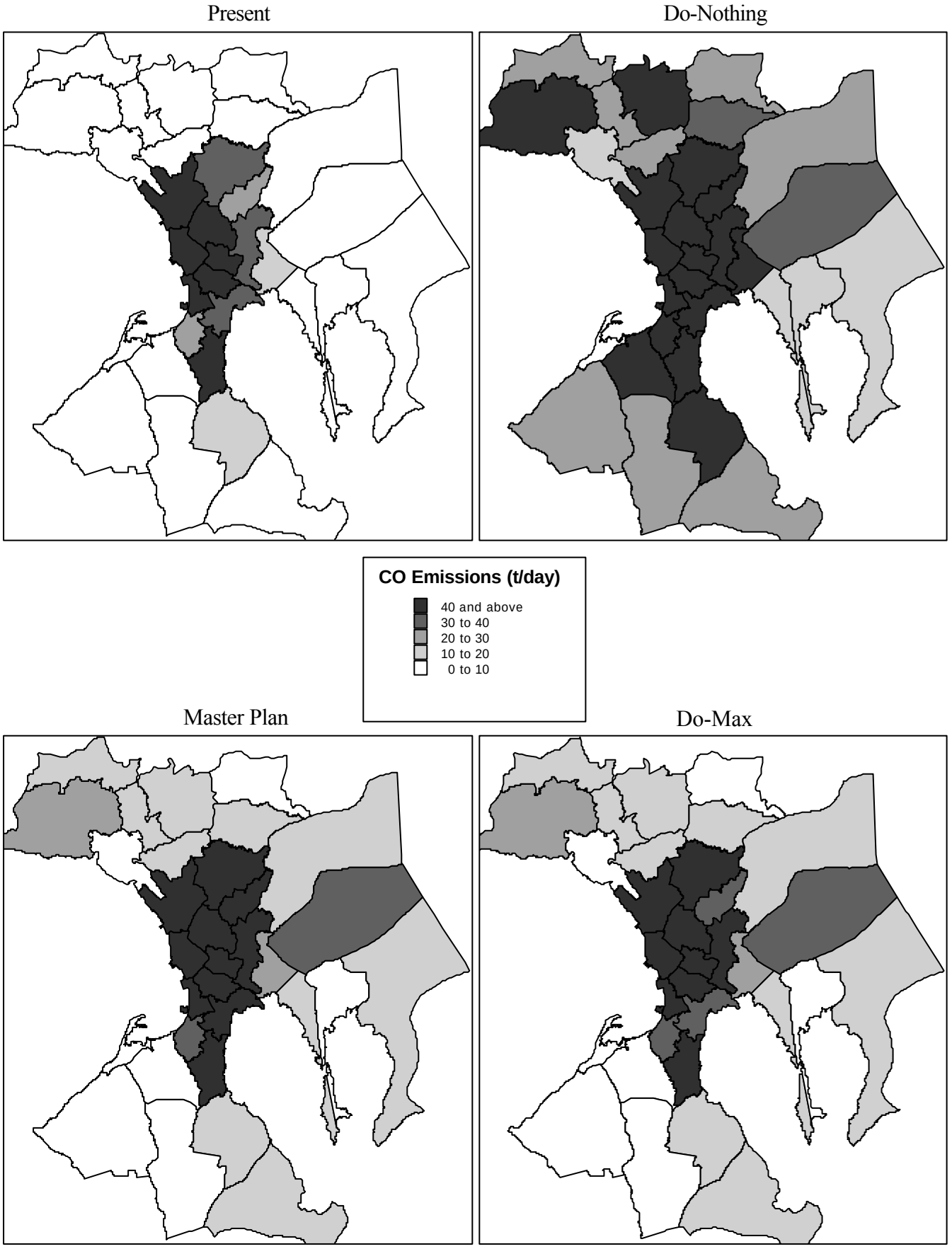


Figure 5
NOx Emissions

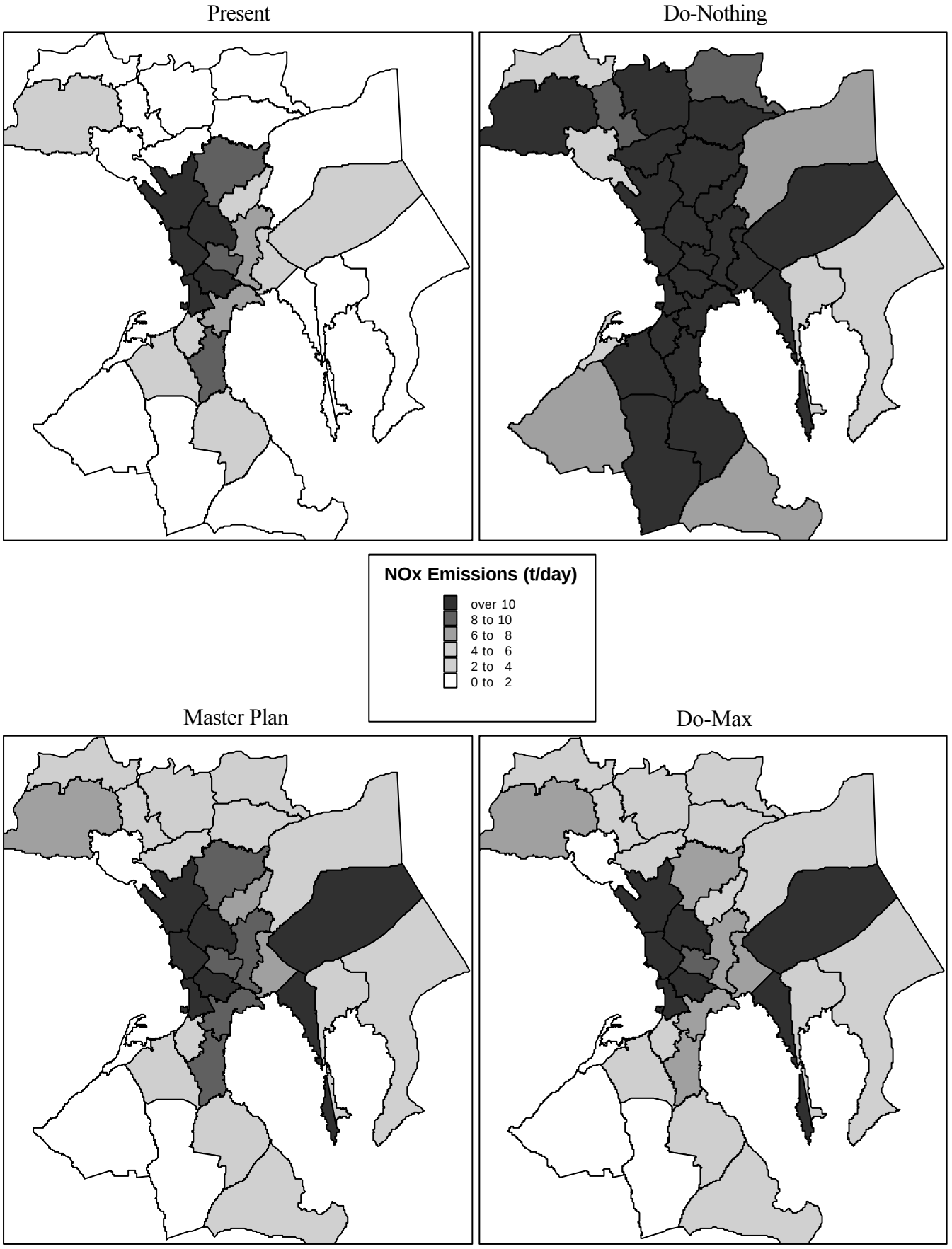


Figure 6
SOx Emission

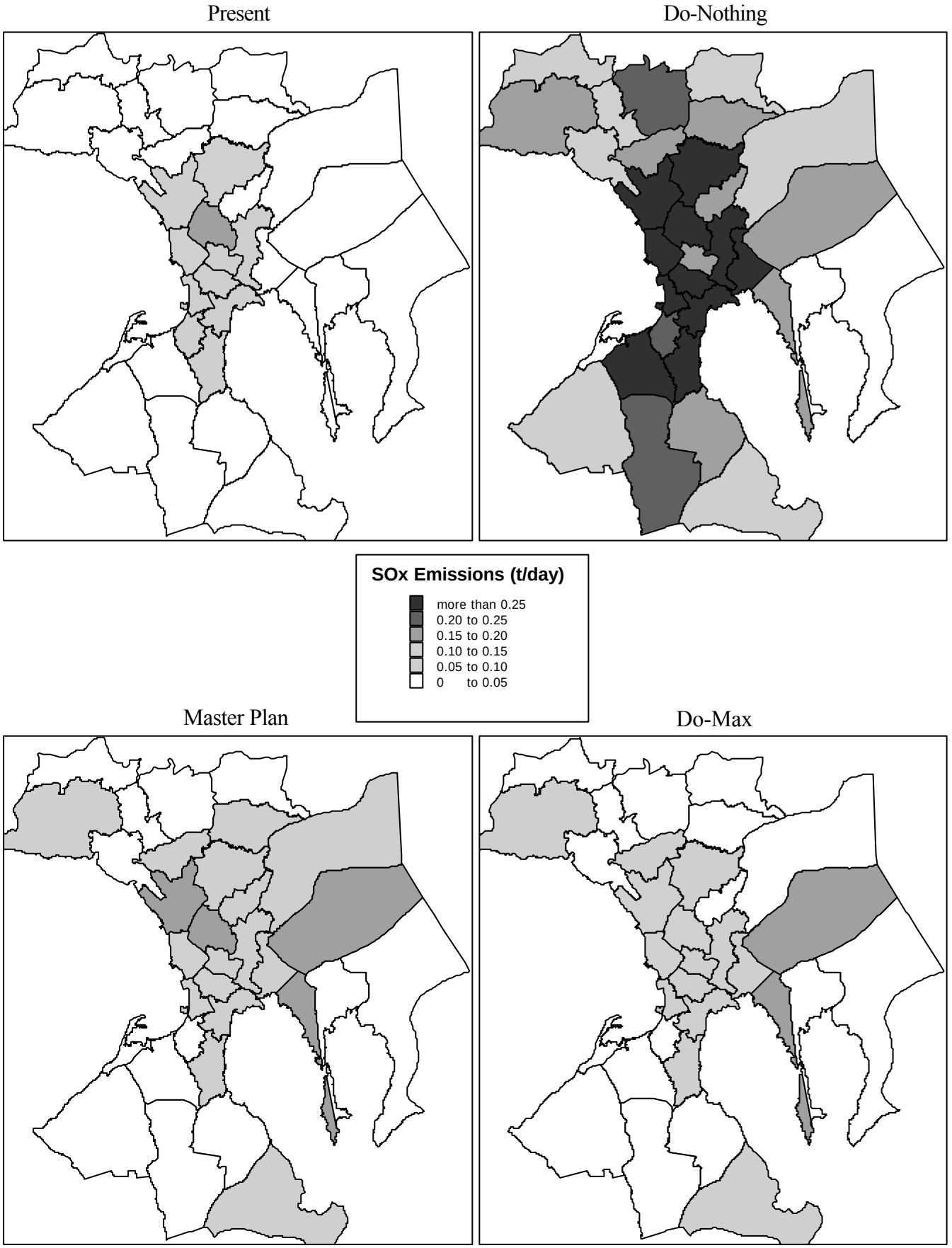
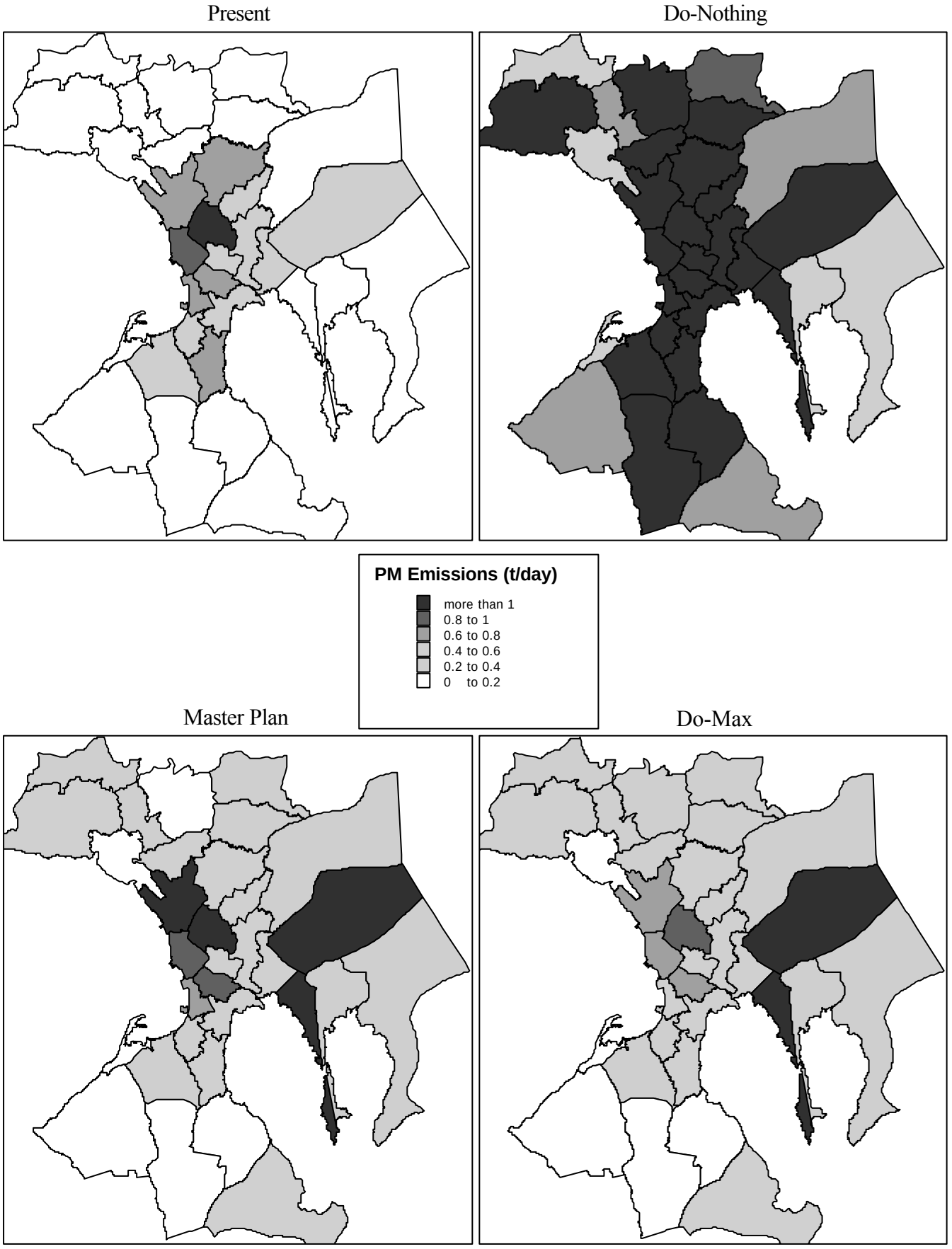


Figure 7
PM Emissions



APPENDIX II

TECHNICAL NOTES/MATERIALS

MMUTIS DATABASE

15. MMUTIS DATABASE

LAST UPDATE: 1999/04/28

Data Category	Second Category	Third Category	File Name	File Size (Kb)	File Format	Description
JICA STRADA	Network	Link Data	Tr68-dom.int	292	INT	Do-maximum Network
			Tr68-mst.int	292	INT	Master Plan Network
			Tr68-mtd.int	292	INT	MTDP Network
			Tr68-doc.int	292	INT	Fixed Projects Network
			Tr68-don.int	292	INT	Present Network
		Line Data	Tr68-dom.tnt	107	TNT	Do-maximum Lines
			Tr68-mst.tnt	106	TNT	Master Plan Lines
			Tr68-mtd.tnt	102	TNT	MTDP Lines
			Tr68-doc.tnt	99	TNT	Fixed Projects Lines
			Tr68-don.tnt	99	TNT	Present Lines
	OD Table		Od96-new.aod	462	AOD	1996
			Od05.aod	462	AOD	2005
			Od15s2.aod	462	AOD	2015
	Parameter		Ipa.ipa	2	IPA	Parameter file for incremental assignment
			Mt05.tpa	3	IPA	Parameter file for transit assignment (2005)
			Mp15.tpa	3	IPA	Parameter file for transit assignment (2015)
	Zone Boundary		Zone1.zxy	13	ZXY	Metro Manila 24-zone boundary
			Zone2.zxy	53	ZXY	Metro Manila 265-zone boundary
			Zone5.zxy	65	ZXY	Metro Manila 265-zone and Outside 51-zone boundary
			Plan.zxy	17	ZXY	MMUTIS Planning 36-zone boundary
Socio-Economy	Population Employment/ Student Income/ Car Ownership Others		Summary.xls	273	Excel	Socio-economic indexes by traffic zone
			Socio96.xls	698	Excel	Socio-economic indexes by traffic zone
			Bantab.dbf	261	Dbf	Barangay Population by MMUTIS zone
			Outside.dbf	10	Dbf	Population in MMUTIS Study Area
Land Use/ Road Network	Land Use Data		Landuse_95.xls	818	Excel	Area of each land use class within each zone(1986/96)
			Landusebyzone_95.xls	59	Excel	Land use by type of land
Demand	Cordon / Screenline		Cordon.dbf	314	Dbf	Cordonline traffic volume by time and section
			Cordon15.dbf	1,191	Dbf	Cordonline traffic volume by 15 minutes and station
			Cordon.xls	46	Excel	Cordonline
			Screen.dbf	422	Dbf	Screenline traffic volume by time and section

Data Category	Second Category	Third Category	File Name	File Size (Kb)	File Format	Description
			Screen15.dbf	1,605	Dbf	Screenline traffic volume by 15 minutes and station
			Screen.xls	57	Excel	Screenline
			Forma.dbf	449	Dbf	Interview data in form A
			Formb.dbf	305	Dbf	Interview data in form B
			Formc.dbf	414	Dbf	Interview data in form C
	OD Matrix		Pa96ma11.mst	5,371	Text	Origin destination data by mode
			Pa96pa11.mst	1,993	Text	Origin destination data by purpose
Road and Traffic	Road Inventory		Road InventoryPR.xls	51	Excel	Road inventory data for provinces
			Road InventoryMM.xls	150	Excel	Road inventory data for metro manila
	Subdivision Road Inventory		Subinvent1.xls	658	Excel	Subdivision road inventory survey data
			Sub-gate.xls	80	Excel	Subdivision road inventory survey data
	Traffic	Travel Speed	Route96.doc	54	Word	Travel speed survey data by route
			Sect96.doc	528	Word	Travel speed survey data by section
			Worst.doc	267	Word	Travel speed survey data by worst section
		Ferry	Ferry.dbf	65	Dbf	Cordonline roadside interview survey at ferry
		Truck	Tod.dbf	314	Dbf	Cargo vehicle roadside interview survey
Person Trip (HIS)	PT Master File	1996	Form1.dbf	4,748	Dbf	HIS data survey
			Form2.dbf	8,067	Dbf	HIS data survey
			Form3.dbf	46,968	Dbf	HIS data survey
			Form4.dbf	1,021	Dbf	HIS data survey
			Form5.dbf	259	Dbf	HIS data survey
			Form6.dbf	1,457	Dbf	HIS data survey
		1983	House80.dbf	2,415	Dbf	JUMSUT Person Trip Survey Household data
			Member80.dbf	3,900	Dbf	JUMSUT Person Trip Survey Member data
			Trip80.dbf	14,577	Dbf	JUMSUT Person Trip Survey data
Public Transport	Route Data	Bus route	Bus ro~2.xls	1,045	Excel	Bus route data
		Jeepney route	Jeepney~3.xls	553	Excel	Jeepney route data
			Route.xls	165	Excel	Public transport survey by route
	Link Data		Alinkrpt.xls	401	Excel	Public transport survey by link
			Linktrip.xls	216	Excel	Public transport survey by link
	Terminal Interview	Passenger	Passint.dbf	220	Dbf	Terminal survey for passenger
			Passint.doc	74	Word	Terminal survey for passenger
		Driver	Driver.dbf	522	Dbf	Terminal survey for driver
			Drvint.doc	15	Word	Terminal survey for driver

Data Category	Second Category	Third Category	File Name	File Size (kb)	File Format	Description
Modal Choice	Willingness to Pay	Special Car	Sp-car.xls	420	Excel	Willingness to pay for travel time reduction (car user)
		Special FX	Sp-fx.xls	378	Excel	Willingness to pay for travel time reduction (FX user)
		Special Taxi	Sp-taxi.xls	513	Excel	Willingness to pay for travel time reduction (taxi user)
			Sp-fx-tab.xls	59	Excel	Summary of interview for willingness to pay
	Water Transport		WaterJpy.xls	622	Excel	Water transport survey for jeepney
			WaterBus.xls	192	Excel	Water transport survey for bus
			WaterFry.xls	280	Excel	Water transport survey for ferry
			WaterBnc.xls	168	Excel	Water transport survey for bancas
Others	Airport	Agency Interview	Emp.dbf	92	Dbf	Staff/ Employee airport survey data
		Occupancy Volume	Empod.dbf	40	Dbf	Origin destination of staff / employee
			Airod.dbf	131	Dbf	Origin destination at airport
		Others	Apc.dbf	59	Dbf	Arriving passengers /crews
			Dpc.dbf	67	Dbf	Departing passengers /crews
			Wwv.dbf	111	Dbf	Well-wishers / visitors
	Garbage Truck		!paya-ma.xls	312	Excel	Garbage truck survey for Payatas
			Carmona.xls	419	Excel	Garbage truck survey for Carmona
			Catmon.xls	180	Excel	Garbage truck survey for Catmon
			Dayly.xls	294	Excel	Garbage truck survey in daily results
			Laspinas.xls	493	Excel	Garbage truck survey for Las Pinas
			Sanmat~1.xls	842	Excel	Garbage truck survey for San Mateo
	Traffic Accident		Nctsacc1.dat	1,250	Text	Accident Record
			Nctsacc2.dat	1,250	Text	Accident Record
			Accident.xls	1,955	Excel	Accident Record
	Environmental		ENV.Data.xls	186	Excel	Survey of air pollution, relation to traffic volume
			Traffic Vol(5sites).xls	214	Excel	Traffic volume survey at air pollution monitoring sites
			VicintyMap.xls	59	Excel	Vicinity map of survey place

APPENDIX III

DRAFT TERM OF REFERENCES
METRO MANILA TRAFFIC INFORMATION CENTER

1. METRO MANILA TRAFFIC INFORMATION CENTER

1.1 Rationale

Metro Manila's chronic traffic problem is worsening day by day. Heavy congestion is a daily event and people waster their time on the road. Efforts have been exerted to alleviate the congestion. One example is UVVR which was implemented in 1996 to reduce the number of cars on the Metro Manila's road network. But the effect of the scheme was soon negated by the remarkable increase in the number of the registered vehicles. In a mega city line Metro Manila congestion is unavoidable as demand far exceeds capacity even a computerized smart signal system in installed. Traffic situation often gets worse when accident, flooding, stalled car, construction work, or other incident occurs. People often become disparate and irritated when they meet an incident unexpectedly and don't know how long they have to endure. Economic loss caused by traffic congestion amount to a huge sum. Metro Manila's air pollution caused by vehicle emission is far above the environmental standards.

Fundamental approach to the problem may be a very stringent control of demand. If there is no alternative mode of transportation, however, restriction is not a good solution and may not be accepted by the people. If a society is depleted of mobility, its economic, social and activities will be much hampered.

Information is becoming increasingly important in the traffic management in a mega city, where minor incident often leads to major congestion. If drivers are properly informed of the road and traffic condition, they can have options to choose. They may take another route defer the starting time or use other mode of communication for example. At the same time, countermeasures can be taken and the incident can be swiftly disposed of. The road condition can be restored to its original in a short time.

Currently Metro Manila Development Authority (MMDA) has a large group of traffic enforcers who are assigned to critical intersections in Metro Manila to control traffic together with police and traffic aids. They activities are, however, limited to individual intersection. Coordination between neighboring intersections is not considered. No system wide approach is taken to tackle the congestion.

The existing Metro Base of MMDA is expected to play a role of communication center. But its functions are very weak due to the constraint of facilities and staff. Considering the important role of information Metro Base will be expanded and a Metro Manila Traffic Information Center will be created. The Center is not considered. No system wide approach is taken to tackle the congestion.

1.2 Metro Base

Metro Base of MMDA was established as 24-hour communications center that monitors traffic situations, road conditions occurrence of fire, floods, typhoons, and other man-made and natural disasters. It objectives are:

1) To link various concerned agencies working together to deliver the basic needs of Metro Manila and suburban areas.
2) To provide timely, accurate and responsive information to meet the demands of an ever growing metropolis

In order to achieve these missions, Metro Base has a close communication link with:

3) Philippine National Police
   - Traffic Management Group
   - National Capital Region Police Office
   - Five Traffic District Commands
4) Department of Transportation Franchising and Regulatory Board
5) Department of Transportation and Communication
6) Department of Public Works and Highways
7) Local government units

Currently, Metro Base has very limited facilities, only several units of radio communication equipment and a few telephone lines. Lack of the facilities hampers that their activities greatly, particularly at the time of emergency when close coordination is required among the agencies concerned. It is very difficult for Metro Base to respond to an emergency and provide timely service.

The proposed Metro Manila Traffic Information Center will be required with a set of modern communication facilities as well as the data processing system to collect process and store the information. It will provide road user and residents alike of useful information in a timely manner through various channels. It will also have a mobile unit to support its activities at the field.

1.3 Traffic Information Center

1.3.1 Objectives

The proposed Metro Manila Traffic Information Center will have the objectives of securing fast, comfortable and safe traffic environments by collecting and providing road and traffic information that directly affects economic, social and other activities in the metropolis.

1.3.2 Functions

The Traffic Information Center consists of the following five functional components:

1) Road and traffic information gathering
2) Road and traffic information database
3) Road and traffic information dissemination
4) Incident disposal
5) Coordination among agencies concerned

In order to support these functions, the Center must be equipped with a suitable information processing and communications infrastructure. Communication network

is vital for gathering and dissemination of information, as well as for coordination with other agencies. Geographic information system capable of operating on a real-time basis must be introduced to process, update and store the based map information. Separately, a mobile unit will be setup and dispatched to the site of incident for proper action.

1.3.1.1 Traffic information gathering

Traffic information will be gathered in several ways. The possible means include:

- Report form traffic enforcer/traffic police at field
- Close circuit television camera installed at strategic locations
- Information from toll road operators
- Communication link with other government agencies (DPWH, DOTC, LGU, Police District etc.)

MMDA traffic enforcer

MMDA has more than 3,000 traffic enforcers. They are developed at all critical intersections in Metro Manila in group to guide traffic and provide assistance to the motorists. They can be a useful source of information because they directly interact with traffic. At each critical intersection, one of enforcers will be designed as reporter, who regularly report the traffic condition at the intersection and neighboring area to the Center through radio communication unit. Guidelines will be developed as to the reporting system, in which reporting schedule, method of describing traffic situation, use of radio communication unit, etc. will be stipulated. The qualification of traffic enforcers currently deployed is generally not high. An intensive training is necessary to establish an effective reporting system.

Closed circuit television camera system

The existing signal system has a closed circuit television system. A total of 19 TV cameras are installed at strategic locations in Metro Manila from Balintawak in the north to Magallanes in the south. A monitoring and control system is placed at Traffic Engineering Center located at Santa Mesa. Communication links using coaxial cable and optical fiber cable are installed for video image and control signal transmission between cameras and central equipment. The maintenance of the system has not been undertaken since 1997 and system is not functioning at this moment. Under the proposed project, new cable network will be installed and all cameras will be connected to the Traffic Information Center. The central monitoring and control equipment will also be relocated to the Traffic Information Center.

Toll road operator

Toll road or expressway is an access road. Entry and exit points are limited to specific locations. Toll is collected from the user in exchange for better service. As such, incident on toll road has bigger impact than that on ordinary road. Toll road information system is a standard facility on today's toll road to maintain service level. Existing North and South Superhighway has no such system. But the operator of these toll roads has a patrol group, which regularly patrol the toll road and attend to

incident. The toll road operator of the on-going Skyway project has a plan to install to road information system. But the detail of the system is not known. Regardless of whether a toll road has information system. But the detail or not, the operator usually has information Center will gather the information, directly through communication link or through telephone line. For the toll road with surveillance system, information can be collected through computer network.

Government agencies

Each government agency has the responsibility to road and traffic in their respective area. DPWH undertakes the maintenance of national roads, while local government unit is responsible for city and municipality roads. These government agencies have the information of road condition as well as the construction and maintenance work schedule. These information will be provided to the Center for dissemination to the public.

Public

General public, motorist or not, is also a good source of information. Especially cellular phone is common these days and motorists on the road have a mean to call Traffic Information Center to inform the condition around them. Telephone number that receives traffic information will be widely publicized to collect information.

1.3.1.2 Traffic Information database

Traffic information database is a nucleus of the proposed system. It will be a geographic information system with a real-time database. All information collected such as congestion, accident, construction work, flooding, fire, etc. will be input into the database as location data together with the details of incident. The information will be updated from time to time. It will be possible to retrieve the stored data by area, by incident type or by the time of occurrence and show them graphically on the monitor. If necessary, countermeasures will be developed and implemented. The current road condition and traffic information will be disseminated to the agencies concerned and to the general public.

The system consists of several sets of computers and a large screen projector. The computers from a local area network and are used as input and output device. A large screen project is used to display a video image taken by one of the cameras, or any monitor screen produced by computer.

A set of computer is used as server to host an Internet home page, where traffic condition map is provided on a real-time basis. The map is updated at a certain interval or as new data is input to the database.

1.3.1.3 Traffic information dissemination

Traffic information useful to motorists will be disseminated in a variety of ways. The possible media to be used include the following:

1) Commercial radio station

2) Exclusive traffic information radio station
3) Changeable message sign
4) Cable TV network
5) Telephone inquiry system
6) Auto answering telephone system
7) Internet
8) Car navigation system

Commercial radio station

Currently, some radio stations have a traffic information program regularly during peak hours. It provides narrative description of the traffic situation along major arterial streets. Although, the contents of the program are limited and broadcasting schedule is flexible it is convenient means for driver to get traffic information. Advantage of using commercial radio station is that traffic information can be disseminated without no new investment on the facilities. The Center will provide more comprehensive and accurate information on the program.

Exclusive traffic information radio station

Traffic information may be distributed through a radio station, which is dedicated to traffic information. It broadcast the pre-recorded message cyclically without stopping. More information can be provided manually or automatically using voice synthesizer. Broadcasting facilities and permission of radio frequency are required.

Changeable message sign

There are seven (7) sets of changeable message sings on Metro Manila's network. The central monitoring and control equipment is located in the Traffic Engineering Center. The system, which is called driver information system, was installed under TEAM projects. But they are not used effectively. Once the traffic Information Center is established the monitoring and control equipment will be transferred to the center and various traffic messages will be shown on them.

Cable TV network

Cable TV service is popular in Metro Manila. It offers a large number of channels with relatively low price. Some channels are used for public service such as arrival information at Ninoy Aquino International Airport. A channel dedicated to traffic information will be developed in cooperation with a cable TV service provider. The channel continuously provides the congestion map of Metro Manila produced by the traffic information database. Live video image taken by TV cameras will also be transmitted sequentially for all cameras together with their location.

Telephone inquiry system

Telephone is the easiest way to get the information. Anybody wanting to know the road and traffic information can call be the Center and ask the situation. The telephone number must be widely announced. Sufficient number of lines must be prepared to avoid busy condition of telephone lines.

Auto answering telephone system

Telephone inquiry system can be automated into auto answering telephone service. It automatically provides information to inquirer, who accesses the service through ordinary telephone. The system responds to the incoming calls and replays one of the pre-recorded messages have to be prepared manually. But once the messages are set, operation is automatic message preparation is possible using computer and voice synthesizer.

Internet

Internet is increasingly becoming popular in the Philippines. There are many internet service providers that offer the service with a reasonable subscription fee. Internet is a very flexible tool of information dissemination and best suited to provide graphical information such as congestion map. One of the computers will be dedicated as web site server. Congestion map created by other computers will be posted at the web site of the Center. Anybody who has an Internet access can retrieve the congestion map. Road users who want to make a trip can access the site before the start and adjust the trip according to the road and traffic condition.

Car navigation system

Car navigation system is already in use some developed countries. The system is a on-vehicle navigation tool and shows the present location of the vehicle determined by the system using the position signal GPS (Global Positioning System) superimposed on a vicinity map on a monitor. If the destination is input, the device tells the driver how to get there. Rail-time version of the system receives the congestion information and displays it in addition to the location of the vehicle.

1.3.1.4 Incident disposal

Swift disposal of incident is crucial to prevent the adverse effect of the incident from propagating. The earlier the action, the lesser the loss caused by the incident. When an incident is reported by traffic enforcer, traffic police, other agencies or general public, the incident is recorded and its nature is assessed. If found necessary, action will be taken, which includes dispatching traffic police, traffic enforcer, ambulance, fire engine etc. Traffic Information Center will act as command center to coordinate the operation.

1.3.1.5 Communication network

In order for Traffic Management Center to work as center of communication. It must be equipped with communication facilities. The facilities include

1) Radio communication network
2) Video signal transmission system
3) Digital with other computer network
4) Dedicated telephone link (hot line)
5) Public telephone service

Radio communication network

The existing radio communication network that connects Traffic Engineering Center, Police Districts and traffic enforcers will be rehabilitated and expanded. New base station will be established at MMDA, which will administer the whole network.

Video signal transmission system

Video signal transmission system using optical fiber cable will be installed to bring the video signal taken by the existing TV cameras to the Center.

Digital link with other computer networks

Digital link will be established between the computer at the Center and the computers in other agencies to facilitate the direct data exchange between the computers.

Dedicated telephone link (hot line)

Hot lines that do not go through telephone exchange will established between the Center and other agencies for voice communication. The line may be leased from PLDT or other telephone company.

Public telephone service

Sufficient number of subscriber lines will be connected to the Center for the telephone inquiry and Internet access.

1.3.3 Mobile unit

The Traffic Information Center will have a mobile unit which consists of several units of ordinary trucks and tow trucks. Trucks will carry good, materials and work force and will be dispatched to the incident site to take countermeasures. Tow trucks will be used to remove the stalled vehicles and illegally parked vehicles.

1.4 Description of the Project

The project consists of two categories of work.

- Establishment of Traffic Information Center
- Organizational setup and staff training

The first part of the work is to construct a traffic information system while the latter is to strengthen the existing organization to operate the system and manage the information efficiently.

1.4.1 Establishment of Traffic Information Center

The work to establish the system include the following:

1) Purchase of center equipment and software, and development of information processing system.
2) Construction of a center building and installation of associated facilities
3) Purchase of radio communication equipment and installation of base station at MMDA
4) Rehabilitation of the existing closed circuit television system and connection of TV cameras with the Center through optical fiber cable system.
5) Purchasing of mobile units which consist of small and large trucks and small and large tow trucks.

1.4.2 Organizational setup and staff training

In order for the Center to function as a focal point of information collection and dissemination, and as a communication center in implementing countermeasure, operational procedure of the center must be clearly defined. For this purpose, jop description and authority and responsibility of the various positions must be made clear. More specifically, the works under this category include the following

1) Definition of role, authority and responsibility of the position at various levels.
2) Establishment of information flow through different media in different cases
3) Establishment of communication link with other agencies and organizations
4) Development of contingency plans and countermeasures against various incidents
5) Training on the use of the equipment comprising the system
6) Preparation of operation manuals which specify the definitions and procedures in detail

Intensive staff training is required to upgrade the capability of the staff and efficiency of the operation at the Center. The training will be carried out in parallel to the construction of the system so that the Center will function properly when the system is completed.

1.5 Technical Assistance

The design of the proposed system requires highly technical knowledge of traffic engineering, computer communications and system integration. Experience of the similar system is essential to design a good traffic information system. Considering the fact that the delay and problems of the on-going signal replacement project partly stems from the lack of competent consultant, it is necessary to retain consultant who is familiar with the system for the design and construction supervision of the proposed project.

Information plays an important role in the operation of the proposed system than the hardware such as computer and communication equipment. Usefulness and effectiveness of the system depend much on the organizational setup and operational procedure. Experience of the similar system in other country will provide valuable

resource of the information in strengthening the organizational capability and development of the operation procedure.

For these reasons, hiring of competent consultant is highly recommended in the implementation of the project.

1.6 Project Cost

The scope of work and the size of the project are yet to be discussed and finalized. The cost estimate at this moment is therefore, very rough and will vary, as the details of the system are determined. The initial cost estimate is presented below.

	Foreign (US$)	Local (Pesos)
Total direct cost	8,342000	93,700,000
Physical contigency (10%)	834,200	9,370,000
Price escalation (5%, 15%)	417,100	14,055,000
Detailed design and supervision (14%)	1,343,062	16,397,500
Total project cost	10,936,362	133,522,500

APPENDIX III

DRAFT TERM OF REFERENCES
METRO MANILA SIGNAL SYSTEM REHABILITATION PROJECT

2. METRO MANILA SIGNAL SYSTEM REHABILITATION PROJECT

2.1 Background

Metro Manila has a computerized signal system. A central computer installed at Traffic Engineer Center (TEC), under Department of Public Works controls more than 400 signal controllers in Metro Manila and Highways (DPWH) located at Santa Mesa. The system has been developed over 15 years. The first phase of the project installed the system in 1980 to 1982 under Metro Manila Traffic Engineering and Management (TEAM) Project financed by the World Bank. The second and third phases of the project were implemented with a financial assistance of Overseas Economic Cooperation Fund of Japan. The second phase was completed in 1987 and the third phase of the system in 1994. Although there is an on-going signal replacement project, the completion of the project is still far away. In the meantime, the existing system must be utilized to the maximum extent possible to provide effective road traffic system. The existing system has the advanced features that a modern computerized signal control system is required to provide. The existing system is, however, at a deplorable condition due to the lack of proper maintenance. Metropolitan Manila Development Authority (MMDA) is mandated the task of traffic management in Metro Manila. In accordance with this policy, the signal system was transferred to MMDA from DPWH in August 1995. This paper proposes a Metro Manila Signal System Rehabilitation Project, which aims at revitalizing the existing signal system.

2.2 Description of the Present Status

2.2.1 Existing system

The system consists of 435 signals, 1,286 vehicle detectors, 19 television cameras, 7 changeable message signs, 4 air pollution monitoring stations, and 5 radio base stations. The control center system includes central computer system, a wall map, communication equipment, control console, TV monitors and air pollution monitoring equipment. The data exchange between the control center equipment and field equipment is made through communication cable network established by the project.

The existing signal has the advanced signal control functions such as traffic responsive signal control, traffic adaptive control, multiple phase sequences, remote flashing etc. Thus the signals can be operated with the most optimum timing parameter without intervention by traffic enforcer.

The system is a comprehensive traffic control system. It can not only control signals but also monitor traffic conditions through television camera and disseminate traffic related information to road users through changeable message signs.

Unfortunately, the system is not performing at its best. The main reason is that the equipment is not well maintained. Communication cable is damaged at many locations by other construction projects so that remote control of signal is no longer possible and TV cameras are not connected with the control center. Lack of

competent personnel in managing the system and indiscriminate of manual control by traffic enforcers are also a problem.

Although some equipment was installed some 15 years ago, the system is still capable of controlling traffic if properly maintained. The central computer system is, however, outdated as the progress of computer technology is so fast. Replacement of the central computer is desirable, as the new computer system will enhance the reliability and user-friendliness of the system.

2.2.2 Signal replacement project

A "smart signal system" project partly funded by Australian aid started in 1997. The project is intended to replace the 419 existing signals with new signals. The progress of the project is, however, slow. Since the commencement of the project in November 1997, only ten (10) intersections have been completed the replacement as of September 1998. The scheduled completion of the replacement of 419 signals by March 2000 is, thus, not certain, considering the problems that the project is facing now.

The replacement project assumed that the existing communication cable network, which has been established in the previous projects, is available and no provision is made in the construction contract for the rehabilitation and expansion of the cable network system. In reality, however, communication cables are damaged at many locations and rehabilitation is needed to utilized it. Another option of leasing telephone lines from the telephone company such as PLDT turned out very costly, several million Pesos a month for telephone bill, and seems not viable.

Another issue to be solved is the control center. TEC is located along Magsaysay Blvd. near Nagtahan intersection, where LRT Line 2 is being constructed. The one third of the existing TEC building must be demolished to construct LRT structure. The new building is planned but no definite plan and schedule has been prepared. In the meantime, the existing central equipment must be relocated without damaging its function.

2.2.3 Maintenance

The maintenance management system worked well until December 1996. A maintenance contract was made between TEC and a maintenance contractor. Periodic inspection, reporting of defect, supply of spare parts, fixing of defective or damaged equipment, and minor modification of the system have been carried out by the maintenance contractor under supervision of TEC maintenance division. Since January 1997, however, no maintenance contract has been made due to lack of budget. The system has been degrading gradually since. Only one time in October 1997, MMDA purchased some spare parts for signal controller. No budget is allocated to the maintenance of the existing system at this moment while the imperfect signal equipment is still controlling Metro Manila's chaotic traffic.

Computerized signal system is a sophisticated computer and communication system. In order for the system to exhibit its functions to the full extent, good maintenance management system must be established under which maintenance work must be

carried out by a competent personnel. As the system is expected to work for several years more, rehabilitation of the system is urgently required.

2.2.4 Transfer to MMDA

The existing signal system was built and operated by TEC, which is under DPWH. In August 1995, the system was transferred to Metro Manila Development Authority under a Memorandum of Agreement between the Secretary of DPWH and MMDA Chairman. The staff of operation and maintenance section was also transferred to MMDA. But the inventory of the equipment and other assets are not yet prepared and the property is not officially transferred to MMDA. This fact made it difficult for both TEC and MMDA to engage in the intense rehabilitation of the system.

2.3 Description of the Project

2.3.1 System/equipment to be rehabilitated

The rehabilitation work shall cover signal system except a portion stated below, closed circuit television system, driver information system, air pollution monitoring system, communication cable network system and radio communication system. The intersection and signal equipment being replaced, which numbers about 100 intersections will be excluded from the project. The exact location and equipment to be excluded depends on the plan of the on-going replacement project and will be discussed with TEC.

2.3.2 Scope of work

The proposed project is intended to rehabilitate and reinstate the existing signal system so that it can perform its original functions. The scope of the work is divided into three groups, which will be undertaken sequentially.

Stage 1: Inspection and identification of the extent of rehabilitation work.
Stage 2: Carrying out the basic rehabilitation work
Stage 3: Upgrading of the central computer system

The regular maintenance of the signal system will be a part of the project in addition to the rehabilitation work. The regular maintenance will commence at Stage 2. The tasks in each stage are described below.

Stage 1: Inspection and identification

In Stage 1 all the pre-existing defects and damages shall be identified and the extent and manner of rehabilitation work will be determined through the site inspection, test and measurement.

1) Inspection and appraisal of the condition of the signal equipment including signal controller, mast-arm and post, lantern and vehicle detectors at intersection except one where signal has been replaced or to be replace soon to identify the defects in the system.

2) Inspection and appraisal of the condition of the central equipment at Center and Sub-stations including central computer, communication equipment, operator console, engine generator and air-conditioning equipment.

3) Inspection and appraisal of the condition of the closed circuit television system including both field equipment at intersection and the central equipment at the Control Center.

4) Inspection and appraisal of the condition of the driver information system including both changeable message sign at field and the central monitoring and control equipment at the Control Center.

5) Inspection and appraisal of the condition of the air pollution monitoring system including both measurement system at sub-station and the central data gathering system at the Control Center.

6) Inspection and appraisal of the condition of the communication cable network system including both telephone cable, coaxial cable and optical fiber cable. The inspection work includes measurements of the cable characteristics.

7) Inspection and appraisal of the condition of the radio communication system including base station console, mobile and portable units, chargers and accessories, antenna system and accessories, and the radio satellite repeaters.

Stage 2: Rehabilitation work

In Stage 2, actual maintenance work will be carried out and the equipment will be restored to the original functioning condition. In addition, regular maintenance work starts in Stage 2. Training on the system operation and maintenance management shall also be undertaken for MMDA personnel.

1) Supply of the spare parts for signal equipment, closed circuit television equipment, driver information system, air pollution monitoring system, communication cable network, and radio communication system as identified by the tasks in Stage 1. The spare parts shall conform to the original specifications unless they are no longer available due to termination of the production.

2) Design and installation, replacement, repair or modification of the defective or damaged parts as identified in Stage 1 using the parts supplied under the item 10 above.

3) Regular maintenance which consists of periodic inspection and accident repair of the equipment that may occur during the Rehabilitation Project.

4) Training of MMDA personnel in the basic course of system operation and maintenance management.

Stage 3: Upgrading of central computer system

In the Stage 3, the existing central computer system will be replaced with a new system. Basically no modification of the functions will be implemented as the existing system has the sufficient functions.

1) Replacement of the central computer system with the new hardware and operating system. The basic functions of the system will remain same but minor enhancement particularly in the man-machine interface will be introduced.

2) Training of MMDA personnel for the use of new computer system and basics for daily operation such as modification of phase sequence and signal timing parameters.

2.4 Technical Assistance

The proposed project requires highly technical knowledge in the field of traffic engineering, computer, and communications. It also needs the practical experience of the installation work, and inspection and testing of various equipment. Considering the fact that the delay and problems of the on-going signal replacement project partly stems from the lack of competent staff, it is highly necessary to have a technical adviser in the implementation of the proposed project. The technical advisor must be an expert of traffic signal system and related technologies, and must have the sufficient experience in the installation, operation and maintenance of the similar system. The adviser will be resident in Metro Manila during the entire period of the project. He will provide advice to the MMDA Director in charge of traffic management on a daily basis and jointly oversee the implementation of the project.

2.5 Technology Transfer and Training

Throughout the all stages of the project, technology transfer to the local counterpart will be given a higher priority. Local counterpart will be intensively involved in the all activities of the rehabilitation project. Particularly during the Stage 1, site inspection shall be carried out jointly by the inspector, who is an expert of the system or equipment under inspection, and local counterpart. This provides the best opportunity to the local staff to understand how the system is constructed and operates as well as the technologies behind the computerized signal control system.

2.6 Project Schedule

The project will take two (2) years to complete. Duration of each stage will be as follows:

Stage 1: Inspection and identification	Three (3) months
Stage 2: Rehabilitation work	Nine (9) months
Stage 3: Computer system upgrading	One (1) year

2.7 Project Cost

The project cost is estimated as shown below. The cost estimate does not include the cost of technical assistance.

	Foreign (US$)	Local (Pesos)
Stage 1	34,000	6,300,000
Stage 2	1,400,000	53,700,000
Stage 3	7,520,000	1,500,000
Contingency (10%)	895,400	6,150,000
Total	9,849,400	67,650,000

APPENDIX III

DRAFT TERM OF REFERENCES
TRAFFIC SIGN AND PAVEMENT MARKING IMPROVEMENT PROJECTS

3. TRAFFIC SIGN AND PAVEMENT MARKING IMPROVEMENT PROJECT

3.1 Introduction

Various traffic regulations such as no left turn, no U turn, no parking, etc. are applied in the road network in Metro Manila to regulate traffic flow for efficient and safe traffic environment. The signs currently used are, however, not consistent in design, material and installation. Makeshift signs are also found. Some signs are not clearly visible as they are not posted at right place. These signs create unintentional violators.

Undisciplined behavior is often blamed as a cause of traffic mess in Metro Manila. Sudden lane change, blocking of other's path, loading and unloading of passengers at inner lane, etc. are common phenomenon. Jaywalkers disturb the flow and risk themselves. If vehicles form orderly flow, the efficiency can be much higher and traffic is much smooth. If pedestrian crossing marking is more conspicuous, pedestrians can cross a road more safely.

Pavement markings are a tool to foster traffic discipline and improve efficiency. They show where to run, where to stop and where to cross. Lane arrow indicates the direction of flow and reduces unnecessary interaction between vehicles.

Currently the condition of pavement marking on the roads in Metro Manila is very poor. Many roads have worn out and almost invisible pavement markings, or no pavement marking at all. The proposed Traffic Sign and Pavement Marking Improvement Project aims to improve the traffic and enhance the discipline among the drivers at by improving the traffic sign and pavement markings.

3.2 Description of the Project

The proposed project consists of three components;

Part 1: Establishment of standards for traffic sign and pavement markings
Part 2: Establishment of traffic sign database and renewal of traffic sign
Part 3: Establishment and implementation of three-year pavement marking program.

The first component will standardize the specifications for the design of traffic signs and for pavement marking materials and develop guidelines for their installation. In the second component, a traffic sign database will be established and the existing traffic signs that is already in bad shape or of sub-standard design will be replaced with a new sign. A three-year pavement marking program will be established and pavement marking will be applied according to the program.

3.2.1 Part 1: Standards

Traffic sign and pavement marking must be uniform and consistent in the design and application to avoid confusion among drivers. The meaning of traffic sign must be clearly defined. Materials used must meet the specifications to maintain the quality. The task consists of the establishment of specifications and the preparation of

installation guidelines.

1) Specifications

Two sets of specifications will be prepared; one for traffic sign and another for pavement marking. The specifications must be suitable to the road and traffic condition and the climate in the Philippines. The specifications adopted during TEAM Project Phase III can be a good reference in establishing specifications.

Standard specifications for traffic sign shall stipulate size, material, reflection property and structure of traffic sign.

Standard specification for pavement marking shall cover both marking materials and reflective studs. Thermo-plastic type marking is recommended for its durability and high reflection property. The specifications for marking material shall set forth the composition, chemical and physical properties, size and amount of glass beads, application method and testing method. The specifications for reflective stud specify the size, color, reflection property and installation method.

2) Design and application guidelines

Two manuals will be prepared; one covers traffic sign and another for pavement marking and reflective stud.

The existing manual ”Philippine Road Sign Manual” prepared and published by then Ministry of Public Works and Highways in 1982 will be revised to reflect new development in traffic. Traffic sign manual stipulates code, name, size, color, design, layout, symbol, font, definition and meaning of various types of regulatory and guidance signs. The United Nation Standards established in 1968 may be used as reference. The manual also contains the installation guidelines.

The existing manual for pavement markings entitled ”Manual on Pavement Markings” prepared and issued by then Ministry of Public Highways in 1980 will be revised and updated. For example, painting of curb in yellow or red to indicate no-parking regulation is used in some cities but it is not included in the current version of the manual. There is no description of reflective stud in the manual, as it was not used during the time the manual was prepared.

The guidelines for pavement marking will specify the size, thickness, color, spacing and location of the markings. The type of markings includes center line, double yellow line, lane line, stop line, pedestrian crossing, zebra, lane arrow, no-parking, and no-stopping. The guidelines for reflective stud will specify the use of the reflective stud specified in the specifications.

Other traffic safety devices such as safety cone, reflective delineator, light emitting stud, etc. may be included in the specifications and guideline.

3) Distribution

Sufficient number of copies of these specifications and guidelines will be printed and distributed to the government agencies concerned such as DPWH, DOTC and local government units, as well as non-governmental organizations. Simplified leaflet showing basic traffic signs and pavement markings will also be printed and distributed to drivers who come to Land Transportation Office for renewal of their driver's license.

3.2.2 Part 2: Traffic Sign

Tasks under this part consist of conducting site survey, establishing a geographic information system and renewal of traffic signs. Location and type of existing traffic signs on all primary and secondary roads will be identified by field survey. The location of turning restriction sign, no-parking sign, one-way and other regulatory signs (Type R signs) will be identified.

A geographic information system will be established and the traffic regulation and sign information in Metro Manila obtained by site survey will be stored in the database. Regulation and sign location will be reviewed and revised if necessary. New traffic signs will be installed at the location where such action is found necessary.

3.2.3 Part 3: Pavement Marking Program

Pavement markings and reflective studs are not a permanent facility. Pavement marking looses its thickness and reflection property over the time as it is exposed to traffic and direct sun. Reflective stud may come off under the repeated load. They must be regarded as consumable and renewed or supplemented at a certain interval.

The proposed project covers all primary and secondary roads in Metro Manila, the total length of which is estimated at 399 km and 235 km, respectively. A three-year pavement marking renewal program will be established. In principle, all pavement markings on these roads will be re-applied every three years according to the program. Center line, lane line, stop line, pedestrian crossing and lane arrow will be drawn but depending on the site condition, other markings such as zebra marking will also be applied.

The tasks in the program includes selection of roads, preparation of base plan, design of pavement markings, scheduling of work and application of pavement markings. All primary and secondary roads will be divided into three groups and each year markings are applied to one group. Base plan will be prepared with the scale of 1/1000 based on the existing plans or aerial photo, on which markings will be designed.

Application of markings will be implemented under a contract with the qualified contractor. Materials used for pavement marking shall be tested at the laboratory at Traffic Engineering Center and shall meet the specifications established under the Part 1 of the project.

3.3 Project Schedule

The overall project will take three and half years to complete. The duration of each component is shown below.

Part 1: Standard	6 months
Part 2: Traffic sign	18 months
Part 3: Pavement marking	3 years

The project starts with Part 1, after which Part 2 and Part 3 will be carried out simultaneously.

3.4 Project Cost

The cost of the project is estimated as shown below.

Part 1: Standard	6.8 million Pesos
Part 2: Traffic sign renewal	32.1 million Pesos
Part 3: Pavement marking application	58.4 million Pesos
Total	97.3 million Pesos

APPENDIX III

DRAFT TERM OF REFERENCES
METRO MANILA NORTHERN ROAD DEVELOPMENT PROJECT
(NORTHERN AND CENTRAL PACKAGES)

4. METRO MANILA NORTHERN ROAD DEVELOPMENT PROJECT (NORTHERN AND CENTRAL PACKAGE)

4.1 Background

Metro Manila and its vicinity has been suffering from worsening traffic situation and severe environmental degradation. Roads have become more congested, commuting time and distance lengthened, in-vehicle congestion and comfort level of public transport decreased, air pollution worsened, and accidents increased. Many of these are attributed to the situation which includes lack of infrastructure, poor maintenance, inadequate traffic and vehicle management, undisciplined drivers and pedestrian attitudes, uncontrolled road side activities and land use, etc. Fast growing population in urban areas are enormous serious threats to sustainable development of urban transportation from the medium to long-term viewpoints. While requirements for more strategic transport planning were necessary, updated database and effective planning tools were insufficient.

Under these circumstances, the Metro Manila Urban Transportation Integration Study (MMUTIS) was conducted, upon request of the Philippine Government, with technical assistance of Japan International Cooperation Agency (JICA) with the following objectives:

- To establish an updated transportation database system similar to the one built in JUMSUT which is intended to contribute to transportation planning research and education in the Philippines;

- To formulate a Master Plan for a comprehensive urban transportation system of Metro Manila for the target year 2015; and

- To formulate a Medium-term Development Plan (1999 - 2004) based on the Master Plan.

The MMUTIS proposes at-grade road development as one of the important strategy. The proposal consists of development of primary arterial roads for missing links and promoting effective north-south urban expansion, and secondary roads to strengthen road network hierarchy. Role of those at-grade roads is also strictly important for the space to accommodate elevated expressway and MRT.

In the mid-term plan, MMUTIS road development plan was categorized as several spatial packages to promote the network development, and to formulate appropriate project sizes. The northern package consists of two new primary roads and two new secondary roads development at the northern part of Metro Manila, whereas the central package consists of seven new secondary roads development and five grade separation projects at the central part of Metro Manila.

4.2 Objective of the Study

The objective of the study is to perform a feasibility study for each component road of the north and south project packages. The study includes:

1. conduct supplemental surveys including traffic surveys, topographic surveys and land use surveys for the projected areas.
2. conduct engineering and alignment studies,.
3. forecast traffic demand up to year 2020.
4. estimate project costs and benefits.
5. prepare alternative plans.
6. conduct economic evaluation.
7. conduct environmental impact evaluation.
8. formulate Project implementation plans.

4.3 Study Area and Outline of the Proposed Project

The study area for the northern package is a northern part of Metro Manila approximately between Tandang Sora Avenue at the south and Bocaue Provincial Road at the north.

The northern package consists of the following road sections:

	Category	Road Name	Length	Project Cost
(1)	Primary Arterial	PN03:North Central Road	11.0 km	P8,087mil
(2)	Secondary Arterial	SM13: Marcos Ave. Extension	4.5 km	P2,116mil
(3)	Secondary Arterial	SM14: Quirino Hwy Novaliches Bypass	1.5 km	P418mil
		Total	17.0 km	P10,621mil

The study area for the central package is a central part of Metro Manila approximately surrounded by Tandang Sora Avenue at the north, C-5 at the east and EDSA at the south.

The central package consists of the following road sections:

	Category	Road Name	Length	Project Cost
1)	Secondary Arterial	SM01: Aurora Ave. Extension to R-10	2.5 km	P1,727mil
2)	Secondary Arterial	SM02: A.M. Maceda & Extension	3.5 km	P838mil
3)	Secondary Arterial	SM03: F. Martinez Extension	1.7 km	P523mil
4)	Secondary Arterial	SM04: South Luzon Expressway Ext.	1.8 km	P2,709mil
5)	Secondary Arterial	SM05: Gilmore Ave. Extension	1.5 km	P1,062mil
6)	Secondary Arterial	SM06: Victoneta Ave. Extension	2.5 km	P865mil

7)	Secondary Arterial	SM17: Kalayaan Ave. Extension	1.0 km	P725mil
8)	Grade Separation	GS01: C-3/A. Bonifacio Ave. Intersec.	---	P480
9)	Grade Separation	GS02: C-3/Quezon Ave. Intersec.	---	P480
10)	Grade Separation	GS03: C-3/Aurora Blvd. Intersec.	---	P480
11)	Grade Separation	GS04: España/Pres. Quirino Ave. Intersec.	---	P480
12)	Grade Separation	GS05: Roxas Blvd./Pres. Quirino Ave. Inters.	---	P480
		Total	14.5 km	P10,849mil

The indicated project costs are an approximate estimation by MMUTIS. The study area is shown in Figure-1.

4.4 Scope of the Study

1) Present Condition Survey of the Study Roads

- Geometric condition
- Road condition
- Roadside development condition
- Land use for proposed alignment

2) Traffic Surveys of the Study Areas

- Analysis on existing traffic data
- Additional traffic volume survey
- OD patterns survey
- Travel speed survey
- Analysis on causes of traffic congestion in the study area

3) Future Traffic Demand Forecast

- Establishment of future socio-economic framework
- Forecast of future traffic demand up to year 2020

4) Preparation of Aerial Photo Mosaic Map for the new road sections

- Aerial photo taking
- Aerial photo mosaic preparation (scale 1:5,000)

5) Establishment of Alternative Route Alignments

- Development of alternative routes for new road sections
- Evaluation and selection of the alternatives

6) Engineering Survey

- Topographic survey (horizontal and vertical alignment survey)

- Geotechnical survey at bridge construction sites
- Soils investigation along the selected alignement
- Hydrological survey and analysis

7) Preliminary Engineering Design

- Geometric design
- Earthwork design
- Pavement design
- Structure design
- Drainage design
- Intersection and/or grade separation design

8) Cost Estimate

- Project cost estimate including further engineering services, right-of-way acquisition and construction
- Maintenance and operation cost

9) Economic and Financial Evaluation

- Cost/benefit analysis
- Fund availability analysis

10) Environmental Impact Evaluation

- Environmental impact assessment
- Proposal of mitigation measures

11) Project Implementation Program

- Prioritization of sections
- Implementation schedule
- Annual fund requirements

9.5 Study Period

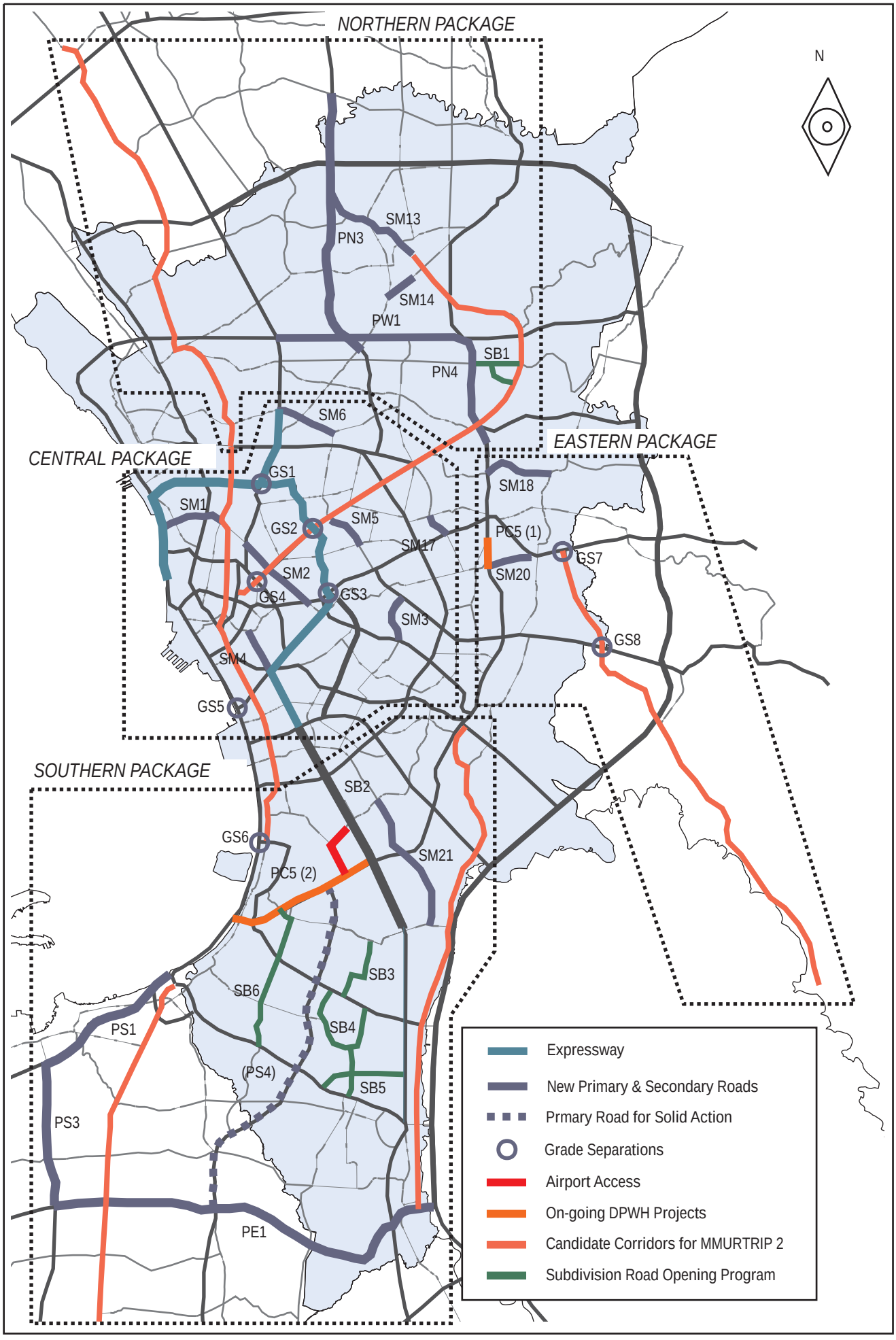
The study shall be completed within a period of 10 (ten) months.

9.6 Man-month Requirements

1)	Team Leader/Highway planner	8 months
2)	Regional Planner	2 months
3)	Highway Engineer	6 months
4)	Structure Engineer	3 months

5) Traffic Surveyor	2 months
6) Traffic Demand Forecast Expert	3 months
7) Economic Analysis Expert	3 months
8) Environmental Specialist	3 months
Total man-months	30 months

Figure 1
Road Project Packages



APPENDIX III

DRAFT TERM OF REFERENCES
METRO MANILA NORTHERN ROAD DEVELOPMENT PROJECT
(SOUTHERN PACKAGES)

5. METRO MANILA NORTHERN ROAD DEVELOPMENT PROJECT (SOUTHERN PACKAGE)

5.1 Background

Metro Manila and its vicinity has been suffering from worsening traffic situation and severe environmental degradation. Roads have become more congested, commuting time and distance lengthened, in-vehicle congestion and comfort level of public transport decreased, air pollution worsened, and accidents increased. Many of these are attributed to the situation which includes lack of infrastructure, poor maintenance, inadequate traffic and vehicle management, undisciplined drivers and pedestrian attitudes, uncontrolled road side activities and land use, etc. Fast growing population in urban areas are enormous serious threats to sustainable development of urban transportation from the medium to long-term viewpoints. While requirements for more strategic transport planning were necessary, updated database and effective planning tools were insufficient.

Under these circumstances, the Metro Manila Urban Transportation Integration Study (MMUTIS) was conducted, upon request of the Philippine Government, with technical assistance of Japan International Cooperation Agency (JICA) with the following objectives:

- To establish an updated transportation database system similar to the one built in JUMSUT which is intended to contribute to transportation planning research and education in the Philippines;
- To formulate a Master Plan for a comprehensive urban transportation system of Metro Manila for the target year 2015; and
- To formulate a Medium-term Development Plan (1999 - 2004) based on the Master Plan.

The MMUTIS proposes at-grade road development as one of the important strategy. The proposal consists of development of primary arterial roads for missing links and promoting effective north-south urban expansion, and secondary roads to strengthen road network hierarchy. Role of those at-grade roads is also strictly important for the space to accommodate elevated expressway and MRT.

In the mid-term plan, MMUTIS road development plan was categorized as several spatial packages to promote the network development, and to formulate appropriate project sizes. The southern package consists of four new primary roads, one new secondary road and one grade separation project.

5.2 Objective of the Study

The objective of the study is to perform a feasibility study for each component road of the north and south project packages. The study includes:

1) conduct supplemental surveys including traffic surveys, topographic surveys and land use surveys for the projected areas.
2) conduct engineering and alignment studies,.
3) forecast traffic demand up to year 2020.
4) estimate project costs and benefits.
5) prepare alternative plans.
6) conduct economic evaluation.
7) conduct environmental impact evaluation.
8) formulate Project implementation plans.

5.3 Study Area and Outline of the Proposed Project

The study area for the southern package is a southern part of Metro Manila and Cavite Province approximately between EDSA at the north and the Governor's Drive at the south.

The southern package consists of the following road sections:

Category	Road Name	Length	Project Cost
(1) Primary Arterial	PS01: Talaba-Kawit Road	6.0 km	P1,496mil
(2) Primary Arterial	PS03: Kawit-Bucandala Road	5.5 km	P1,052mil
(3) Primary Arterial	PS04: South Central Road	15.5 km	P13,133mil
(4) Primary Arterial	PE01: Bucandala-Muntinglupa Road	16.0 km	P5,450mil
(5) Secondary Arterial	SM21: Pasay Road Extension	5.5 km	P4,805mil
(6) Grade Separation	GS06: Roxas Blvd./Mia Road Intersec.	---	P480mil
	Total	48.5 km	P26,416mil

The indicated project costs are an approximate estimation by MMUTIS. The study area is shown in Figure-1.

5.4 Scope of the Study

1) Present Condition Survey of the Study Roads

- Geometric condition
- Road condition
- Roadside development condition
- Land use for proposed alignment

2) Traffic Surveys of the Study Areas

- Analysis on existing traffic data
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4) Preparation of Aerial Photo Mosaic Map for the new road sections

- Aerial photo taking
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6) Engineering Survey

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10) Environmental Impact Evaluation

- Environmental impact assessment
- Proposal of mitigation measures

11) Project Implementation Program

- Prioritization of sections
- Implementation schedule
- Annual fund requirements

5.5 Study Period

The study shall be completed within a period of 10 (ten) months.

5.6 Man-month Requirements

1) Team Leader/Highway planner	8 months
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Figure 1
Road Project Packages