CHAPTER 4 URBAN FACILITIES RESTORATION AND IMPROVEMENT PLAN (ROAD AND TRANSPORTATION SECTOR)

4.1 Policy and Strategy for Road and Transport Plan

4.1.1 General Urban Transport Enhancement Strategy

4.1.1.1 Road Network Development

Transport is an entitlement to the citizens of Greater Monrovia, and good transport networks have multiple benefits; socially, economically, environmentally and culturally. Equity is also important as transport should be affordable to all so that there is equal and affordable access to opportunities of employment, education and social inclusion. Furthermore, the paybacks in both direct and indirect terms are substantial and will contribute directly to improved economic performance, productivity and greatly reduce the negative stresses that citizens endure on a daily basis. The Government of Liberia(GoL)'s foremost objectives of road and transportation sectors are to quickly embark upon the rehabilitation of infrastructure and the rebuilding of systems to deliver basic services in order to create the conditions and linkages needed to achieve broad-based growth and poverty reduction. Rebuilding roads and transport service, in particular, is central to achieving all of the GoL's other major objectives. Without adequate road and transportation infrastructure, the ability to create jobs, expand the rule of law and reduce poverty will be severely constrained, increasing the likelihood of returning to conflict.

4.1.1.2 Urban Transport Efficiency

Roads are the most predominant mode of transport in urban areas and especially in Monrovia. They interconnect production with consumption and market centers. Most of the roads in Monrovia can hardly cope with rapid increase in traffic volumes due to their bad state and insufficient road capacities. Other road related problems particularly in Monrovia include, inadequate stopping and parking spaces, lack of maintenance and room for future expansion, lack of modern terminal (bus/truck terminals), inadequate facilities for non-motorized traffic and pedestrian lanes and lack of road furniture. Furthermore, road capacity has been reduced by road side parking and public bus stops, street vending and pedestrians who are compelled to walk on the carriageways as most of the walkways are full of parked vehicles and petty businesses.

4.1.1.3 Traffic Flow Management and Accident Mitigation

There is a need to minimize traffic congestion in the major Central Business Districts as well as Red Light, Waterside, Duala and other places in Monrovia. There is serious traffic congestion in Monrovia particularly in the areas mentioned above due to rapid increase in car ownership and use. Apparently, the existing road capacity has not been able to cope with vehicle influx. Congestion has also been caused by lack of public education and awareness, lack of parking spaces, poor traffic management including inefficient traffic signals, poorly designed junctions, lack of signs and markings and laxity in traffic regulation enforcement. Furthermore, Greater Monrovia faced the problem of high rate of road traffic accidents, which resulted in significant economic damage.

4.1.1.4 Public Transportation Service Implementation

The provision of transport services in urban centers like Monrovia is generally dominated by the private sector. At present, public transport share of the market in Monrovia is negligible, except private taxi service. In order to meet the transport service demand in urban areas in terms of customer safety, comfort and adequacy, the transportation planning strategy should consider to develop and operate modes of transport on the basis of economic savings on fuel use, operational efficiency including reducing traffic congestion, environmental protection and safety; to segregate public transport. In addition, bus transport should be confined to selected routes to speed up traffic flow; and to establish trucks/bus terminals near the main cities.

4.1.2 Strategy for Road and Transport Plan in Greater Monrovia

4.1.2.1 Overall Goals:

Analyzing the present road and transportation situation and reviewing the existing strategy in terms of road and transportation sectors, such as PRS and NTS, the strategy for road and transport planning in Greater Monrovia for this study is formulated as follows:

To recover and enhance the economic activity through improving the road infrastructure, keeping the stable transport network and reducing traffic congestion, mainly is achieved by road and bridge rehabilitation.

To reduce poverty and raise living standard through implementing the fundamental public transportation services and managing traffic control and safety.

4.1.2.2 Main Short Term Objectives (2008-2014) in the Road and Transport Sector

In the short term, the aim is to rehabilitate major roads and bridges, a critical component of infrastructure and basic services pillar, to facilitate economic activities and combat poverty. Without adequate road infrastructure, the ability to reduce poverty is severely hindered and increases the likelihood of returning to conflict. Massive road projects will provide thousands of jobs for the youth and will have substantial multiplier effects on the economy and poverty reduction, facilitating the enhancement of networking that spur rapid national development.

4.1.2.3 Main Objectives in the Medium Term (2015- 2019)

The main objective of road and transportation sector in the medium term is to restore the road network through maintenance of paved roads, upgrading of primary roads and rehabilitation of secondary and feeder roads in order to reduce traffic congestion. This is critical for getting product out to markets and for improving economic activities throughout the country.

4.1.2.4 Main Objectives in terms of Public Transportation and Traffic Management

The objectives of public transport and traffic management are to install fundamental public transportation service, to manage traffic flow efficiency and to reduce traffic accidents. This is another critical issue for improving economic activities and improving living standard throughout Greater Monrovia.

The policy and strategy of urban transportation planning stated above is summarized as a form of logical

frame shown in Table 4.1-1.

Table 4.1-1 Logical Frame of Urban Transportation Planning for Greater Monrovia

Term	Policy and Strategy	Action Plan
Short term Plan Phase 1 (2008 - 2011)	To reduce poverty To recover economic activities	Three year Road Development Plan with LITF by GOL and International organizations (WB, AfDB and so on))
Short Term Plan Phase 2 (2012 - 2014)	To reduce poverty To facilitate economic activities	To link a urban road network by paved and categorized road system To reconstruct the missing ling and damaged bridge and keep continuous traffic through the year
	To implement fundamental public transportation service	To implement the bus stop facilities and enhance scheduled public bus service
	To mitigate traffic congestion and accident	To intense the capacity of primary road To install and study traffic control and management system (traffic education, traffic signal, traffic sign and traffic regulation)
Medium Term Plan (2015 - 2019)	To support economic activity growth To rise living standards and address transportation poor To facilitate additional need of citizen and make efficient transportation system	To enhance the function of road network (capacity, surface, linkage) To implement comprehensive public transport system and transit terminal To implement traffic control and management system

4.1.3 Basic Direction of Road Network Development

In line with the urban transport planning strategy and the conceptual action plans integrated with the land use plan, the infrastructure development in road and transportation sectors is planned in the basic direction as described below.

1) Full utilization of existing facilities

New physical improvement of road facilities shall be minimized by fully utilizing the existing facilities.

2) Urgent need of pavement improvement

The pavement of urban and feeder/ neighborhood streets, as well as primary /secondary roads are in urgent need of improvement to let the vehicles fully utilize these streets. Improved pavement is expected not only to distribute urban traffic on urban streets, thus relieving traffic congestion on primary roads but also to improve the urban environment.

3) Minimum/selected implementation of new construction

Although the present road network is not well developed, certain missing links of important roads exist, which should be newly provided as minimum physical improvement measures.

4) Implementation of functional hierarchy road network

The feeder and neighborhood road system to support the primary and secondary roads shall be developed in the entire urban area

5) Improvement of congested primary roads

The Primary roads in Monrovia are very congested because of concentration of traffic, and shall be improved by widening the existing roads or providing alternative, detourring roads.

6) Reconstruction of existing bridges and culverts

There exist many deteriorated or collapsed bridges and culverts along with existing feeder/ neighborhood roads, which are not usable, particularly during rainy seasons. The urgent reconstruction of these bridges shall be undertaken.

4.1.4 Road Hierarchy and Classification System

4.1.4.1 Necessity of Road Classification System

For the planning and management of road facilities, road classification system to assist with the coordination and planning of land use and transportation should be developed. The establishment of roadway classification system can help with the establishment of designated road right-of-way widths and design standards for access control, road cross-sections, pavement structure, drainage systems, sidewalks and boulevards and street lighting. It can assist with the establishment of traffic operations standards and guidelines for traffic control devices, pavement markings, on-street parking and stopping regulations, speed limits and pedestrian and cycling facilities.

Road classification aids the organization of data and information for road design and traffic operations. It can assist with the establishment of standards and guidelines for street cleaning and litter removal, and pavement, sidewalk and main roads reconstruction and maintenance. It can also be used in the development of guidelines for right-of-way management for the accommodation of utilities, potential advertising, vendors and banners and pennants. A road classification system not only provides a fundamental management tool for transportation staff. Road users as well as communities derive benefits from its existence and its consistent application. Formalized road classifications help residents, residents' groups, business people, planning professionals and other stakeholders to have clear understanding of the function and characteristics of particular roads.

4.1.4.2 Characteristics of Road Classification System

Road classification is "the orderly grouping of roads into systems according to the type and degree of service they provide to the public." Road classification system groups streets in a hierarchical manner by different groups which perform different functions each other. The hierarchy provides a variation in service. The highest order roads provide high traffic service levels and have little or no access to abutting properties. The lowest order roads (local roads) provide low traffic service levels but with full property access. Between these two extremes, arterial roads provide relatively high traffic service levels with some property access, while collector roads provide equal priority to traffic service and property access. Collector roads, as their name implies, serve to collect traffic from local roads and provide access to arterial roads, which then may connect to expressways or main highways. Collectors also can be thought of as distributors of traffic from the main roads to the minor roads. As would be expected, traffic volumes are typically higher on higher level roads than on lower level roads. Other characteristics of roads are dependent on road classification too. Speed limits and traffic operating speeds tend to be higher on higher level streets.

Higher level roads are generally wider with more traffic lanes and bus and streetcar service is generally concentrated on arterial and collector roads. Because more pedestrians are likely to use roads of higher classification, sidewalks or shoulders are more important on these roads than on local streets with low volumes of motorized traffic traveling at low speeds. Cyclists will generally not need special facilities on local streets but are more likely to need bicycle lanes or shoulders on arterial roads, where competition for road space is more intense.

The Figure 4.1-1 illustrates the road function by road class. The function of a road can fundamentally be measured by mobility of the vehicle, and accessibility to the adjacent land space and activities. Although all of the road links are expected to have both functions, the unplanned mixture of these two functions will cause higher side frictions on main highway or increase of accidents by through traffic in the residential area. It is therefore critically important to classify the road links depending on which of these two functions should have more priority.

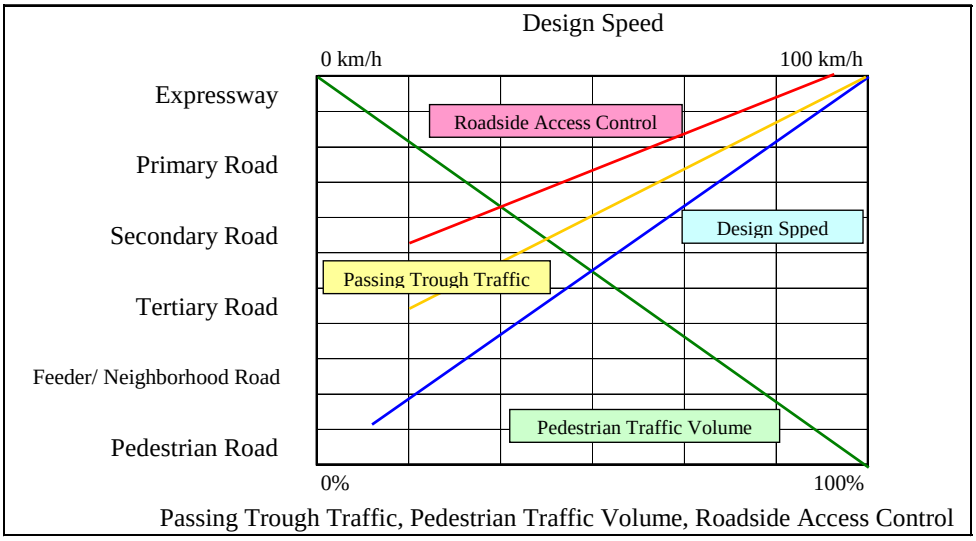


Figure 4.1-1 Road Function by Road Class

4.1.4.3 Define the Road Hierarchy, Road Class for Greater Monrovia

The road network plan has principally taken into account network pattern, road hierarchy, and road density in the process of developing the road network plan. Network patterning is as known effective method in network planning. The Monrovia road network adopts the ring and radial patterns because of the existing road network and land-use characteristics are suitable for that pattern. To develop a proper road network, a systematic and hierarchical functional classification is necessary. The hierarchical classification of functions is stratified into primary, secondary and tertiary facilities according to the level of services.

(1) Urban Primary Roads

Urban primary roads represent critical road transport spines that anchor future urban evolution and economic activity.

(2) Urban Secondary Roads

Urban secondary roads provide mobility for medium distance traffic, such as between townships within the city. Network bus services may be provided on this type of road as well as other upper road classes as long as physical and operational conditions so permit, but will largely operate in mixed traffic.

(3) Urban Tertiary Roads

Urban tertiary roads provide accessibility to defined geographical areas within the city, and are intended to provide linkage with other higher-order roads. Urban tertiary roads also provide accessibility to and/or between neighborhoods, communities and individual plots.

The main characteristics of each functional class are summarized in Table 4.1-2.

Table 4.1-2 Definition of Road Classification for Greater Monrovia

Class	Function
Urban Primary Road	✓ Link to national primary road outside of Monrovia ✓ From core metropolitan spines ✓ Accommodate longer trips ✓ Connect major trip generators ✓ Network Bus service provided
Urban Secondary Road	✓ Link between township ✓ Accommodate travel demands between townships or major communities. ✓ Link to urban primary roads ✓ Network Bus service provided
Urban Tertiary Road （Feeder road, Neighborhood Road）	✓ Link Between Community ✓ Provide circulation within as well as between townships and communities

4.1.4.4 Road Design Standards by Classification

The functional elements of the new system embody not only "traffic oriented" considerations, but also the broader aspect of mobility and connectivity between various elements of the urban fabric. For example, urban primary roads form the backbone of connectivity involving major urban precincts such as CBD or townships. Neighborhoods and communities, in turn, would have a higher reliance on urban secondary roads. This, in turn, implies various guidelines in terms of design speed, number of lanes, shoulder and sidewalk.

The proposed road design standards for the master plan basically follow the international standards, such as the American Association of State Highway and Transportation Officials (AASHTO) and Road Structure Guidelines, Japan Association of Road. The Table 4.1-3 explained the proposed road design standard by road class. In reality, however, it is often difficult to secure sufficient space for roads in urban areas due to resettlement problems and high compensation costs. Therefore, planning of road cross-sections must balance these constraints and the space requirements of roads according to function, because road space is not merely for vehicle traffic but also for pedestrian traffic, landscape improvement, and as space for various activities

Table 4.1-3 Proposed Design Standards by Road Class

Classification	Design Speed (km/hr)	Lane Wide (m)	Typical No. of Lanes	Shoulder (m)	Sidewalk (m)
Urban Primary Road	60 - 80	3.00 – 3.50	4 - 6	1.0 – 3.0	2.0 – 4.0
Urban Secondary Road	40 - 60	3.00 – 3.25	2 --4	1.0 – 2.0	1.0 – 3.0
Urban Tertiary Road	30 - 40	2.50 – 3.00	1 - 2	0.5 – 1.0	0.0 – 2.0

4.1.4.5 Road Cross Section Standard by Road Class

Based on the proposed design standards, the typical cross section by road class is illustrated as follows.

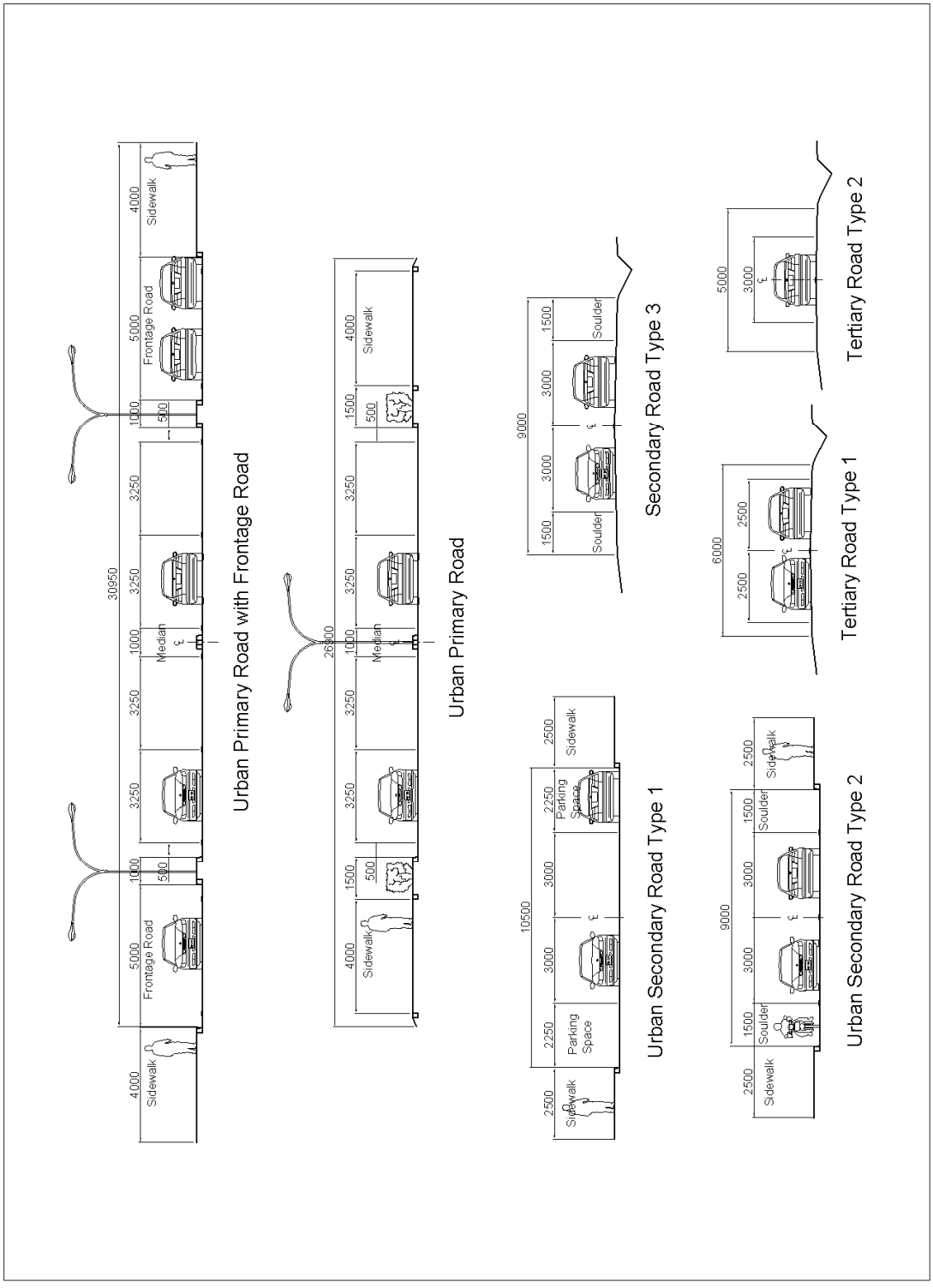


Figure 4.1-2 Typical Cross Section by Road Class

4.2 Traffic Demand Forecast

4.2.1 Methodology

4.2.1.1 Transportation Modeling

Consideration of the urban area throughout Greater Monrovia is necessary as a base to precisely determine transportation investment decisions regarding comprehensive, cooperative, and continuing transportation planning process. Significant element of the transportation planning process involves projecting future transportation demand. The most accepted method of projecting future transportation demand, and for evaluating investment strategies to serve the projected demand, is the use of travel demand and forecasting models. Transportation modeling is to find the relationship between urban situation and people's movements. In this case the models have utilized socio-economic data that was presented in Chapter 3 to estimate travel demand coupled with simulation of the transportation system to represent transportation supply. Together with this socio-economic data, the simulated transport network, and mathematical travel models simulate the ability of the transportation system to serve the estimated demand. Figure4.2-1 shows the flowchart of this stage.

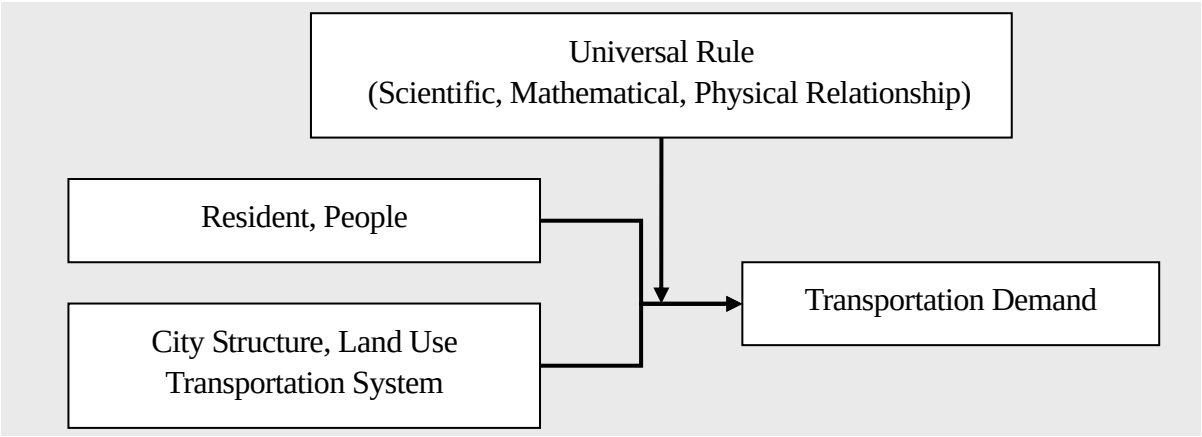


Figure 4.2-1 Principle of Transportation Modeling

4.2.1.2 Four-step Approach

Travel models have been implemented by using a wide variety of model structures, computer software systems, and data sets. While it is rare to find two models that have identical model structures, software, and data sets, the majority of travel models applied in the world wide are similar in that context. The transport model framework uses a conventional 4 steps approach which has been well-tried and found to be effective in many cities around the world. The concept of the 4 steps approach is shown as Figure 4.2-2. It includes the following basic four steps or components:

- Trip Generation and Attraction Model: estimating the amount of travel and where it begins and finishes;
- Trip Distribution Model: linking the trip together to form trips between the origins and destinations;
- Modal Split Model: accessing the modal shares of the available travel modes; and,
- Assignment Model: usage of each segment of the road and public transport networks.

The main thrust of the model is targeted at representing the travel demand of the residents of the study area, and their usage of private and public transports such as private car, taxi, shared taxi, tram, bus metro and so on.

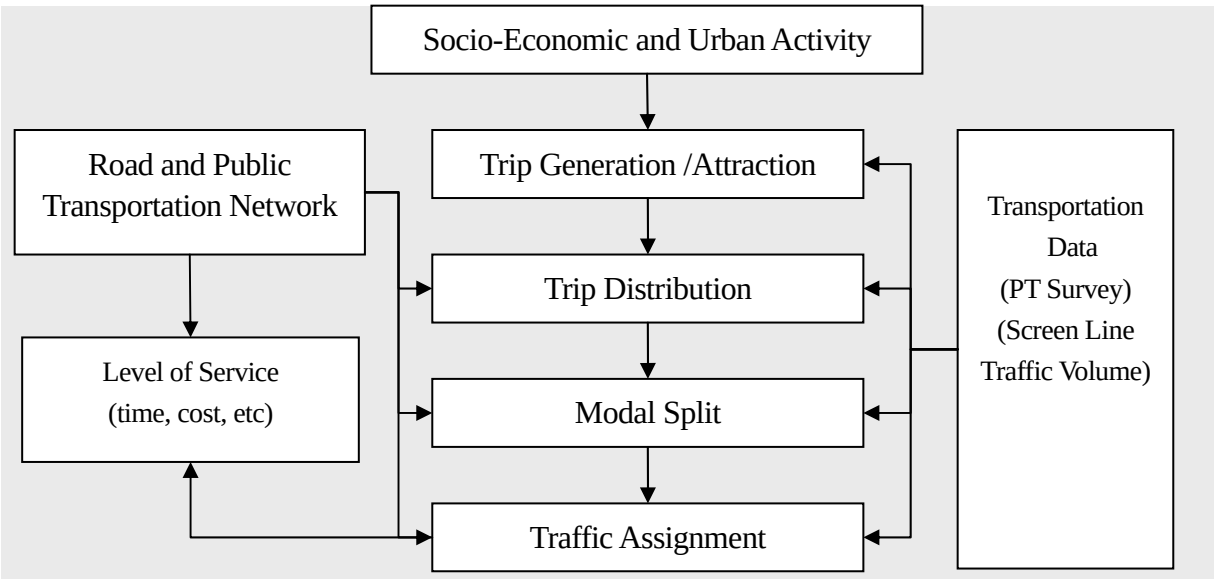


Figure 4.2-2 Concept of Four-Step Approach of Transport Modeling

4.2.1.3 Modeling and Forecasting Tools

During all steps of travel model calibrations and demand forecast, JICASTRADA system and EXCEL spread sheet are employed. JICASTRADA is a geographic information system designed specifically for the planning, managing, and analyzing of transportation systems. The software provides a set of tools for travel demand modeling as well as capabilities for geographic database management, presentation graphics and transportation models. JICASTRADA system is applied for simulation of travel time and cost. For better precision, efficiency and minimization of trial errors, model calibrations and forecasts in trip generation, trip distribution and modal split steps are programmed by using Excel spreadsheet, and as the final step, traffic assignment stage is computed by JICASTRADA system.

4.2.2 Future Socio-economic Framework

4.2.2.1 Total Framework

The socio-economic indicators which have been assessed as a basis for transport planning in this study are summarized in Table 4.2-1 below. The methodology and detailed discussion are mentioned in Chapter 3.

Table 4.2-1 Total Socio-Economic Framework for Greater Monrovia (Study Area)

		Year 2008	Year 2014	Year 2019
Population	Total	1,010,575	1,250,000	1,470,000
	Age 13 yrs and above	639,540	830,347	1,013,233
	Age 10-20	223,286	272,832	308,966
Number of Worker		248,315	342,197	436,891
Housewife / Jobless		391,225	488,150	576,342
GDP per Capita (USD)		197	348	561
Car Ownership (Vehicle /1000 person)		15	27	43
No of vehicle (Private Car) in Great Monrovia		15,159	33,216	62,907
No of Vehicle (All Vehicle) in Great Monrovia		74,621	163,508	309,667

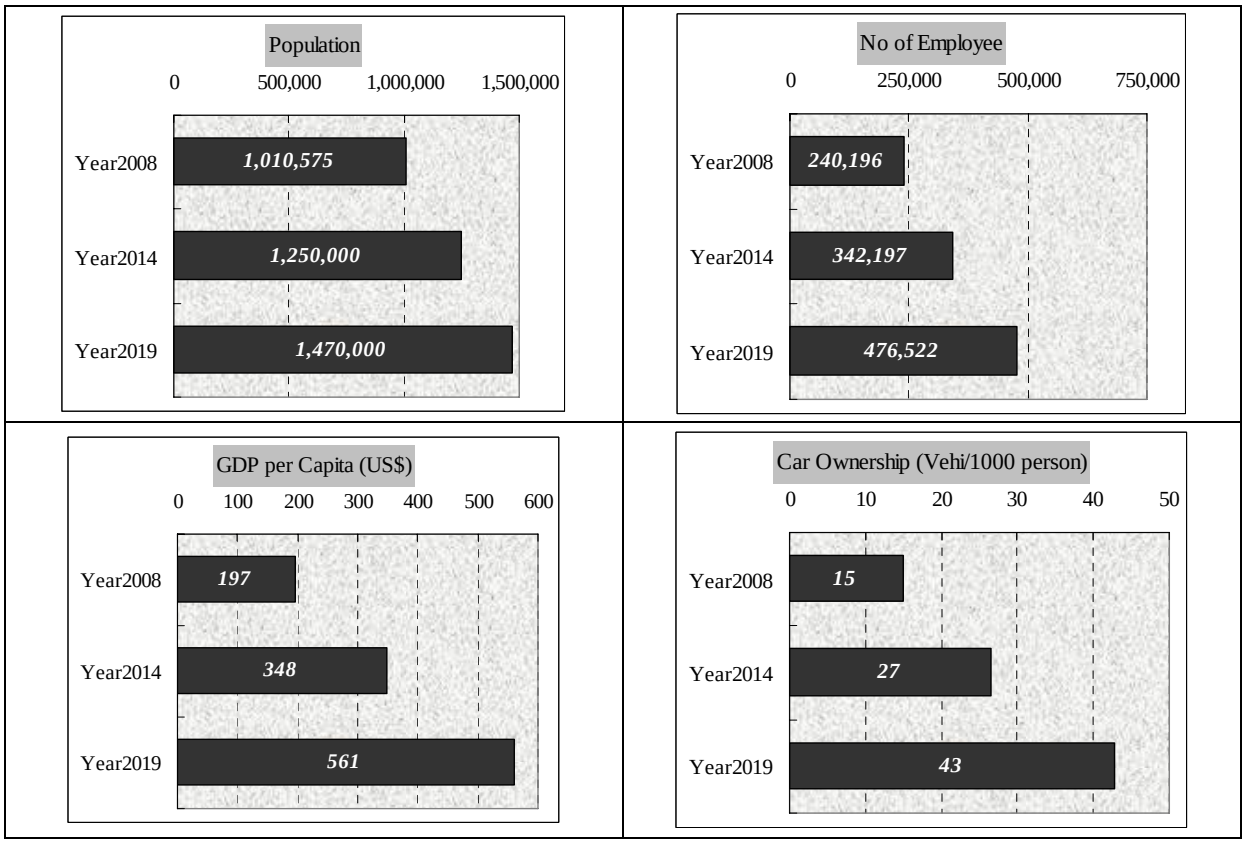


Figure 4.2-3 Trend of Socio-Economic Framework for Greater Monrovia (Study Area)

4.2.2.2 Zonal Framework

For the purpose of summarizing the population, employee and student forecasts used as inputs for the transport demand forecast, the study area was divided into 16 geographical zones. These zones collectively account for about 160 communities, which are the basis for the estimation of total traffic flows in the Transportation Demand Model. The summarized estimation of zonal frameworks is given in Tables 4.2-2 to 4.2.-4 respectively.

Table 4.2-2 Zonal Population Framework in Year 2008

Zone		Total Population	Population 13 and above	Worker Office Base	Student School Base
1	New Kru Town	73,379	48,452	5,381	12,658
2	Logan Town	58,168	38,408	7,191	8,867
3	Clara Town	55,462	36,621	19,118	2,560
4	West Point	29,516	19,489	4,305	684
5	Central Monrovia A	42,139	27,824	95,224	22,937
6	Central Monrovia B	40,688	26,866	8,658	5,056
7	Sinkor	43,780	28,908	27,404	11,039
8	Lakpazee	42,045	27,762	4,521	1,386
9	Old Road	48,274	31,875	4,446	7,406
10	Congo Town	25,217	16,651	2,899	3,882
11	Paynesville	350,998	231,762	44,522	47,258
12	Gardnersville	80,397	53,086	11,318	11,886
13	New Georgia	54,188	35,780	1,699	4,233
14	Barnersville	35,224	23,258	2,100	6,500
15	Johnsonville	4,514	2,981	220	324
16	Caldwell	26,586	17,555	1,190	436
Total		1,010,575	667,278	240,196	147,112

Table 4.2-3 Zonal Population Framework in Year 2014

Zone		Total Population	Population 13 and above	Worker Office Base	Student School Base
1	New Kru Town	80,173	53,257	8,348	10,849
2	Logan Town	65,730	43,663	12,561	8,895
3	Clara Town	62,075	41,235	26,208	8,400
4	West Point	27,454	18,237	5,795	3,715
5	Central Monrovia A	59,163	39,300	108,142	26,006
6	Central Monrovia B	46,631	30,976	14,368	6,310
7	Sinkor	51,792	34,405	37,376	7,009
8	Lakpazee	49,559	32,921	6,118	6,706
9	Old Road	57,622	38,277	7,184	7,797
10	Congo Town	36,086	23,971	4,540	4,883
11	Paynesville	445,954	296,238	80,415	60,347
12	Gardnersville	99,431	66,050	19,594	13,455
13	New Georgia	70,162	46,607	2,451	9,494
14	Barnersville	46,588	30,947	2,872	6,304
15	Johnsonville	7,403	4,918	804	1,002
16	Caldwell	44,177	29,346	5,420	5,978
Total		1,250,000	830,347	342,197	187,152

Table 4.2-4 Zonal Population Framework in Year 2019

Zone		Total Population	Population 13 and above	Worker Office Base	Student School Base
1	New Kru Town	77,795	53,622	12,104	10,924
2	Logan Town	67,997	44,898	19,118	9,146
3	Clara Town	58,874	38,874	35,774	7,919
4	West Point	29,516	19,489	7,832	3,970
5	Central Monrovia A	60,723	40,095	131,275	26,168
6	Central Monrovia B	48,595	32,087	21,436	6,537
7	Sinkor	49,806	32,887	50,879	6,699
8	Lakpazee	46,905	30,971	8,292	6,309
9	Old Road	54,426	35,937	10,600	7,321
10	Congo Town	33,133	21,878	6,610	4,457
11	Paynesville	660,010	435,802	123,904	88,778
12	Gardnersville	100,389	66,286	29,720	13,503
13	New Georgia	63,975	42,242	3,435	8,605
14	Barnersville	45,736	30,199	3,915	6,152
15	Johnsonville	29,457	19,450	1,464	3,962
16	Caldwell	42,661	28,169	10,162	5,738
Total		1,470,000	1,013,233	476,522	211,938

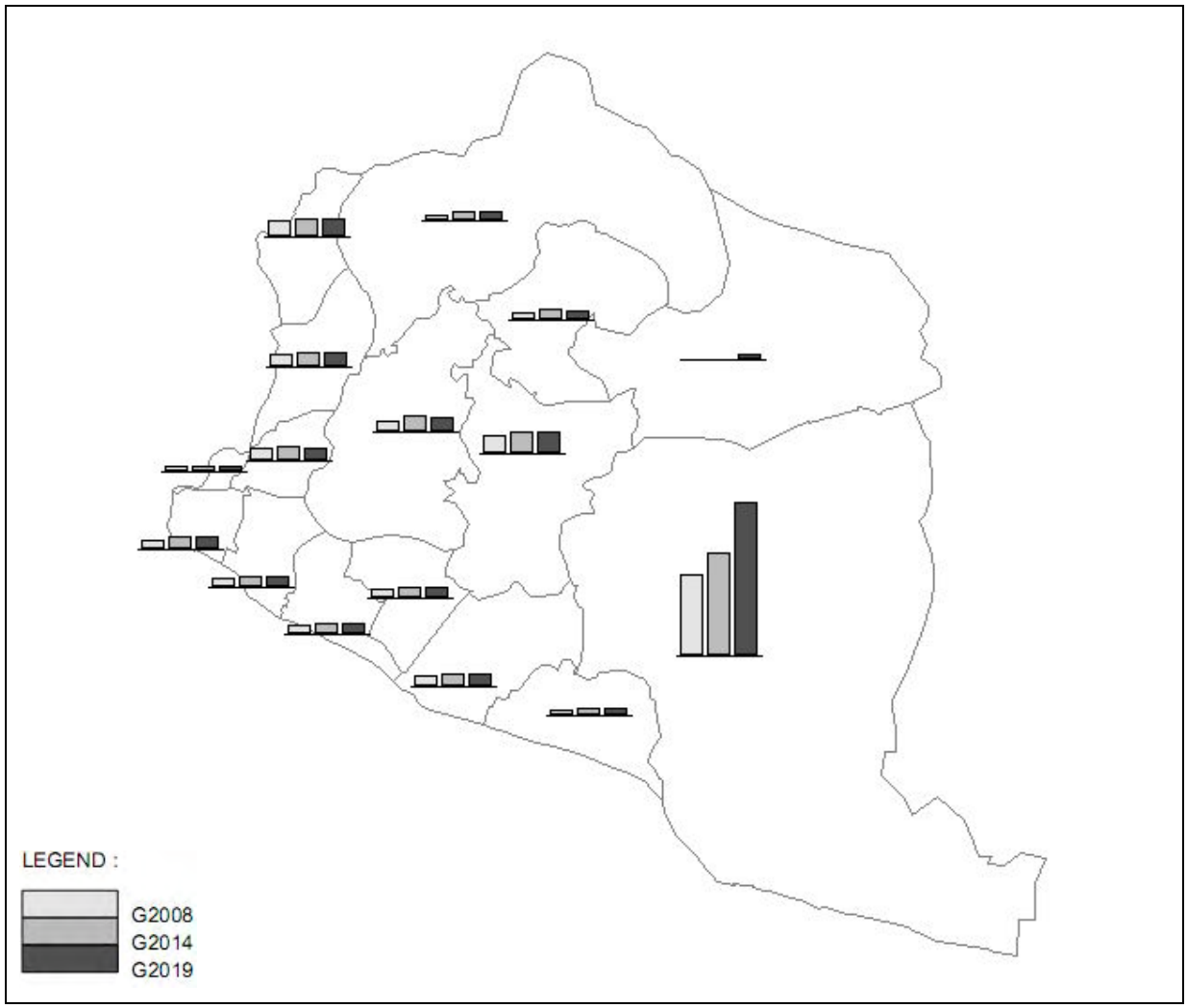


Figure 4.2-4 Trend of Zonal Population

4.2.3 Future Trip Rate and Total Trip Production

4.2.3.1 Modeling Trip Rate per capita

In the analysis of the trip rate per capita obtained from the conducted person-trip survey, personal occupation and car ownership status are the attributes that are very much affecting the trip rate. As for the trip rate per capita by occupation, the one of worker is 2.64 in average, the highest among the occupation categories, 2.02 for students, and 1.61 for un-employee. The trip rate by employee is swelled according to increase of household income, 1.92 trip per capita for the person with income under LRD 2,999 and 2.53 trip per capita for the person with income of LRD 40,000 and above. The difference of trip rate by car ownership is also relatively big, that is, 2.15 without car and 2.41 with car access.

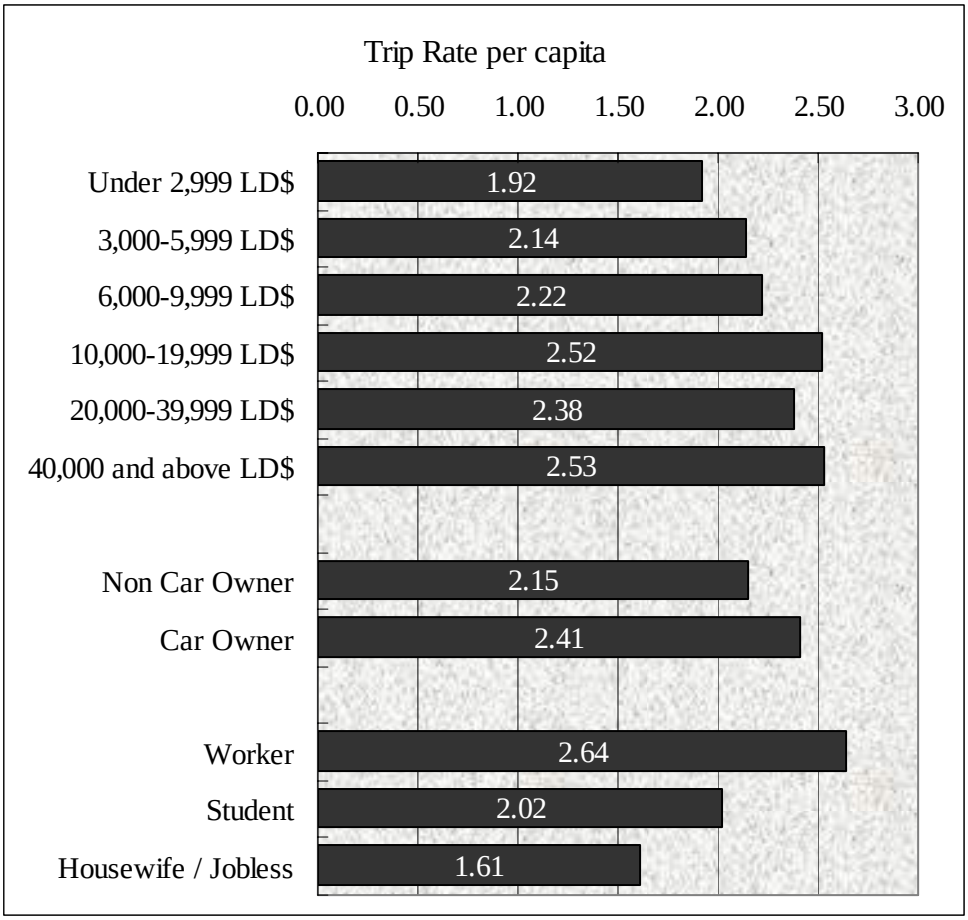


Figure 4.2-5 Analysis of Trip rate per Capita per Day

The cross-classification methods of calculating trips production can separate the population in the study area into relatively homogenous groups based on certain socio-economic characteristics. Considering the influence of the shift of economic situation and life style in future on trip production, especially increase in number of labor force and private car following the economic growth, the trip rate per capita is modeled by the Cross-Classification method by occupation, car ownership and trip purpose shown in Table 4.2-5.

Table 4.2-5 Table Trip Rate Cross-Classification Matrix

Car Ownership	Occupation	Trip Rate per capita per day					
		Home	Work	School	Business	Other	Total
No	Worker	1.149	0.698	0.041	0.330	0.374	2.592
	Student	0.976	0.001	0.858	0.007	0.177	2.018
	Housewife / Jobless	0.740	0.080	0.008	0.145	0.611	1.584
	Total	0.953	0.295	0.223	0.182	0.420	2.074
Yes	Worker	1.345	1.075	0.041	0.279	0.278	3.017
	Student	0.976	0.001	0.858	0.007	0.177	2.018
	Housewife / Jobless	0.830	0.036	0.067	0.228	0.770	1.931
	Total	1.091	0.519	0.252	0.193	0.358	2.414
Total		0.967	0.317	0.225	0.183	0.415	2.107

4.2.3.2 Future Total Trip Generated from Greater Monrovia

Based on the Cross-Classification trip rate table and the total future framework, the total trips production in the study area is forecasted to expand to 1.75mln trips per day in 2014 and 2.14 mln trips per day in 2019 from 1.35 mln trips in 2008 as shown in Table 4.2-6 and Figure 4.2-6.

Table 4.2-6 Estimation of Total Trip Production for Study Area

Car Ownership	Occupation	Trip per day in 2008					
		Home	Work	School	Business	Other	Total
No	Worker	251,934	152,938	8,904	72,302	82,006	568,085
	Student	132,589	81	116,517	928	24,032	274,146
	Housewife / Jobless	165,221	17,750	1,778	32,297	136,412	353,457
	Total	551,269	170,779	128,695	105,321	243,114	1,199,178
Yes	Worker	39,245	31,369	1,182	8,127	8,100	88,023
	Student	16,870	10	14,825	118	3,058	34,881
	Housewife / Jobless	12,434	540	999	3,419	11,531	28,923
	Total	67,023	31,909	15,510	11,870	22,024	148,336
Total		618,292	202,688	144,205	117,192	265,138	1,347,514
Car Ownership	Occupation	Trip per day in 2014					
		Home	Work	School	Business	Other	Total
No	Worker	319,864	194,175	11,305	91,797	104,118	721,258
	Student	162,010	99	142,371	1,134	29,364	334,978
	Housewife / Jobless	195,691	21,023	2,106	38,253	161,569	418,643
	Total	675,596	209,295	157,719	129,074	297,943	1,469,628
Yes	Worker	85,993	68,736	2,590	17,809	17,748	192,876
	Student	20,613	13	18,115	144	3,736	42,621
	Housewife / Jobless	27,245	1,183	2,189	7,492	25,267	63,376
	Total	128,581	61,216	29,755	22,773	42,252	284,578
Total		804,178	270,511	187,474	151,847	340,196	1,754,206
Car Ownership	Occupation	Trip per day in 2019					
		Home	Work	School	Business	Other	Total
No	Worker	363,021	220,374	12,830	104,183	118,166	818,573
	Student	183,466	112	161,227	1,284	33,253	379,342
	Housewife / Jobless	213,715	22,959	2,299	41,777	176,451	457,202
	Total	755,568	234,069	176,389	144,353	333,211	1,643,590
Yes	Worker	162,862	130,179	4,906	33,728	33,613	365,287
	Student	23,343	14	20,514	163	4,231	48,266
	Housewife / Jobless	51,599	2,241	4,146	14,189	47,852	120,028
	Total	225,973	107,583	52,293	40,022	74,255	500,126
Total		981,541	341,653	228,682	184,375	407,467	2,143,716

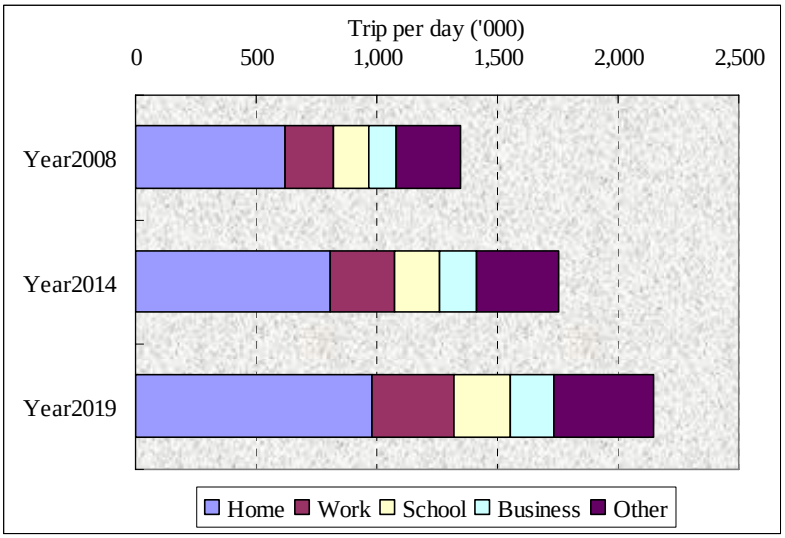


Figure 4.2-6 Trend of Number of Trips by Purpose

4.2.4 Future Trip Generation and Attraction

4.2.4.1 Modeling Trip Generation and Attraction by Zone

The objective of trip generation and attraction model is to forecast the number of trips that will start and arrive in each traffic zone within the study area. The linear regression models by trip purpose are adopted in the study. The model parameters are calibrated based on the person-trip survey as shown in Table 4.2-7.

$Oi = ai*X1i + bi*X2i$ $Dj = aj*X1j + bj*X2j$

where; *Oi: Trip Generation in zone i*
Dj : Trip attraction in zone j
X1i, X2j: Attributes in zone i, j
ai, aj, bi, bj: Coefficient

Table 4.2-7 Trip Generation and Attraction Model Parameters

Model Type	Trip Purpose	Population 13 & Above	Worker at Office Base	Student at Enrolment Base	R Squared
Trip Generation	To HOME	0.45886	1.66365	-	0.9939
	To WORK	0.25440	-	-	0.9926
	To SCHOOL	0.25482	-	-	0.9903
	BUSINESS	0.20246	0.03149	-	0.9866
	OTHERS	0.51078	-	-	0.9861
Trip Attraction	To HOME	1.07919	-	-	0.9957
	To WORK	-	0.85355	-	0.9912
	To SCHOOL	-	-	1.06784	0.9927
	BUSINESS	0.11820	0.28287	-	0.9938
	OTHERS	0.31375	0.52814	-	0.9833

It is necessary to achieve an exact balance between trip generations and attractions before performing the trip distribution process. This is because each generation must be paired with corresponding attraction. As with most models, higher confidence level is placed on generations since they are generated from

household data. Employment data is much more difficult to collect, hence, has a lower confidence level of accuracy. Consequently, using the total trip productions by purpose trip forecast, when applying the Cross-Classification trip rate as shown in the above Table 4.2-7, trip generations and attractions are balanced.

4.2.4.2 Future Trip Generation and Attraction

The future zonal frameworks, such as population, employee and students, are applied to trip generation and attraction models developed, the trip generation and attraction for year 2008, 2014 and 2019 are projected. The results of trip generation and attraction by 18 zones are given in Table 4.2-8 and Figure 4.2-7 below.

Table 4.2-8 Future Trip Generation and Attraction

No	Zone Name	Trip Generation			Trip Attraction		
		2008	2014	2019	2008	2014	2019
1	New Kru Town	79,956	93,003	99,106	81,859	92,071	98,523
2	Logan Town	67,721	84,450	95,066	68,093	83,592	94,282
3	Clara Town	82,758	100,332	108,168	77,370	99,285	106,855
4	West Point	35,337	36,059	40,639	31,789	35,691	40,314
5	Central Monrovia A	182,576	214,928	238,515	199,290	230,588	253,092
6	Central Monrovia B	52,752	67,739	78,397	51,899	67,041	77,580
7	Sinkor	83,590	105,962	119,237	88,213	104,831	117,448
8	Lakpazee	47,947	58,863	58,993	43,290	58,272	58,613
9	Old Road	53,944	68,540	69,767	54,296	67,852	69,296
10	Congo Town	29,034	42,983	42,684	29,232	42,550	42,390
11	Paynesville	410,320	566,060	839,809	406,447	560,315	834,232
12	Gardnersville	95,646	128,599	142,364	95,803	127,288	141,159
13	New Georgia	55,671	74,425	69,867	52,055	73,690	69,609
14	Barnersville	37,665	51,203	51,912	38,993	50,694	51,679
15	Johnsonville	4,753	8,635	32,012	4,426	8,549	31,898
16	Caldwell	27,842	52,423	57,180	24,461	51,896	56,748
	Total	1,347,512	1,754,204	2,143,716	1,347,516	1,754,205	2,143,718

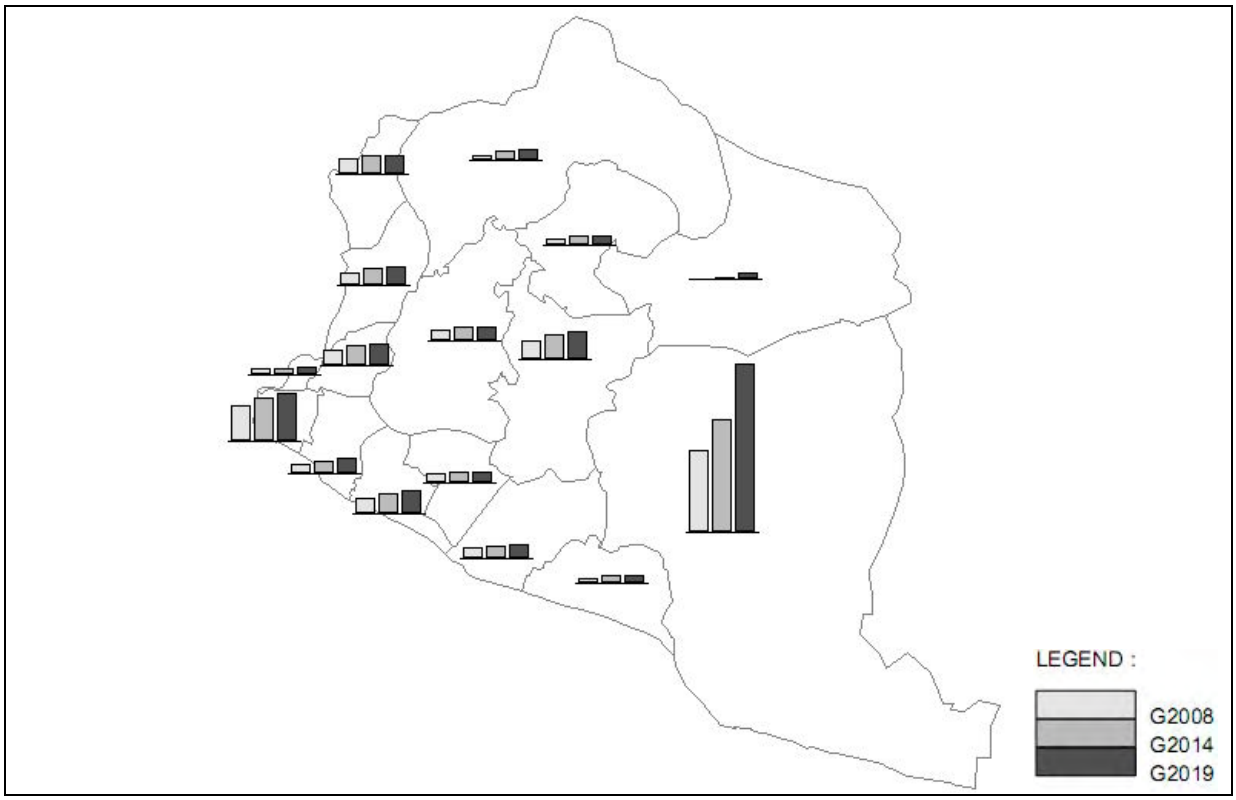


Figure 4.2-7 Trend of Trip Generation by year

4.2.5 Future Trip Distribution

4.2.5.1 Modeling Inter Zonal Trip Distribution

Trip distribution is the second major step in the travel demand modeling process. Trip production (the first major step) facilitates the methodology for estimating trip generations and attractions for each purpose within each zone. Trip distribution is the process of linking trip generations and attractions as pair of each zone. The Gravity Model is applied linking the trip production and attractions to form the trip matrices. Trip distribution model type applied in the study is Doubly Constrained Gravity Model as shown in the following formulas:

$$X_{ij} = A_i B_j \times kO_i^{\alpha} D_j^{\beta} L_{ij}^{\gamma}$$

in which;

$$A_i = \frac{1}{\sum_j B_j kD_j^{\beta} L_{ij}^{\gamma}} \qquad B_j = \frac{1}{\sum_i A_i kO_i^{\alpha} L_{ij}^{\gamma}}$$

$$\sum_j T_{ij} = O_i, \quad \sum_i T_{ij} = D_j, \quad \sum_i O_i = \sum_j D_j$$

where; *Xij : trip distribution from i to j*
Oi : trip generation of zone i
Dj : trip attraction of zone j
Lij : travel length from i to j (kilometer)
k, α, β, γ : coefficient
Ai, Bj: balancing factor

4.2.5.2 Modeling Intra Zonal Trip Distribution

Intra zonal trip rates of each zone are derived from the person-trip survey. These rates are applied for future demand forecasting, for intra zonal trips, and are assumed to be constant.

4.2.5.3 Calibration and Validation of Trip Distribution Model

To verify and confirm the accuracy of developed models, the comparison analysis of trip distribution between the observation and models has been done. Figure 4.2-8 explains the fitting situations between observed and modeled trip generation and attractions in 2008.

Table 4.2-9 Parameters of Trip Distribution Models

Trip Purpose	α	β	γ	K	R-squared
To Home	0.4062	0.5062	-1.1792	1.2555	0.9522
To Work	0.5888	0.3916	-0.9400	0.9237	0.8177
To School	0.5868	0.5164	-1.1801	0.3935	0.9535
Business	0.4987	0.4026	-0.9927	1.1405	0.7813
Others	0.5296	0.3763	-1.6723	1.0621	0.9595
Total					0.9623

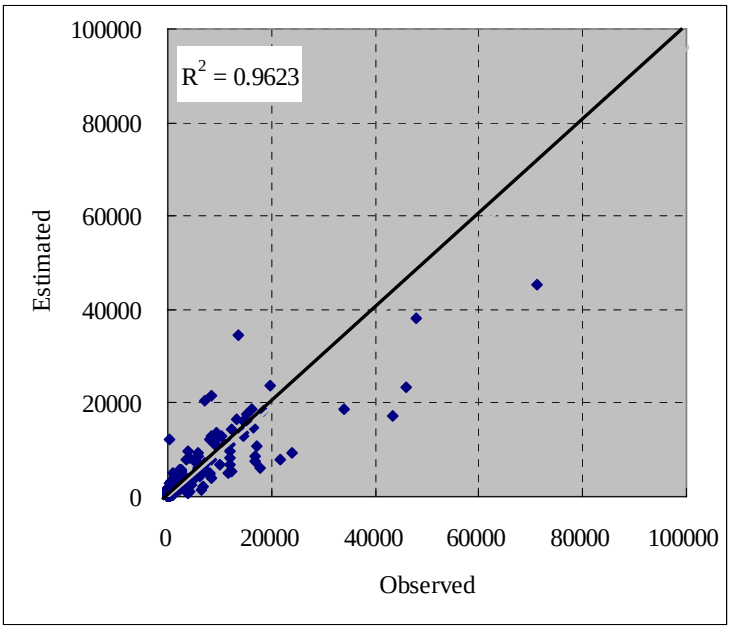


Figure 4.2-8 Verification Results of Observed and Modeled Trip Distributions

4.2.5.4 Future Trip Distribution

Based on the trip distribution in 2004 and 2025, the charts by spider network assignment method, which clarify the trip distribution and interaction among zone pairs, are presented in Figure 4.2-9

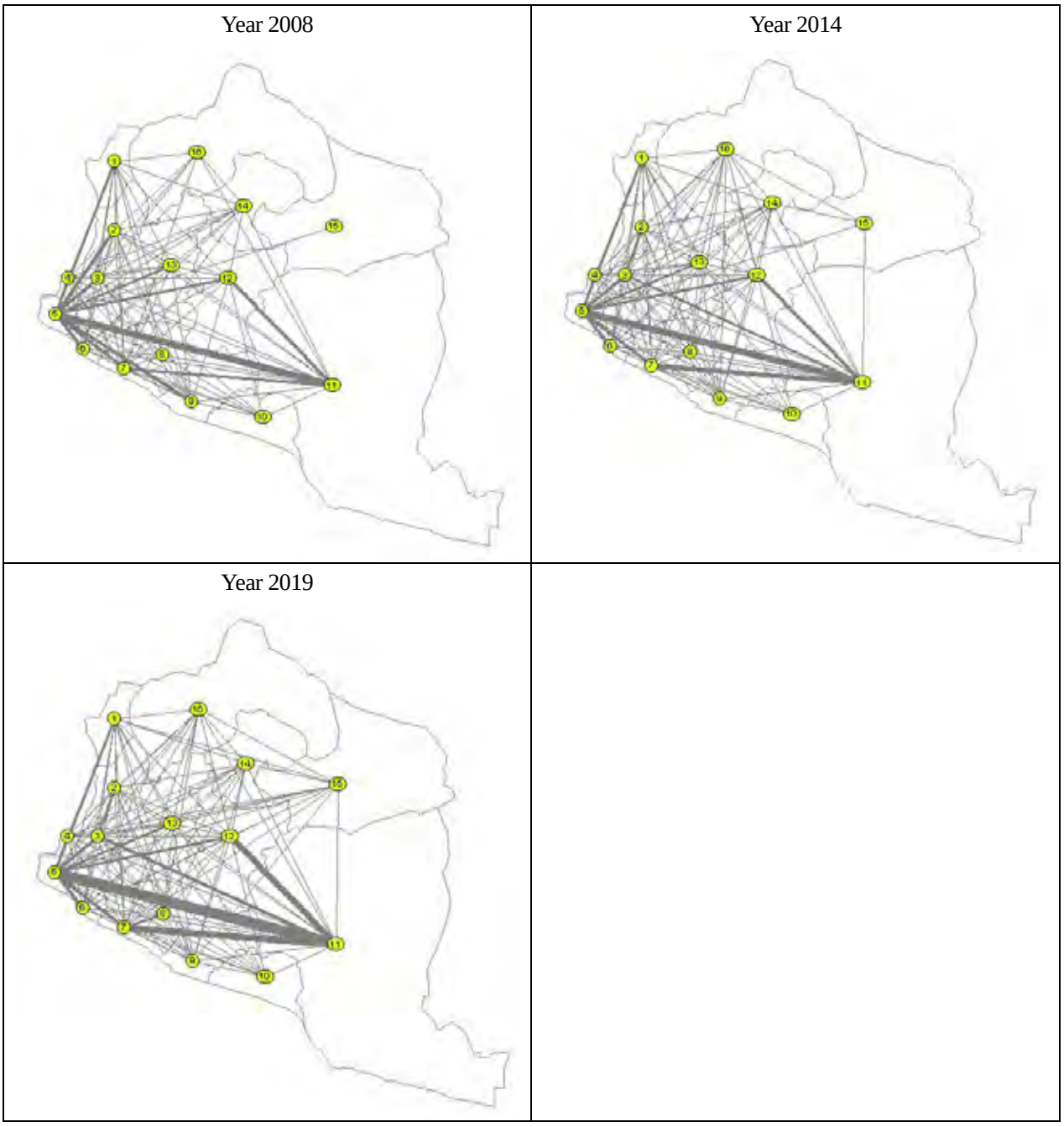


Figure 4.2-9 Future Trip Distribution Patterns by Desiring Line Maps

4.2.6 Future Modal Split

4.2.6.1 Modal split Model Hierarchy

Modal split models are applied to analyze and predict the choices of individuals or groups of individuals who chose the transportation modes when they make particular types of trips. Typically, the goal of this modeling is to predict the share or absolute number of trips by mode. The modal split models in this study comprise of two models, that is, "Walk Split Model" and "Private-Public Split Model" as shown in Figure 4.2-10 below. Walk Split Model provides the modal share between WALK and all other modes. Private-Public Split Model is to split person-trips other than walking into private modes (private passenger car) and public modes (taxi and bus). The modal split models are established by car ownership status, using the person-trip survey data.

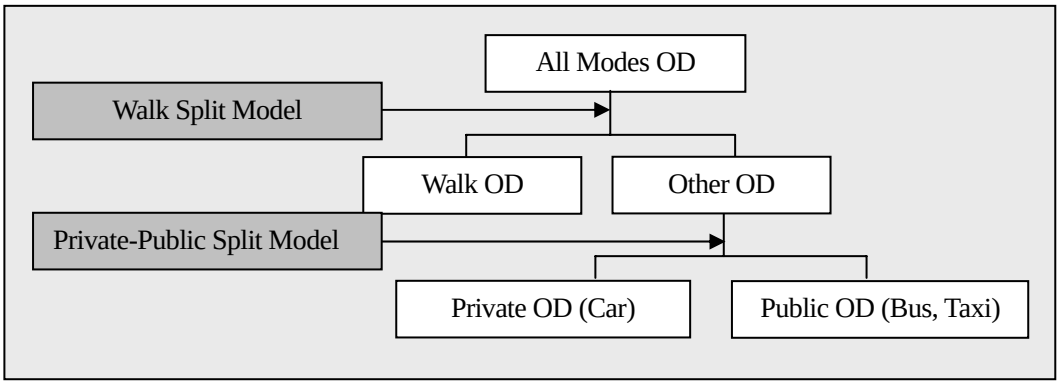


Figure 4.2-10 Modal Split Hierarchy

4.2.6.2 Modeling Inter Zonal Modal Split

With wide usability and the proven application, the logit models are chosen for inter zonal modal split models as following equations:

$$P_a = \frac{e^{U_a}}{e^{U_a} + e^{U_b} + e^{U_c}}$$

in which

$$U_a = K_n Y_{an} + K_a$$

where; Pa: modal split of mode "a"
Ua: utility function of mode "a"
Kn: coefficient of attribute "n" in utility function
Ka: constant coefficient of mode "a"
Yan: attribute "n" of utility function of mode "a"

In this model, two explanatory variables by zonal pair are introduced. The factors consist of travel length for WALK split model and travel time for Private-Public Modal split model

4.2.6.3 Calibration Results

The following parameters were calibrated and identified by the method of maximum likelihood, which attempts to find a set of parameters that is most likely to have resulted in the choices observed in the person- trip survey data (See Table 4.2-10).

Table 4.2-10 Parameters of Modal Split Models

	Travel Length (km)	Travel Time (min) Private Mode	Travel Time (min) Public Mode	R-Squared
WALK Split Model	0.45145	-	-	0.99219
Private Public Model Non Car owner	-	0.07342	0.00000	0.97942
Private Public Model Car owner	-	0.00000	0.00228	0.81676

4.2.6.4 Modeling Intra Zonal Trip Distribution

Intra zonal modal split of each zone are derived from the person-trip survey. These shares are applied for future demand forecasting, for intra zonal modal share and are assumed to be constant in the future.

4.2.6.5 Future Modal Split

Using the modal split models built above, the future modal split of person trips was projected. The projection was performed under the framework of "Do-nothing" case in 2008, 2014, and 2019, given in Table 4.2-11 and Figure 4.2-11.

Table 4.2-11 Future Modal Split

	Walk	Private Car	Public Mode	Total
Year 2008	369,037	113,827	864,650	1,347,514
	27.4%	8.4%	64.2%	100.0%
Year 2014	488,823	167,549	1,097,834	1,754,206
	27.9%	9.6%	62.6%	100.0%
Year 2019	584,523	237,155	1,322,039	2,143,716
	27.3%	11.1%	61.7%	100.0%

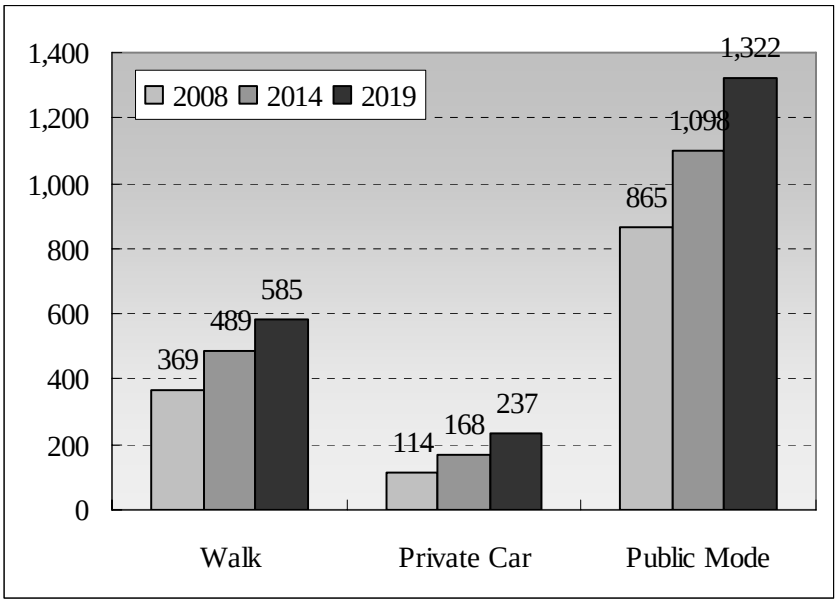


Figure 4.2-11 Future Trip by Travel Mode (Unit; Thousand Trips per Day)

4.2.7 Future Traffic Assignment

4.2.7.1 Traffic Assignment Model

Traffic assignment process allocates passenger traffic to individual transportation networks and links. This step takes as an input matrix that indicates the volume of passenger traffic between origin and destination pairs. By applying the traffic assignment stage, daily traffic volume for each road section is projected.

In this study, JICASTRADA assignment module is applied for vehicle-trip assignment models. JICASTRADA prepares three types of assignment modules; those are Incremental, User Equilibrium and Stochastic User Equilibrium Assignment Modules. Equilibrium means that any passenger can not reduce his travel time even if he selects any other routes, and changes to any other routes. In other words, equilibrium is to find the best balanced points between the demand and supply of the transportation reality. In this study, the incremental assignment module which is the most suitable for public mode assignment is selected.

4.2.7.2 External Zone Traffic Demand

Traffic demand related to external zones (outside Greater Monrovia) is classified into external-external, internal-external, external-internal trips. The existing demand obtained from the Cordon Line Survey is added to the Person-Trip Survey data. Future demands related to external zone were forecasted by the growth factor method based on the future private mode trip estimation. The growth rate of 2014 and 2019 against 2008 are 1.47 and 2.08 respectively.

4.2.7.3 Auto Occupancy Rate and Passenger Car Unit

Trips generated by travel mode during the trip generation step (and consequently through the trip distribution and modal split steps) are defined in person-trip base. Auto occupancy rates and passenger car units (PCU) are utilized to convert from person-trips to vehicle-trips prior to assigning the traffic to the roadway network. These factors which are obtained from the Screen Line Survey and the Cordon Line Survey are shown Table 4.2-12.

Table 4.2-12 Occupancy Rate and Passenger Car Unit

		Passenger Car	Taxi	Mini Bus	Large Bus	Truck	Bike
Occupancy Rate	Person Trip OD	3.33	4.94	13.45	28.57	2.67	1.74
	Cordon Line OD	4.72	5.06	13.45	21.63	4.47	1.60
PCU (Passenger Car Unit)		1.00	1.00	1.50	2.50	2.00	0.20

4.2.7.4 Estimation of Future Vehicle Trip by Vehicle Type

Based on the methodology mentioned above, future vehicle-trips production classified by vehicle category is projected as shown in Table 4.2-13 and Figure 4.2-12. The growth rate of vehicle trip is 1.31 for year 2014 and 1.63 for year 2019 against the present 2008 vehicle-trip.

Table 4.2-13 Future Vehicle-Trips by Vehicle Category

Year	Pax. Car	Taxi	Mini Bus	Large Bus	Truck	Bike	Total
2008	36,457	157,192	8,609	726	10,536	34,763	248,282
2014	53,662	199,584	10,931	921	15,509	44,138	324,746
2019	75,945	240,349	13,165	1,099	21,950	53,151	405,659

Note; Pax Car = Passenger Car (Sedan or Pick up)

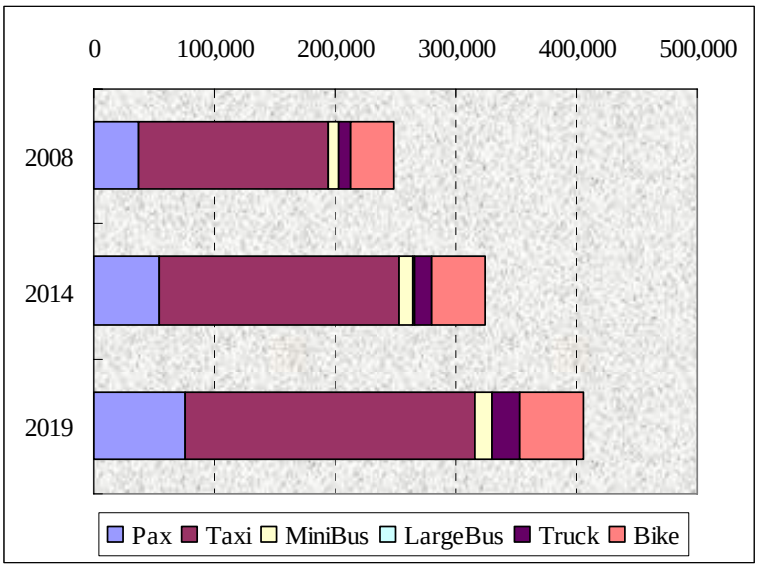


Figure 4.2-12 Trend of Vehicle-Trips by Vehicle Category

4.2.7.5 Link Cost Function

Inputs required for JICASTRADA assignment module are expressed in terms of link performance functions. These functions describe the travel time across a link under various conditions of congestion measured by volume-to-capacity ratios. The most commonly applied function is the BPR (Bureau of Public Roads) equation. In this equation, the user selects link capacity and two calibration parameters (alpha and beta). While the basic BPR equation used values of 0.15 and 4.0 for alpha and beta, respectively, recent surveys for daily traffic assignment suggest values 0.48 for alpha and 2.82 for beta. The resulting variation of link speed using these values is demonstrated in Figure 4.2-13 and Table 4.2-14.

$$Vc = Vo / \{1 + \alpha(Vol/C)^{\wedge}\beta\}$$

where, Vc: Congested Speed
Vo: Free-Flow Speed
Vol: Traffic Volume (PCU)
C: Ideal Traffic Capacity (PCU)
α=0.48,β=2.82

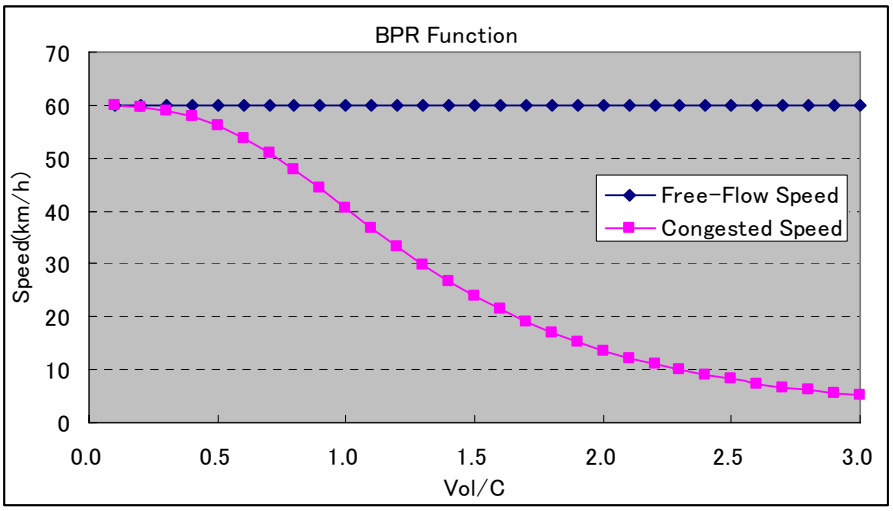


Figure 4.2-13 Travel Speed Variation with Volume per /Capacity Ratio (VCR)

Table 4.2-14 Free Flow Speed and Capacity by Road and Surface Type

Road Class	No. of Lane	Surface Condition	Free Flow Speed (km/h)	Capacity (PCU / day)
Primary	2	Good	60	18000
		Fair	54	16200
		Bad	42	12600
		Very Bad	30	9000
	4	Good	60	36000
		Fair	54	32400
		Bad	42	25200
		Very Bad	30	18000
	6	Good	60	54000
		Fair	54	48600
		Bad	42	37800
		Very Bad	30	27000
Secondary	1	Good	30	2500
		Fair	27	2250
		Bad	21	1750
		Very Bad	15	1250
	2	Good	40	10000
		Fair	36	9000
		Bad	28	7000
		Very Bad	20	5000
	4	Good	40	28000
		Fair	36	25200
		Bad	28	19600
		Very Bad	20	14000
Tertiary	1	Good	20	2000
		Fair	18	1800
		Bad	14	1400
		Very Bad	10	1000
	2	Good	30	6000
		Fair	27	5400
		Bad	21	4200
		Very Bad	15	3000

4.2.7.6 Traffic Assignment Results of Present Road Network

With the objective of effectively assessing the transport policy and undertaking countermeasure studies, it was first assumed that no improvement would be achieved in the transportation supply initially. This is referred to as the "Do-Nothing" case analysis. The car assignment results of the existing case (2008) and "Do-Nothing" case in 2014and 2019, are summarized in Table 4.2-15. The figures in the table explains the traffic condition by some transportation indicators, such as the following two indicators.

Table 4.2-15 Car Assignment Results in Do-Nothing Case

	Year 2008	Year 2014	Year 2019
Number of Vehicle Trips	248,282	324,746	405,659
PCU-Hour ('000)	106	152	237
PCU-Km ('000)	1,768	2,223	2,922
Average Speed (km/hr)	16.6	14.6	12.3
VCR (Volume Capacity Ratio)	0.86	1.08	1.42

(1) Traffic Indicator (Do Nothing)

Average traffic indicators of vehicular trips are evaluated from the view points of changes in vehicular trips, PCU-hr, PCU-km, average speed and VCR. The vehicular trips are forecasted to increase from 0.248 mln trips in 2008 to 0.045 mln in 2019 with a growth of about 1.6 times. In addition, the indicators of PCU-hr and PCU-km are also increasing, especially the PCU-hr that drastically increases from 106 thousand PCU-hr in 2008 to 237 thousand in 2019 with a growth of about 2.2 times. As a result, the average travel speed is decreased from 16.6 km/hr in 2008 to 12.3 km/hr in 2019 and VCR in 2019 reached to 1.42, which means that the level of service on the road network will face severe situation from the economic and environmental points of view.

(2) Traffic Congestion (Do nothing)

The results of analyzing the volume to capacity ratio VCR is to investigate the road congestion in each road section. The VCR on most primary roads in 2008 show desirable ratio of about 1.00 to 2.00. The results of the year 2019 show unacceptable level of traffic congestion in both primary road and some secondary roads more than VCR 2.00. (see Figure 4.2-14 to 16).

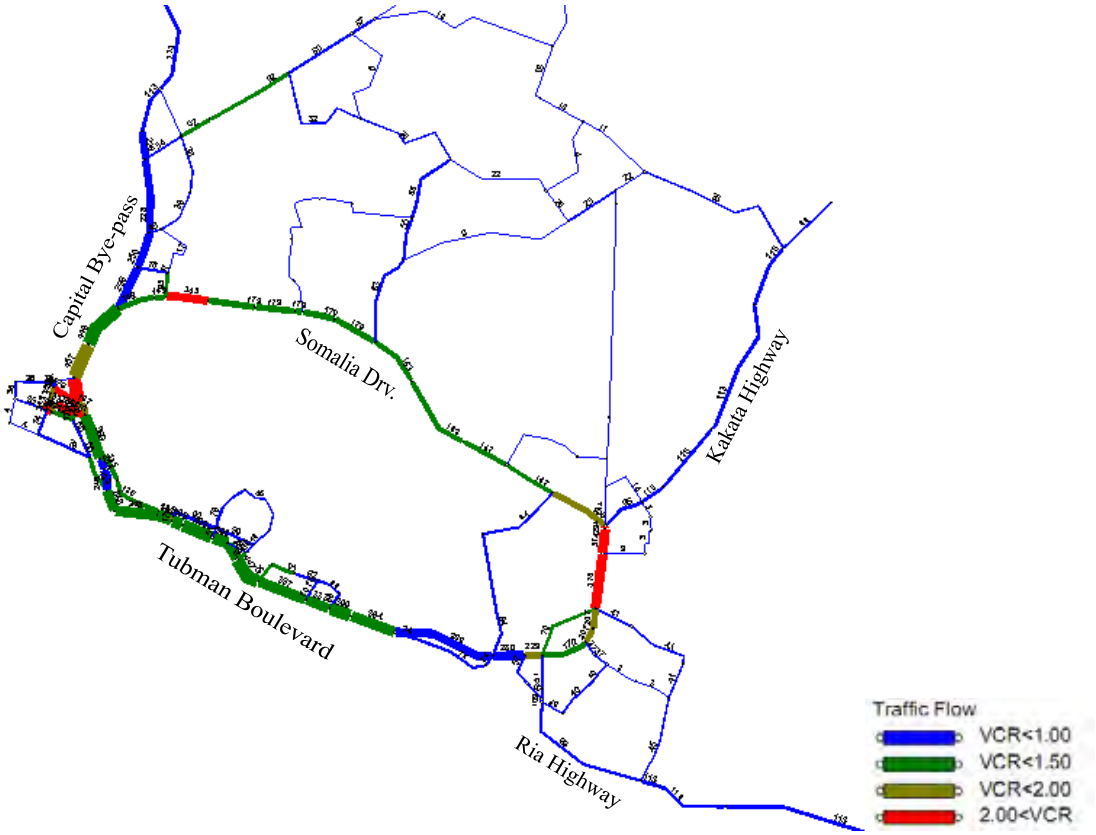


Figure 4.2-14 Present Traffic Assignment Result in 2008

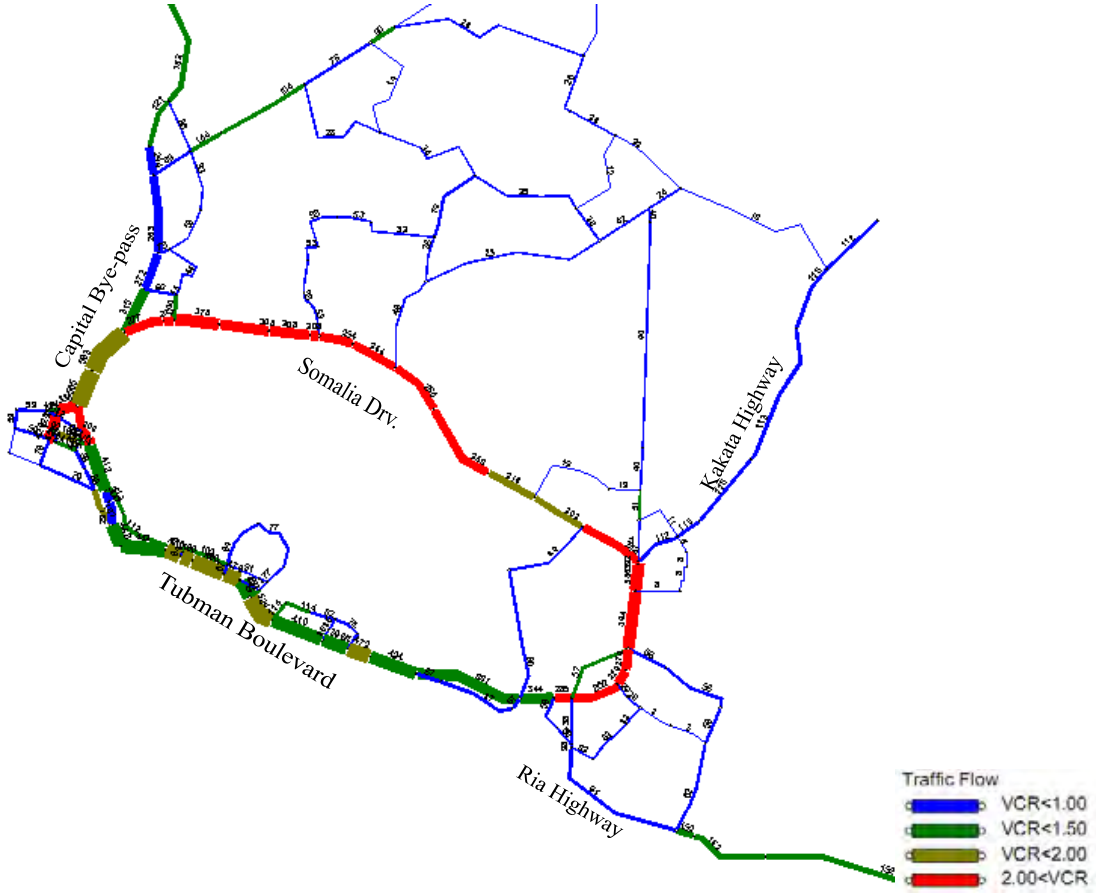


Figure 4.2-15 Future Traffic Assignment in 2014 (Do-Nothing Case)

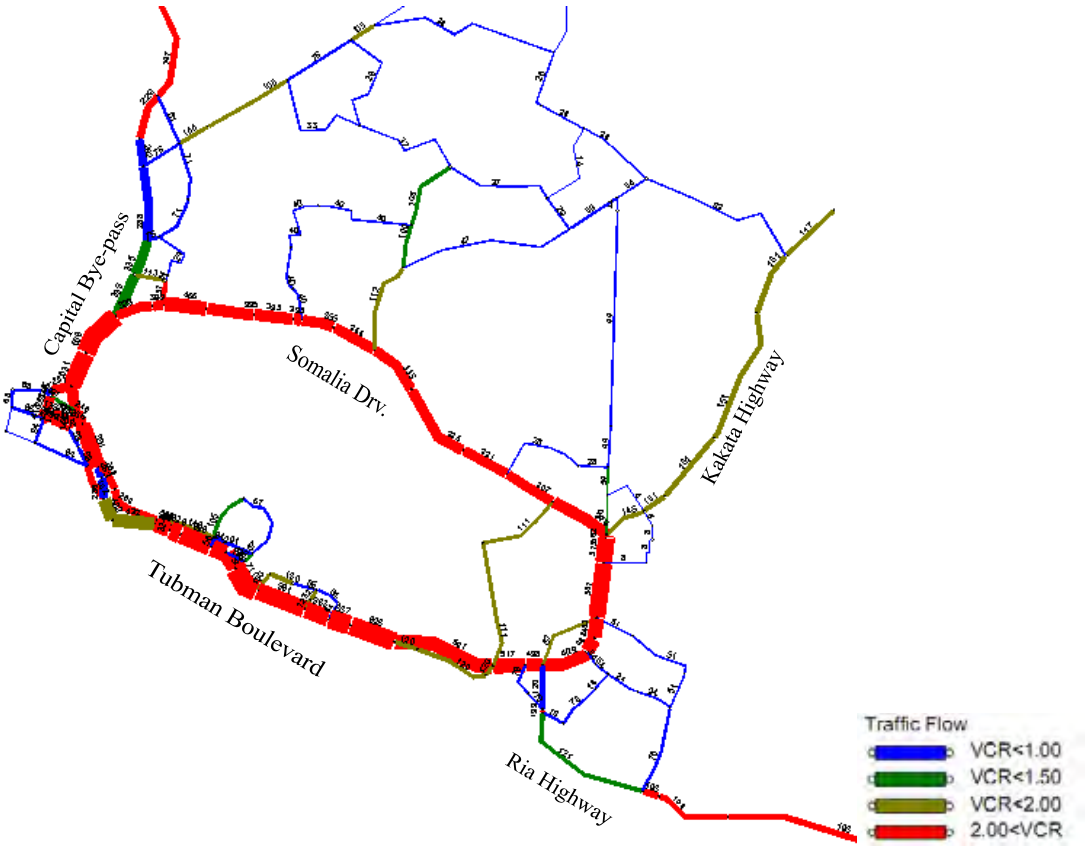


Figure 4.2-16 Future Traffic Assignment in 2019 (Do-Nothing Case)

4.3 Road Network Plan

4.3.1 Future Road Network Development Plan

4.3.1.1 Proposed Future Road Network plan

Based on the road network development policies and the concept to integrate land use plan and transport system, the future basic road network system was developed. Components of the future basic road network are classified based on their purpose and target, 1) Congestion Mitigation Type, 2) Network Formation Type, and 3) Development Promotion Type.

- Congestion Mitigation Type; One of the main targets of the Master Plan is to alleviate existing and expected traffic congestion. Bypasses and detour routes needed to reduce the congestion are incorporated in the proposed network.
- Network Formation Type; This type of roads is to form functionally balanced road network. An example of this type is the tertiary road linking community each other directly.
- Development Promotion Type; Still another type of road is required to promote the planned development.

The proposed functional road network is shown in Figure 4.3-1 and 4.3-2. The planned road length by functional classification is shown in Table 4.3-1. In contrast to the CBD road network, the road network in surrounding area is undeveloped and incomplete, and cannot support the present daily socioeconomic activities and the future development. To solve the problems of the urban road network, enhancement of trunk road network by urban primary and secondary road and new network, which connects the community each other by new urban tertiary road was proposed. The future proposed road network is composed from

11 sections of urban primary roads with 60 km, 51 sections of urban secondary road with 105 km and 224 sections of tertiary roads with 200 km. Table 4.3-2 shows the list of the proposed road network projects. Fundamentally, the number of lanes of each road was selected based on the functional class of the road; 4 lanes for urban primary road, and 2 lanes for secondary and tertiary roads. However, where the forecasted traffic volume does not warrant 4 lanes, tentative 2 -lane construction is proposed.

Table 4.3-1 Summary of Road Network Development Plan

Road Class	Distance (km)
Urban Primary Road	60.4 km
Urban Secondary Road	105.0 km
Urban Tertiary Road	200.3 km
Total	365.8 km

(1) Urban Primary Road Network

The urban primary network plan adopts radial and circumferential roads. The circumferential road is formulated by Tubman Boulevards, Somalia Drive and a part of Ganta Highway and UN Drive. The radial network consists of UN Drive, Ganta Highway and RIA highway. Basically the primary road network has 4 driving lanes, the section for the ring road is required to be improved by 2014. The section for the radial section should be expanded to 4 lanes following the increase of traffic demand

(2) Urban Secondary Road Network

The urban secondary roads are planned to complement the urban primary and inter-district roads mainly to ensure continued mobility on the whole urban road network. Major planned urban secondary roads in this area comprise supplementary ring and radial roads between the primary ring and radial roads. Some sections of the urban secondary road have the function of bypassing for the urban primary road network to reduce the traffic concentration on the primary road network.

(3) Tertiary Roads

Tertiary roads are basically planned and constructed as an integrated component of urban development rather than from the transportation planning viewpoint. The soma sections of the tertiary roads make new linkage between communities without using the primary and secondary road network.

(4) Major Bridges

Twenty four (24) bridges are proposed as part of the road network. The proposed bridges were identified by considering the network configuration, land-use plan, and construction costs.

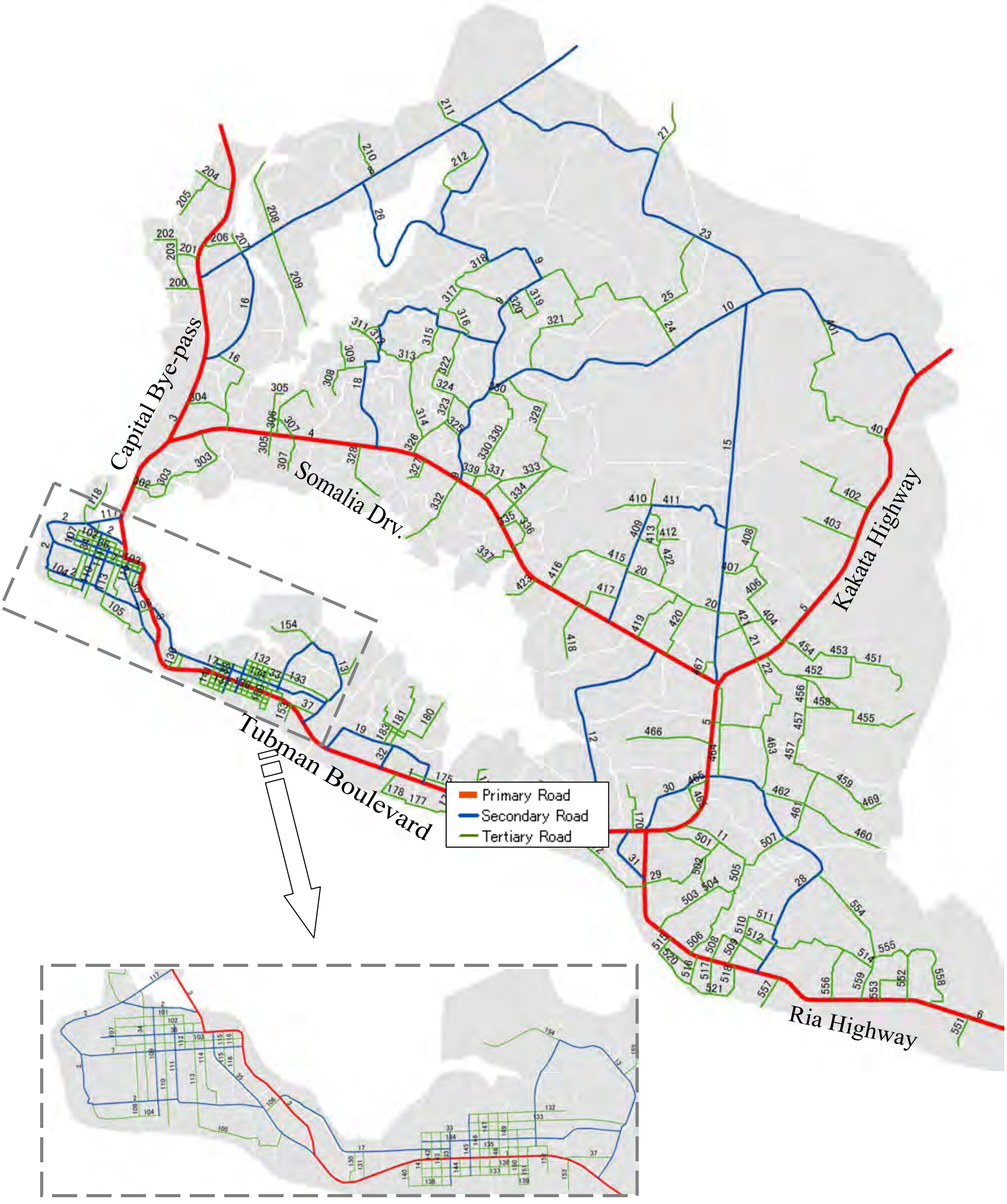


Figure 4.3-1 Road Network Development Plan by Road Class (Road No; Refer as Table 4.3-2)

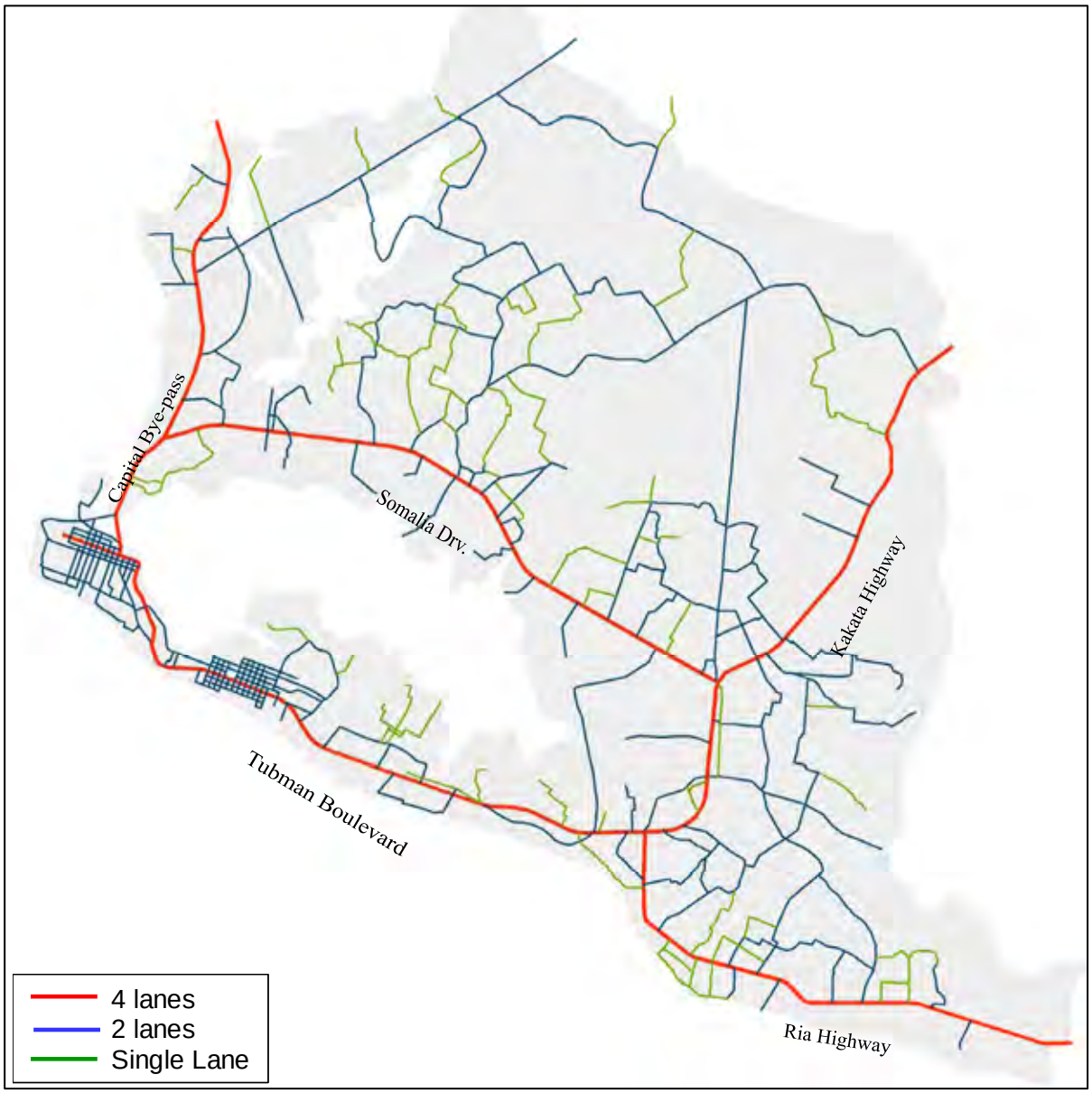


Figure 4.3-2 Road Network Development Plan by Number of Lane

4.3.1.2 Component of Road Network Development Plan

This future road network development plan includes mainly the improvement of road function, such as road surface improvement, bridge and culvert renovation, missing-link connection, geometrical improvement for intersections, and installation of signalized intersection. Some major projects are presented and discussed in the next sections.

Table 4.3-2 List of Road Network Development Plan

Road No.	Road Class	Road Name	Distance (km)	Width (m)	Lane 2009	Surface 2009	Condition 2009	Lane 2019	Remarks
1	Primary	TUBMAN Bounlevard	11.31	15.0	4	AC	Fair	4	WB
3	Primary	UN Drive 2	3.39	6.5	2	AC	Fair	4	WB
3	Primary	Capital Bypass	0.61	19.5	4	AC	Fair	4	WB CBD
3	Primary	Capital By-Pass	1.58	15.4	5	AC	Fair	4	WB
3	Primary	Johnson Street	0.84	14.0	4	AC	Fair	4	WB
3	Primary	UN Drive 1	5.47	21.5	4	AC	Fair	4	WB
4	Primary	SOMALIA Drv. 1	0.10	14.5	4	AC	Fair	4	
4	Primary	SOMALIA Drv. 2	13.08	6.8	2	AC	Fair	4	
5	Primary	Ganta Highway 1	3.99	7.0	2	AC	Fair	4	WB
5	Primary	Ganta Highway 2	8.88	7.0	2	AC	Good	4	WB
6	Primary	RIA Highway	11.19	7.0	2	AC	Good	4	WB
2	Secondary	Sekou Toure avenue	1.28	12.0	2	AC	Good	2	WB CBD
2	Secondary	UN Drive 1	0.70	11.0	2	CC	Bad	2	WB CBD
2	Secondary	UN Drive 2	0.64	10.2	2	AC	Bad	2	WB CBD
2	Secondary	UN Drive 3	0.64	6.0	2	CC	Fair	2	WB CBD
2	Secondary	UN Drive 4	0.79	9.0	2	AC	Good	2	WB CBD
2	Secondary	UN Drive 5	0.83	9.2	2	AC	Fair	2	WB CBD
2	Secondary	Water Street	0.92	9.0	2	AC	V Bad	2	WB CBD
7	Secondary	Benson Street 1	0.20	13.0	2	CC	Fair	2	WB CBD
7	Secondary	Benson Street 2	1.75	13.0	2	AC	Bad	2	WB CBD
8	Secondary	Caldwell Rd. 4	6.11	9.0	2	Gravel	Fair	2	MPW
8	Secondary	Caldwell Rd. 5	1.92	5.0	2	Gravel	Fair	2	
8	Secondary	Caldwell Rd. 1	0.40	7.5	2	AC	Fair	2	MPW
8	Secondary	Caldwell Rd. 2	0.61	7.5	2	AC	Bad	2	MPW
8	Secondary	Caldwell Rd. 3	0.13	5.0	1	CC	Bad	2	WB
9	Secondary	Barnesville Rd. 1	3.22	7.0	2	AC	Bad	2	MPW
9	Secondary	Barnesville Rd. 2	1.84	8.0	2	Gravel	Fair	2	MPW
9	Secondary	Barnesville Rd. 3	5.90	4.0	1	Gravel	V Bad	2	
10	Secondary	Johnsonville Rd.	10.67	9.0	2	Gravel	Fair	2	MPW
12	Secondary	SKD Boulevard+72nd Rd.	4.97	10.0	2	AC	Fair	2	WB
13	Secondary	Flamah Rd. 1	0.70	7.5	2	AC	Bad	2	MPW
13	Secondary	Flamah Rd. 2	2.00	7.5	2	BST	Good	2	MPW
13	Secondary	Flamah Rd. 3	0.40	7.5	2	AC	Fair	2	MPW
13	Secondary	Flamah Rd. 4	0.50	14.0	2	AC	Fair	2	MPW
14	Secondary	Congo Town Back Rd.	2.48	7.0	2	AC	Fair	2	Finish
15	Secondary	Pipeline Rd. 1	2.40	9.0	2	Gravel	Bad	2	MPW
15	Secondary	Pipeline Rd. 2	4.66	4.0	1	Earth	V Bad	2	Missing
15	Secondary	Pipeline Rd. 2	0.82	4.0	2	Earth	V Bad	2	MPW
16	Secondary	Logan Town Rd. 1	1.68	7.5	2	Gravel	Bad	2	MPW
16	Secondary	Logan Town Rd. 2	1.08	7.5	2	CC	Fair	2	MPW
17	Secondary	Jallah Town Road	2.35	9.0	2	AC	Good	2	MPW

Road No.	Road Class	Road Name	Distance (km)	Width (m)	Lane 2009	Surface 2009	Condition 2009	Lane 2019	Remarks
18	Secondary	New Georgia Rd. 1	1.90	7.0	2	Gravel	Fair	2	
18	Secondary	New Georgia Rd. 2	2.54	5.0	1	Earth	Bad	2	Missing
18	Secondary	New Georgia Rd. 3	1.56	7.5	2	AC	Bad	2	
19	Secondary	Congo Twon Old Rd.	2.89	7.5	2	AC	Good	2	MPW
23	Secondary	Samuka Rd.	8.13	3.0	1	Gravel	V Bad	2	
26	Secondary	Dixbille Rd.	3.62	3.0	1	Earth	Bad	2	MPW
28	Secondary	Rehab Rd.	4.87	10.0	2	Gravel	Fair	2	MPW
28	Secondary	Duport Rd.	1.20	7.0	2	AC	Fair	2	Finish
30	Secondary	Abtolbert Rd.	1.90	6.0	2	AC	V Bad	2	MPW
31	Secondary	S.D. Cooper Rd.	1.28	7.0	2	AC	Good	2	MPW
32	Secondary	VP Rd.	0.53	7.0	2	AC	Good	2	Finish
33	Secondary	12th Street	0.63	7.0	2	AC	Fair	2	Finish
35	Secondary	Camp Johnson Rd.	1.12	8.5	2	AC	Fair	2	WB CBD
36	Secondary	Broad Street	1.24	17.0	4	AC	Bad	4	WB CBD
109	Secondary	Randall Street	1.25	16.5	4	AC	Bad	4	WB CBD
111	Secondary	Center Street	0.86	14.0	2	AC	Bad	2	WB CBD
117	Secondary	Vai Town Bridge	0.46	6.2	2	CC	Broken	2	WB
134	Secondary	Cheeseman Avenue	2.43	8.3	2	CC	Fair	2	Finish
145	Secondary	14th Street	0.71	9.0	2	AC	Bad	2	
409	Secondary	Rehab Road	1.44	6.5	2	Gravel	V Bad	2	
411	Secondary	City View Road	1.93	5.0	2	Gravel	Bad	2	
11	Tertiary	GSA Rd. 1	0.83	7.0	2	Gravel	Bad	2	MPW
11	Tertiary	GSA Rd. 2	0.72	6.5	2	Gravel	V Bad	2	MPW
16	Tertiary	Logan Town Broad Street	1.68	5.0	2	Gravel	V Bad	2	MPW
20	Tertiary	Pipeline Community Road	0.93	4.5	1	Gravel	Bad	2	MPW
20	Tertiary	Pipeline Rock Hill Road	0.66	3.0	1	Earth	Bad	2	Missing
21	Tertiary	Parker Paint Road	1.32	5.0	2	Gravel	Fair	2	MPW
22	Tertiary	Benson Hospital Road	1.04	4.5	1	Earth	Bad	2	MPW
22	Tertiary	Red Light Detour 2	1.16	3.0	1	Earth	V Bad	2	
22	Tertiary	Red Light Detour 3	0.71	5.0	2	Gravel	Bad	2	
24	Tertiary	Greena Town Rd. 1	2.98	3.0	1	Earth	Bad	2	
24	Tertiary	Greena Town Rd. 2	1.14	5.0	2	Gravel	Bad	2	
25	Tertiary	Johnson Ville St	2.09	2.5	1	Gravel	V Bad	1	
27	Tertiary	Sah Twon Rd.	1.15	3.0	1	Earth	V Bad	1	
29	Tertiary	Kotafe Rd. 1	0.40	3.0	1	CC	Good	2	
29	Tertiary	Kotafe Rd. 2	1.62	6.5	2	Gravel	V Bad	2	
33	Tertiary	Coleman Ave.	1.38	7.0	2	Gravel	Bad	2	
34	Tertiary	Mechlin Street 1	0.60	8.5	2	CC	Bad	2	WB CBD
34	Tertiary	Mechlin Street 2	0.69	8.5	2	AC	V Bad	2	WB CBD
37	Tertiary	Airport Short cut	0.58	6.5	2	AC	Fair	2	MPW
101	Tertiary	Front Street	0.82	11.0	2	AC	Bad	2	WB CBD

Road No.	Road Class	Road Name	Distance (km)	Width (m)	Lane 2009	Surface 2009	Condition 2009	Lane 2019	Remarks
102	Tertiary	Ashmun Street	1.05	14.3	4	AC	Bad	4	WB CBD
103	Tertiary	Carey Street	1.52	9.0	2	AC	Fair	2	WB CBD
104	Tertiary	Mamba Point Street	0.90	6.0	2	CC	Fair	2	WB CBD
105	Tertiary	Redemotion Street	1.20	7.0	2	AC	Fair	2	MPW
106	Tertiary	Bassa Community	0.23	9.0	2	AC	Bad	2	WB CBD
107	Tertiary	Nelson Street	0.32	9.0	2	AC	Bad	2	WB CBD
108	Tertiary	Newport Street	0.83	9.0	2	AC	Fair	2	WB CBD
110	Tertiary	Gurley Street	0.50	10.0	2	AC	Bad	2	WB CBD
112	Tertiary	Buchanan Street	0.38	9.5	2	AC	Fair	2	WB CBD
113	Tertiary	Lynch Street	1.20	8.5	2	AC	Bad	2	WB CBD
114	Tertiary	Johnson Street	0.92	11.5	2	AC	V Bad	2	WB CBD
115	Tertiary	MacDonald Street	0.23	9.5	2	CC	Fair	2	WB CBD
115	Tertiary	Mcdonald Street	0.19	9.5	2	AC	Fair	2	WB CBD
116	Tertiary	Clay Street	0.19	10.0	2	CC	Bad	2	WB CBD
116	Tertiary	Clay street	0.66	10.0	2	AC	Fair	2	WB CBD
118	Tertiary	West Point Road	1.12	5.5	1	AC	Bad	2	
130	Tertiary	2nd Street	0.40	6.0	1	Earth	Bad	2	
131	Tertiary	3rd Street	0.30	7.5	2	Gravel	Bad	2	MPW
132	Tertiary	Barclay Street	1.16	8.0	2	AC	V Bad	2	
133	Tertiary	Gibson Avenue	1.87	8.0	2	AC	V Bad	2	Missing
135	Tertiary	Russell Street	0.94	8.0	2	AC	V Bad	2	
136	Tertiary	Warner Avenue	1.28	8.0	2	AC	Bad	2	
137	Tertiary	Pyne Avenue	1.28	9.2	2	AC	Bad	2	
138	Tertiary	Gardner Avenue	0.51	14.0	1	Earth	V Bad	2	
139	Tertiary	Alik Avenue	0.11	17.0	1	Earth	Bad	2	
140	Tertiary	8th Street	0.27	4.7	1	Gravel	V Bad	2	
141	Tertiary	9th Street	0.62	7.8	2	AC	Fair	2	Finish
142	Tertiary	10th Street	0.62	9.0	2	AC	Fair	2	Finish
143	Tertiary	11th Street	0.63	8.0	2	AC	Fair	2	Finish
144	Tertiary	13th Street	0.21	8.0	2	AC	Fair	2	Finish
146	Tertiary	15th Street	0.72	7.5	2	AC	Fair	2	Finish
147	Tertiary	16th Street	0.72	7.5	2	AC	Fair	2	Finish
148	Tertiary	17th Street	0.72	8.5	2	AC	Fair	2	Finish
149	Tertiary	18th Street	0.72	8.0	2	AC	Fair	2	Finish
150	Tertiary	19th Street	0.63	8.0	2	AC	Bad	2	
151	Tertiary	20th Street	0.44	7.0	2	AC	V Bad	2	
152	Tertiary	22nd Street	0.28	8.5	2	AC	Bad	2	
153	Tertiary	24th Street	0.34	9.0	2	Gravel	Bad	2	
154	Tertiary	Matadi Road	1.00	7.4	2	AC	Fair	2	Finish
155	Tertiary	Zoo Road	0.53	6.0	2	Gravel	Bad	2	
170	Tertiary	12 house Road	1.09	6.0	2	Gravel	Bad	2	MPW

Road No.	Road Class	Road Name	Distance (km)	Width (m)	Lane 2009	Surface 2009	Condition 2009	Lane 2019	Remarks
171	Tertiary	SIM Road	0.40	5.0	1	Gravel	V Bad	1	MPW
172	Tertiary	Oldest Congo Town road	1.92	5.5	1	Gravel	V Bad	1	MPW
173	Tertiary	Pagos Island Road	1.35	4.0	1	Gravel		1	
174	Tertiary	Peace Island Road	0.89	5.0	1	Gravel	V Bad	1	Missing
175	Tertiary	Old Congo town rd	0.34	4.5	1	Earth	V Bad	1	
175	Tertiary	Old Congo Town Road	1.29	4.5	1	Gravel	V Bad	1	
176	Tertiary	Solotori road	0.80	5.0	1	Earth	V Bad	2	
177	Tertiary	Bachue Town	0.61	3.5	1	Earth	Bad	2	Missing
178	Tertiary	Sophie Community Road	0.61	5.0	1	Gravel	Fair	2	
179	Tertiary	Sophie Community Road	0.47	6.0	2	AC	V Bad	2	MPW
180	Tertiary	Gaye Town Road	0.14	6.6	2	Earth	Bad	2	
180	Tertiary	Gaye Town Road	0.35	6.6	2	AC	Good	2	Finish
180	Tertiary	Gaye town road	1.18	6.0	2	AC	Good	2	Finish
181	Tertiary	Chugbor Old Road	1.13	5.0	1	Earth	Bad	1	
181	Tertiary	Chugbor Road	0.34	6.6	2	AC	Good	2	Finish
182	Tertiary	Smyth Road	0.65	5.5	2	Gravel	V Bad	2	
182	Tertiary	Unknown	0.14	6.0	2	Gravel	Bad	2	
183	Tertiary	Smyth Road	0.65	5.5	2	Gravel	V Bad	2	
200	Tertiary	Popo Beach road	0.47	6.0	1	AC	V Bad	2	
200	Tertiary	Point Four road	0.24	7.2	2	CC	Fair	2	MPW
201	Tertiary	Jloh Street	0.44	5.0	1	Earth	Bad	1	
202	Tertiary	New Kru Town Road	0.47	7.5	2	CC	Fair	2	Finish
203	Tertiary	New Kru Town Road	1.08	7.2	2	CC	Fair	2	Finish
204	Tertiary	Island Clinic Road	0.86	4.5	1	Gravel	Bad	2	MPW
205	Tertiary	White Avenue	0.96	3.0	1	Earth	Bad	1	
206	Tertiary	Mombo Town Road	0.69	6.0	2	Gravel	Bad	2	
207	Tertiary	Stockton Creeek Road	0.45	5.0	1	Grave	Bad	2	MPW
208	Tertiary	New Georgia North Road	1.61	4.0	1	Gravel	Bad	1	
209	Tertiary	Caldwell New Georgia Road	2.02	5.0	1	Gravel	Bad	2	MPW
210	Tertiary	Taylor Mayor Compound	0.97	5.5	1	Gravel	Bad	1	
211	Tertiary	Waterside Road	0.66	4.0	1	Gravel	Bad	1	
212	Tertiary	Benson street	1.45	5.0	1	Earth	V Bad	1	
301	Tertiary	Clara Town road	0.92	5.5	2	AC	V Bad	2	MPW
302	Tertiary	Clara Town Road	0.67	5.5	2	AC	V Bad	2	MPW
303	Tertiary	Doe Community Road	1.14	6.0	1	Gravel	V Bad	1	MPW
303	Tertiary	SK Doe Community Road	0.80	6.0	1	Gravel	V Bad	1	Missing
304	Tertiary	Jamaica Road	1.22	5.0	2	AC	Good	2	MPW
305	Tertiary	Battery Factory road	0.86	0.6	1	Gravel	V Bad	2	Missing
305	Tertiary	Plank Field	0.42	14.0	2	Gravel	V Bad	2	
306	Tertiary	Silent street	1.59	4.0	1	Earth	V Bad	2	Missing
307	Tertiary	Barclay Town Road	0.59	3.5	1	Earth	V Bad	2	Missing

Road No.	Road Class	Road Name	Distance (km)	Width (m)	Lane 2009	Surface 2009	Condition 2009	Lane 2019	Remarks
307	Tertiary	Topoe Village Road	0.76	5.5	1	Gravel	Bad	2	MPW
308	Tertiary	Island Community road	0.76	3.5	1	Earth	Bad	1	
309	Tertiary	Bassa Town road	0.57	4.0	1	Earth	Bad	1	
310	Tertiary	Bassa Town Road	0.41	5.5	2	Earth	Bad	2	
311	Tertiary	New Georgia Gulf Road	0.36	2.5	1	Earth	V Bad	1	MPW
312	Tertiary	New Georgia Gulf Road	0.83	3.0	1	Earth	Bad	1	
313	Tertiary	Sign Board Road	0.78	4.5	1	Earth	V Bad	1	
314	Tertiary	Tusa Field Road	1.57	4.0	2	Gravel	V Bad	2	
315	Tertiary	U Curve Community Road	1.07	3.0	1	Earth	V Bad	1	Missing
315	Tertiary	U curve Community Road	0.40	3.0	1	Earth	Bad	1	
316	Tertiary	Estate Area C Road	1.05	7.0	2	AC	Bad	2	
317	Tertiary	Beh Wein Community Road	0.57	3.0	1	Earth	Bad	1	Missing
317	Tertiary	Behwein Community Road	0.57	3.0	1	Earth	Bad	1	Missing
318	Tertiary	Behwein Community Road	2.02	3.0	1	Earth	V Bad	2	MPW
319	Tertiary	Palm Hill Community Road	0.93	3.5	1	Earth	Bad	1	
320	Tertiary	Palm Hill Road	0.57	3.5	1	Gravel	V Bad	1	
321	Tertiary	Kaba - Johnsonville	0.37	3.0	1	Gravel	Bad	1	
321	Tertiary	Kaba - Johnsonville	0.55	3.0	1	Gravel	Bad	1	
321	Tertiary	Old Field Palm Community	1.38	3.0	1	Gravel	Bad	1	
322	Tertiary	Duan Town Road	0.73	3.0	1	Earth	Bad	1	Missing
322	Tertiary	Duan Town Road	0.49	3.0	1	Earth	Bad	1	
323	Tertiary	Nyanfor Town Road	0.63	4.5	1	Earth	Bad	1	
324	Tertiary	Patience Shop Road	1.27	5.0	1	Gravel	Bad	1	
325	Tertiary	Town Hall Road	0.40	5.0	1	Gravel	V Bad	1	
326	Tertiary	Nyanfor Town Road	0.96	5.0	1	Earth	V Bad	2	MPW
327	Tertiary	Snow Hill Road	1.29	5.0	1	Earth	Bad	2	
328	Tertiary	Chocolate City Road	1.28	5.0	1	Gravel	Fair	2	MPW
329	Tertiary	Kearduma Community Road	1.63	5.0	1	Earth	Bad	1	Missing
329	Tertiary	Kearduma Community Road	0.92	5.0	1	Earth	Bad	1	
329	Tertiary	Kearduma Community Road	0.61	5.0	1	Earth	Bad	1	Missing
330	Tertiary	Bassa Town Road	0.70	3.5	1	Gravel	Bad	1	MPW
330	Tertiary	Bassa Town road	0.92	3.5	1	Gravel	Bad	1	
330	Tertiary	Bassa Town road	0.36	3.5	1	Gravel	Bad	2	
330	Tertiary	Bassa Town Road	0.52	3.5	1	Gravel	Bad	1	Missing
331	Tertiary	Shoe Factory Road	0.59	2.5	1	Earth	V Bad	1	
332	Tertiary	Kessely Boulevard	1.69	7.5	2	Gravel	Bad	2	MPW
333	Tertiary	LPRC Road	0.89	4.0	1	Gravel	Bad	2	
333	Tertiary	LPRC Road	0.60	6.5	2	AC	Bad	2	
334	Tertiary	Chicken Soup Factory Road	1.92	6.5	2	Gravel	Fair	2	MPW
335	Tertiary	Chicken Soup Factory Road 2	0.53	3.5	1	Gravel	V Bad	1	Missing
335	Tertiary	D-C Block Road Road	0.55	2.5	1	Earth	V Bad	1	Missing

Road No.	Road Class	Road Name	Distance (km)	Width (m)	Lane 2009	Surface 2009	Condition 2009	Lane 2019	Remarks
335	Tertiary	Steven Tolbert Road	0.44	4.5	1	Earth	V Bad	2	
336	Tertiary	E-C Block Street	0.58	15.0	4	CC	Fair	4	Finish
337	Tertiary	Swaggart Island Road	1.01	7.0	2	Earth	V Bad	2	
338	Tertiary	Shoe Factory Road	0.27	4.0	1	Gravel	Bad	2	
339	Tertiary	Shoe Factory Road	0.35	3.0	1	Earth	Bad	2	
401	Tertiary	Lorma Community Road	0.48	3.0	1	Earth	V Bad	1	
401	Tertiary	Karnga Town Road	3.68	4.0	2	Gravel	Fair	2	Finish
402	Tertiary	FDA Road	1.99	5.5	2	AC	Bad	2	Missing
403	Tertiary	Telecom Road	1.20	7.5	2	AC	Good	2	Finish
404	Tertiary	SPS Road	1.13	3.5	2	Gravel	Bad	2	MPW
405	Tertiary	Woodcamp Community road	0.48	3.0	1	Gravel	Bad	2	
406	Tertiary	Morris's Farm Road	0.84	4.0	1	Gravel	V Bad	2	Missing
407	Tertiary	Old Field Road	0.64	3.0	1	Gravel	V Bad	2	Missing
408	Tertiary	Wein Town Old Field road	1.57	3.5	1	Earth	V Bad	2	
409	Tertiary	Rehab Road	0.56	3.5	2	Gravel	V Bad	2	
410	Tertiary	Garvan Town Road	0.91	3.0	1	Gravel	V Bad	1	
412	Tertiary	Christian community Road	0.42	2.0	1	Gravel	Bad	1	
413	Tertiary	City View Road	0.90	2.0	1	Gravel	V Bad	2	
414	Tertiary	Kpelleh Mansion Road	0.44	2.5	1	Gravel	Bad	1	
415	Tertiary	Old Field Road	1.33	4.0	1	Earth	V Bad	1	Missing
416	Tertiary	Jacob Peace Island Road	0.75	5.5	1	Gravel	V Bad	1	MPW
417	Tertiary	Jacob Town Road	0.95	3.0	1	Earth	Bad	1	Missing
418	Tertiary	St Francis Road	1.22	4.0	2	Earth	Bad	2	Missing
419	Tertiary	Neezoe Road 1	1.35	3.0	1	Gravel	Bad	2	MPW
420	Tertiary	Neezoe Community Road	1.27	4.0	2	Gravel	V Bad	2	
421	Tertiary	Supermarket Community road	0.66	4.0	2	Gravel	Bad	2	Missing
422	Tertiary	Ballah creek road	0.61	3.0	1	Gravel	Bad	2	Missing
423	Tertiary	Amegashi Road	0.72	3.0	1	Earth	Fair	2	MPW
451	Tertiary	Moses Blah Road	1.37	3.0	1	Earth	V Bad	2	Missing
452	Tertiary	Diamond Creek Road	1.61	3.5	1	Gravel	Bad	2	MPW
453	Tertiary	Moses Blah Road	0.82	3.5	2	Gravel	Bad	2	
454	Tertiary	Coca-Cola Factory Road	1.01	3.5	1	Gravel	V Bad	2	
455	Tertiary	Soul Clinic Road	3.90	5.5	2	Earth	V Bad	2	MPW
456	Tertiary	Old Cape Mount town Road	0.56	5.0	2	Gravel	Bad	2	
457	Tertiary	Kemah Duport	1.19	3.5	1	Earth	Bad	2	
457	Tertiary	Old Cape Mount Road	0.58	3.5	1	Earth	Bad	2	
458	Tertiary	New Cape Mount Road	0.67	5.5	2	Gravel	Bad	2	
459	Tertiary	Cow Field Road	1.27	3.5	1	Earth	Bad	1	
460	Tertiary	Duport Road South	1.84	6.0	2	AC	Fair	2	Finish
461	Tertiary	Duport South North St1	0.71	3.5	2	Gravel	V Bad	2	Missing
461	Tertiary	Zubah Town Community Road	0.84	3.5	2	Gravel	V Bad	2	Missing

Road No.	Road Class	Road Name	Distance (km)	Width (m)	Lane 2009	Surface 2009	Condition 2009	Lane 2019	Remarks
462	Tertiary	Duport Road	0.89	5.6	2	AC	Fair	2	Finish
463	Tertiary	Cow Field Road	1.34	4.0	2	Earth	Bad	2	Missing
464	Tertiary	Harmon Field	1.93	3.5	1	Earth	Bad	1	MPW
465	Tertiary	Town Hall Road	0.62	5.5	2	Earth	Bad	2	
465	Tertiary	Town Hall Road	0.42	5.6	2	AC	Bad	2	
466	Tertiary	Police Academy Road	1.77	12.0	4	Earth	V Bad	2	MPW
467	Tertiary	Pipeline Road	0.48	5.0	1	Gravel	Bad	2	
469	Tertiary	Shera Community Road	0.30	3.0	1	Earth	V Bad	2	
501	Tertiary	ELBC Road	1.11	5.0	1	Earth	V Bad	2	MPW
502	Tertiary	GSA / Rock Hill Road	0.80	4.0	2	Gravel	V Bad	2	Missing
503	Tertiary	Rock Hill Community Road	1.31	3.0	1	Gravel	V Bad	2	
504	Tertiary	Zinna Hill Road	0.61	3.0	1	Earth	Bad	2	
505	Tertiary	Duasa Community Road	0.73	4.0	1	Earth	V Bad	2	
506	Tertiary	Rock Hill Community Road	1.86	7.5	2	Gravel	V Bad	2	
507	Tertiary	Zubah Town Road	1.08	9.0	2	Gravel	V Bad	2	
508	Tertiary	ELWA Oldfield Road	1.08	9.0	2	Gravel	V Bad	1	Missing
509	Tertiary	Cooper's Farm Road	0.47	5.5	2	Earth	Bad	2	
510	Tertiary	Cooper's farm Road	0.63	4.0	1	Gravel	Bad	1	
511	Tertiary	Cooper Farm Road	0.61	6.0	2	Gravel	Fair	2	
512	Tertiary	Cooper farm road	0.79	3.0	1	Earth	V Bad	2	Missing
513	Tertiary	Gator Tate Road	0.62	3.5	1	Earth	V Bad	1	
514	Tertiary	Rehab Rockhill Road	2.33	9.0	1	Gravel	Bad	2	
515	Tertiary	ELWA Beach Road	0.38	6.3	2	BST	Good	2	Finish
516	Tertiary	ELWA Campus Road	0.59	5.6	2	Earth	V Bad	2	
517	Tertiary	Snowe Road	0.69	6.0	2	Gravel	Bad	2	
518	Tertiary	Cooper Beach Road	0.68	4.0	2	Earth	V Bad	2	Missing
519	Tertiary	ELWA Compound Road	0.77	5.6	2	BST	Good	2	Missing
520	Tertiary	ELWA Campus Road	0.93	6.0	2	BST	Fair	2	Finish
521	Tertiary	Cooper Beach Road2	0.85	4.0	1	Earth	Bad	1	Missing
551	Tertiary	Mabas Town Road	0.64	10.0	2	Earth	V Bad	2	
552	Tertiary	Seminary Old Field road	0.92	6.0	2	Gravel	Bad	2	
553	Tertiary	Kpayon Town Road	0.98	3.5	1	Gravel	V Bad	1	
554	Tertiary	Thinkers Village Old Rd	2.17	10.5	2	Gravel	V Bad	2	Missing
555	Tertiary	Gio Mission Road	0.79	5.0	2	Gravel	Bad	1	Missing
556	Tertiary	Thinkers Village	1.12	4.0	2	Gravel	V Bad	2	MPW
557	Tertiary	Kendeja Road	0.71	4.0	2	AC	Good	2	Finish
558	Tertiary	Borbor St	0.82	9.0	2	Gravel	V Bad	1	
558	Tertiary	Borbor St	0.62	9.0	2	Gravel	V Bad	2	Missing
558	Tertiary	Seminary Old Field Road	0.62	5.5	2	Gravel	V Bad	2	Missing
559	Tertiary	Thinkers Village Old Field	0.95	9.0	2	Gravel	V Bad	2	

4.3.2 Johnson Street Improvement Project

4.3.2.1 Background

The existing bridge is located at the entrance of Central Monrovia, the most developed Central Business District (CBD). The access to CBD is only allowed through UN Drive from northern area and Tubman Boulevard from eastern area. Both approaching roads of the bridge have multi-lanes for one direction, but the bridge does not have enough width for multi-lane operation, so the carriageway is divided to provide one lane for one direction. This narrowed section is the bottleneck of the traffic. Another bridge, called Vai Town Bridge located on UN Drive, for access to CBD collapsed in 2006. The reconstruction project is scheduled to complete in 2010. Although new bridge would be provided, the capacity of bridges is insufficient according to the traffic forecast. The traffic congestion of the roads on both sides of bridge will be worse near future.

4.3.2.2 Existing and Future Traffic Situation of Johnson Street Bridge

The present traffic volume surveyed as of 9th Feb. 2009 is 48,000 vehicles per day. The busiest traffic by time by direction is about 4,500 vehicles for 9:00 to 10:00 AM, from Vai Town to CBD direction. The peak rate is about 16 %.

Table 4.3-3 Traffic Volume on Johnson Street Bridge (As of 9th Feb 2009, Unit; Vehicle per Day)

	Sedan /Pickup /Wagon	Taxi	Mini Bus	Large Bus	Light Truck	Heavy Truck	Trailer	Bike	Bicycle	Total
From CBD To Vai Town	7,224	9,045	1,605	246	55	36	6	1,490	8	19,715
From Freeport To CBD	10,521	12,858	3,372	479	50	35	8	1,072	3	28,398
Total	17,745	21,903	4,977	725	105	71	14	2,562	11	48,113
Share	36.9%	45.5%	10.3%	1.5%	0.2%	0.1%	0.0%	5.3%	0.0%	100.0%

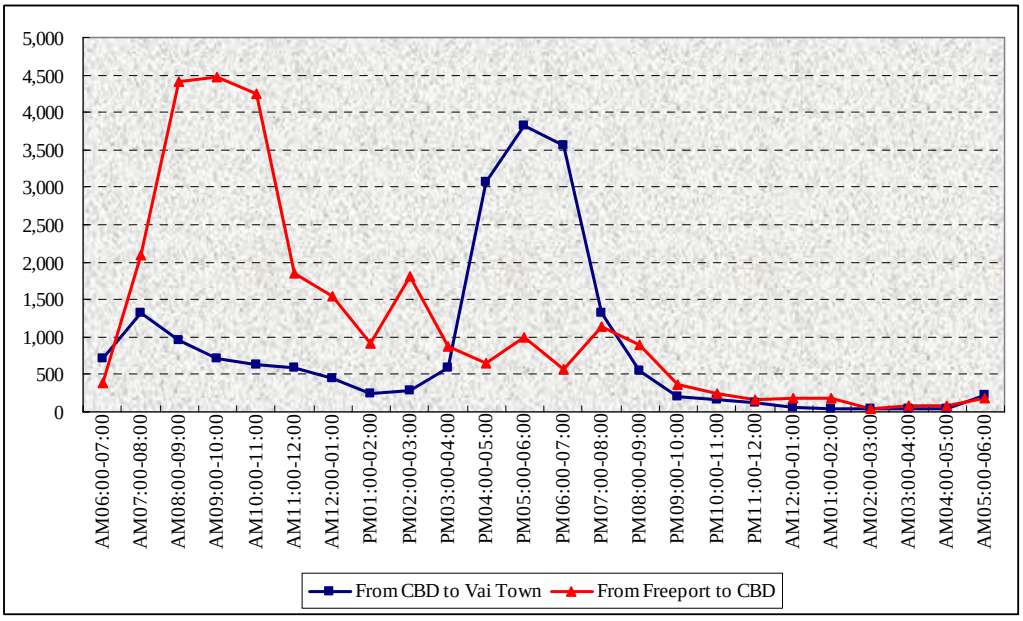


Figure 4.3-3 Hourly Traffic Volume by Direction (As of 9th Feb 2009)

The future traffic volume on Johnson street bridge based on the JICASTRADA simulation is expected to

be 54,800 vehicles at year 2014 and 66,600 vehicles at year 2019. The traffic volume for new Vai Town Bridge on the same simulation results is expected to be 21,900 vehicles for 2014 and 29,700 vehicles for 2019 respectively.

4.3.2.3 Objectives of the Project

- To mitigate the traffic congestion
- To provide favorable and acceptable road service at crossroads of Mesurado marshland

4.3.2.4 Location of the Project

- Central Monrovia and Clara Town District in Greater Monrovia

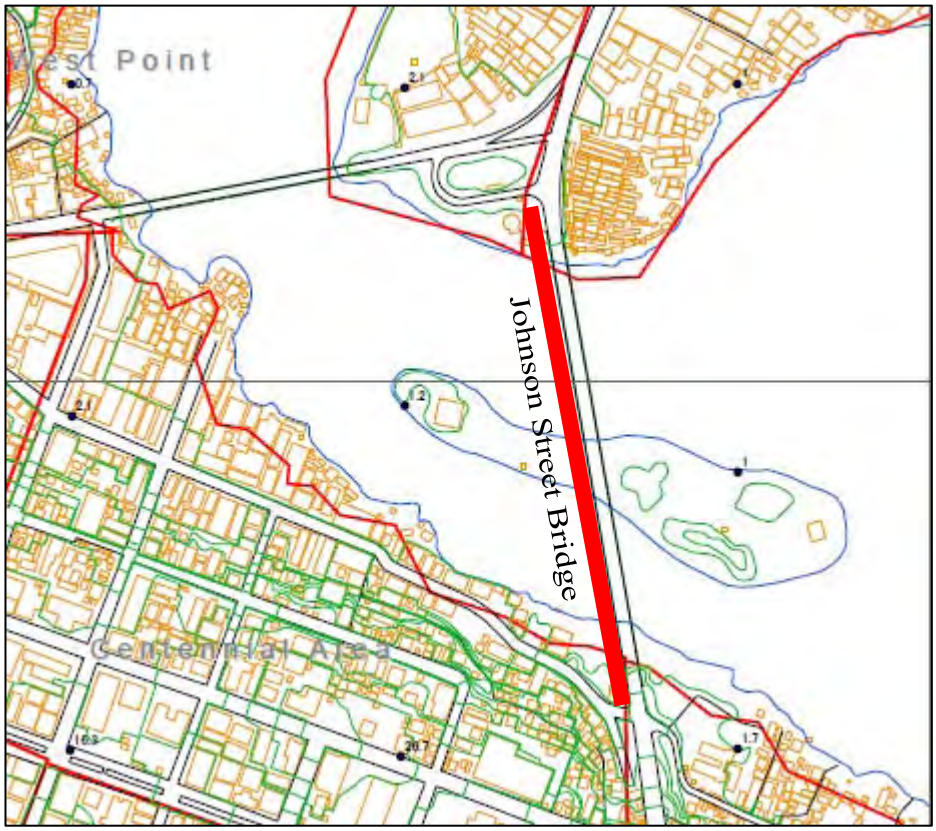


Figure 4.3-4 Location of Johnson Street Bridge

Figure 4.3-5 Present Situation of Johnson Street Bridge

4.3.2.5 Scope of the Project

- Construction of New Bridge parallelling to the existing bridge: 450 m and Approach Road: 400 m

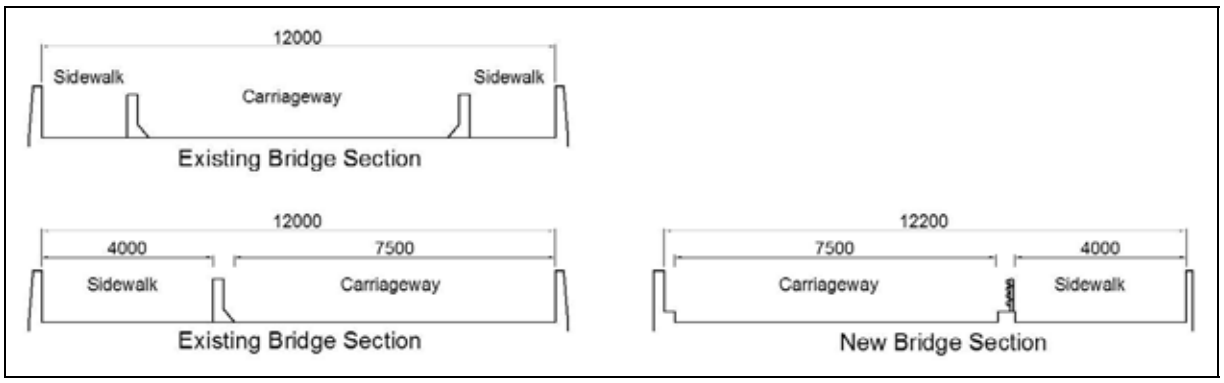


Figure 4.3-6 Existing and Planned Cross Section of Johnson Street Bridge

4.3.2.6 Estimated Cost

- Detailed Design & Supervision Cost: USD 2.2 mln
- Construction: Bridge: USD 20.9 mln
  Approach Road: USD 0.9 mln
- Total Cost: USD 24.0 mln

4.3.2.7 Effects of the Project

- Vehicle-operation cost savings and travel time reduction
- Exact operation of public transport
- Reduction of energy loss and exhaust fume

4.3.3 Somalia Drive Improvement Project

4.3.3.1 Background

Somalia Drive is one of the busiest primary roads in Grater Monrovia. This road was rehabilitated by the World Bank grant in 2008. The original road width had 4 lane carriageways, but only 2 lanes were rehabilitated. The road is located on north of Mesurado marshland. The land use of the roadside is mainly

commercial purpose including the Ma-juah market, nearby stalls and some open garages. The vicinity consists of many narrow community alleys which connect directly to Somalia Drive, thereby causing congestion as vehicles from said alleys try accessing the Somalia Drive. The congestion has caused severe economic losses over time, and is projected to increase by 2014. Therefore, the upgrading of road capacity to secure the smooth traffic flow is necessary, as it completes the ring road in Greater Monrovia Area that connects with Tubman Boulevard.

4.3.3.2 Existing and Future Traffic Situation of Stockton Bridge

The present traffic volume surveyed as of 4th and 5th Feb. 2009 is 40,000vehicles per day. The busiest traffic by time by direction is about 3,100 vehicles for 17:00 to 18:00 AM, East bound at Stockton Bridge. The peak rate is about 14 %.

The future traffic volume on Stockton Bridge and Double bridge on Somalia Drive based on the JICASTRADA simulation is expected to be 52,400 and 49,200 vehicles at year 2014, and 64,900 and 57,700 vehicles at year 2019 respectively..

Table 4.3-4 Traffic Volume on Stockton Bridge (As of 4th Feb 2009, Unit; Vehicle per Day)

	Sedan /Pickup /Wagon	Taxi	Mini Bus	Large Bus	Light Truck	Heavy Truck	Trailer	Bike	Bicycle	Total
West Bound	7,194	6,525	2,164	224	116	152	99	2,037	16	18,527
East Bound	8,631	7,859	1,984	217	137	190	117	2,410	18	21,563
Total	15,825	14,384	4,148	441	253	342	216	4,447	34	40,090
Share	39.5%	35.9%	10.3%	1.1%	0.6%	0.9%	0.5%	11.1%	0.1%	100.0%

Table 4.3-5 Traffic Volume on Double Bridge (As of 5th Feb 2009, Unit; Vehicle per Day)

	Sedan /Pickup /Wagon	Taxi	Mini Bus	Large Bus	Light Truck	Heavy Truck	Trailer	Bike	Bicycle	Total
West Bound	3,848	5,053	2,778	1,859	1,619	968	503	1,187	162	17,977
East Bound	5,684	7,418	2,811	1,643	1,358	874	408	938	171	21,305
Total	9,532	12,471	5,589	3,502	2,977	1,842	911	2,125	333	39,282
Share	24.3%	31.7%	14.2%	8.9%	7.6%	4.7%	2.3%	5.4%	0.8%	100.0%

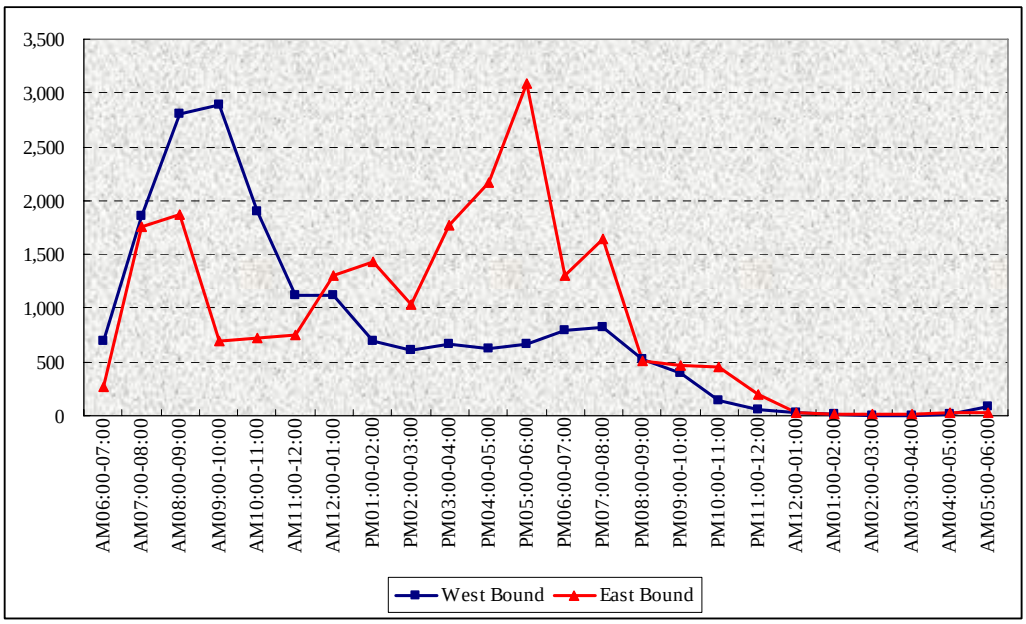


Figure 4.3-7 Hourly Traffic Volume by Direction at Stockton Bridge (As of 4th Feb 2009)

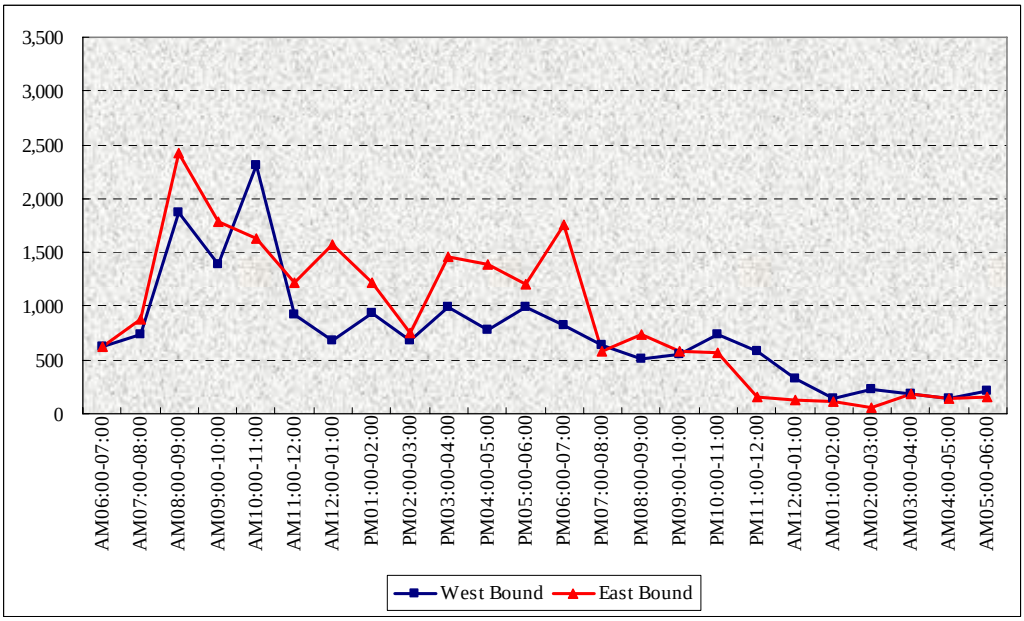


Figure 4.3-8 Hourly Traffic Volume by Direction at Double Bridge (As of 5th Feb 2009)

4.3.3.3 Objectives of the Project

- To mitigate the traffic congestion
- To provide favorable and acceptable road service at ring road around Mesurado marshland

4.3.3.4 Location of the Project

- Clara Town, New Georgia, Gardnersville and Paynesville District in Grater Monrovia

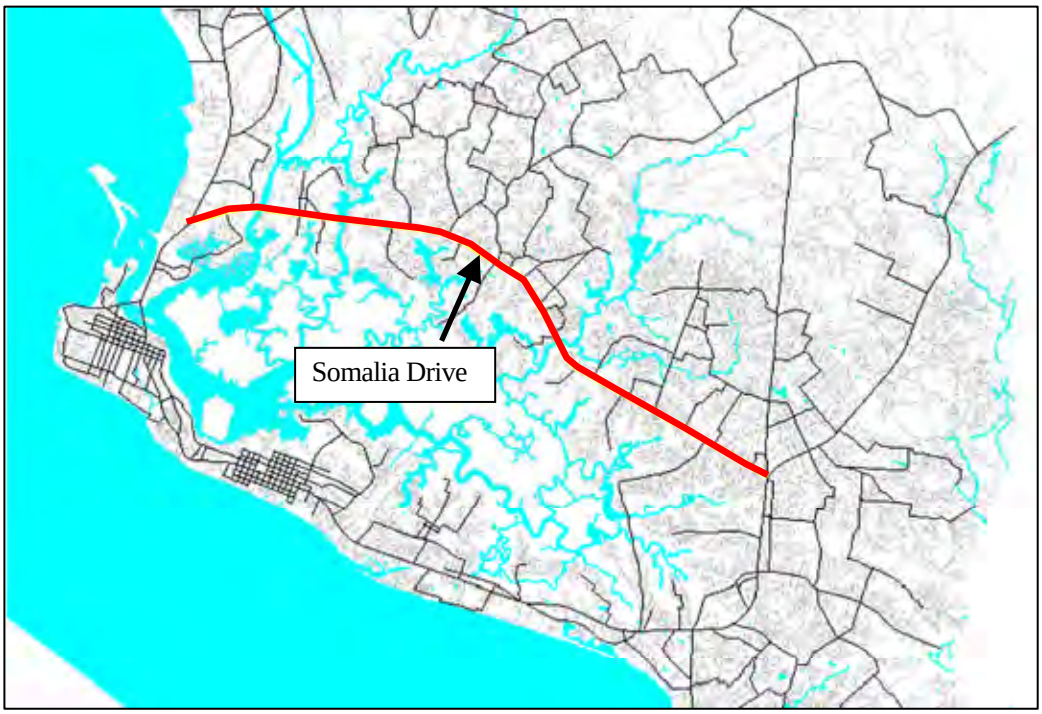


Figure 4.3-9 Location of Somalia Drive

4.3.3.5 Scope of the Project

- Expanding carriage way to be 4 lanes of 13 km stretch
- Additional Bridge on Stockton Bridge
- Rehabilitation of the existing Double Bridge
- Improvement of major intersections

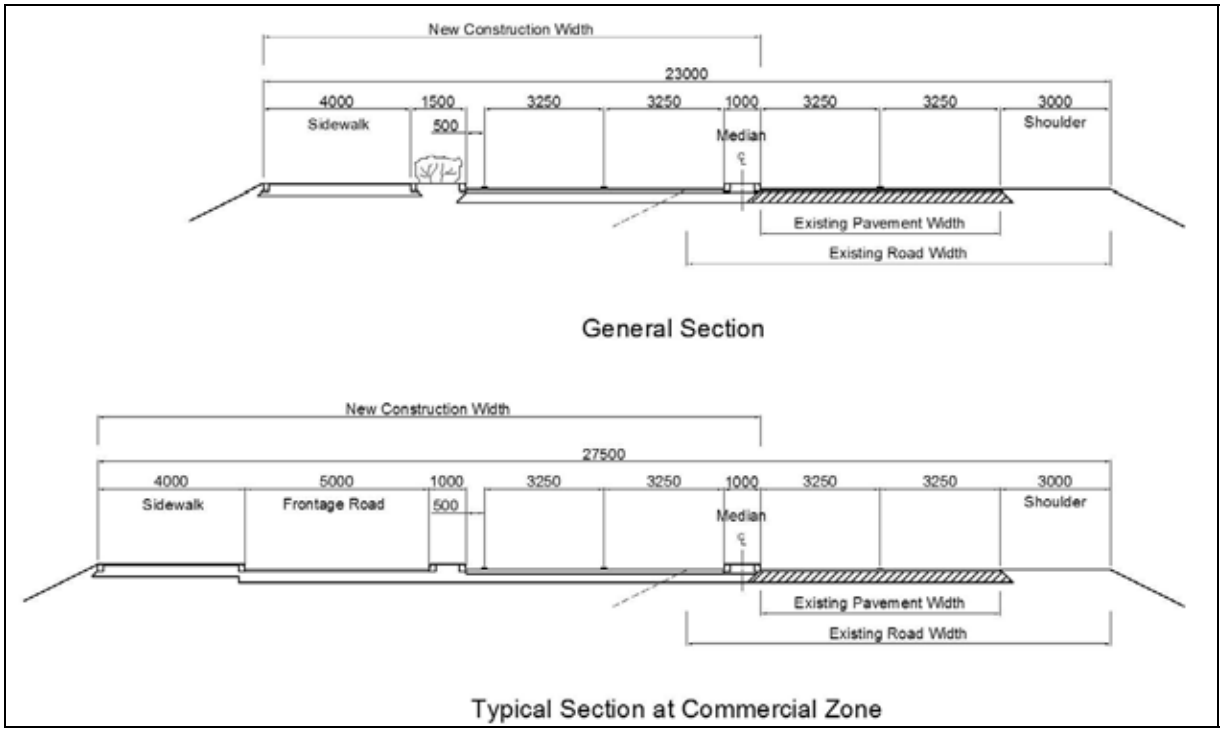


Figure 4.3-10 Planned Cross Section of Somalia Drive

4.3.3.6 Estimated Cost

- Detailed Design & Supervision Cost: USD 1.91 mln
- Construction:
  - Earth Work: USD 2.285 mln
  - Pavement: USD 9.790 mln
  - Road Facilities: USD 3.515 mln
  - Bridge: USD 3.600 mln
- Total Cost: USD 21.100 mln

4.3.3.7 Effects of the Project

- Vehicle operation cost savings and travel time reduction
- Exact operation of public transport
- Reduction of energy loss and exhaust fume

4.3.4 Bridge on Missing Link Improvement Project

4.3.4.1 Existing Condition of Bridge and Culverts

Based on the survey by aerial photo, 487 bridges and culverts exist for Greater Monrovia. Presently, MPW and the international donor are going to have restoration projects for road network including bridge and culverts renovations. But the comprehensive and area drainage system is not planned so far, the concept of the on-going project is to keep the traffic for severe damaged and important sections.

This MPW project is using Liberia Infrastructure Trust Fund, but the limitation of budget because of lack of fund source results in the delay of improvement for the costly section or minor road linking the community each other. In rainy season, some communities have lost the access way to other communities and cities.

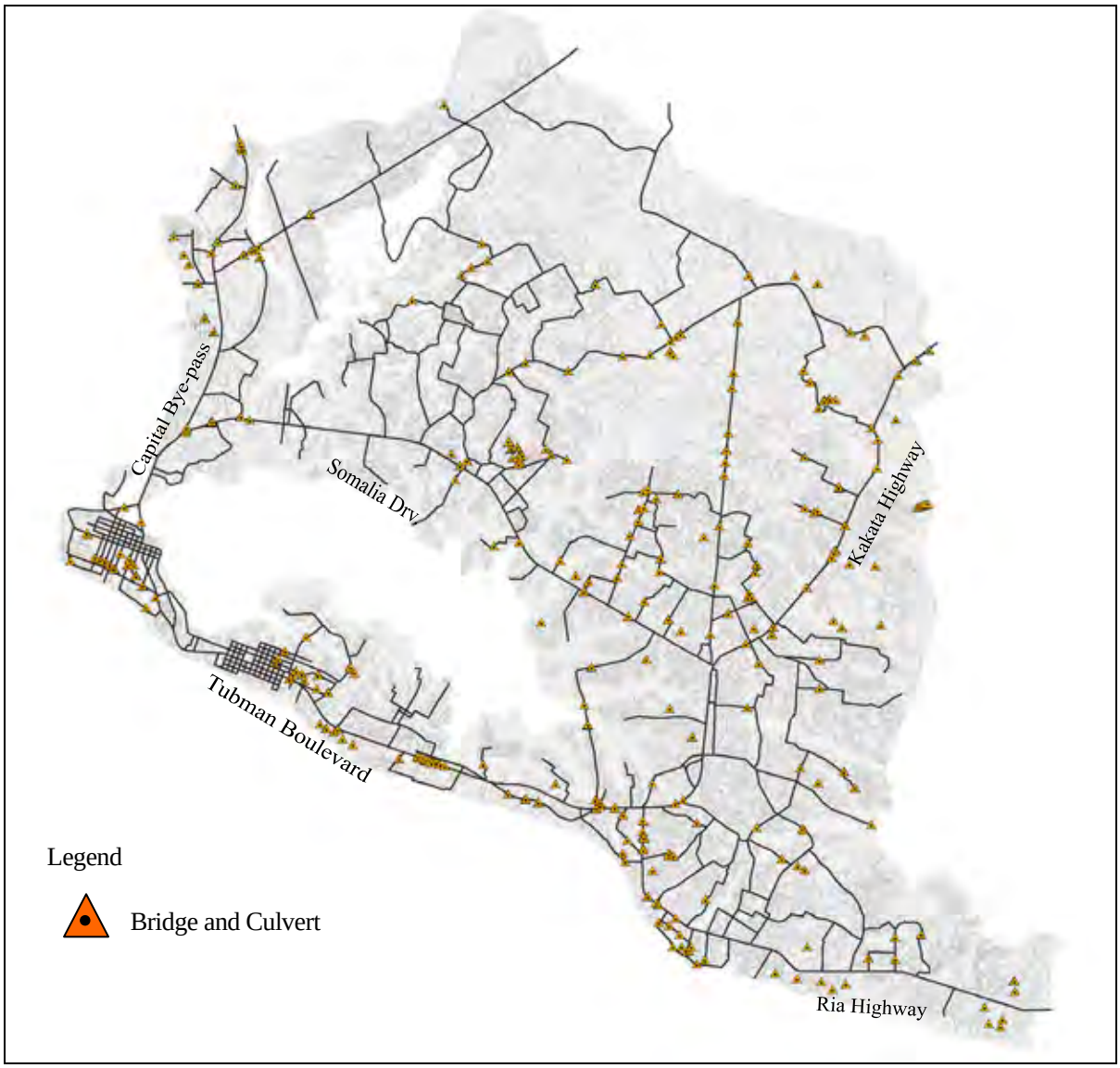


Figure 4.3-11 Location of Present Bridge and Culvert

4.3.4.2 Supplemental Bridge Inventory survey

To make up-to-date the status of bridge and culvert, the supplemental Bridge Inventory survey has carried out in rainy season, July 2009. The Figure 4.3-12 explains the remarkable problems and the status of each bridge surveyed.

Figure 4.3-12 Supplemental Bridge Inventory Survey Results

Table 4.3-6 Results of Supplemental Bridge and Culvert Inventory Survey

Map No.	Location	Length	Existing Width	Existing Structure Type	Condition	Remarks
1	Johnson Street	420.0m	9.0m	3 span PC Box Girder	Fair	Expand 4 lanes
2	Saint Paul	286.5m	9.0m	3 span PC Box Girder	Fair	Expand 4 lanes
3	Stockton Bri. Somalia Drive.	83.5m	9.2m	4 span RC Girder	Fair	Expand 4 lanes
4	Double Bri. Somalia Drive	50.5m	7.2m	2 span PC I Girder	Fair	Expand 4 lanes
5	Caldwell Rd.	107.0m	5.1m	multi span steel Girder	V Bad	Expand 2 lanes
6	Pipeline Rd.	-	-	Pipe Culvert	Broken	impassable
7	New Georgia Rd.	15.0m	3.3m	1 span Bailey	V Bad	impassable
8	Johnsonville Rd.	11.7m	5.3m	1 span RC Slab	Bad	
9	Johnsonville Rd.	7.0m	8.0m	2 span RC Slab	Fair	
10	Johnsonville Rd.	7.4m	3.0m	1 span RC Slab	Bad	1 lane
11	Red light detour	5.6m	3.3m	1 span RC Slab	V Bad	impassable
12	Red light detour	9.0m	5.0m	2 span RC Slab	Fair	Flooded
13	Barnersville Rd.	18.0m	3.3m	1 span steel Girder	V Bad	temporary
14	Greene Town Rd.	10.5m	3.6m	1 span RC T-Girder	Bad	1 lane
15	Dixbille Rd.	9.0m	3.3m	1 span steel Girder	V Bad	temporary
16	Flama Rd.	10.0m	7.0m	3 span RC Slab	Fair	
17	Peace Island Rd.	4.0m	3.0m	Wooden	Bad	temporary
18	Duan Town Rd.	9.0m	1.3m	RC made pedestrian Br	Bad	impassable
19	Basa Town Rd.	5.0m	3.0m	RC	Fair	Flooded
20	D-C Block Rd.	7.0m	1.2m	Wooden pedestrian Br	Bad	impassable
21	Swaggart Island Rd.	3.5m	4.0m	Wooden Slab	Bad	temporary
22	Neezoe Community Rd.	9.0m	5.8m	1 span RC Girder	Fair	Flooded
23	Kearduma Community Rd.	30.0m	1.5m	RC made pedestrian Br	Bad	impassable
24	Peace Island Rd.	10.0m	5.0m	1 span RC Girder	Fair	Flooded
25	Peace Island Rd.	12.0m	5.5m	2 span RC Slab	Fair	Flooded
26	Neezoe Rd.	13.0m	6.0m	2 span RC Girder	Fair	Flooded
27	FDA Rd.	-	-	Pipe Culvert	Broken	impassable
28	Moses Blah Rd.	20.0m	1.2m	Wooden pedestrian Br	Bad	impassable
29	Zubah Town Community Rd.	25.0m	1.0m	Wooden pedestrian Br	Bad	impassable
30	Cooper's Farm Rd.	-	-	Pipe Culvert	Broken	impassable
31	Vai Town Bridge	260.0m-	7.5m	-	Broken	impassable

4.3.4.3 Project Objective

Some of the road links to/from the community are impassable by vehicle at present and people are forced to walk to the main road where transport service is available. The most critical problem is the water stream crossing the road where a bridge is necessary. Some of the communities tried to solve the problem by themselves and they constructed the pedestrian footpass temporarily to secure their daily activities. In order to recover the connection of missing community links, the reconstruction of bridges is an urgent issue and it is strongly expected. Given this condition, the project aims to construct missing links of the communities by reconstructing permanent bridges.

4.3.4.4 Location of the Project

Considering the bridge inventory survey, discussion with MPW and other international donors, eleven (11) bridges on Missing link are proposed as part of the road network development as shown in Table 4.3-7. The proposed bridges and culverts were identified by considering the network configuration, future traffic demand, and land-use plan.

Target Area is as follows

- New Georgia, Gardnersville, Barnersville, Caldwell and Paynesville District in Grater Monrovia

The priority A bridges are defined as matching the following conditions. Other bridged has a lower priority B from the viewpoint of urgency.

- Road class is the secondary road, which means the important road as traffic function of road.
- Broken bridges, which are impassible by both walking and motor vehicles.

The existing width of bridge is more than 3.0 m, which means the motor vehicles were able to drive before the war.

Figure 4.3-13 Location of Bridge on Missing Link Project

Table 4.3-7 List of Bridge on Missing Link Project

Road No.	Location（Road Name)	Length	Width	Road Class	reason	Condition	Priority	Proposed Length
18	New Georgia Rd.	15.0m	3.3m	Secondary	impassable	V Bad	A	20.0m
20	Red light detour	5.6m	3.3m	Tertiary	impassable	V Bad	A	15.0m
9	Banersville Rd.	18.0m	3.3m	Secondary	temporary	V Bad	A	25.0m
26	Dixbille Rd.	9.0m	3.3m	Secondary	temporary	V Bad	A	20.0m
322	Duan Town Rd.	9.0m	1.3m	Tertiary	impassable	Bad	B	30.0m
335	D-C Block Rd.	7.0m	1.2m	Tertiary	impassable	Bad	B	30.0m
329	Kearduma Community Rd.	30.0m	1.5m	Tertiary	impassable	Bad	B	50.0m
402	FDA Rd.	-	-	Tertiary	impassable	Broken	A	40.0m
451	Moses Blah Rd.	20.0m	1.2m	Tertiary	impassable	Bad	B	30.0m
461	Zubah Town Community Rd.	25.0m	1.0m	Tertiary	impassable	Bad	B	30.0m
512	Cooper's Farm Rd.	-	-	Tertiary	impassable	Broken	A	15.0m
							Total	305.0m

4.3.4.5 Scope of the Project

- Construction of: 11 bridges on Missing Links
- Construction of Approach road of bridges

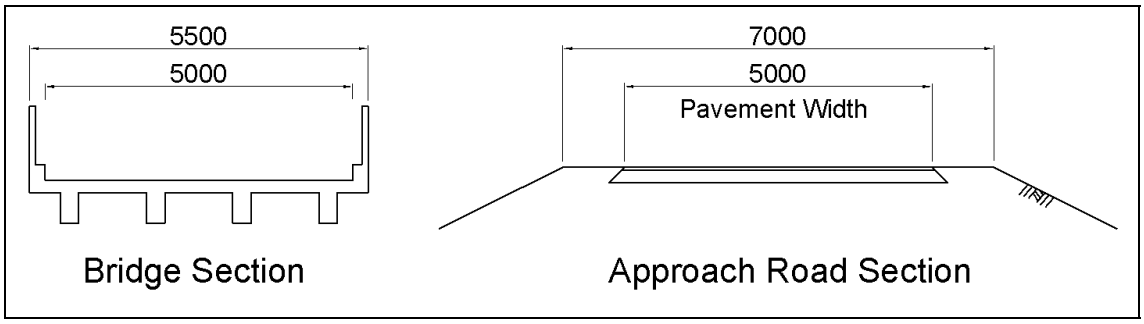


Figure 4.3-14 Planned Cross Section of Somalia Drive

4.3.4.6 Estimated Cost

- Detailed Design & Supervision Cost: USD 1.00 mln
- Construction: Bridge: USD 9.15 mln
  Approach: USD 0.49 mln
- Total Cost: USD 10.64 mln

4.3.4.7 Effects of the Project

- Utilization of sustainable road service
- Exchange of social & economic activities between villages
- Improvement of convenient & time saving for travel
- Provide opportunities to attend market business

4.3.5 Impact of Road Network Development Plan on Traffic Performance

4.3.5.1 Transport Performance

The basic traffic indicators expressing traffic system performance of the road network development plan, so called Master Plan (MP) are assessed as shown in Table 4.3-8. The MP case covers all the transportation

investment projects proposed by the study, including the on-going projects, the road network development, public transportation plan and transport management plan discussed in the next sections.

The number of vehicle trips is gradually growing according to population and economic escalation. If there is no investment or development for road and transportation sector in Greater Monrovia, the traffic situation in 2014 and 2019 would be going from bad to worse or the worst. The traffic situation in the future is foreseen by the simulation indicators of Without Project, vehicle-*hours and average travel speed. The average travel speed is about 21 km/h in 2008. That of 2014 and 2019 could be worse to 17 km/h and 14 km/h respectively. The situation with the average travel speed 14 km could not support economic activities properly. In case of MP development and investment, transport situation and performance could be improved than the present situation even though moralization expansion and increase of population. The travel speed in 2019 is expected to be 25 km/h, that is better situation than the present.

In contrast to Vehicle-Hours, the vehicle*km has not much difference between Base and MP cases. The detour roads will be compelled by introduction of new road network, because drivers usually want to avoid crowded road. This natural behavior causes the constant of total vehicle-km. However, the composition of low speed road will be decreased and then that of high speed road will be increased, as shown in Table 4.3-8.

Table 4.3-8 Traffic Performance Indicators for Base Case and Master Plan Case

		Without Case (Base Case)			MP Case		(MP) - (Without)	
		2008	2014	2019	2014	2019	2014	2019
Trips		231,404	309,327	395,893	309,327	395,893	0	0
Vehicle*hour		116,771	196,062	312,151	118,213	174,277	-77,849	-137,874
Vehicle*km	0 - 5 km/h	17,623	31,317	43,877	2,304	0	-29,013	-43,877
	5 -10 km/h	60,749	141,741	336,635	16,216	33,338	-125,525	-303,297
	10 - 15 km/h	167,887	845,550	1,871,947	75,168	120,502	-770,382	-1,751,444
	15 - 20 km/h	665,311	704,062	904,366	219,587	510,704	-484,474	-393,662
	20 - 25 km/h	364,766	726,568	786,713	339,641	877,337	-386,926	90,624
	25 - 30 km/h	455,077	522,385	256,277	891,054	1,401,614	368,669	1,145,337
	30 - 35 km/h	404,228	200,503	80,438	743,760	964,255	543,256	883,817
	35 - 40 km/h	142,999	39,064	85,047	813,146	206,143	774,082	121,096
	40 - 45 km/h	71,637	87,253	33,989	177,774	140,826	90,520	106,838
	45 - 50 km/h	59,660	10,373	0	49,573	121,356	39,200	121,356
	50 - 55 km/h	6,483	0	0	0	34,459	0	34,459
	55 - 60 km/h	0	0	0	0	0	0	0
	Total	2,416,421	3,308,815	4,399,289	3,328,223	4,410,534	19,408	11,245
Average Trip Length (km)		10.44	10.70	11.11	10.76	11.14	0.06	0.03
Average Travel Time (min)		30.3	38.0	47.3	22.9	26.4	-15.1	-20.9
Average Speed (km/h)		20.7	16.9	14.1	28.2	25.3	11.3	11.2

4.3.5.2 Impact on Air Quality Environment

Among various environmental impacts, air pollution has been taken into account for With and Without the project analysis. By implementing the road network development plan (MP case), the impact of travel speed of moving vehicles on emissions and air quality will be improved, especially with the reduction of

low speed vehicles (under 10kph). The air pollution components of CO2, NOx and SPM produced by MP case and Base Cases are estimated as follows:

(1) Emission Rate by Travel Speed

The emission unit by travel speed is set up based on the standard unit as of 2007 in Japan, as shown in Table 4.3-9. The Study Team tried to apply the emission units in Liberia, however, it is impossible to set the Liberian standard due to the lack of essential data and information.

Table 4.3-9 Emission Unit of CO2, NOx and SPM

	CO2 g/Vehicle*km	NOx g/Vehicle*km	SPM g/Vehicle*km
0 - 5 km/h	0.547	1.162	0.105
5 -10 km/h	0.342	0.671	0.052
10 - 15 km/h	0.269	0.498	0.046
15 - 20 km/h	0.229	0.407	0.037
20 - 25 km/h	0.204	0.374	0.034
25 - 30 km/h	0.186	0.336	0.031
30 - 35 km/h	0.172	0.299	0.028
35 - 40 km/h	0.161	0.266	0.025
40 - 45 km/h	0.152	0.238	0.023
45 - 50 km/h	0.146	0.217	0.021
50 km/h -	0.141	0.203	0.019

Source: Act Collection of Road Policy Evaluation, Japan Road Announcing Center, 2007

(2) Impact on Air Pollution

Table 4.3-10 indicates the forecasting results of air pollution in MP Case and Base Case. All the emissions have strong ties with Vehicle-km with low speed road, so that big impact on emission will be expected. The reduction of CO2, NOx, and SPM will be about 150 kg, 320 kg, and 27 kg per day in 2014 and 247 kg, 513 kg, and 43 ton in 2019, respectively.

Table 4.3-10 Forecasting Results of Air Pollution in MP and Base Cases

	Without Case (Base Case)			MP Case		(MP) - (Without)	
	2008	2014	2019	2014	2019	2014	2019
CO2 (kg/ day)	502.1	757.2	1,092.7	607.5	845.5	-149.8	-247.2
NOx (kg/ day)	897.2	1,381.8	2,014.3	1,060.5	1,501.3	-321.2	-513.0
SPM (kg/ day)	83.8	127.3	183.6	100.1	140.1	-27.2	-43.5

4.4 Public Transportation Plan

4.4.1 Present Condition, Problems and Issues of Public Transport

So-called para-transit including shared taxis, minibuses and motorcycle taxis are major transport means in passenger transport in Greater Monrovia Area. Long-distance passenger transport between Greater Monrovia Area and other cities or counties depends mostly on pickup type taxis on charter basis. On-road parking stations for those long distance trips managed by Federation of Transportation Union are located at Redlight and ELWA junctions and Duala area. Railway is barely used for commodity transport and not

for passenger transport for now. Robert International Airport is used for passenger transport by air.

4.4.1.1 Services by Public Transport Mode

(1) Bus (Medium and Large)

Medium and large buses are serving as major passenger transport means together with other public transport modes. Those bus services are provided by private sector and MTA (Monrovia Transit Authority) that is officially subsidized. Same as shared taxis and minibuses, medium and large bus services are managed almost by individuals. The reason for a large number of individual bus service operators is ascribed to relatively smaller tax compared to the business income tax levied to private companies by Ministry of Commerce and Industry. Same tariff table for minibuses is applied to private bus service, however loading and unloading places (bus stops) are fixed as MTA bus service. MTA bus operation and services are followings.

(a) Fleets

Donated DAF and VOLVO buses from international aid organization including Spanish Government are put in operation. The fleet capacity is from 43 to 45 seats and 32 standees. The fleet is 45ft length and 102 inch width in general. Front axle is equipped with two tires and the rear with four tires. Mounted diesel engine capacity is between 10,000cc and 116,000cc generating 220 to 240 HP. Tare weight of the DAF bus is 10,780kg.

(b) Service

MTA buses operate almost to all of their passenger capacities because of low tariff. Operation time is from 5:30 to 20:30 and eight round trips are made on the average. However no timetable is used. 11 MTA bus routes are provided at present. Flat fare of LRD15 is applied to MTA bus ride. MTA is currently studying a book of coupons offering a small discount, for instance, a book of 14 coupons for LRD200 and a book of 21 coupons for LRD300.

Table 4.4-1 MTA Bus Routes

	Route No.		No. of Buses in Operation	Remarks
1	101	Central Monrovia - Paynesville	5	
2	102	Central Monrovia - Redlight	3	Including Express
3	103	New Kru Town - Redlight	2	
4	104	Central Monrovia - Duala	2	
5	105	Central Monrovia - Old Road	2	
6	106	Duala - Redlight	2	SKD Blv.
7	107	Broad St. - New Georgia	2	
8	109	UN Drive - Lakpazee Market	2	
9	201	ELWA/Bethesta – Harbel Market	2	
10	202	Brewerville - Poor River	2	
11	203	Fendel - Redlight	2	

Source: Monrovia Transit Authority

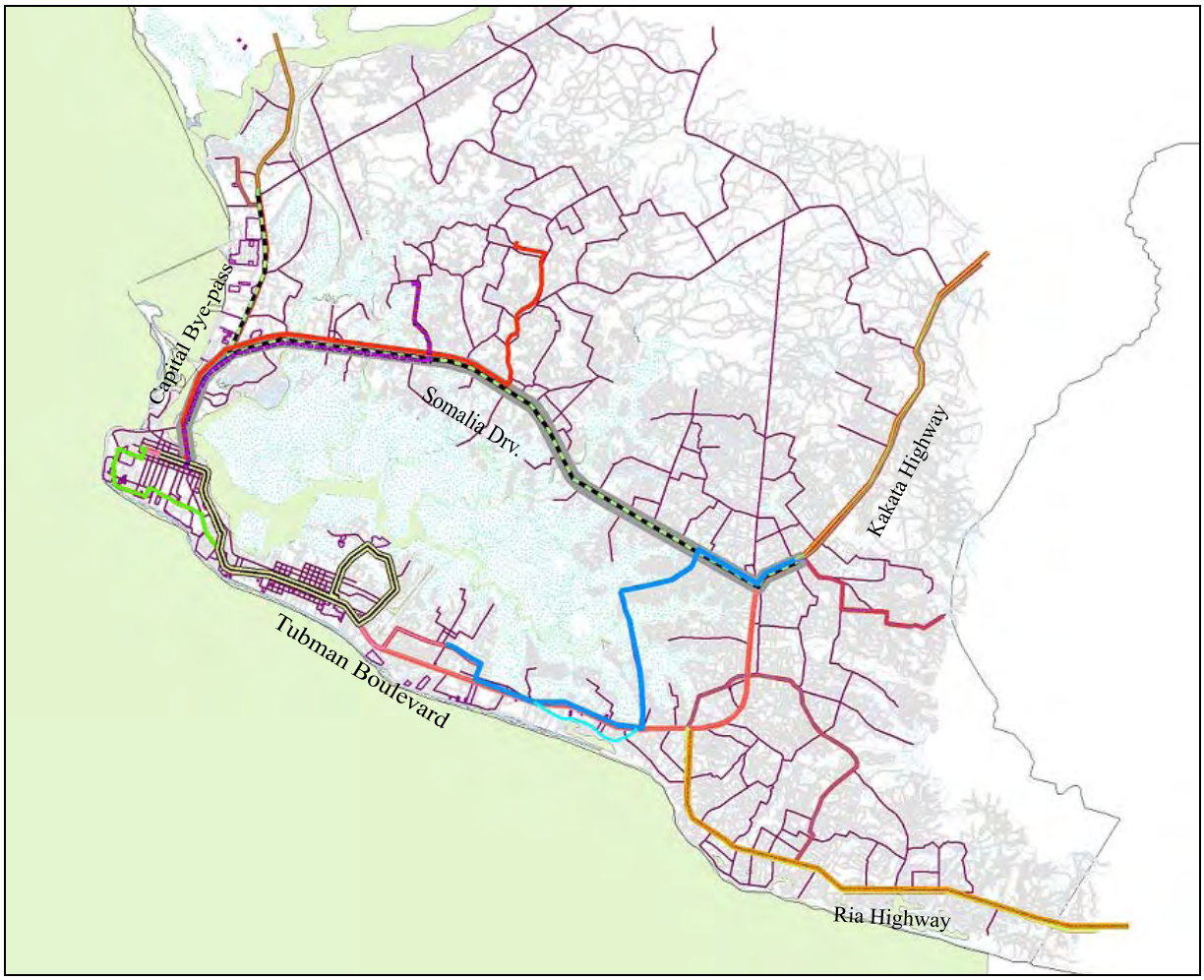


Figure 4.4-1 MTA Bus Routes

(c) Management

The number of passengers transported by MTA bus in May 2009 was 364,269pax./month, translated to some 12,000pax./day. The share of passenger trips by MTA in the total person trips by public transport in Greater Monrovia Area is estimated to be 0.15%. In total 175 workers including part time drivers are working at MTA with average salary of USD130 to 140 a month. Other expenditures necessary for operation are the costs for security (USD15,000-20,000/6month) and ticket printing (USD15,000/year). Both are contracted out. MTA is managed with subsidy from Min. of Finance, Philippine Government. In 2008 the subsidy was USD258,000, and MTA is in anticipation of USD1mln. in 2009.

(2) Shared Taxi

Shared taxis observed in Greater Monrovia Area, the fares and routes of which are specified, fall into the category of public transport means so-called jitney. Shared taxis provide pliable services such as free loading and unloading on the route and alteration or extension of operation route with additional charge on passengers' request. Those shared taxis are functioning as a main transport means in Greater Monrovia Area. Average occupancy rate is four to five passengers per vehicle, therefore it is operated in a very efficient way compared to the one or two passengers on the passenger cars and taxis in other countries. Such high occupancy contributes to provide public transport services in the suburban areas of low passenger transport demand density and help reduce traffic volume in Greater Monrovia Area. On the

contrary, compared with route bus (medium and large) transport efficiency of shared taxis is low in high passenger transport demand density areas such as central business and commercial areas, causing large traffic volume.

(a) Fleets

Imported secondhand small size TOYOTA or NISSAN sedan cars with engine capacity of some 1,600cc are commonly used. Though the capacity of those vehicles is five, usually it transports five passengers, one on front seat an four on rear seats.

(b) Service

Shared taxi fares fall into the range between LRD10 and LRD45 per passenger. Distance related tariff table prepared by Min. of Transport is applied for shared taxis. The fare is about LRD3 to 3.5 per passenger-km. Each passenger is obliged to bear same fare. Operators are not bound to register shared taxi routes and are able to determine routes at their will. Usually shared taxi waits for passengers at origin and starts after it becomes full. Passengers can freely get in and get off at any point on the route. Moreover it accommodates passenger's request to alter or extend operation route with additional charge.

Table 4.4-2 Table Major Shared Taxi Routes

	Route No.	No. of Taxis in Operation	Remarks
1	Central Monrovia - Paynesville	>1,000	Individual Owners (No Regulation)
2	Central Monrovia - Redlight	>1,500	Including Express
3	New Kru Town - Redlight	>1,000	
4	Central Monrovia - Duala	>1,000	
5	Central Monrovia - Old Road	>2,000	
6	Duala - Redlight	>2,000	SKD Blv.
7	Broad St. - New Georgia	>700	
8	UN Drive - Lakpazee Market	>500	

Source: JICA Study Team based on MOT hearing

(c) Management

Shared taxi shares 53% of total person trips made in 2009 in Greater Monrovia Region, and some 71% of the total person trips excluding those by walk. Almost all service providers are individuals. Individuals and companies to enter shared taxi business ought to have permission of Min. of Transport and register. The registration is required every year and the registration fee is USD125 a year. Though the permission for business is prerequisite, entry into shared taxi business is almost free and high growth rate of shared taxis are observed recently.

(3) Minibus

In Greater Monrovia Area minibus with some 15 passenger capacity remodeled from coach type vehicle is used as shared taxi stated above on the fixed route.

(a) Fleets

Imported secondhand TOYOTA coach type vehicles are commonly used. The fleet is remodeled into minibus with some 15 passenger capacity. In case of TOYOTA Hi-Ace, diesel engine is used and its capacity is 3,600cc.

(b) Service

The fares of coach type minibuses and pickup type utility vehicles determined by Min. of Transport are lower than those of shared taxi. The fare is distance-related and the fare level is between LRD1.5 and LRD1.7 per passenger-km, meaning about a half of that for shared taxi. Each passenger taking minibus shall bear the officially determined fare. In Greater Monrovia Area the fares of minibus fall into the range between LRD5 and 25. One driver and one conductor run a minibus. The passenger capacity is 15. Usually minibus waits for passengers at origin and starts after it becomes full. Passengers can freely get in and get off at any point on the route. However it is not pliable as shared taxi and seldom accommodates passenger's request to alter or extend of operation route with additional charge. Though minibus is more economical than sedan type shared taxi from the fare aspect, the people in Greater Monrovia Area prefer shared taxi to minibus.

Table 4.4-3 Table Major Minibus Routes

	Route No.		No. of Minibuses in Operation	Remarks
1	101	Central Monrovia – Paynesville	20-22	
2	102	Central Monrovia – Redlight	25-30	
3	103	New Kru Town – Redlight	15-20	
4	104	Central Monrovia – Duala	15-20	
5	105	Central Monrovia - Old Road	<6	
6	106	Duala – Redlight	15-20	
7	107	Broad St. - New Georgia	>20	
8	109	UN Drive - Lakpazee Market	<10	
9	202	Brewerville - Poor River	<6	
11	203	Fendel – Redlight	<10	

Source: JICA Study Team based on MOT hearing

(c) Management

Minibus shares 7.4% of total person-trips made in 2009 in Greater Monrovia Region, and some 10% of the total person-trips excluding those by walk. Almost all service providers are individuals. Individuals and companies to enter shared taxi business ought to have permission of Min. of Transport and register. The registration is required every year and the registration fee is USD150 a year. Though the permission for business is prerequisite, entry into minibus business is almost free and service provider can plan fixed minibus route and operate.

(4) Motorcycle Taxi

Motorcycle taxis are used to supplement shared taxis and minibuses and to accommodate relatively short distance trips. Chinese and Indian motorcycles are commonly used. The fare levels are LRD40 for 1km ride, LRD100 for 4km ride and LRD200 for 10km ride. However compared with those of minibus and shared taxi, the fare level is considerably high. Motorcycle taxi is usually not used for feeder transport means combined with minibus or shared taxi.

4.4.1.2 Prospect of Public Transport Modal Share

Public transport service providers are obliged to register vehicles for public transport with Min. of

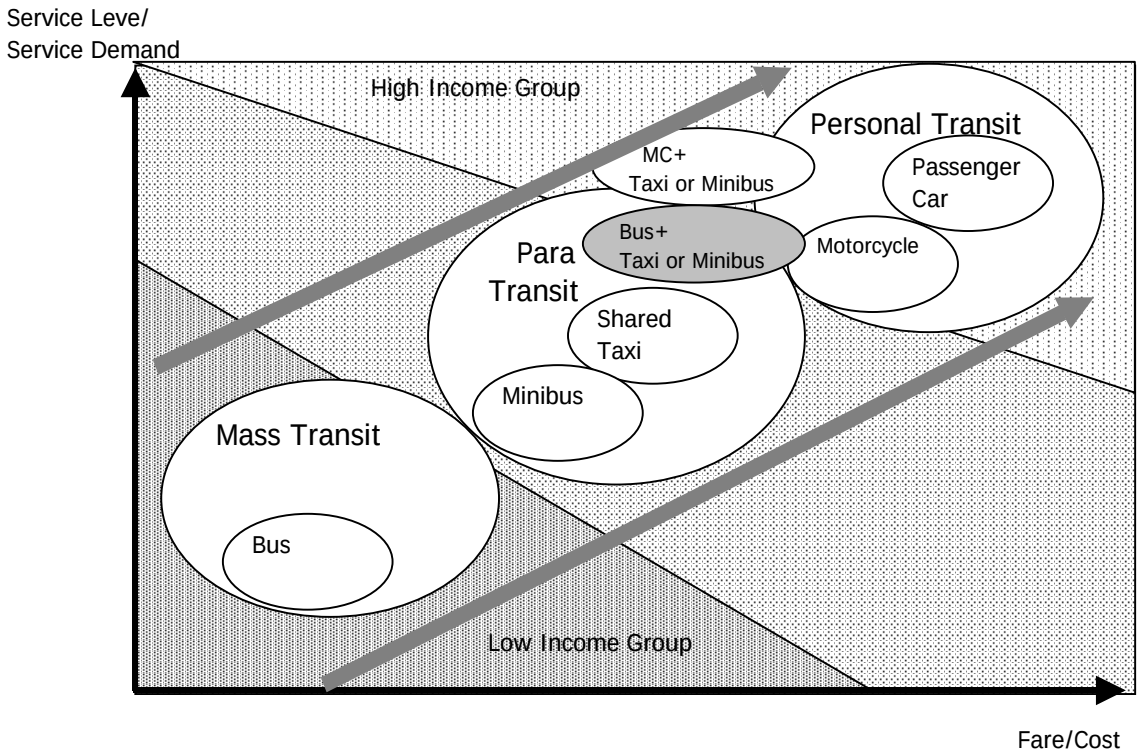
Transport. According to the data provided by Min. of Transport, the number of registered shared taxis steadily shows increase every year. Number of registered large buses steeply increased in 2007 but the increase rate dropped in 2008, instead number of registered minibuses showed sharp increase in 2008.

Table 4.4-4 Estimated Number of Public Transport Fleets

Type	No. of Fleets Registered					
	2006 (veh.)	Growth Rate	2007 (veh.)	Growth Rate	2008 (veh.)	Growth Rate
Taxis in GMA	4,000	(-)	6,215	(55%)	9,600	(54%)
Minibuses in GMA	2,600	(-)	3,102	(19%)	5,000	(61%)
Large buses in GMA	1,026	(-)	2,816	(174%)	3,400	(21%)

Source: Ministry of Transport

"Para-transit" is a general term representing intermediate transport means between mass transit representing route bus and personal transit representing private car, motorcycle and bicycles. It plays a role following public transport means. In greater Monrovia Area para-transit including shared taxi, minibus and motorcycle taxi are functioning as main transport means. Such para-transit locates at matching point of individuality and massiveness/regularity from the viewpoint of transport service, and also locates at intermediate point between personal transport means and mass transport means from the viewpoint of transport cost.

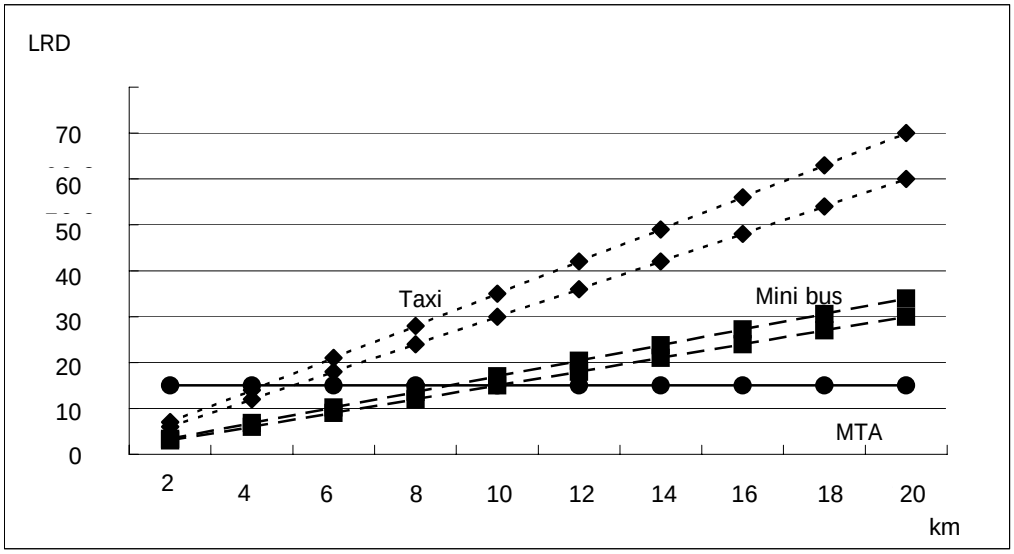


Source: JICA Study Team

Figure 4.4-2 Figure Relationship between Income Level and Public Transport Mode

In case the income level of people rise in future, the modal shift from shared taxi characterizing the public transport system in Greater Monrovia Area to personal transit is deemed to proceed. The result of

interview with residents that they prefer shared taxi to minibus endorses such conjecture. Flat fare at LRD15 is applied to MTA buses. Detailed tariff table for taxi (TX), bus/pickup (TB)/(TP) is provided by Min. of Transport in and around Monrovia.



Source: JICA Study Team based on MOT Data

Figure 4.4-3 Relationship between Distance and Fare by Public Transport Mode

As distance-related fare is applied to shared taxi, fare of shared taxi service after 4 or 5 km ride becomes higher than the one of MTA bus service. Comparing public transport operation costs per passenger capacity, MTA bus operation cost is the lowest, then those of minibus, shared taxi, and motorcycle follow in this order.

Table 4.4-5 Table Public Transport Operation Cost per Passenger Capacity (Unit; USD)

	Motorcycle Taxi	Shared Taxi (PC)	Shared Taxi (minibus)	MTA Bus
Vehicle Operating Cost/100veh.km/head)	13.811	3.302	1.235	0.734

Source: JICA Study Team

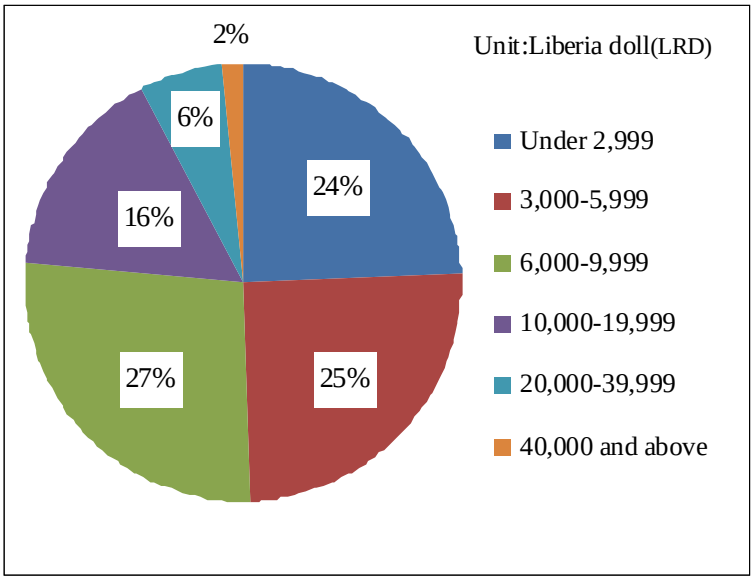
Table 4.4-6 Basic Data for VOC Calculation by Public Transport Mode (Reference)

	Motocycle Taxi	Shared Taxi (PC)	Shared Taxi (minibus)	MTA Bus
Vehicle type	HONDA	NISSAN SUNNY	TOYOTA Hi-Ace	DAF
HP metric	7	94	100	220
Tare weight (kg)	70	1,260	2,680	10,780
Engine Oil Required (l)	1	3	6	20
ESA	0	0	0	0.6
Passenger capacity	1	4	20	75
No. of axles	2	2	2	2
No. of Tires	2	4	4	6
Average km driven in operation (per day)	40	140	120	160
Average vehicle life (years)	5	6	6	6
Average tire life (km)	30,000	50,000	50,000	50,000
Average hours driven (per day)	10	10	10	17
Financial Costs (USD)				
Vehicle price (USD)	300 (secondhand)	5,000 (secondhand)	9,000-10,000 (secondhand)	45,000-100,000 (secondhand)
Vehicle Depreciation (USD/day)	0.164	2.283	4.338	31.963
Tire cost (per tire) (new)	30	60	75	375-425
Tire cost (USD/veh.day)	0.066	0.548	0.548	6.575
Crew cost (USD/veh.day)	3.333	3.333	5.000	5.000
Administration cost (USD/veh.day)	-	-	-	9.033
Maintenance cost (USD/veh.day)	1.096	3.835	3.288	8.767
Registration cost (per day)	-	0.342	0.411	-
Petrol (per liter)	0.86	0.86	-	-
Diesel (per liter)	-	-	0.82	0.82
Engine oil (per liter)	0.66	0.66	0.79	2.20
Engine oil change (km)	5,000	10,000	10,000	10,000
Engine oil cost (USD/day)	0.005	0.028	0.057	0.704
Fuel Efficiency (km/l)	40.0	9.2	6.0	4.5
Fuel cost (USD/day)	0.860	13.087	16.400	29.156
Others (security & Ticket) (USD/day)	-	-	-	82
Vehicle Operating Cost/100veh.km/head) (USD)	13.811	3.302	1.235	0.734

Source: JICA Study Team
Note: Assumed average crew sizes are 1 on Motorcycle Taxi and Shared Taxi (sedan) and 2 on Shared Taxis (minibus) and MTA Bus.

In case of MTA bus ride, it costs LRD15 for one ride and LRD600 a month for 20 round trips. If motorcycle taxi is complementarily used as feeder transport for MTA bus, minibus and shared taxi, the total cost for public transport becomes much higher. Assuming 20% of household expenditure is marginal for

transport, LRD3,000 of household income gives the lower limit to afford the expenditure. According to the Person-Trip Home Interview Survey conducted in this Study, about one forth of the sampled households fall into this category. It is too high in consideration of household expenditure compositions in other countries (ex. In Japan the transport cost mostly shares less than 10% of household expenditure.). Accordingly transferring of public transport means in Greater Monrovia Area impose considerable burden on households especially in the restoration and reconstruction period.



Source: Person-Trip Household Survey conducted by the JICA Study Team

Figure 4.4-4 Composition of Households by Income Level

Problems in the public transport sector from the viewpoint of urban infrastructure restoration and reconstruction are summarized below.

- Most of the residents living in the swampy informal settlement adjacent to the Central Monrovia are regarded as what is called “living area bound class”, therefore most of those settle as transportation poor not to bear the public transport expenditures.
- Urban area is spreading outward at low population density inviting the situation where public transport service by private sector is hardly expected due to low density of transport demand.
- Because only small portion of people bear the burden for transferring cost, it is hardly justifiable to form public transport network based on the transferring.
- The fares of public transport means do not comply with actual transport costs, and MTA buses that are officially subsidized coexist with private public transport means in competition. And private sector public transport services are mostly provided by individuals, hence such situation makes it difficult to subsidize those operators.
- Traffic congestion at commercial areas or market places are caused by the para-transit vehicles waiting for passengers on the road. Especially at intersections between ring road and radial road such as Red light junction those para-transit vehicles become the main cause of congestion.
- Since the public transport network is complicated and not becomes user friendly, convenient movement of people is restricted.
- Vehicles used for public transport are mostly secondhand and aged, moreover not well maintained.

Accordingly such public transport vehicles emerge NOx and COx emission on a massive scale and noise leading to the environmental degradation

4.4.2 Public Transport Policy

4.4.2.1 Policy and Strategy by Upper Plan

The Government's policy directions of land transportation is to improve the supply of largely private sector-led transportation services, without compromising customer accessibility, safety and comfort. Public transport policies in Liberia are summarized below.

(1) "Poverty Reduction Strategy", Apr. 2008, Republic of Liberia

In the "Poverty Reduction Strategy", Apr. 2008, Republic of Liberia, the goals in the transport sector are shown in the abstract expression. Goal: 'To improve the Liberian transport sector through policy, systems and infrastructure development that create access to reliable, affordable and efficient services'

Strategic objective in the transport sector of Greater Monrovia Area is shown in following sentence.

Strategic objective 2: To improve urban transit in Monrovia and its environs

Restoration of buses, purchasing buses, and arrangement of three bus stations (ELWA, Fendel and Brewersville) are included in the PRS.

Note: Above three bus stations are coincident with MTA (Monrovia Transit Authority) 's concept.

(2) "National Transport Policy and Strategy & Investment Plan", Aug. 2008, MPW

Following directions are shown in consideration of appropriateness of transport means, passenger safety and comfort.

- ✓ Increase private sector participation in the provision of transport and alternative transport services;
- ✓ Develop and operate modes of transport on the basis of economic savings on fuel use, operational efficiency including reducing traffic congestion, environmental protection and safety;
- ✓ Segregate public transport and in particular bus transport should be confined to the selected routes to speed up traffic flow;
- ✓ Have in place strong operator union(s) and forums for efficient and effective transport services;
- ✓ Streamline regulatory functions;
- ✓ Encourage use of non-motorized transport and possibly mass passenger transport as alternative to ever growing traffic demand;
- ✓ Establish trucks/bus terminals near the main cities.

(3) "An Act to Authorize the Establishment of the National Transit Authority", Mar. 2009

An Act to establish the National Transit Authority (NTA) approved in Mar. 2009 is prepared to realize a reliable and safe movement of people and goods within and without the country at affordable cost, subject to regulations of the Ministry of Transport through establishment of NTA.

4.4.2.2 Public Transportation Policy for this Study

Based on the above governmental transport policies following public transport policies for Greater Monrovia Area are proposed.

(1) Direction of Public Transport Modal Shift

(a) Esteem of Para-Transit

Though bus is advantageous with respect not only to fare/cost but also to socio-environment, it can only provide limited services for individual transport demands. Para-transit, currently regarded as major public transport mode, is advantageous with respect to passenger convenience, fare/cost, and socio-environment to some extent. Therefore, it should remain as a main protagonist in future in the public transport sector by applying countermeasures to reduce demerits such as improvement of transferring, bay construction to remove para-transit vehicles' parking on road, and arrangement of public transport terminals.

(b) Promotion of Shift to Mass Transit in the High Transport Demand Density Areas

However, as bus has advantages in fare/cost and socio-environment, conversion from para-transit to bus as a mass transit shall be promoted in the areas with high transport demand density. Especially it shall positively accommodate the transport demand in the line hall reach within the urban area.

(c) Improvement of Interrelation between Mass Transit (bus) and Para-Transit

Although better public transport service is expected, the combination of mass transit/para-transit with para-transit as a feeder transport is not realistic for now, due to the increase in fares for two rides or more. However interrelation between mass transit (bus) and para-transit shall be improved through rerouting of present public transport routes to restrain vehicle traffic volume increase in urban area and improve public transport passenger convenience. To this end subsidization to public transport to compete with personal transit regarding cost shall be reconsidered by deliberate measures, for instance, imposing burden on personal transit passengers and allocating those to the socio-environmental cost.

Present motorcycle taxis is not likely to be a major feeder public transport mode in the long horizon due to its safety problem and high operating cost. Instead it should be adequately conceived that NMT would bear the role of motorcycle taxi.

(2) Direction of Governmental Subsidization

(a) Improvement of Public Transport Service Efficiency through Competition in the Market

Improvement of efficiency in public transport system though public transport market shall be pursued in principle, in other word, optimum allocation of resources shall be pursued.

(b) Governmental Subsidization

Governmental subsidization shall positively apply as a measure for transportation poor and civil minimum measures to provide public transport services in the areas where transport demand density is too small for private sector to make profits. Subsidy to public transport operators and household, and tax exemption or reduction are the recommendable examples of concrete such measures. Direct subsidization to household is said to be effective for transport poor. Spontaneous market formation near the residential areas is considerably attributed to the transport cost of each household.

Most of the inhabitants living in the swampy informal settlement adjacent to the central Monrovia are regarded as what is called "living area bound class", therefore most of those settle as a transportation poor in such areas without any choice of alternative settlement. Relocation of inhabitants for the project implementation and clearance of informal settlement is not so easy. Housing development for low income group shall locate within the walking distance from trunk bus route. Attention should be paid to locate alternative housing areas by utilizing public domain. In case where private sector hesitates to enter the public transport service business because of low transport demand density, official subsidization to the private public transport operator is appropriate. As private sector barely takes a risk to provide public transport service on the route whose profitability is uncertain, contrivances like combined business permission with highly profitable route will be required. Liberian government subsidizes only MTA. Transparency of administration is a precondition for official subsidy. Currently only MTA suffices the precondition among all the public transport service operators.

(3) Direction of Facility Rehabilitation and Reconstruction

In comparison of typical public transport network patterns, multi-nodal network pattern was recommended for Greater Monrovia Area.

Table 4.4-7 Comparison of Public Network Patterns

	Single node pattern	Multi nodal pattern	Dispersed nodal pattern
Traffic congestion	Partial solution of present traffic congestion	Effective solution of present traffic congestion	Not so much expected
Transferring	Clear	Clear to some extent	Not so clear due to complication
Servicing area	Not effective covering of urban area due to radial routing	Effective covering of urban area to some extent	Effective covering of urban area
Time cost saving	Making active urban activities in the short run but rather inactive in the long time	Making diverse urban activities at multi-cores active	Making urban activities inactive in the long run
Terminal construction cost	Large	Costly to some extent	Small
Urban structure inducement	Conformation to present urban structure (resulting in increase of transport cost, socio-economic cost accruing to concentration), but not conformation to proposed future urban structure	Conformation to proposed urban structure	Not conformation to present urban structure and proposed future urban structure
Land use potential	Adverse utilization to present land use potential for multi urban cores	Effective utilization of present land use potential for multi urban cores	Not effective utilization of present land use potential for multi urban cores
Town scale	Suitable for small metropolitan area	Suitable for up to medium scale metropolitan area	Suitable for large scale metropolitan area (10.mln.)
Vehicle size	Not applicable to many large size vehicles (incl. Railway) because of a large site required	Applicable to buses	Applicable to large size vehicle

(a) Intensification of Interrelated Network by Terminal

Para-transit vehicle is not free from waiting for passengers from business aspect. Such para-transit vehicles parking on road waiting for passengers are the main cause of the traffic congestion. Therefore para-transit vehicles waiting for passengers on road shall be relocated from the carriageway of the road. Intensification of interrelated network and traffic fluidity are expected by arrangement of public transport terminal function at the nodal points of ring road comprising Somalia Drive and Tubman Boulevard and radial trunk roads, UN Drive, RIA Highway and Ganta Highway. Attention shall be paid to followings.

- Terminal arrangement shall accommodate to the present para-transit pattern that meet residents' transport demand and operators' cost for operation.
- Terminals shall have the function to mitigate present traffic congestions at junctions of Redlight, ELWA, and Freeport/Somalia Drive.
- In consideration of the residents' solvency, arrangement of terminal shall avoid as much as possible the increase of transfer.
- In the Central Monrovia area terminal shall be linear type along streets since it is difficult to secure the large tract of land. The linear type terminal shall be composed of dispersed bays by direction to give the parking/stoppage spaces for para-transit vehicles and buses.

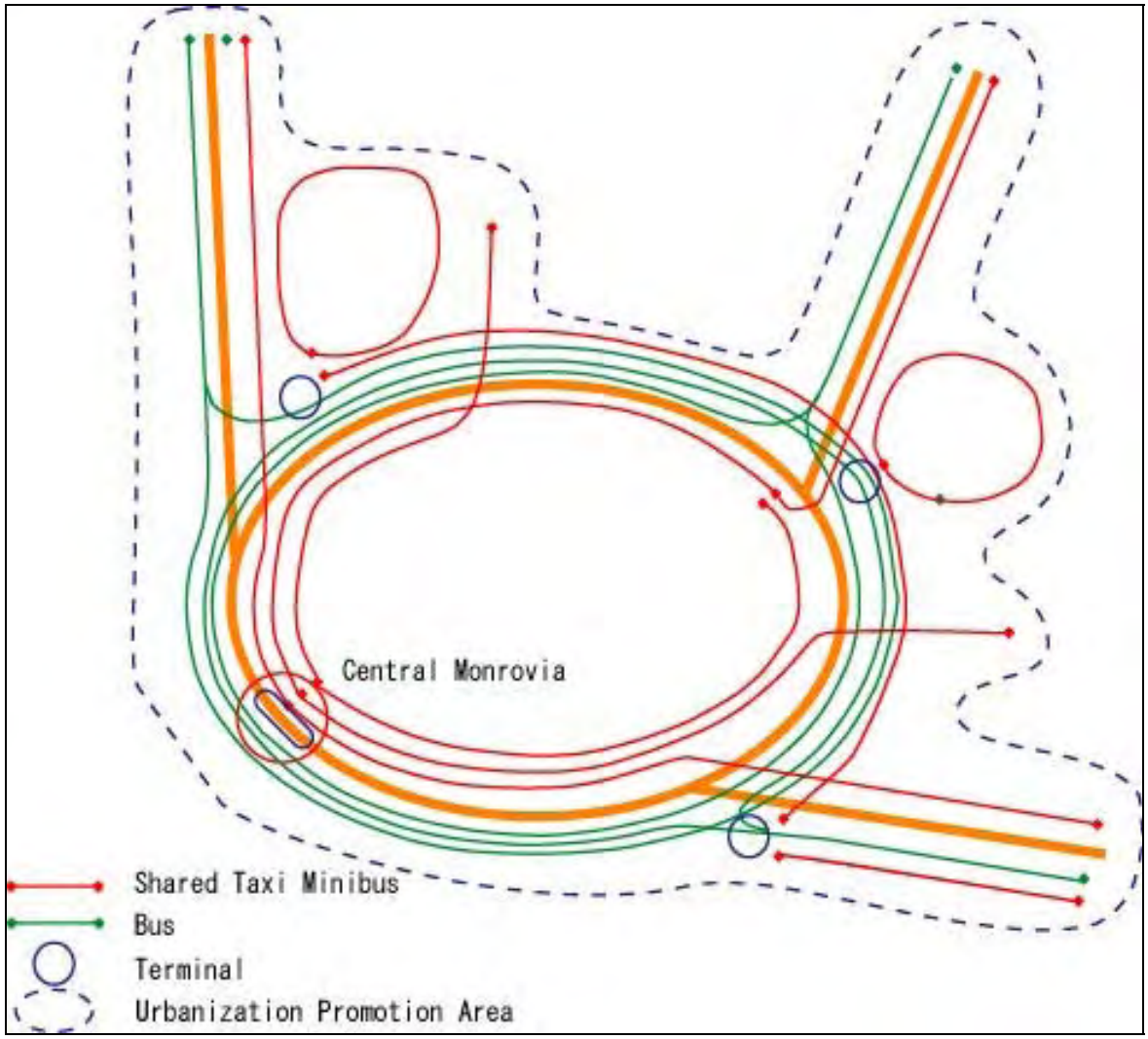
This measure is expected to have a great positive effect to mitigate present heavy traffic congestion at Redlight and Somalia Drive junction with Freeport Road.

(b) Promotion of Shifting to Circular Route Pattern

Public transport routes shall shift from a shuttle pattern to a circular pattern for the purposes of expansion of service area and avoidance of concentration of routes on the specific reach of the roads. Along with the shift of operation pattern, public utility vehicles shall wait for passengers at terminal in principle to eliminate public utility vehicles waiting for passengers on road.

(c) Conformation of Public Transport Service Area to Urbanization Promotion Area

Urbanization Promotion Area was proposed in the former section on future urban structure. Public transport service area shall be provided within UPA based on the future urban structure.



Source: JICA Study Team

Figure 4.4-5 Figure Conceptual Public Transport Network

4.4.3 Projects in Public Transport Sector

4.4.3.1 Public Transport Terminal Project

(1) Objective

To arrange public transport terminals to streamline public transport network and improve the road traffic fluidity

(2) Background

Para-transit vehicles waiting for passengers on the road are causing traffic congestion at commercial areas or marketplaces. Especially at intersections between ring road and radial road such as Red light junction those para-transit vehicles are the main cause of congestion. To checek such situation is the restoration and reconstruction activities. Public transport network is complicated and becomes not user friendly and convenient movement of people is restricted.

(3) Contents of the Project

(a) Location

Three public transport terminal functions will be located at nodal points of ring road and trunk radial roads (Red light, UN Drive/Somalia Drive, and ELWA) and one linear type public transport terminal will be located at central Monrovia.

(b) Required Specifications

Following required specifications of the terminals were roughly estimated based on the traffic survey conducted in 2008 in this Study. The figures give a baseline standard because of the transport demand expansion in future.

Table 4.4-8 Table Required Specifications by Terminal

		Red light	ELWA	Freeport/Somalia Drive Junc.	C. Monrovia
Estimated Incoming Traffic Volume from All Direction (veh./day)	Taxi	13745	22342	7220	14763
	Minibus	6882	4448	880	2940
	Bus	3039	1365	70	377
No. of Vehicles covered by Terminal (veh./day)	Taxi	9622	15639	5054	10334
	Minibus	4817	3114	616	2058
	Bus	2127	956	49	264
No. of Vehicles covered by Terminal (veh./hour) covering rate=70%	Taxi	962	1,564	505	1,033
	Minibus	482	311	62	206
	Bus	213	96	5	26
Required berths Turnover rate=10 (Shared Taxi), 4 (Minibus & Bus)	Taxi	96	156	51	103
	Minibus	120	78	15	51
	Bus	53	24	1	7

Source: JICA Study Team

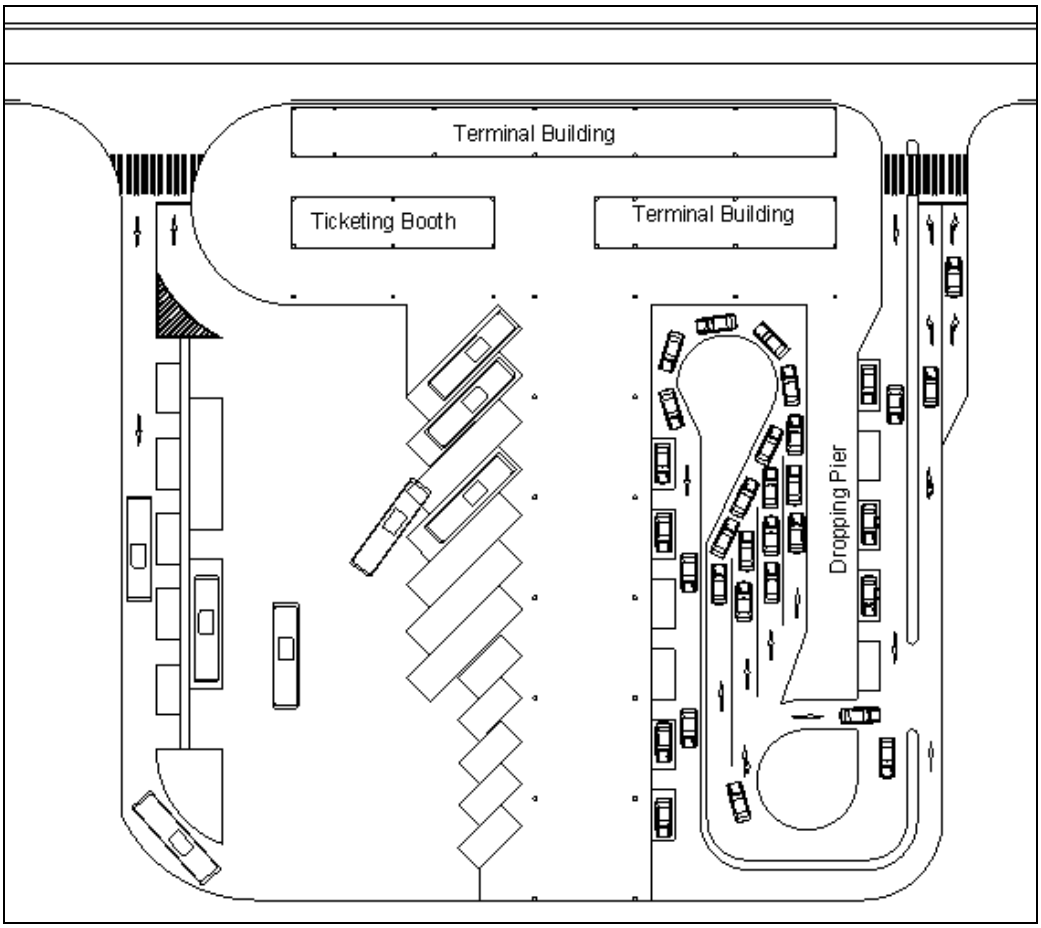


Figure 4.4-6 Typical Design of Transit Terminal

4.4.3.2 Para-Transit Bay Construction Project

(1) Objective

To construct para-transit bays in the reaches of the trunk roads where traffic congestion often occurs

(2) Background

Para-transit vehicles waiting for passengers on the road are causing traffic congestion at commercial areas, though parking of para-transit waiting for passengers until it becomes full is inevitable from its business aspect. To check such situation is the restoration and reconstruction activities. Therefore para-transit vehicles waiting for passengers on the road shall be relocated from the carriageway of the road for smooth traffic flow.

(3) Contents of the Project

Considering the existing and future scheduled bus network, the future bus stops have been planned

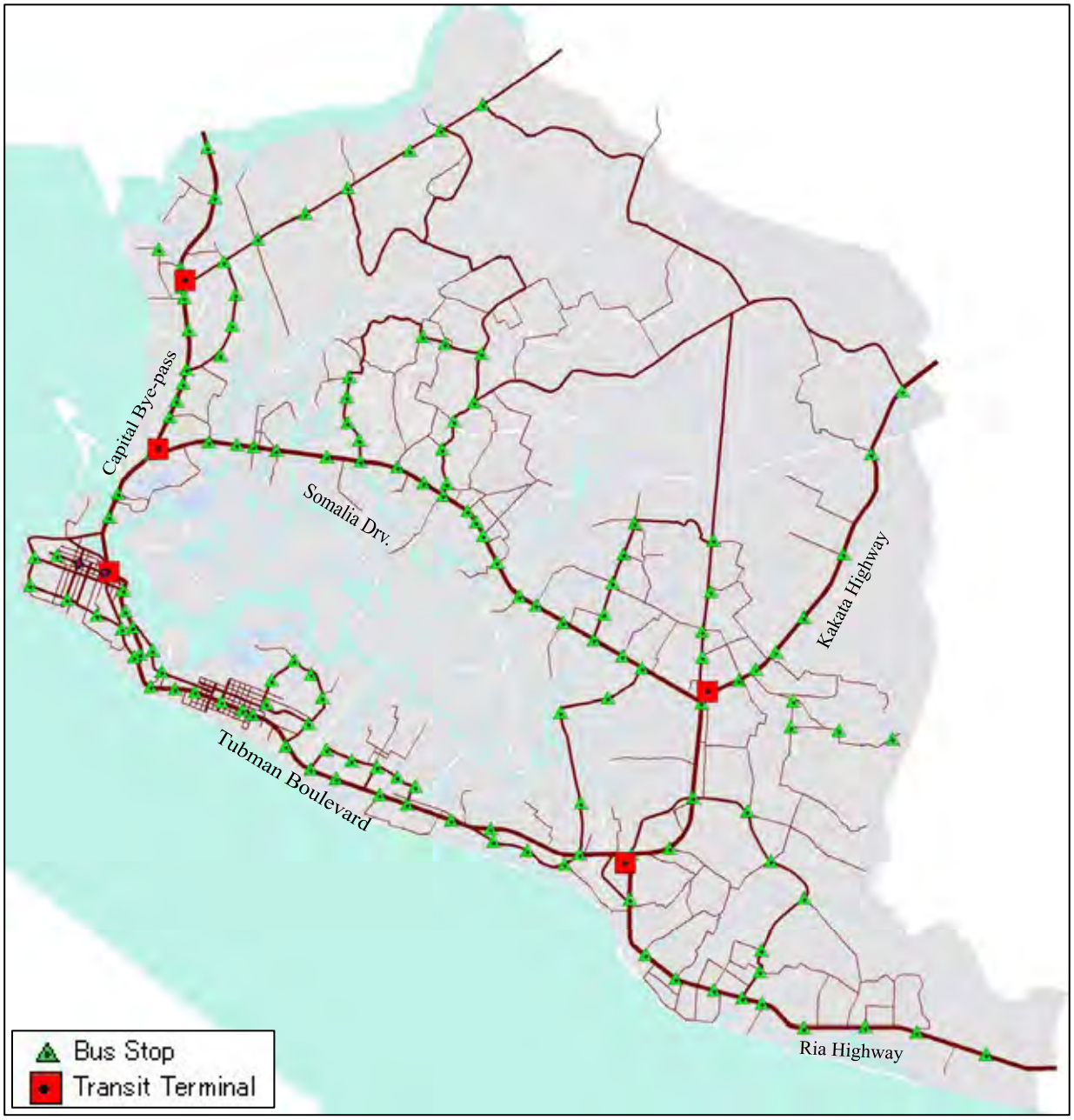


Figure 4.4-7 Existing and Future Bus Stop Plan including Transit Terminal Plan

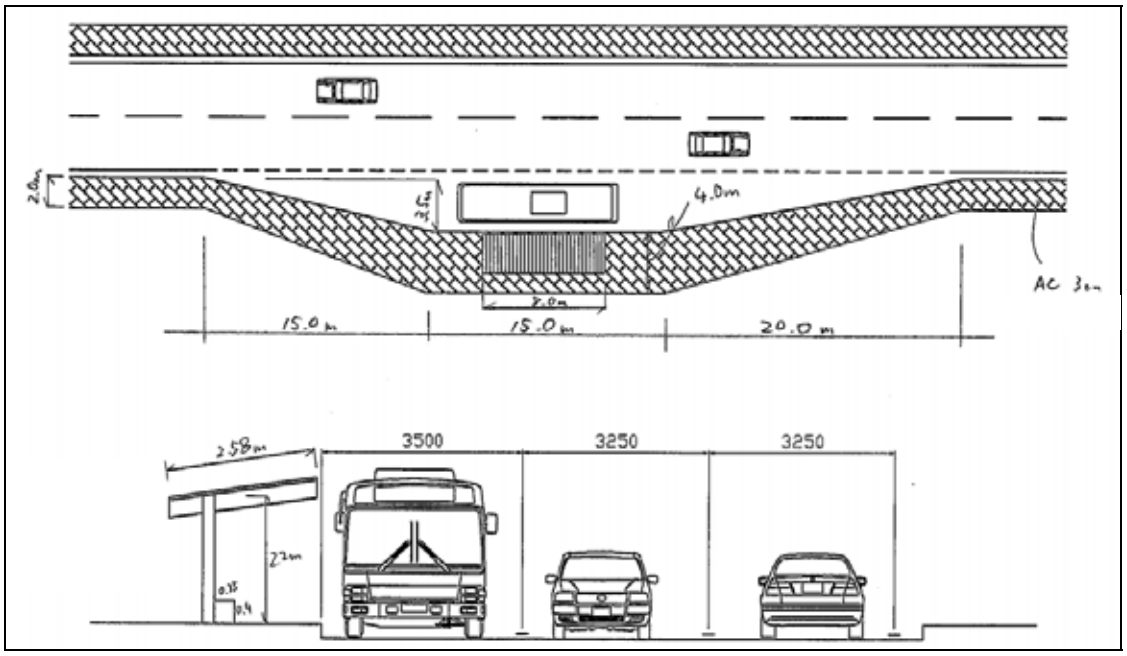


Figure 4.4-8 Typical Design Plan of Bus Stop Facility

4.4.3.3 Bus Transport Technical Cooperation Project

(1) Objective

To provide bus operator with technical cooperation to secure public transport service for BHN and to aim at environmental protection and safety improvement at the same time

(2) Background

Urban area is spreading outward at low population density inviting the situation where public sector hardly provide public transport service due to low density of transport demand. However public transport service as civil minimum in the areas where currently no public service is provided within future Urbanization Promotion Area (UPA) is needed.

Also appropriate measures are required for maintaining buses in good condition to contribute to the environmental protection and safety improvement.

(3) Contents of the Project

MTA will be provided with technical cooperation. Component of technical cooperation are followings.

(a) Provision of Training

Training including OJT for transport demand analysis, public transport network planning, feasibility study of bus route, route planning, and gas emission standard/noise standard/safety standard will be provided.

(b) Dispatch of Experts.

Experts in conjunction with above trainings will be dispatched.

(c) Equipment/Material Supply

Equipment and material for safety improvement and environmental protection will be supplied and bus

acquisition by MTA will be assisted. Since the latter has civil minimum characteristics and lacks profitability, therefore close coordination with MOT for official subsidization and permission of operation routes combined with profitable routes shall be performed.

4.5 Traffic Management System Plan

4.5.1 Objectives of Traffic Management System Plan

4.5.1.1 Planning Concept

One of the advantages of traffic management is to implement various countermeasures in the short /medium term and at low cost in order to alleviate the various transportation problems. The necessity for traffic management can be summarized as follows.

Existing traffic facilities in the study area are not used effectively. If the traffic management and operation was improved, these would contribute to the effective use of existing facilities and the traffic capacity would increase substantially.

Traffic management in the study area such as road facilities, traffic operation, and traffic safety plan, is still in the developing stage. Modernization of traffic management and operation is necessary so that the city will become an international city in near future.

An aim of traffic management is to assure safe, comfortable and speedy traffic movement. Among these aims, traffic safety is the fundamental requirement of the Monrovia citizens.

4.5.1.2 Objective of Traffic Management Plan

Objectives of the traffic management plan are to prepare comprehensive measures to achieve a safe, smooth and comfortable traffic environment for road users. The measures should be prepared based on a careful study of the traffic problems which are currently occurring, and are expected to occur, in the future in order to cope with these problems.

4.5.2 Basic Direction of Traffic Management Measures

Traffic problems have been becoming more pronounced year after year. Implementation of remedial measures is an urgent task. In particular, implementation of balanced 3-E measures (Traffic Engineering, Education and Enforcement) is a key factor. The 3-E concept applied to the Study Area is summarized below.

4.5.2.1 Measures of Traffic Engineering

(1) Improvement of Intersection and Road Section

It is important to increase traffic capacity by improving intersections since the most serious factors to disrupt main traffic flow are the small traffic capacities of intersections. In addition, improving traffic facilities and the traffic operation system of roads are necessary so that the obstructions to traffic flow are eliminated and smooth traffic flow can be achieved.

(2) Installation and Improvement of Traffic Signal

The number of existing traffic signals is insufficient, and the existing signals are out-dated and inefficient. Therefore, the modernization of the existing traffic signal control system and installation of signals at certain intersections are important. These measures will contribute to a decrease in traffic congestion at intersections.

4.5.2.2 Promotion of Traffic Education

One of the reasons for the drastic increase in traffic accidents is undisciplined behavior of the drivers and pedestrians. Thus the promotion of traffic safety and traffic education is an essential task.

4.5.2.3 Strengthening of Traffic Enforcement

At present, drivers' observance and attitudes to traffic regulations are extremely poor. Strengthening of traffic enforcement is necessary. Improvement in this area is important not only for the safety of the citizens but also for attracting foreign tourists.

4.5.3 Traffic Engineering Measures

4.5.3.1 Improvement of Intersection and Road Section

In general, most of the congestion occurs at intersections rather than at road sections. Moreover most of the congestion, as well as traffic accidents, usually occur at the intersections in the urban areas. In the case of the Study Area, however, congestion is also observed at road sections. Thus, if obstructions at road sections are eliminated or reduced, smoother traffic flow and decrease in traffic accidents can be expected.

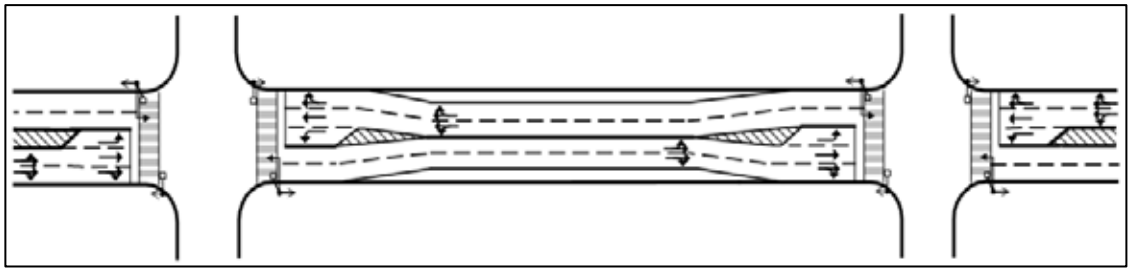


Figure 4.5-1 Ideal Design of Exclusive Left Turn Lane and Intersection Markings

(1) Segregation of Slow-Speed Vehicles from High-Speed Vehicles

Because of the left-turn operation at intersections (both signalized intersections and non-signalized ones), the slow-speed vehicles should be completely segregated from the other vehicles. This means that these slow-speed vehicles should cross the intersection in two stages or steps similar to pedestrians. This measure will become somewhat inconvenient for drivers of such vehicles but it will bring much-needed safety.

(2) Pavement Markings

Pavement markings are the important traffic facility in addition to good road surface for the smooth flow of traffic. An yellow centerline can prevent disorderly traffic; otherwise drivers cannot recognize which lane

to drive in and may drive on the opposite lane.

(3) Exclusive Left-turn Lane

Exclusive left-turn lanes need to be provided depending on the demand of left-turning vehicles. With an exclusive left turn lane, traffic processing capacity and safety are expected to be improved unless the volume of left-turning traffic is extremely heavy and poses an obstruction to through traffic.

(4) Raised Medians

Raised medians provide a higher level of traffic safety and improve operations for through traffic on multi-lane street. The benefits of the medians are:

- physically separating opposing traffic,
- restricting access to/from the arterial,
- providing pedestrian refugee areas.

(5) Sidewalk and Crosswalk

Although sidewalks are provided in the urbanized area in principle, sidewalk maintenance is effectively not carried out. Pedestrians have to walk on the roadway given that sidewalks are not continuous and are obstructed. Thus improving sidewalks and eliminating the obstructions to provide continuous walkways are recommended. However, it is very difficult to implement this in the short due time and financial constraints. A gradual or step-by-step approach is recommended.

(6) Prohibition of Parking in and near Intersections

The Traffic Law abates parking in/around intersections. Even if there is no designation around intersections, drivers are not legally allowed to park in such areas. It is however recommended to install yellow curb markings around intersections in order to clearly indicate parking prohibitions.

4.5.3.2 Traffic Signal Control

(1) Improving Signal Operation

It is not necessary to introduce high level signal system within the next five (5) years, but the existing local controllers of signals should be replaced by an up-to-date type of local controllers with required functions, and such new controllers should be used at all the new intersections that are due to be signalized.

(a) Minimum Functions Required for Local Controller

The following functions are required for the new controllers:

- Time-of-day signal control (with a minimum of three (3) patterns for a week and five (5) patterns for a day)
- Number of signal phases (at least, phases for through vehicles, left-turning vehicles, exclusive pedestrian signal, blinking red and yellow lights etc.)
- Coordinated function for progressive signal control between adjacent intersections
- Function of operation with emergency signal timing during malfunction

(b) All Red Signal Display

It is recommended that all-red signal display after the yellow signal be introduced in order to achieve total clearance of vehicles and pedestrians within the intersection.

(c) Location of Signal Heads and Other Control Devices

It is recommended to review appropriately to the installation standard of traffic control devices at intersections such as location of signal heads, location of pedestrian crossings, stop lines markings and no-parking curb markings.

(2) Future Plan of Signal Control and Operation

In parallel with increase in traffic demands and improvement of the road network and facilities, traffic signal operation should be improved. Thus, a traffic signal development plan is proposed for the traffic signal facilities at 28 intersections, considering the future increase in traffic demand with road classification (primary and secondary roads intersection) and effective signal operation. Figure 4.5-2 shows a plan for signal improvements. The staging implementation plan is as shown in Table 4.5-1.

Table 4.5-1 Staging Plan of Traffic Signal Development

Term	Implementation Concept	No of Intersection
Priority No. 1	replace temporary working and destroyed signals and at traffic bottleneck intersections	6
Priority No.2	Install at the intersections with heavy traffic mainly along Tubman Boulevard	9
Priority No. 3	Install at the intersections with primary and secondary roads.	13

Figure 4.5-2 Future Plan of Signalized Intersections

4.5.4 Parking Facility

4.5.4.1 Status of Parking Issues in Monrovia

At present, there are many vehicles parked on the road sides and sidewalks in commercial areas especially in Monrovia CBD, obstructing the safe passages of pedestrians.

Figure 4.5-3 Roadside Parking Status in Monrovia CBD

The study team had carried out parking survey for Monrovia CBD area in May 2009, so as to evaluate the existing parking situation. Based on the survey, total number of parked vehicles is 3,457 vehicles at 30 km roadside length. As of parking by vehicle type, the major vehicle type is Passenger car with 68%, followed by Pick up with 8%. The parking density on average is about 11.6 vehicles per 100m. The location with parking density more than 30 vehicles per 100m, which means most of roadside is occupied by parked car, located on Randall street, Broad street, Gurley street, Center street, UN drive, Benson street, Carey street, Ashmun street, Sao boso street, and Mechlin street. Hourly distribution at the busiest street is almost constant during day time, about 450 vehicles.

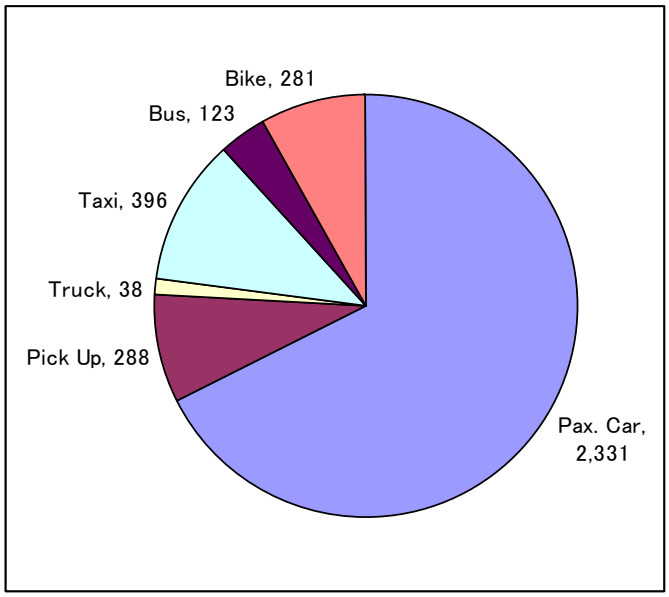


Figure 4.5-4 Number of Parking in Monrovia CBD

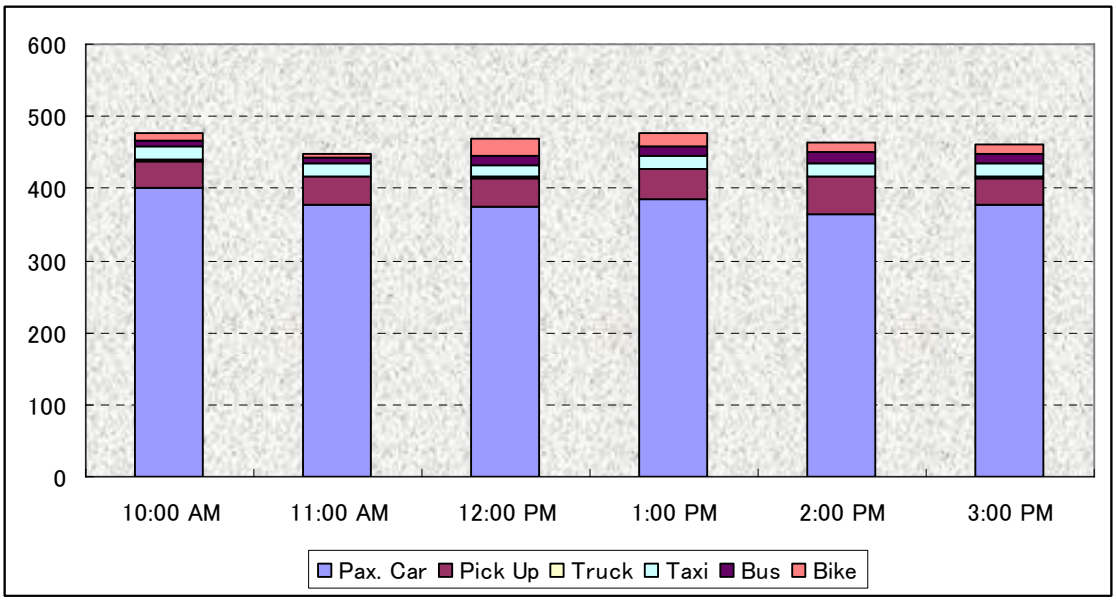


Figure 4.5-5 Hourly Parking Distribution at the Busiest Streets in Monrovia CBD

4.5.4.2 Direction of Parking Management in Monrovia CBD and Commercial Area

As analysis of the existing parking situation,, the roadside or sidewalk parking is obstructing the safe passage of pedestrians and reducing the traffic capacity. In the future more passenger car will be concentrating to CBD area, the growth rate of concentrating on passenger vehicle to Monrovia CBD is about 1.4 times against the present as shown in Table 4.5-2. Therefore, several measures, such as on-street parking prohibition, off-road parking and parking regulation should be introduced in order to reduce the frequent diversion of pedestrians onto the carriageway and the corresponding congestion of the affected road sections. In addition, since it is expected that traffic demand will increase rapidly in the future, securing adequate parking spaces will be an important issue of traffic management in the future.

Table 4.5-2 Trend of Vehicle Trip Attraction (Unit; Vehicle Trip/Day)

	Year 2008	Year 2014	Year 2019
Grater Monrovia Total	248,267	324,738	405,659
Growth Rate	100%	131%	163%
Monrovia CBD	45,381	54,947	63,570
Growth Rate	100%	121%	140%

4.5.5 Traffic Safety Education

In this section, enhancement of traffic safety perception and education is discussed. Discussion includes the suitable type of educational activities appropriate to the audience categories. These are examined based on the present traffic accident condition, characteristics of accidents and result of daily traffic observation as well as the result of the Traffic Campaign carried out in the Study. Recommended remedial measures on traffic safety education are as follows:

4.5.5.1 Implementing Regular Traffic Safety Campaign

One of the effective methods to overcome the problem of high traffic accidents is a traffic safety campaign

targeted at all citizens, namely the general public, school children, parents and drivers. Traffic safety campaign is suggested to be carried out repeatedly and regularly as one of the effective means and first priority in the Study Area, as proven by the actual performances of the Traffic Safety Campaign held by the MPP and Study Team.

4.5.5.2 Training for Instructors on Traffic Safety Education

One of the reasons that current traffic safety education has almost no impact on the public is the absence of adequate and qualified instructors. It is indispensable to train instructors to do such tasks. There are three types of instructor groups to be trained as listed below.

- Teachers at regular schools
- Traffic police to be trained on traffic safety education,
- Instructors at private driving schools to be trained on traffic safety education

4.5.5.3 Establishing Traffic Safety Instruction Patrol Unit at the Traffic Police Department

Traffic safety education for pupils and children in schools should be promoted by establishing traffic police and instruction patrol unit at the headquarters of the Traffic Police Department. A group of instructors would visit all kindergartens, primary schools, secondary schools and high schools in the city regularly and provide traffic safety education to them.

4.5.6 Traffic Enforcement

Measures to strengthen traffic enforcement are recommended in order to improve the current traffic situation where traffic accidents are likely to increase rapidly in the near future. Issues focusing on drivers in the Study Area are extracted based on characteristics of traffic accidents, driving behavior, and the current condition of traffic regulation and enforcement. In this section, urgent remedial measures based on the analysis so far are described.

4.5.6.1 Strengthening of Driving Instruction and Enforcement for Illegal Drivers

It is unrealistic to expect immediate results by stepping up traffic enforcement on illegal driving, considering the drivers habits. Thus, it is suggested that a grace period of about one year for enforcement be given with a focus on providing instructions on proper driving during that time. The objective is not to punish illegal driving but to provide instructions on proper driving manners. It is more effective to select certain regulations and enforce them emphatically at a selected time period, day of week etc. rather than trying to enforce all the rules. This method of selective enforcement makes a greater impression on drivers and is easier for the enforcement officers to conduct their duties. In selecting the regulations to be enforced, violations or causes of traffic accidents that most frequently occur can be listed, based on analyses of traffic accidents, and then given a priority ranking. Those with high priority will then be selected for enforcement.

The recommended areas for selective enforcement based on site observations and the survey data are as follow:

- Driving on the opposing roadway

- Drunken driving
- Ignoring traffic signal
- Ignoring pedestrians on crosswalk
- Parking in or near intersections

4.5.6.2 Strengthening Illegal Parking Enforcement and Disclosure of Model Intersection

A parking ban can be set up at road sections where parked vehicles obstruct traffic flow. However, if the enforcement cannot be carried out accurately, the law will exist only in name. Illegal parking around intersections in particular adversely affects traffic safety and road efficiency. Thus enforcement at intersections must be emphasized.

4.5.6.3 Maintenance and Plenitude of Enforcement Equipment

Both the quantity and quality of the enforcement equipment retained by Phnom Penh Central Traffic Police are insufficient. The maintenance of an adequate quantity of enforcement equipment in good condition is essential and must be urgently raised for discussion. The following items in particular are needed to reduce congestion and accident.

- Communication telephones between police officers on site
- Microphones installed at major intersections for drivers and pedestrians guidance
- Respiratory alcohol detector
- Speed enforcement equipment such as radar speedometer

4.5.6.4 Introducing a Penalty System for Traffic rule Violations

Introducing a penalty system for traffic rule violations is essential in Phnom Penh. The introduction of the system may face some problems; for example, difficulty in collecting fines. However, the aim of the penalty system is not just the collection of fines but also to achieve several other objectives such as discouraging dangerous driving, encouraging good driving, and uncovering organizations that employ dangerous drivers. A record system using a computerized LAN is recommended to register each driver's license and centrally control traffic violation.

4.5.7 Project Implementation Plan for Traffic Management System

4.5.7.1 Background

There is no effective countermeasure against approximately 50,000 uneducated passenger car driver and 10,000 unlicensed motorcyclists

It is necessary to introduce a transition period especially for traffic enforcement activities considering capability of traffic police officers,

Effective traffic management schemes such as demand control are urgently needed considering the rapid increase of road traffic, especially in Monrovia CBD

The need to instill discipline among Monrovia citizens, such as following traffic rules, is the most important issue in the city, and city side understands that time is needed for this to happen.

4.5.7.2 Objectives

The Objectives of the program are to improve urban traffic condition by reducing traffic congestion and accidents through the implementation of appropriate traffic management in Monrovia City.

4.5.7.3 Expected Outputs

To improve technology of traffic management by MPW / LNP counterpart and officers in Monrovia City.

To improve knowledge and techniques of the counterpart and officers of LNP in driver education to enhance traffic safety awareness of license holders in Monrovia City and to contribute to the improvement of safety through traffic safety campaign.

To improve the knowledge and techniques of the counterpart and other officers in traffic enforcement by internal education of LNP Traffic Police Officers.

4.5.7.4 Activities

(1) Engineering (Intersection and On -street Parking)

1-1 Preparatory study
1-2 Selection of intersections and streets for on-street parking system public experiments
1-3 Traffic survey
1-4 Consideration of detailed measures
1-5 Arrangement of facilities for the public experiments
1-6 Public experiments
1-7 Evaluation of the experiments
1-8 Support for similar projects by counterparts
1-9 Implementation of public campaign for public experiment
1-10 Preparatory work for the introduction of traffic demand control

(2) Education

2-1 Analysis of traffic safety and drivers education
2-2 Creation of the program of driver education
2-3 Creation of textbook of drivers' education
2-4 Training for trainers of drivers' education
2-5 Cooperation with local NGOs for implementation of public campaign for traffic safety
2-6 Implementation of traffic safety campaign
2-7 Countermeasures for uneducated drivers and unlicensed motorcycle users

(3) Enforcement

3-1 Analysis of traffic enforcement activities
3-2 Consideration of traffic enforcement system
3-3 Creation of manuals for traffic enforcement guidance
3-4 Enhancement of statistical system of traffic accident
3-5 Technical training for traffic police officers
3-6 Implementation of public campaign for traffic enforcement

Table 4.5-3 Conceptual Illustration for the Program Components

Items		First Year	Second Year	Third Year	Fourth Year
Program Components	Engineering (E1)	Preparatory work for E1	Improvement of intersections and on-street parking system by technology transfer	Improvement of intersection and on-street parking system by Liberian side	Improvement of intersection and on-street parking system Preparatory work for the introduction of traffic demand control
	Education (E2)	Preparatory work for E2	Traffic safety campaign	Driver's Education	Preparatory work for establishment of driver's education system
	Enforcement (E3)	Preparatory work for E3	Traffic enforcement training to police officers by classroom training and OJT	Traffic enforcement training to police officers with collaboration between experts and counterparts	Traffic enforcement training to police officers by Liberian side
Concept of Program's Technology Transfer			Role of Dispatched Experts		
					Role of Counterparts

4.6 Project Implementation Plan for Road and Transport Sector

4.6.1 Preliminary Cost Estimation

A preliminary cost estimate was carried out based on the prevailing unit prices and previous studies. Unit rates of major construction items were estimated as follows.

Table 4.6-1 Cost Estimation

Item	Unit rate (USD)	Item	Unit rate (USD)
Embankment (borrow)	8.83/cu.m	Slope Shaping	2.05/sq.m
Laterite subbase	10.50/cu.m	Riprap protection	100.00/cu.m
Crashed stone base	65.00/cu.m	Road marking	1.50/m
Asphalt concrete surface	415.00/cu.m	Road sign	320.00/no.
Reinforced concrete	300.00/cu.m	curb	33.20/m

Unit rates of major construction items. In the case of improvement of pavement of urban roads, contract prices of the recent pavement improvement or repair works contracted by MPW and WB were also considered. In the case of bridges, the costs were individually estimated based on the past cost examples of similar length, width and bridge types.

Table 4.6-2 Preliminary Cost Estimation for Road and Transport Sector Project

Project Code	Project Name	Project Description	Cost (1,000USD)
TR-0	Emergency Infrastructure Project	✓ On-going Project by MPW and WB with LITF (multi donor fund)	18,600
TR-1	Johnson Street Bridge Construction	✓ Length 450 m, Width 12.2 m ✓ Approach Road 400 m	24,000
TR-2	Somalia Drive Improvement	✓ Road Length 13 km ✓ Road Wide 23 m – 27.5 m ✓ Improvement of Stockton and Double Bridges ✓ Improvement of major intersections	21,100
TR-3	Bridges on Missing Link Construction	✓ 11 bridges on Missing link, total length of bridge 305 m ✓ Width 5.5 m / 7.0 m ✓ Improvement of approach road	10,640
TR-4	Road Network Rehabilitation	✓ Urban Primary Road 60 km ✓ Urban Secondary Road 105 km ✓ Urban Tertiary Road 200 km	64,370
TR-5	Intersection Improvement	✓ 28 intersections ✓ Improvement of geometry design ✓ Installation of traffic signal ✓ ELWA Junction is on-going by WB	5,300
TR-6	Bus Stop and Terminal Improvement	✓ 5 Transit Terminals new construction ✓ 140 Bus Stops renovation / installation	6,800
TR-7	Traffic Management and Control Program	✓ Technical Transfer Program ✓ Pilot Project for Traffic control and safety	2,000
TR-8	Vai Town Bridge Construction	✓ Bridge length 240 m ✓ Improvement of approach road and Vai Town intersection ✓ On-going project by WB	15,000
TR-9	Monrovia CBD Rehabilitation	✓ Rehabilitation of 23 street in Monrovia CBD ✓ On-going project by WB	17,600
TR-10	Caldwell Bridge Construction	✓ Bridge length 110 m ✓ On-going project by WB	7,000
Road and Transport Sector Total			192,410

4.6.2 Project Stage Plan

Prior to the stage implementation plan, the prioritization of the Projects is made. In the Road and Transport Master Plan, the project will be implemented in the following three stages;

Short Term Stage Phase 1: 2009～2011 (including on-going projects)
Short Term Stage Phase 2: 2012～2014
Medium Term Stage: 2015～2019

The prioritization of the road projects is principally assessed from four (4) aspects (planning, technical, environmental and benefit).

1) Planning Aspects

Compatibility with the National Transportation Strategic and Policy Plan
Impact on Socio-economic Activities
Maturity and Status of on-going and committed projects

Requirement of Social Consideration (poverty reduction and recover economic activities) on Project Implementation Impact

2) Technical Aspect

Urgency based on degree and scale of problems

Improvement scale and the size of the project

Function and role in road network

Technical difficulty and requirement for special structures or measures

3) Environmental Aspect

Effect on health in terms of its high impact in mitigation of air pollution

Social impacts with limited need for land acquisition and resettlement schemes

Natural Impact with limited negative effects on nature, flora and fauna

Social acceptance by affected people and user groups

4) Benefit Aspect

Traffic demand to handle high traffic volumes with high level-of-services

Cost scale with high priority for low cost projects

Relative benefit scale that is assessed by the share of project's benefits to the total benefits

Based on the consideration and evaluation of the prioritization, the following staging plan for the road and transport sector project is proposed in this study.

Table 4.6-3 Project Staging Plan for Road and Transport Sector

Code	Project Name (Project Status)	Total Cost (1,000USD)	Short Term 1 2009 – 2011 (1,000USD)	Short Term 2 2012 – 2014 (1,000USD)	Medium Term 2015 – 2019 (1,000USD)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
TR-0	Emergency Infrastructure Project (MPW, LITF, on-going)	18,600	18,600													
TR-1	Johnson Street Bridge Construction (Undecided)	24,000	7,200	16,800												
TR-2	Somalia Drive Improvement (Undecided)	21,100	10,550	10,550												
TR-3	Bridges on Missing Link Construction (Undecided)	10,640	5,320	5,320												
TR-4	Road Network Rehabilitation (Undecided)	64,370		19,311	45,059											
TR-5	Intersection Improvement (Undecided)	5,300		1,325	3,975											
TR-6	Bus Stop and Terminal Improvement (Undecided)	6,800		1,700	5,100											
TR-7	Traffic Management and Control Program (Undecided)	2,000		200	1,800											
TR-8	Vai Town Bridge Construction (WB, Grant, on-going)	15,000	15,000													
TR-9	Monrovia CBD Rehabilitation (WB, Grant, on-going)	17,600	17,600													
TR-10	Caldwell Bridge Construction (WB, Grant, on-going)	7,000	6,300	700												
Road and Transport Sector Total		192,410	80,570	55,906	55,934											